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Research Article

Occurrence of Taeniid Infections in Dogs in Mpwapwa District, Tanzania: A Possible Source of Infection to other Animals

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Abstract

Taeniid infection in dogs is of public health concern due to significant losses resulting from their larval stages. Studies conducted in northern Tanzania have determined its prevalence and determinants. Understanding this information from different regions may contribute to informed plans for protecting dogs, intermediate hosts, and the public. A cross-sectional study was conducted to determine the prevalence and associated risk factors for taeniid infections in dogs in Mpwapwa District, Tanzania. Fecal samples were collected from 168 dogs, processed by floatation technique, and examined for taeniid eggs using a light microscope. A structured questionnaire was also administered to 168 dog-owning households to study the associated risk factors. Coproscopic examination revealed a prevalence of 11.3% (95% Confidence Interval (CI) 6.9-17.1) for taeniid infections in dogs. The difference in prevalence between age groups was statistically significant (X^2=11.6, df= 3, p=0.0088). The difference in prevalence between breeds was also statistically significant (X^2=8.3, df= 2, p = 0.015). Descriptive data analysis revealed that in the past twelve-month period only 35.7% (60/168) of dog-owning households dewormed their dogs while the rest didn't. The prevalence was high in non-dewormed dogs compared to dewormed dogs. The difference in prevalence between non-dewormed and dewormed dogs was statistically significant (X^2=3.7, df=1, p=0.0542. These findings highlight the need for increased dog owners' awareness of the importance of regular deworming. Also, it emphasizes the need to consider young and older age groups and pure breeds when controlling taeniid infections in dogs.

Keywords: Coenurosis; Mpwapwa; Hydatidosis; Prevalence; Taeniid; Tanzania

Abbreviations and Acronyms

CI: Confidence Interval; URT: United Republic of Tanzania; WHO: World Health Organization; LITA: Livestock Training Agency

Introduction

Taeniid infections in dogs are caused by several species of tapeworms of veterinary and public health concern that belong to the family Taeniidae. These species include *Taenia multiceps, Taenia hydatigena, Taenia ovis, Taenia pisiformis, Taenia sirialis, Taenia brauni, Echinococcus granulosus, Echinococcus multilocularis and Echinococcus vogeli. T. multiceps, T. sirialis, T. brauni, E. granulosus, E. multilocularis, and E. vogeli* are zoonotic [1,2]. All taeniids have segmented bodies and their life cycles involve sheep, goats, cattle, pigs, horses, buffaloes, yaks, rabbits, rodents, and humans as intermediate hosts and domestic dogs and wild canids like foxes, jackals, and coyotes as definitive hosts. Taeniids larval stages cause economic losses in intermediate hosts due to the formation of coenuri *(T. multiceps, T. serialis, and T. brauni)*, hydatid (*E. granulosus, E. multilocularis, and E. vogeli) or cysticerci (T. hydatigena, T. ovis and T. pisiformis)* in organs.

In animals, Coenurus cerebralis, (*T. multiceps* cysts) develops coenuri to the brain and spinal cord, leading to neurological signs like circling, ataxia, incoordination, and convulsions. Coenurus serialis, (*T. serialis* cysts) develop coenuri to the muscles and retro peritoneum resulting in swelling, pain, and lameness which impairs mobility. Coenurus brauni (*T. brauni* cysts) develop coenuri to subcutaneous tissues and eyes resulting in subcutaneous swelling and vision impairment. Hydatid cysts develop in the liver and lungs and rarely in the spleen, heart, and kidney [3]. Lung cysts cause persistent coughing and difficulty breathing hence respiratory failure and death. *T. hydatigena and T. pisiformis* cysts develop in the omentum, liver, visceral surfaces, and sometimes in the lungs, kidneys, and brain [4]. The cysts impair digestion and nutrient absorption, leading to reduced growth rates. *T. ovis* cysts invade the heart and muscles and disturb their functions.

Human coenurosis develops coenuri to the brain, spinal cord, eyes, and subcutaneous tissues. Brain coenuri leads to neurological signs like seizures, while subcutaneous tissue coenuri causes swellings, and coenuri in the eyes impairs vision. Human hydatidosis occurs in cystic form *(E. granulosus* infection), alveolar form *(E. multilocularis* infection), and polycystic form *(E. vogeli* infection). Depending on the form, the disease causes cysts to develop in the liver, lungs, and rarely in the spleen, kidneys, and heart [3]. Cysts in the liver present abdominal pain and jaundice, whereas cysts in the lungs interfere

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with the respiratory system.

The life cycle of taeniids involves releasing eggs or gravid proglottids from definitive hosts through feces that contaminate the environment and are later ingested by grazing intermediate hosts [1]. Within the intermediate hosts, the eggs hatch to release oncospheres that penetrate the intestinal walls and circulate into tissues. Depending on the tapeworm species, the oncospheres undergo further development into larval stages (coenuri, cysticerci, or hydatid). Definitive hosts become infected by ingesting larval stages from intermediate hosts. The adult parasite undergoes development into the small intestine and starts passing out eggs or gravid proglottids through feces. Clinically, taeniid infections in dogs vary depending on the extent of infection and species involved. Common signs include; diarrhea, vomiting, and weight loss. Taeniid infections can be managed by adherence to regular deworming every three months using 5-10 mg/kg praziquantel, maintenance of hygiene, and preventing scavenging dogs [2].

Cases of taeniid infections in dogs have been reported globally [5-12]. In Tanzania, studies conducted in northern regions have determined the burden and risk factors for taeniid infections in dogs [6,12]. Similarly, coenurosis, hydatidosis and cysticercosis cases in ruminants and small ruminants have been reported in different parts of Tanzania [12-21]. Human hydatidosis has been also documented in Tanzania [22,23]. This raised a need to understand this information from central regions of the country like Mpwapwa District of Dodoma region, due to the existence of unpublished reports on coenurosis and hydatidosis diseases in sheep and goats. This study determined the prevalence and associated risk factors for taeniid infections in dogs in Mpwapwa District, Tanzania, and suggested appropriate interventions.

Materials and Methods

Study area

The study was conducted in Mpwapwa District which is located in the central part of Dodoma Region, Tanzania (Figure 1). The district has a human population of 403,247 [24]. It is bordered by Kongwa District to the north, Kilolo District to the south, Kilosa and Gairo Districts to the east, and Chamwino District to the west. The district lies between latitude 6.567° South of the Equator and longitude 36.600° Eastern of Greenwich. It covers an area of 7,489 km^2 and has 4 administrative divisions namely Mpwapwa, Mima, Kibakwe, and Rudi. It also has 33 wards and 113 villages. Most parts of the district

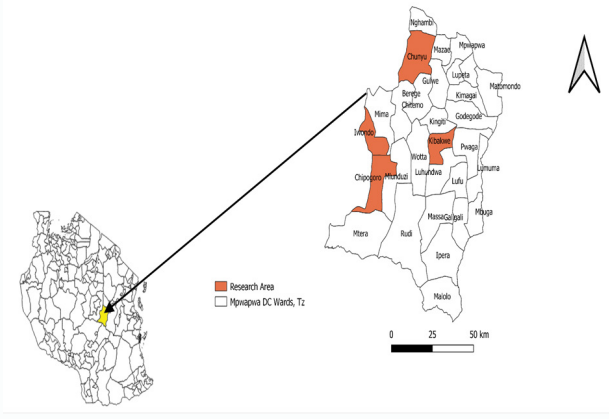

Figure 1: Map of Mpwapwa district council, showing the study area.

receive an average of 712 mm of annual rainfall. The temperature in the district ranges between 20.2°C to 29.7°C. The district has 13,485 domestic dogs [25].

Study design and sample size determination

A cross-sectional study that involved a coproscopic examination of taeniid eggs in dogs and a household questionnaire survey was conducted from November 2023 to February 2024.

The sample size was calculated using the formula: n=Z2PQ/D2 [26]. were, n=sample size; Z=standard normal deviation, set at 1.96 corresponding to a 95% confidence level; Q=(1-P); D=allowable error (degree of accuracy), set at p-value <0.05 which was 5%; P=known or estimated prevalence from the target population. The estimated prevalence of 12.5% was used as per the study conducted in northern Tanzania [12]. Therefore, the sample size used in dogs was 168, i.e.,1.962 × 0.125 × 0.875/0.052 = 168.07~168. Similarly, the same 168 households were interviewed to study the associated risk factors for taeniid infections in dogs.

Sampling technique, data collection, and processing

Sampling: A purposive sampling technique was used to select representative wards from the district. Coproscopic examination of taeniid infections and a questionnaire survey to assess associated risk factors involved a random selection of 168 households. The households were selected from four wards representing each division: Chunyu, Iwondo, Kibakwe, and Chipogoro. The wards were selected due to their larger populations of dogs and livestock and frequently reporting cases of coenurosis and hydatidosis from small ruminants [25]. Within the wards, all villages were involved and households were selected using a simple random technique that employed a random number generator method to generate random numbers of the households. The selection criteria of a household depended on the ownership of dogs greater than or equal to one year. A total of 168 households were interviewed to study the associated risk factors. The number of representative households from each ward was the proportion of households owning dogs from each ward. Therefore, the households selected were 28 in the Iwondo ward, 39 in the Chipogoro ward, 40 in the Kibakwe ward, and 61 in the Chunyu ward. In each household, one dog was randomly selected by using a simple random technique that employed a lottery method and sampled for coproscopic examination. Important biodata of the dog like origin, age, sex, and breed were identified and recorded before fecal sample collection. Each animal was humanely restrained and up to 10g of the fecal sample was collected per rectum using a gloved finger and stored tightly closed in a cool box packed with ice packs during the fieldwork. The collected samples were transported to the Livestock Training Agency (LITA) Mpwapwa campus Parasitology Laboratory for analysis.

Coproscopic examination: To identify taeniid infection, coproscopic examination was undertaken within twenty-four hours of fecal sample collection. In case of delays, fecal samples were stored at (4°C) refrigeration temperature before laboratory examination. Fecal samples were analyzed and interpreted by using a fecal floatation technique. The procedure used was as instructed in the diagnostic Parasitology for Veterinary Technicians book 6th Edition [27]. It involved the preparation of a Sheather's sucrose floatation solution by using 454 g of table sugar in every 355 ml of distilled water to attain a specific gravity of 1.25. Thereafter, 6mls of 40% formal aldehyde solution was added for every 100mls of solution as a preservative.

Then, 2 grams of each fecal sample collected was broken and thoroughly mixed in uncontaminated containers to ensure an even distribution of eggs. Then, the fecal sample was strained through a sieve to remove large debris and then transferred into a fecal flotation test tube. Thereafter, 30 ml of a floatation solution was added to fill the test tube, stirred well with the feces, and a cover slip was placed on top of the test tube to touch the mixture. The test tubes were then allowed to sit undisturbed for 10 to 20 minutes to allow the parasite's eggs to float to the surface and attach to the coverslip. Then, the coverslips were carefully removed by lifting them straight up without tilting and placed on a microscopic slide. An examination of the slide under a microscope using low magnification initially x^4 then x^{10} to locate eggs and then higher magnification x^{40} and x^{60} for a detailed examination of taeniid eggs was performed. Identification of taeniid eggs was based on published morphological keys. Positive samples were those presenting taeniid egg(s).

Households questionnaire survey: Households sampled for coproscopic examination from Chunyu, Iwondo, Kibakwe, and Chipogoro wards were visited and interviewed. A structured questionnaire which combined closed and open-ended questions was used to assess risk factors associated with taeniid infections such as dog origin, breed, sex, age, and deworming history. The questionnaire was administered by a Veterinarian (V.P) and animal health paraprofessionals (F.C and A.M) through face-to-face interviews and recorded by using the EpiCollect 5 application, version 7.0.3.

Data analysis

The data were recorded in Microsoft Office Excel, cleaned, coded, and analyzed using STATA 14 software. Descriptive data like frequencies and means were calculated. The prevalence of taeniid infections was calculated as the proportion of sampled animals found positive for the disease. The Chi-squared test was used to assess statistical differences between proportions.

Factors associated with taeniid infections in dogs were analyzed by using Logistic regression, both univariate and multivariate, in STATA 14 software. Taeniid infection positivity (yes or no) as an outcome (dependent) variable, and selected household practices and individual animal attributes as independent variables. The independent variables selected included origin, sex, breed, deworming history, and age. Univariate analysis was conducted before multivariate analysis. Variables with a p-value of ≤0.25 in univariate analysis qualified for multivariate analysis. The final model was built using a backward stepwise approach where all selected independent variables were entered into the model at once. Confounding variables were assessed, and an option for the interaction of variables was checked. In the multivariate analysis, independent variables were dropped one after another iteratively, retaining only those with a p-value of less than 0.05 and the confounders. A factor was considered a confounder if its removal from the model caused a relative change of 25% or an absolute change of 0.1 in the coefficients of other variables. The Likelihood Ratio Test was used to test the Goodness of fit of the model at a significance level of 5%.

Ethics approval

Permission to carry out this research was obtained from the Ethical Review Committee of the Sokoine University of Agriculture with the reference number SUA/DPRTC/R/186. Permission to collect data was obtained from the President's Office, Regional Administration, and Local Government Authorities. Verbal consents were obtained from participants before data collection and the confidentiality of the information was adhered.

Results

Dog management practices

The average number of dogs owned by dog keepers was 3, with a minimum number of 1 and a maximum number of 13. Among the dog management practices reported by dog owners included, the provision of food to dogs reported by 38% (63/168) of households, while 62% (105/168) left them to scavenge. Of the households that provided food, 92% (58/63) cooked the food before giving it to dogs whereas 8% (5/63) gave them without cooking. For the past twelve-month period, 35.7% (60/168) of the households dewormed their dogs, while 64.3% (108/168) never dewormed their dogs. Moreover, only 4% (7/168) of the dog-owning households had kennels. The remained 96% (161/168) allowed their dogs to roam freely day and night.

Prevalence of taeniid infection in dogs

Coproscopic analysis of taeniid eggs (Figure 2) revealed an overall prevalence of 11.3% (95% CI 6.9-17.1) for taeniid infections in dogs. The prevalence across different variables is indicated in Table 1. The specific prevalence in each ward was 2.5% (95% CI 0.1-13.1) in Kibakwe ward, 21.4% (95% CI 8.3-40.9) in Iwondo ward, 13.1% (95% CI 5.8-24.2) in Chunyu ward, and 10.3% (95% CI 2.9-24.2) in Chipogoro ward. The difference in prevalence across the wards was not statistically significant (X^2=6.1945, df=3, p=0.1025). The prevalence in dogs aged 1 to less than 3 years was 15.9% (95% CI 6.64-30.07), the prevalence of dogs aged 3 to less than 6 years was 4.6% (95% CI 1.25-11.23), the prevalence of dogs aged 6 to less than 9 years of age was 17.9% (95% CI 6.06-36.89) while the prevalence of those aged more than 9 years was 37.5% (95% CI 8.52-75.51). The difference in prevalence between age groups was statistically significant (X^2=11.6096, df=3, p= 0.0088). This shows that taeniid infections were more common in dogs between 1 to less than 3 years and above 6 years. The prevalence in female dogs was 12.6% (95% CI 6.4-21.5), while that in male dogs was 9.9% (95% CI 4.3-18.3). The difference in prevalence between sexes was not statistically significant (X^2=0.3202, df=1, p= 0.5714). The prevalence in dewormed dogs was 5.0% (95% CI 1.04 -13.92), while that in non-dewormed dogs was 14.8% (95% CI 8.7-22.9). The difference in prevalence between dewormed and non-dewormed dogs was statistically significant (X^2=3.7043, df=1, p=0.0542). This shows that the disease was more common in non-dewormed dogs. The prevalence in cross breeds of dogs was 6.5% (95% CI 0.79-21.42), in local breeds was 8.9% (95% CI 4.36 -15.81) while in pure breeds, it was 28.0% (95% CI 12.07-49.39). The difference in prevalence across breeds was statistically significant (X^2=8.3055, df=2, p=0.0157). This shows that the disease was more common in pure breeds of dogs.

Association between taeniid infections in dogs and selected household practices and individual dog's attributes

Four variables, namely origin, breed, deworming history, and age qualified for multivariate Logistic regression analysis (Table 2). In the final multivariate model, deworming history was found to be associated with taeniid infections in dogs, with the dewormed group of dogs being at a lower risk for taeniid infections compared to the non-dewormed group (OR=0.24, 95% CI 0.054–0.992, p=0.048) (Table 3), with no confounders. The Likelihood Ratio Test generated

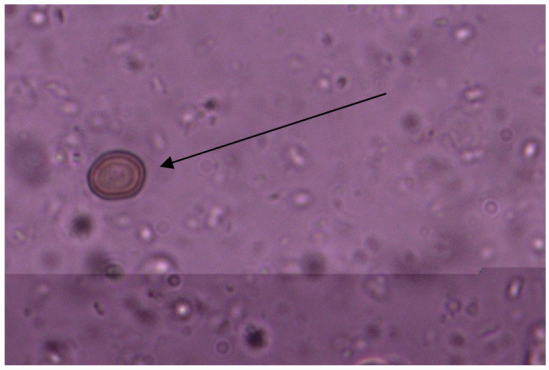

Figure 2: Image of a taeniid egg recovered from coproscopic examination.

Table 1: Prevalence of taeniid infections in dogs across different variables in Mpwapwa district, Tanzania (N=168),

Variable	Variable Category	Number examined	Number of positive	Chi-square	*p*-value
Origin (ward)	Kibakwe	40	1(2.5%)	6.1945	0.1025
	Iwondo	28	6(21.4%)		
	Chunyu	61	8(13.1%)		
	Chipogoro	39	4(10.3%)		
Age	0.5 ≥ years <1	0	0(0.0%)	11.6096	0.0088*
	1 ≥ years <3	44	7(15.9%)		
	3 ≥ years <6	88	4(4.6%)		
	6 ≥ years <9	28	5(17.9%)		
	9 ≥ years	8	3(37.5%)		
Sex	Female	87	11(12.6%)	0.3202	0.5714
	Male	81	8(9.9%)		
Breed	Cross	31	2(6.5%)	8.3055	0.0157*
	Local	112	10(8.9%)		
	Pure	25	7(28.0%)		
Deworming history	Yes	60	3(5.0%)	3.7043	0.0542*
	No	108	16(14.81%)		

The age grouping criteria followed [28]

a Chi-square value 25.26 with a p-value of 0.0027 from the final developed model.

Discussion

This study established the prevalence of taeniid infections in dogs in Mpwapwa district, Tanzania. A prevalence of 11.3% was obtained from this study implying the existence of taeniid infection cycles from dogs to other intermediate hosts like livestock and humans within the district. Despite the results relying only on microscopic examination, which cannot identify taeniid species like *T. multiceps, T. hydatigena, T. pisiformis, T. sirialis,* and *E. granulosus*, they provided new information about the status of taeniid infections in dogs in central zone of Tanzania. This is because there is limited information on studies of taeniid infections in dogs, with existing studies, being only from the Arusha and Manyara regions [6,12]. The prevalence found in this study was lower compared to that reported in these previous studies. This may be due to differences in production systems, eco-climatic conditions, availability of intermediate hosts, immunity levels, and husbandry practices like routine deworming of dogs [6,7,29].

The observed higher prevalence of taeniid infections in non-dewormed dogs may be a result of the low proportion of dog-owning households deworming their dogs (only 35.7%). This is because inadequate deworming practices perpetuate taeniid infections within dog populations, thereby increasing the risk of transmission to intermediate hosts. Deworming plays a significant role in eliminating adult worms and decreasing the shedding of tapeworm eggs into the environment as evidenced by its impact on reducing the prevalence of these parasites in this study.

Table 2: Univariate analysis of household practices and individual dog attributes in relation to the prevalence of taeniid infections in dogs in Mpwapwa district Tanzania,

Univariate Analysis				
Variables	Variable category	n/N (%) #	OR (95% CI)	*p*-Value
Origin (ward)	Chipogoro	39/168(23.2)		
	Iwondo	28/168(16.7)	2.25(0.57-8.82)	0.245
	Kibakwe	40/168(23.8)	0.23(0.02-2.10)	0.191
	Chunyu	61/168(36.3)	1.46(0.41-5.26)	0.554
Sex	Female	87/168(51.8)		
	Male	81/168(48.2)	0.75(0.28-1.98)	0.572
Breed	Cross	31/168(18.5)		
	Local	112/168(66.7)	1.42(0.29-6.85)	0.661
	Pure	25/168(14.8)	5.64(1.05-30.20)	0.043
Deworming history	No	108/168(64.3)		
	Yes	60/168(35.7)	0.30(0.08-1.08)	0.056
Age	Early adulthood (1≥years<3)	44/168(26.1)		
	Middle-aged (3 ≥ years < 6)	88/168(52.4)	0.25(0.06-0.91)	0.036
	Late adulthood (6 ≥years<9)	28/168(16.7)	1.14(0.32-4.05)	0.829
	Senior (9 ≥ years)	8/168(4.8)	3.17(0.61-16.41)	0.169

The observed higher prevalence of taeniid infection in pure breeds of dogs may be due to a weakened immunity response, or exposure to contaminated environments which influenced susceptibility. A lack of prevalence in crossbred dogs may be a result of greater genetic variation, which enhanced immunity response and resilience against infections. Also, a lower prevalence in local breeds of dogs may be due to their increased resilience to local parasites due to long-term exposure, which enhanced their immune responses.

The significant difference in the prevalence of taeniid infections across age groups suggests a potential age-related susceptibility to taeniid infections in dogs. The increased prevalence in younger and older age groups may be attributed to their weakened immunity which reduces their ability to resist infections. The higher prevalence in young dogs under two years of age was also observed by [6] in a study conducted in Ngorongoro district, Tanzania. The reduced prevalence in dogs aged three to less than six years indicates a reduced risk of contracting taeniid infections in this age group. This may be due to their more developed immune systems, which enabled them to resist infections more effectively. Also, dogs in this age group are commonly used for different purposes; therefore, they are more likely to receive regular deworming treatments or preventive medications.

This study noted a decreased responsibility among dog owners on proper management practices for their dogs, such as housing dogs, feeding, and routine health programs like deworming. Factors like financial constraints, limited access to veterinary services, and lack of awareness of proper management of dogs may have impacted the ability of dog owners to provide adequate care for their dogs. These weaknesses contribute to the continuation of the taeniid infection cycle between dogs and other intermediate hosts.

Table 3: Multivariate analysis of household practices and individual dog attributes in relation to the prevalence of taeniid infections in dogs in Mpwapwa district Tanzania,

Variable	Variable category	n/N (%) #	OR (95% CI)	*p*-Value
Age	Early adulthood (1 ≥years<3)	44/168(26.1)		
	Middle-aged (3≥years <6)	88/168(52.4)	0.37(0.09-1.46)	0.158
	Late adulthood (6≥years <9)	28/168(16.7)	1.87(0.44-7.92)	0.392
	Senior (9 ≥years)	8/168 (4.8)	5.32(0.77-28.64)	0.089
Deworming history	No	108/168(64.3)		
	Yes	60/168(35.7)	0.24(0.05-0.99)	0.048*
Origin	Chipogoro	39/168(23.2)		
	Iwondo	28/168(16.7)	1.66(0.36-7.60)	0.512
	Kibakwe	40/168(23.8)	0.19(0.02-2.08)	0.173
	Chunyu	61/168(36.3)	1.29(0.32-5.18)	0.713
Breed	Cross	31/168(18.5)		
	Local	112/168(66.7)	1.32(0.24-7.41)	0.748
	Pure	25/168(14.8)	4.76(0.78-28.70)	0.088

Conclusion

This study provided valuable insights into the prevalence of taeniid infections in dogs in Mpwapwa district, Tanzania. The higher prevalence in non-dewormed dogs was identified. Weakness in deworming practices among dog owners was also determined. Moreover, age-specific susceptibility and breed-specific susceptibility to taeniid infections were established. These findings highlight the need for comprehensive control measures to mitigate the burden of taeniid infections in dog populations. The following recommendations are suggested: Educating dog owners on the importance of regular deworming to their dogs. Age-specific control measures particularly younger and older dogs, should be developed to address age-related differences in susceptibility to taeniid infections. Also, breed-specific susceptibility is to be considered and further research to identify taeniids to species level is of immense value.

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