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Prevalence of Soil Transmitted Helminths infection in domesticated pigs and dogs of Morogoro region, Tanzania

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Abstract

Soil-transmitted helminths (STH) infections are caused by a group of nematode worms that require development in the soil to become infective. These infections cause ill health in animals; some are responsible for zoonotic infection. Zoonotic STH of dogs and pigs include; *Ancylostoma* species, *Toxocara canis*, and *Ascaris suum*. This study was carried out due to limited information on STH infections in domesticated pigs and dogs in Tanzania. The study aimed to determine the prevalence of STH in domestic pigs and dogs in Morogoro Municipality and Mvomero District, Tanzania. This was a cross-sectional study which involved a total of 281 dogs and 237 pigs from two districts in the two study areas. The study animals were randomly selected and faecal samples collected and examined for STH using a simple flotation technique. The data collected was entered in Excel and analysis done using Stata version 14. Prevalence of the STH was computed for both animal species and chi-square used to obtain p-values as the test for statistical significance. The prevalence of STH in dogs was 50.53% with *Ancylostoma* species being the most prevalent (47.33%), followed by *Toxocara* (12.46%), *Trichuris* (2.49%) and *Strongyloides* species (1.07%). The STH prevalence in pigs was 85.23% and the isolated species were *Oesophagostomum* (81.01%), *Trichuris* (12.24) and *Ascaris* species (5.49%). Males and pigs aged ≥1 year were more infected with STH species with a p-value of 0.025 and 0.016, respectively. Dewormed dogs were observed to be less likely to be infect with STH species (p- value = 0.002). Results of this study show that STH species were prevalent gastrointestinal parasites in dogs and pigs in the study area. Mixed infection was common in both animal species. Measures for control of STH infections in dogs and pigs should be practiced to improve animal health.

Keywords: *Soil-Transmitted Helminths; Dog; Pig; Morogoro; Tanzania*

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Introduction

Soil-transmitted helminths (STH) are a group of parasitic nematodes that infect humans and other animals and are transmitted through ingestion of infective eggs or larvae, or penetration of infective larvae into the skin from the environment contaminated by faeces from infected animals (Massetti *et al.*, 2020). Among domesticated animals, STHs occur frequently in dogs, cats and pigs.

Dogs are known to play a crucial role in the transmission of STHs to humans and other animals (Crompton, 2000). Most parasitic nematodes that infect dogs belong to the STH group (Yacob *et al.*, 2007). These nematodes include *Ancylostoma caninum*, *Ancylostoma braziliense, Ancylostoma ceylanicum, Uncinaria stenocephala, Trichuris vulpis, Toxascaris leonina* and *Toxocara canis* (Jia-Chi *et al.*, 2016; Traversa, 2012). STH infections in dogs are characterized by bloody diarrhoea, abdominal pain, poor growth, anaemia and death in cases of acute and heavy infections (Agustina *et al.*, 2021; Chidumayo, 2018).

Dogs are also known to harbour STH reported to be zoonotic in different parts of the world. These zoonotic STH include the hookworms, *A. caninum*, *A. braziliense, A. ceylanicum* and *U. stenocephala* and the ascarid, *Toxocara canis* (Jia-Chi *et al.*, 2016; WHO, 2016). Canine hookworms cause cutaneous larva migrans in humans (Traub *et al.*, 2021). *Ancylostoma braziliense* is the only species capable of causing creeping eruptions and *A. caninum* can lead to aphthous ileitis and eosinophilic enteritis (Walker *et al.*, 1995). In humans, *Toxocara* can cause visceral larva migans, which include ocular toxocariasis and in children, neurological toxocariasis (Strube *et al.*, 2013; Walsh and Haseeb, 2014).

The major STH infecting domestic pigs are *Ascaris suum*, *Trichuris suis*, *Strongyloides ransomi*, *Trichostrongylus* species and *Oesophagostomum* species (Roepstorff & Nansen, 1998). Domestic pigs infected with one or more of these helminths could have diarrhoea, decreased litter size and stunted growth while ascariosis caused by *A. suum* is among the leading cause of liver condemnation resulting from migration of larvae stage two within the liver tissues (Nganga *et al.*, 2008; Tumusiime *et al.*, 2020). *Ascaris suum* and maybe *T. suis* are reported to be zoonotic to human beings (de Silva *et al.*, 2003, Cutillas *et al.*, 2009). Ascariasis in humans is associated with deficiency of vitamin A, impaired cognition, stunting and asthma due to migration of worms toward the lungs (Lynn *et al.*, 2021).

Control of STH is somehow difficult due to the high resistance of their egg/larvae to climatic factors and their ability to remain viable and infective in soil for years (Traversa *et al.*, 2014). However, the three key interventions crucial for long-lasting control of STH infection include anthelminthic drug treatment, improved sanitation and public health education (Tchuenté, 2011).

Soil-transmitted helminth infections in domestic pigs and dogs are reported worldwide (Agustina *et al.*, 2021; Jia-Chi *et al.*, 2016; Moskvina and Ermolenko, 2016; Agustina *et al.*, 2022; Sharma *et al.*, 2020), including in Africa (Chidumayo, 2018; Tumusiime *et al.*, 2020; Nwafor *et al.*, 2019). In the context of Tanzania, several studies have been conducted to establish the status of gastrointestinal helminth infection including STH in domestic pigs (Esrony *et al.*, 1997; Mkupasi *et al.*, 2010; Ngowi *et al.*, 2004; Kabululu *et al.*, 2015 and Nonga and Paulo, 2015) and dogs (Kidima, 2019; Makene *et al.*, 1996 and Swai *et al.*,2010). Although several previous studies in Tanzania have reported the occurrence of gastrointestinal helminth infections in pigs and dogs, this study aimed to update the current status of STH of domesticated pigs and dogs useful to provide information that guides designing effective control measures.

Materials and Methods

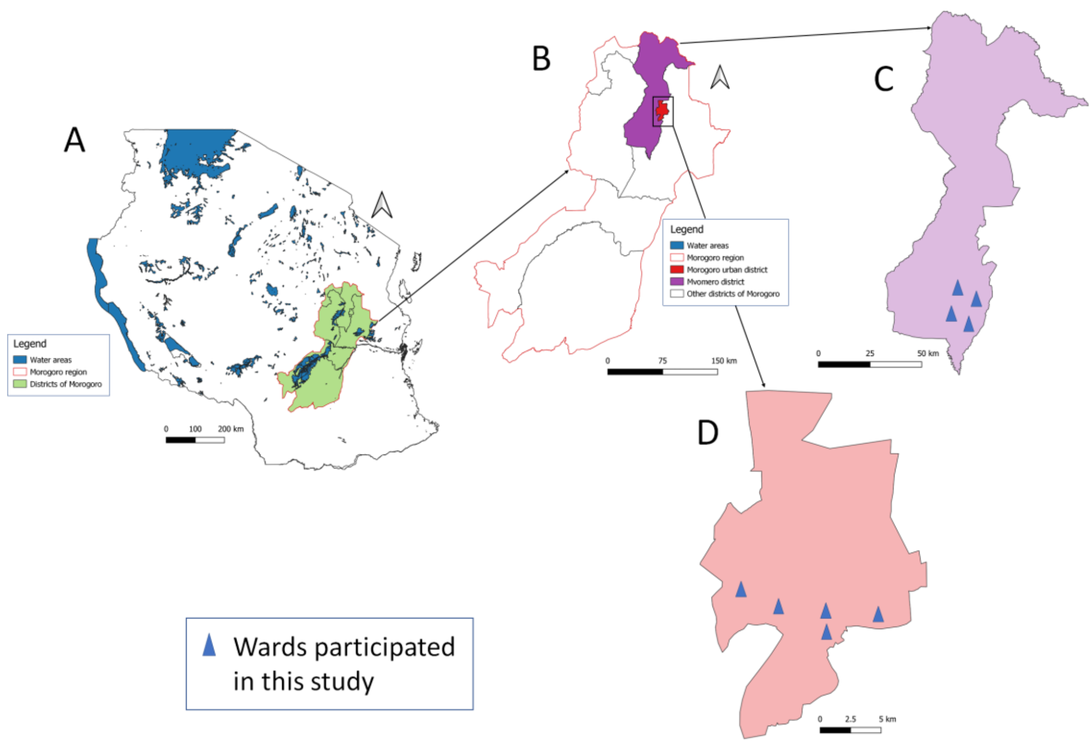
The study area

This study was conducted in Mvomero District and Morogoro municipality of Morogoro region. The estimated population in the Morogoro region is 3,197,104 according to the Tanzania population and household census conducted in 2022. The study sites fall into the river valleys and basin agro-ecological zone with high temperatures (average of 30ºC) and rainfall range between 900mm to 1400mm annually. The major economic activity in this region is agriculture including small-scale farming, livestock keeping, plantations and estates. The number of dogs in each study area was estimated to be 4624 (Morogoro municipality) and 5645 (Mvomero District). Mvomero District lies at latitude 06º 26' South and longitude 37º 32' East. It is bordered by the Tanga region (North), Pwani region (Northeast), Morogoro Rural District (East), Morogoro Urban (Southeast) and Kilosa District (West). It has a total area of 7,325 km^2 and has the largest water area (1,882 km^2) in the region. Based on Tanzania's population and household census, the Mvomero District is divided into 4 divisions with 30 Wards and 130 villages. In this study, the samples were collected from two divisions

(Mzumbe and Mgeta) and four Wards (Nyandila, Mgeta, Lingali and Mlali). Morogoro municipality is found at latitude 06° 49' South and longitude 37° 39' East. It is located on the lower Uluguru Mountain slopes with a peak of about 500 to 600 above sea level. It has a total land area of 531 km². It has 29 Wards and 294 streets. Wards included in this study were Mazimbu, Kihonda Maghorofani, Kilakala, Bigwa and Kichangani (Figure 1).

Figure 1

Map of Tanzania (A) showing location of Morogoro region (B), Mvomero District (C) and Morogoro municipality (D)



Study design and selection of study sites

This was a cross-sectional study conducted on randomly sampled domestic pigs and dogs in the study sites. The selection of wards, villages, households and subsequently animals to be sampled was based on simple random method. At selected wards list of villages with communities domesticating domestic pigs and dogs was obtained from the ward offices and villages/streets were selected at random Similarly at selected villages/streets a list of households keeping domestic pigs and dogs was obtained from the local leaders and then participating households were selected at random

Sample size estimation

The sample size was determined by using the formula below according to (Sharma et al., 2020)

Sample size $(n) = ((Z_{1-\alpha/2})^2 (p) (q)) / d^2$

n stands for sample size, $Z_{1-\alpha/2}$ stands for critical value and a standard value for the corresponding level of confidence (at 95% CI or 5% level of significance is 1.96), p stands for prevalence that is presumed (0.5), q stands for 1-p and d stands for the margin of error (0.05).

Sample size for dogs according to the prevalence from Chidumayo, (2018); $n = ((1.96)^2 \times (0.24 \times 0.76)) / (0.05)^2 = 280$ faecal samples.

Sample size for domestic pigs according to Kabululu et al. (2015); $n = (1.96)^2 \times (0.175 \times 0.825) / (0.05)^2 = 222$ faecal samples. Therefore, a total sample of 502 domestic pigs and dogs were sampled and examined for STHs infections.

Data collection

A data capture form was used to obtain information about the participating households (district, ward, the owner's name and contact) and the animals (age, sex, deworming status, housing condition or management system (indoor / semi-intensive / free roaming) and the cleaning of the housing facilities).

Prior to samples collection, the participating households were briefed about the purpose of the study and then faecal samples were collected from the randomly selected domestic pigs and dogs. During the faecal sample collection, the selected animals at household level were observed for some time until they defecated, then fresh faecal samples were collected from the ground using gloved hand and the sample put into a faecal container with lid. Each sample was labelled with the unique identification, age, sex, date and location of the household as previously described by Roepstorff and Nansen, (1998). The faecal samples were transported in a cool box with ice bags to Parasitology Laboratory at the College of Veterinary Medicine and Biomedical Sciences of Sokoine University of Agriculture and refrigerated at 4 – 8^{o}C awaiting analysis.

Laboratory samples processing

The samples were processed by simple flotation method (Soulsby 1982), whereby 50 mL of flotation fluid was poured into a container and mixed with 3 g of feces using a tongue blade. The faecal suspension was filtered using a tea strainer and poured into a beaker. The test tube was placed into a beaker with the filtrate and waited for 10 minutes. The test tube was lifted from the beaker, transferred and ought to touch the surface of a microscopic slide for few seconds to allow the drop to run off. A cover slip was mounted on top of the microscope slide with the filtrate drop and examined under a microscope at 10x and 40x magnification as described by Roepstorff and Nansen (1998); Soulsby (1982) and Hansen and Perry (1990). Identification of the STH eggs were based on their size and shape as explained by Foreyt (1989).

Faecal samples found to have strongyle types of eggs were further subjected to faecal culture in order to ascertain the identity of the strongyle nematodes at genus level. Briefly, 10g of faecal sample were mixed with 4 g of sterile sawdust in a plastic container and distilled water was added to obtain the required consistency. The mixture was then left at room temperature for 7 days to allow eggs to hatch and larvae to develop of third stage. The third stage larvae were harvested by Baerman technique (Demelash *et al.,* 2016). Briefly, harvesting was achieved as follows; a conical sedimentation flask was filled with tape water halfway, the culture wrapped in a double layer of gauze and fasten to a wood stick applicator. Thereafter, the culture was submerged in the tap water in the conical sedimentation flask and water was refilled 1cm to 3cm above the faeces and allowed to stay overnight (24 hours) for larvae to sediment. The following day the supernatant was discarded to obtain sediment containing the third stage larvae. Few drops from the sediment were transferred to a microscopic slide and a drop of iodine added. Thereafter, a coverslip was mounted on the slide that was examined at 10x magnification for identification of larvae using morphological features described by Abu – Elwafa et al., (2016) and Van Wyk et al., (2004).

Data management and statistical analysis

Data obtained for this study was entered using Microsoft Excel windows 10 and uploaded into STATA statistical software version 14 for cleaning and analysis. The prevalence (P) and chi square was computed. A *P*-value <0.05 was considered as statistically significant (Demeke *et al.*, 2021 and Salam *et al.*, 2009).

Ethics approval and consent to participate

Ethical clearance number

SUA/DPRTC/R/186/Vol. IV - 26 was obtained from Sokoine University of Agriculture. All owners of animal participants were consented before sample and data collection.

Results

Proportion of STH infected animals in Morogoro Municipality and Mvomero District, Tanzania, based on location and animal information

A total of 281 dogs were recruited, out of these 137 were from Morogoro Municipal Council and 144 from Mvomero District. Majority (54.1%) of the dogs were males with the median age of 2 years. A higher proportion of dogs from Morogoro Municipal Council (54.7%) were infected compared to those from Mvomero District (46.5%) (Table 1). Moreover, male, free roaming and dogs with no history of being dewormed were recorded to have more infection (Table 1). There was a positive association between STH infection with having no history of being dewormed whereby dewormed dogs were less likely to be detected with STH infection (*p*-value = 0.002).

Table 1

Proportion of sampled dogs and pigs infected with soil transmitted helminths (STH) in Morogoro Municipality and Mvomero District, Tanzania, based on location and animal information

Variables		Dogs Infected % (n/N)	Pigs Infected % (n/N)
Location	Morogoro Municipality	54.7% (75/137)	82.8% (101/122)
	Mvomero District	46.5% (67/144)	85.8% (101/115)
Sex	F	47.3% (61/129)	80.3% (106/132)
	M	53.3% (81/152)	91.4% (96/105)
Age	≤ 1 year	50% (37/74)	88.2% (157/178)
	> 1 year	50.7% (105/207)	76.3% (45/59)
Deworming status	Yes	39.1% (43/110)	87% (127/146)
	No	57.9% (99/171)	82.4% (75/91)
Last deworming	Within 1 year	39.1% (43/110)	87% (127/146)
	Never	57.9% (99/171)	82.4% (75/91)
Management system	Free-roaming	53.3% (64/120)	-
	Semi-intensive	48.4% (78/161)	-
	Indoor	-	85.2% (202 /237)

Of the 237 pigs examined, 122 were from Morogoro Municipality and 115 from Mvomero District Council. Majority of the pigs were females with a median age of 6 months. Location wise, pigs from Morogoro Municipal were most infected, while in terms of sex and age groups; male and pigs aged one year and below were more infected with STH species (Table 1). The difference in pig STH prevalence for age groups and sex was statistically significant with p-value of 0.025 and 0.016, respectively. However, dewormed pigs were most infected compared to those with no deworming history.

Prevalence of soil transmitted helminths in dogs
Overall prevalence of STH in dogs was 50.53%, with *Ancylostoma* species being the most prevalent. Eggs encountered in faecal samples were those of *Ancylostoma* (47.33%), *Toxocara* (12.46%) *Trichuris* (2.49%) and *Strongyloides* species (1.07%). Dogs in Mvomero District were more infected with *Toxocara* species while other detected STH species were more prevalent in Morogoro Municipal. Male dogs had relatively higher prevalence for almost all detected STH species with an exception *Trichuris.* Age group wise, adult's dogs were recorded to be more infected with *Ancylostoma* while younger dogs were observed to have more infected by *Toxocara, Trichuris* and *Strongyloides.* Dogs with deworming history within one year were recorded to have lowest infection compared with those that have never been dewormed in their lifetime. Lastly, dogs kept under semi intensive system had more infection in *Strongyloides* while free roaming were having higher infection of *Ancylostoma, Toxocara* and *Trichuris* species (Table 2)

Table 2

Prevalence of STH Species in dogs from Morogoro Municipality and Mvomero District, Tanzania, based on location and animal information

STH species		*Ancylostoma* %(n)	*Toxocara* %(n)	*Trichuris* %(n)	*Strongyloides* %(n)
Location	Morogoro Municipality (N=137)	52.6%(75)	10.9%(15)	3%(4)	2.9%(3)
	Mvomero (N=144)	42.4% (61)	13.9% (20)	2.1% (3)	0% (0)
Sex	F (N=129)	44.2%(57)	12.4% (16)	3.9%(5)	0% (0)
	M (N=152)	50%(76)	12.5% (19)	1.3% (2)	2% (3)
Age group	≤ 1 year (N=74)	45.9% (34)	14.9% (11)	2.7%(2)	2.7%(2)
	> 1 year (N=207)	47.8% (99)	11.6% (24)	2.4% (5)	0.5% (1)
Deworming status	Yes (N=110)	35.5%(39)	6.5%(7)	0.9%(1)	0.9%(1)
	No (N=171)	55%(94)	16.4%(28)	3.5%(6)	1.2%(2)
Last deworming	Within 1 year (N=110)	35.5%(39)	6.5%(7)	0.9%(1)	0.9%(1)
	Never (N=171)	55%(94)	16.4%(28)	3.5%(6)	1.2%(2)
Management system	Free- roaming (N=120)	47.5% (57)	14.2%(17)	4.2% (5)	0% (0)
	Semi-intensive (N=161)	47.2% (76)	11.2% (18)	1.2%(2)	1.9% (3)

Prevalence of soil transmitted helminths in pigs
In pigs, the overall prevalence of STH was 85.23% with the most prevalent species being *Oesophagostomum* (81.01%), followed by *Trichuris* (12.24) and *Ascaris* (5.49%). Male and pigs aged one year or below were more infected by all identified species of STH (*Oesphagostomum*, *Trichuris* and *Ascaris*). More pigs from Mvomero District were infected with two STH species compared to those from Morogoro, with the exception of *Trichuris species.* Pig with a history of deworming within one year had relatively more

infection by all STH reported in this study except *Ascaris* species (Table 3).

Table 3

Prevalence of STH Species in pigs from Morogoro Municipality and Mvomero District, Tanzania, based on location and animal information

STH species		*Oesophagostomum* %(n)	*Trichuris* %(n)	*Ascaris* %(n)
Location	Morogoro Mc(N=122)	77.9% (95)	23% (28)	4.9% (6)
	Mvomero (N=115)	84.3% (97)	0.9% (1)	6.1% (7)
Sex	F (N=132)	78.8% (104)	9.8% (13)	4.5%(6)
	M (N=105)	83.8% (88)	15.2% (16)	6.7% (7)
Age group	≤ 1 year (N=178)	82.6% (147)	16.3% (29)	5.6%(10)
	> 1 year (N=59)	76.3% (45)	0%(0)	5.1%(3)
Deworming status	Yes (N=146)	83.6% (122)	18.5%(27)	4.8% (7)
	No (N=91)	76.9% (70)	2.2% (2)	6.6% (6)
Last deworming	Within 1 year (N=146)	83.6% (122)	18.5%(27)	4.8% (7)
	Never (N=91)	76.9% (70)	2.2% (2)	6.6% (6)
Management system	Indoor (N=237)	81.01%(192)	12.2%(29)	5.5%(13)

Mixed infection

This study observed that STH infection in pigs and dogs would occur either due to one or multiple types of parasite species (coinfection). Infection due to one type of STH species in pigs was recorded as *Oesophagostomum* 67.9% (n=161), *Trichuris* 2.1% (n=5) and *Ascaris* species 0.8% (n=2). However, the most common two STH species infection was observed for *Oesophagostomum* and *Trichuris* species 8.9% (n=21) followed by *Oesophagostomum* and *Ascaris* species 3.4% (n=8) and *Trichuris* and *Ascaris* species 0.4% (n=1). Moreover, for dogs single STH species infection occurred only for *Ancylostoma* 35.9 % (n=101) and *Toxocara* species 2.8% (n=8). However, two and three STH species coinfection was recorded as follows; *Ancylostoma* with *Toxocara* species 8.2% (n=23), *Ancylostoma* with *Trichuris* species 1.1% (n=3), *Ancylostoma* with *Strongyloides* species 1.1% (n=3), *Toxocara* with *Trichuris* 0.4% (n=1) and *Ancylostoma*, *Trichuris* and *Toxocara* 1.1% (n=3).

Discussion

Soil-transmitted helminths (STH) is one of the neglected tropical disease reported by WHO whose main source of infection is through contaminated soil. The infection is responsible for parasitic diseases in both human and animals with a great possibility for zoonosis. *Ascaris suum, Ancylostoma* and *Toxocara* species from pigs and dogs respectively, are reported to be of zoonotic importance (Nejsum *et al.*, 2012; WHO, 2016). This study was designated to investigate the prevalence of STH among domestic pigs and dogs to give information that would help to prioritize prevention and control interventions of STH infections. This would help to improvement animal health and minimize risk of zoonotic parasite to be transmitted to human beings. This study revealed that STH are major gastrointestinal parasite infecting pigs and dogs.

The observed STH prevalence in pigs (85.23%) was higher compared to the previous studies conducted in Tanzania which recorded for gastrointestinal helminths prevalence of 53% and

63.7% (Esrony *et al*., 1997; Kabululu *et al*., 2015). Higher STH prevalence than previous studies done in Tanzania may be due increased pig population thus it became difficult to apply good animal husbandry practice leading to increased parasite circulation in the ecosystem. Moreover, climatic change may have favored the survival of the infective eggs and larva in the environment. Similar findings to this study have been reported in Rwanda (84.6%) and Kenya (84.2%) onto which STH were the most prevalent gastrointestinal parasites in pigs with *Strongyle*-type helminths being the most prevalent egg species (Kagira *et al*., 2012; Tumusiime *et al*., 2020). This similarity may be because of the traditional rearing system adopted in these countries having poor management systems, housing, hygiene and feeding along with lack of regular deworming of pigs giving room to continuous infestations and re-infection (Nganga *et al*., 2008; Roepstorff *et al.,* 2011). Generally, High prevalence STH infection in African countries may be due to lack of effective disease prevention and control strategies (Tamboura *et al*., 2006).

Furthermore, this study has reported the occurrence of three STH species infecting pigs that include *Oesphagostomum* species, *Trichuris suis* and *Ascaris suum.* Similar species have been reported by previous studies in Tanzania and elsewhere (Gabon, South Africa and Kenya) (Esrony *et al*., 1997; Kabululu *et al*., 2015; Kagira *et al*., 2012; Maganga *et al*., 2019; Nwafor *et al*., 2019). Nevertheless, there was a significant association of sex and age with STH infestations. Younger pigs were the most infected age group with all three detected STH species while infection rate was low in adult. Similar to other studies, this was associated with stronger immune memory acquired by adult pigs after several prior infestations that enable them to expel immature parasite in the small intestine before they are able cause morbidity and/or lay eggs (Kagira *et al*., 2008; Roepstorff and Nansen 1994; Tamboura *et al*., 2006).

Additionally, this study reported that male pigs were more infected with all three detected STH species than females which was in agreement with Sowemimo *et al*., (2012), a study done in Southwest Nigeria. Contrary, other studies reported a non-significant effect of sex to gastrointestinal helminths infestation and female pigs had higher prevalence prevalence (Maganga *et al*., 2019; Sharma *et al*., 2020; Tamboura *et al*., 2006). High rooting behavior of male pigs that lead to increased access to infected soil was associated with higher prevalence for male pigs in comparison to females (Forrester *et al.,* 1982). Interestingly in this study, pigs with history of deworming within one year had relatively higher infection especially for *Oesphagostomum* species and *Trichuris suis* which is different from other studies (Kabululu *et al.,* 2015; Tamboura *et al*., 2006). This study relied on a self-reported antihelminthic treatment practiced by farmers. Farmers might be missing the correct timing to administer antiparasitic drug and might be administering less effective drugs in the incorrect dosage (Roesel *et al.,* 2016). Moreover, without effective STH control strategies, there is a high chance of reinfection especially in the already contaminated environment (Nganga *et al*., 2008).

Moreover, in this study dogs were presented with an overall STH prevalence of 50.53% which was lower in comparison to previous studies within Tanzania (Makene *et al*., 1996. Kidima, 2019). This may be due to deworming of animals in the present study as Kidima, 2019 report was based on stray dogs. Moreover, the present advancement in control strategies (proper management system and health education) from 1996 may have influenced the low prevalence in the present findings; however, eco - climatic conditions that could occurred overtime may have played part (Jia-Chi *et al.,* 2016). Nevertheless the obtained prevalence in this study was higher compared to previous study in Bali, Indonesia that reported a prevalence of 38% (Agustina *et al.,* 2021). The inconsistence of the prevalence in these countries might be due to differences in soil nature, climatic conditions and the altitude of the study sites (Moskvina and Ermolenko, 2016; Jia-Chi *et al.,* 2016). The STH detected from dogs in the present study were *Ancylostoma, Toxocara, Trichuris* and *Strongyloides* species, with the *Ancylostoma species* being most prevalent in all age groups. The later observation concurs with previous studies in Tanzania and elsewhere in the world (Makene *et al*., 1996; Kidima, 2019). Contrary to previous studies in Tanzania (Makene *et al*., 1996; Kidima, 2019), present study reports the occurrence of *Trichuris* species in dogs for the first time. Male dogs had relatively higher prevalence of the STH infestation even though sex was not reported to significantly influence STH prevalence of dogs in this study. Similarly, study done earlier in Tanzania reported that sex had no effect on infection prevalence (Makene *et al.*, 1996). However, it was reported in Nigeria that male dogs significantly had higher infection prevalence than females (Anosike *et al.,* 2004). The later results were associated with the fact that male dogs tend to be more free-ranging when are compared to female. Free roaming dogs has higher chances to come into contact with contaminated soil and hence become infected by many types of STH species (Jia-Chi *et al*., 2016). This explains why free-roaming dogs in this study had more STH infections compared to those kept under semi-intensive management system.

Nevertheless, age group wise the infection rate was comparable for almost all STH detected in this study indicating that age did not influence the STH prevalence. However, these results were contrasting to a study done earlier in Morogoro which pointed out that age was significantly associated with gastrointestinal helminths prevalence where higher prevalence were observer for puppies (Makene *et al*., 1996). The later attributed their results to transplacental and transmammary infection transmission routes in puppies and/or continued contamination of the environmental especially by asymptomatic adult dogs (Makene *et al*., 1996). Conversely, adult had relatively higher prevalence of *Ancylostoma* species than young dogs which might be because this was the most prevalent species reported for this study. These results are also consistent with study of (Kidima, 2019) done in Rukwa, Katavi and Arusha and (Swai *et al*., 2010) done in Arusha, Tanzania who had reported the high prevalence of hookworm. High prevalence of hookworm infection in dog was associated with increased availability of hookworm paratenic hosts, vertical transmission in *utero* and puppies acquisition of hookworm through nursing (Kidima, 2019).

Dogs with deworming history within one year were recorded to significantly have lowest STH infection when compared with those that have never been dewormed in their lifetime. Deworming has been associated with reduced worm burden in animals which might be the explanation of low infection rate in dewormed animals that participated in this study. Moreover, regular deworming was suggested to reduce the effect of sex on helminths infection susceptibility (Chidumayo, 2018).

Nonetheless, hookworms and roundworms of pigs and dogs are the most important helminths imposing risk to animals and human health. The present findings reported the occurrence of zoonotic STHs in dogs (*Ancylostoma* and *Toxocara* species) and pigs (*Ascaris* species). It was observed that zoonotic species were the most prevalent in dogs while in pigs was the least detected species. Ancylostomiasis has been associated with chronic hemorrhagic and microcytic hypochromic anemia. Besides, *Toxocara* species may be acquired direct to human being even through pets' hair containing infective eggs. Toxocariasis in human can cause ocular and visceral toxocariasis that is more prevalent in children and adult, respectively (Moskvina & Ermolenko, 2016).

Conclusion

The study findings indicate that STHs species are prevalent among dogs and pigs kept in the study sites. Owners of the pigs and dogs are prudently advised to undertake appropriate control measures against the STH infection to improve animal health and production where applicable. Furthermore, the appearance of zoonotic parasites (*Ancylostoma* species, *Toxocara* species and *Ascaris suum*) calls for one health interventions to control the parasites in order to safeguard the public health.

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