Prevalence and management of gastrointestinal helminths in pigs in Mpwapwa district, Dodoma, Tanzania

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SUMMARY

This study assessed the prevalence and management of gastrointestinal helminths (GIH) in pigs in three wards of Mpwapwa District, Dodoma, Tanzania. Faecal samples from 160 pigs were analyzed using the saturated sodium chloride flotation method, and eggs per gram (EPG) were quantified with a McMaster counting chamber. A structured questionnaire was used to collect information on GIH control practices from 52 smallholder pig farmers. Gastrointestinal helminths were detected in 31.9% of pigs (95% CI: 24.7% - 39.7%), with strongyle-type helminths showing the highest prevalence (26.9%), followed by *Ascaris suum* (6.3%) and *Trichuris suis* (3%). Single-species infections were most common (28.1%), while double infections were less frequent (3.8%). Although the prevalence of infection was higher in female pigs (23.8%) compared to males (8.1%), the difference was not statistically significant ($\chi^2 = 0.796$; $p = 0.372$). Adult pigs showed a significantly higher prevalence (26.9%) compared to piglets (5%) ($\chi2 = 5.828$; $p = 0.016$). Among the villages, Gulwe had the highest prevalence (13.7%), followed by Igovu (12.5%) and Ving'hawe (5.6%), although differences were not statistically significant. Infection intensity was classified as low for EPG ≤ 100 and high for EPG ≥ 500. Effective control practices for GIH identified in this study included deworming using modern drugs, improved sanitation, and water source, and meat inspection. This study highlights the presence of *Ascaris suum*, *Trichuris suis*, and strongyle-type helminths in pigs in Mpwapwa district. An integrated approach, including enhanced veterinary services, farmer education, and parasite management, is crucial. The zoonotic risk of certain helminths emphasizes the importance of a One Health approach to safeguard animal and human health while improving pig productivity.

Keywords

Ascaris suum, *Trichuris suis*, *Strongyle* species, infection intensity, parasite control, small-holder farmers

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INTRODUCTION

Pigs play a crucial role in the social-economic development of rural communities worldwide, particularly in Low- and Middle Income Countries (LMIC) where they contribute significantly to food security, income generation, and poverty alleviation (Cyprian et al., 2022). As an important source of animal protein, pigs are efficient in converting low-quality feed into high-quality meat, making them a key component in smallholder farming systems (Minani et al., 2025). In Tanzania and other states in the East Africa Community region, pig industry has seen steady growth over the past few decades (Maganira et al. 2019). This has largely been due to low cost of investment, high demand for pork in both rural and urban areas and quick earnings from the pig industry as compared to other livestock such as cattle (Maganira et al., 2019; Phiri et al., 2003; Nnenna et al., 2018) The increase in pork demand is driven by rapid urbanization, population growth, and the rising middle class in many developing countries, which has led to a shift in dietary preferences toward more protein-rich diets (Mutua & Dione, 2021). In addition, pork is often affordable and widely accepted in many areas (Nnenna et al., 2018). Furthermore, pigs serve as an economic safety net, helping households mitigate the risks of agricultural uncertainties such as crop failure. This is evident in regions like Dodoma, where frequent droughts and declining crop yields have led many households to adopt pig farming as a resilient activity and reliable income source (Kagira et al., 2010)

Despite their importance, up to 98% of pigs in Tanzania are kept by smallholder farmers under semi-intensive and extensive systems, while less than 2% are raised by commercial farmers using intensive production systems. Pig farming practices used by smallholder farmers expose pigs to various health challenges, including gastrointestinal helminths (GIH) (Kompi et al., 2023; Ngowi et al., 2014).

Gastrointestinal helminths infections in pigs, caused by a variety of parasitic worms, are a major cause of economic losses due to reduced growth rate, poor feed conversion, and increased susceptibility to secondary infections (Delsart et al., 2020). Helminth infections are prevalent in many LMIC where poor sanitation, inadequate veterinary services, and traditional farming practices allow easy transmission and persistence of parasites in the environment (Traoré et al., 2017). Gastrointestinal helminths such as *Ascaris suum*, *Trichuris suis*, and various *Strongyle* species are known to affect pigs globally with significant prevalence in tropical regions (Unanam & Lekko, 2023). Pig keeping systems that allow free-ranging of pigs expose pigs to parasite eggs and larvae from contaminated environment particularly in regions with warm and humid climates, which facilitate the survival of these parasites (Ngowi et al., 2014). The warm, humid conditions in Mpwapwa create an ideal environment for the growth and survival of soil-transmitted helminths (STH), as eggs of *Ascaris suum* and *Trichuris suis* require moist, warm settings, typically around 25–30°C with high humidity, to develop into their infective stages, with such conditions accelerating egg development and prolonging their viability (Oyesola et al., 2022). Infective eggs can persist in the soil for extended periods, thereby increasing the risk of reinfection among pigs. Poor sanitation and warm, humid conditions intensify environmental contamination in pig farms, making effective control more difficult.

Regular deworming is crucial for helminth control, but the humid and warm environment makes single intervention insufficient (Cyprian et al., 2022). The control of GIH in pigs typically involves a combination of strategies, including regular anthelmintic treatment, and sanitation (Charlier et al., 2018). However, in many rural areas, parasite control measures are often inadequate as there may be limited access to veterinary services, high cost of drugs, and a lack of farmer awareness (Mengele et al., 2020). As a result, many farmers may rely on sporadic deworming, which is often ineffective in controlling parasitic infections.

Despite the availability of control measures, the prevalence of GIH in pigs remains high in many parts of Tanzania. Several studies have reported varying infection levels across the country, with some areas exhibiting particularly high prevalence rates of up to 83% (Swai et al., 2017). These elevated infection rates are often attributed to inconsistent control practices and the persistence of parasite eggs in the environment (Kouam et al., 2018). In Mpwapwa District, a similar trend is expected due to the predominance of semi-extensive farming systems. Nevertheless, the prevalence of GIH and their control practices in the region are currently unknown.

This study assessed the prevalence of GIH and smallholder pig farmers' parasite control practices in Mpwapwa District, Dodoma, to provide valuable insights into the current parasite burden in the region. This is important to inform the development of targeted control strategies, which can improve pig health, enhance productivity, and ultimately support the livelihoods of rural communities in Dodoma.

MATERIALS AND METHODS

Study area

This study was conducted in three villages (Gulwe, Ving'hawe, and Igovu) in Mpwapwa District, Dodoma, Tanzania (Figure 1). The district is located between latitude 6°16'30" and 6°33'30"S, and longitude 36°22" and 36°30"E. Mpwapwa is about 120 km from the Dodoma Capital. It covers an area of 7,379 km^2. Bordered to the north by Kongwa District, to the east by Morogoro Region, to the south by Iringa Region, and the west by Chamwino District. Mpwapwa experiences a semi-arid climate characterized by an annual average temperature of 27°C. The area receives between 600 mm and 1,200 mm of rainfall per annum. The district receives relatively more rain compared to other districts of Dodoma Region. Mountainous areas like Kiboriani, Wotta, Lufu, Mbuga, and Mang'aliza receive heavy rainfall of up to 1200mm per annum. The human population in Mpwapwa is estimated at 403,247 (DHS, 2022) and the pig population is estimated at 13550, equal to 30.9% of total pigs in the Dodoma Region (Maro, 2006). The economic and livelihood activities in Mpwapwa Districts include crop farming, livestock keeping, fishing, and mining. However, smallholder pig farming in the district is on the rise

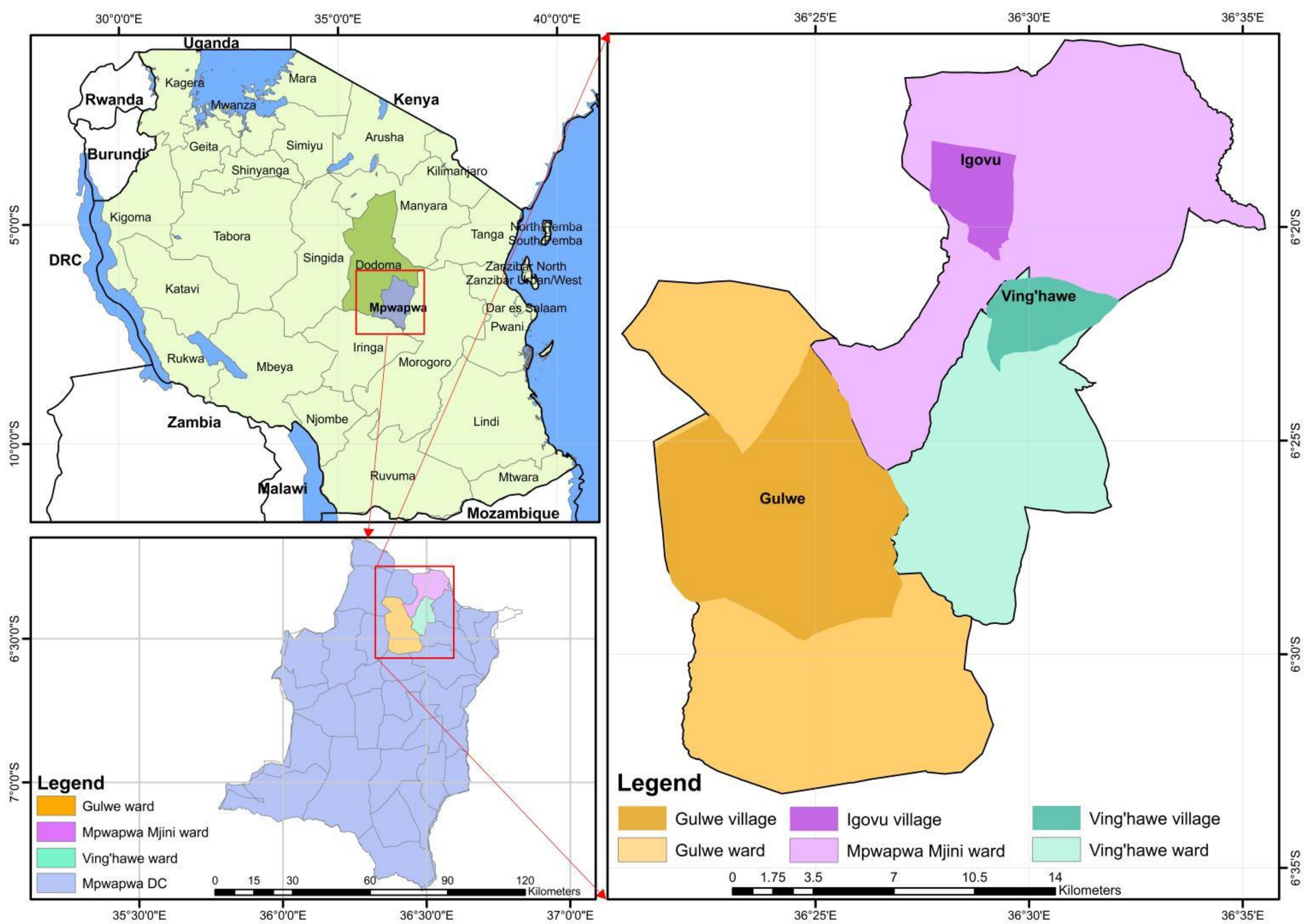

Figure 1: Map of Mpwapwa District showing study villages

Study design and sample size estimation

A cross-sectional survey was conducted in June 2024 to detect GIH in pigs kept by smallholder farmers. Fresh faecal samples were collected for laboratory analysis, and a structured questionnaire was administered to the heads or representatives of households keeping pigs to assess GIH control practices. The sample size for faecal analysis was estimated using the formula $n=Z^2PQ/L^2$ (Thrusfield, 2002), where n is the required sample size, P is the expected prevalence of GIH in Mpwapwa District (set at 10%) (Pfeiffer, 2002), Z is the standard score (z-score) for the desired confidence level (95%), Q is the proportion of pigs expected to be free from infection ($Q=1-P$), and L is the desired precision (5%). This yielded an estimated sample size of 160 pigs.

Selection of participating households

Ten wards with the highest pig populations were initially identified based on information from district veterinary officers. Simple random sampling was then used to select three wards (Gulwe, Ving'hawe, and Mpwapwa Mjini) by blind-folded drawing names from a pool of wards on small pieces of paper. Following similar procedure employed in the selection of wards, three villages (Gulwe, Ving'hawe, and Igovu) were randomly selected from the three wards. Households keeping at least two pigs from each selected village at the time of data collection, and with a representative willing to participate, were included in the study. A total of 52 household heads or representatives from all study villages participated in the survey. In households with two or three pigs, all pigs were sampled, while in households with more than four pigs, a maximum of four pigs were randomly selected using simple random sampling.

Feacal sampling and questionnaire survey

About five grams of faecal samples were collected per rectum from 160 pigs owned by 52 smallholder pig farmers. Sample collection involved gently inserting a gloved finger approximately 5–7 cm into the pig's rectum to manually retrieve fresh faecal material, which was then placed into labelled sterile containers for GIH analysis. Households keeping at least two pigs at the time of data collection were included in the study after obtaining verbal informed consent from the household heads to participate. Pigs were classified as adults if older than four months and as piglets if aged 4 months and below. During sampling, pigs were restrained using a hog catcher. Sample collection was performed using sterile plastic gloves, and each sampled pig was marked to prevent duplication. The collected samples were stored in well labelled 50 ml plastic containers with 70% ethanol before they were transported to the Molecular Laboratory at the College of Veterinary Medicine and Biomedical Sciences (CVMBS), Sokoine University of Agriculture (SUA), for analysis. All samples were handled with care to prevent contamination by using sterile equipment, wearing gloves, and following standard protocols for sample collection.

A structured questionnaire was used to gather data on helminth control practices among pig farmers. The questionnaire design was informed by previous studies conducted in similar rural settings by Maganira et al. (2019) and Sanga et al. (2023), with modifications tailored to suit the specific context and objectives of the present study. To enhance content-related, construct-related, and face-related validity, the questionnaire was reviewed by a subject matter expert who had participated in those earlier studies. Although the tool was not formally pretested in the field, expert feedback was used to refine question clarity, relevance, and appropriateness. The questionnaire covered key areas including pig deworming practices, feed and water sources, pig management systems, and sanitary conditions, aimed at capturing comprehensive data on gastrointestinal parasite control practices in the study area.

Laboratory data analysis

Faecal samples were analysed at the CVMBS, SUA. The McMaster counting technique was employed to determine the faecal egg count (FEC) per gram of faeces (EPG), providing a quantitative estimate of helminth eggs output. Each faecal sample was weighed, and 3 grams were placed in a beaker labelled with the corresponding sample identification code. A 40% sodium chloride (NaCl) flotation solution (specific gravity = 1.2) was locally prepared in the laboratory by dissolving 40 grams of analytical-grade sodium chloride in 100 milliliters of distilled water. This was followed by adding 42 milliliters of the prepared solution to the faecal sample, and the mixture was thoroughly stirred with a glass rod. Large debris was strained out, and the solution was transferred to a test tube, left to stand for 10 minutes, and stirred again before filling to form a convex meniscus (Lutakyawa et al., 2018). A coverslip was placed on the tube and left for 10 minutes to allow helminth eggs to float to the surface, after which it was transferred to a glass slide for examination at 40x magnification under a compound microscope. A transfer pipette was used to fill both chambers of the McMaster slide, which was then left to settle for 5 minutes. Each slide was examined under a compound microscope (10x magnification), and helminth eggs were identified using identification keys based on morphological features (Adhikari et al., 2021). Quantification was done by counting all eggs within the two chambers, with the total multiplied by 50 to obtain eggs per gram (EPG). Infection levels were categorized as low (EPG below 100), moderate (EPG above 100 and less than 500), or high (EPG above 500) (Nwafor et al., 2014; Wiegand et al., 2021).

Statistical data analysis

The prevalence of GIH in pigs was computed using descriptive statistics in R software version 4.4.1 (Core Team, 2018). Control practices were summarized using descriptive statistics and categorized based on WHO's 2017 guideline. Chi-square tests were employed to compare parasite infection rates across villages, sex, and age groups, with statistical significance set at $p < 0.05$. Additionally, 95% confidence intervals (CIs) were calculated to provide estimates of infection prevalence.

Ethical approval

This study was approved by the SUA Ethical Committee (reference number MDB/D/2022/0003). Research clearance was provided by the Tanzania President's Office, Regional Administration, and Local Government (PO-RALG) ministry (reference number JC.156/254/01). Verbal informed consent was also sought from household heads or representatives of households involved in this study

RESULTS

Characteristics of study animals

In total, 160 pigs from 52 households in 3 villages in Mpwapwa District were examined (Table 1). The overall mean age of the pigs examined was 7.3 months (7.5 months for female, and 6.6 months for male pigs). More adult pigs (n = 113, 70.6%; C.I: 62.9% - 77.6%) than piglets (n = 47, 29.4%; C.I: 22.5% - 37.1%) were examined and their difference was significant ($\chi^2 = 27.23$, $p < 0.05$). A higher number of female pigs (n=110, 68.8%; C.I: 61.0% - 75.8%) were examined compared to males (n=50, 31.2%; C.I: 24.2% - 39.0%), and this difference was statistically significant ($\chi^2 = 22.5$, $p < 0.05$).

Table 1: Gastrointestinal helminths infection in pigs from Gulwe, Igovu and Ving'hawe villages in Mpwapwa District, Dodoma, Tanzania.

Factor	Level	#pigs	#+pigs	%prev	95% C.I.	*p*-value
Village	Gulwe	60	22	13.7	8.8 – 20.1	0.161
	Igovu	58	20	12.5	28.8 – 44.2	
	Ving'hawe	42	9	5.6	2.6 – 10.4	
Sex	Male	50	13	8.1	4.4 – 13.5	0.372
	Female	110	38	23.8	17.4 – 31.1	
Age	Adult	113	43	26.9	20.2 – 34.5	0.016
	Piglet	47	8	5.0	2.2 - .9.6	
	Total	160	51	31.9	24.7 – 39.7	< 0.05

Key: #pigs = Number of pigs examined; #+pigs = Number of pigs infected with gastrointestinal helminths; %prev = Percentage prevalence; and C.I = Confidence interval

Prevalence of gastrointestinal helminths in examined pigs

In total, 160 pigs were examined across the three villages, with 51 pigs from 25 households testing positive for GIH eggs (Figure 2), resulting in an overall prevalence of 31.9% (95% CI: 24.7–39.7%). Infections included both single and mixed helminth species. The study found that 28.1% of pigs had a single infection, while 3.8% of pigs were found to be co-infected with more than one helminth species (Table 2). Although both male and female pigs harbored the same GI helminth species, female pigs had a relatively higher infection rate compared to male pigs, but the difference was not statistically significant (Table 1).

Among the villages, Gulwe had the highest prevalence (13.7%), followed by Igovu (12.5%), and Ving'hawe (5.6%) (Table 1). *Strongyle*-type helminths were the most prevalent across all three villages. There was significant difference found in the prevalence rates among the villages ($\chi^2 = 3.65$: p = 0.161)

Gastrointestinal helminths infection intensity

The estimated intensity of GIH infections, measured by EPG in the examined faecal samples, varied across pig sex and age groups (Table 3). The infections were categorized as light, moderate, or high infections when the egg counts ranged between 100 and below, between 100 and 500, and above 500, respectively. Adult pigs had the heaviest infection, while piglets had the lightest infection rate for all the three GIH identified. For strongyle-type helminths, the highest estimated mean EPG was 638 in adults, compared to 550 in piglets. *Ascaris suum* had an estimated mean EPG of 133 in adults and 100 in piglets, whereas *Trichuris suis* was recorded only in adults with a mean EPG of 150. The EPG values indicated that Strongyle-type helminth infections were generally heavy across all study villages, while *Ascaris suum* and *Trichuris suis* infections ranged between light and moderate intensity (Table 3)

Table 2: Multiple gastrointestinal helminths infection

Infection type	GIH	Male	Female	Total	%inf	Young	Adult	Total	%inf
Single infection	*Trichuris suis*	0	0	0	0.0	0	0	0	0.0
	Strongyle-type helminth	10	27	37	23.1	2	35	37	23.8
	Ascaris suum	2	6	8	5.0	1	7	8	5.0
Double infection	*Trichuris suis* and Strongyle-type helminth	0	4	4	2.5	0	4	4	2.5
	Trichuris suis and *Ascaris suum*	0	0	0	0.0	0	0	0	0.0
	Strongyle-type helminth and *Ascaris suum*	1	1	2	1.3	0	2	2	1.3

Key: GIH = Gastrointestinal helminths; %inf = Infection proportion

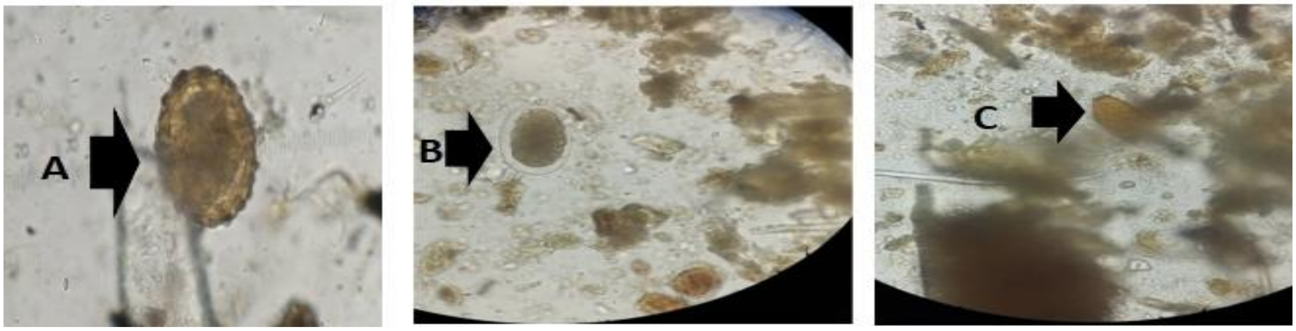

Figure 2: Gastrointestinal helminths' eggs recovered from faecal samples of pigs from Mpwapwa District, Dodoma, Tanzania (A = Egg of *Ascaris suum*; B = Egg of Strongyle-type helminths; and C = Egg of *Trichuris suis*)

Table 3: Gastrointestinal helminths (GIH) infection intensity by age and sex of pigs and type of Gastrointestinal helminth

GIH Species	Factor	Level	Light infection	Moderate infection	Heavy infection
Trichuris suis	Sex	Male	0	1	0
		Female	1	2	0
	Age	Piglet	0	0	0
		Adult	3	0	0
	Village	Igovu	1	2	0
		Ving'hawe	0	0	0
		Gulwe	0	1	0
Strongyle-type helminth	Sex	Male	0	1	2
		Female	1	5	10
	Age	Piglet	0	1	2
		Adult	1	3	12
	Village	Igovu	1	7	7
		Ving'hawe	0	1	6
		Gulwe	1	8	10
Ascaris suum	Sex	Male	1	1	0
		Female	3	5	0
	Age	Piglet	0	0	0
		Adult	2	8	0
	Village	Igovu	1	2	0
		Ving'hawe	1	1	0
		Gulwe	3	2	0

Parasite control practices in Mpwapwa District

The parasite control practices identified by smallholder pig farmers in the study area, using a structured questionnaire are indicated in Table 4. Control practices were considered effective when the prevalence rate, measured as the percentage of households with at least one positive pig, was 20% or lower, in line with the WHO (2017) guideline. On the other hand, a prevalence exceeding 20% indicated that the control practices were less effective.

Table 4: Parasite control practices in Mpwapwa District, Dodoma Tanzania.

GHI control practice	Level	#Respondents (%)	# +Households (%)	Control practice status
Deworming	Modern drugs	48 (92.3)	5 (10)	Effective
	Traditional medicine	4 (7.7)	2 (50)	Less effective
Sanitation	Regular cleaning and disinfection	25 (48.1)	6 (24)	Less effective
	Proper pig feces management	40 (76.9)	7 (18)	Effective
	Proper pig pen design	48 (92.3)	6 (13)	Effective
Water source	Well	48 (92.3)	7 (15)	Effective
	River	2 (3.8)	1 (50)	Less effective
Meat inspection	Official slaughter slab	35 (67.3)	11(31.4)	Less effective
	Home/clandestine slaughter	0	0	NA
Pig feed source	Local feed	48 (92.3)	24 (50)	Less effective
	Commercial feed	4 (7.7)	1 (25)	Less effective

Key: #Respondents = Number of questionnaire respondents; #+Households = Number of households with positive pigs; % = Percent; NA = Not Applicable; Modern drugs = e.g. Albendazole, and Ivermectin; Traditional medicine = herbs; Local feed = e.g. Maize bran, sunflower cake, kitchen leftovers; Commercial feed = e.g. Pig starter feed, booster

DISCUSSION

This study assessed the prevalence of GIH and pig management practices in Mpwapwa, Dodoma Tanzania. The overall prevalence of GIH was 31.9% indicating a significant burden of gastrointestinal helminth infection in the region. Strongyle-type were the most prevalent, followed by *Ascaris suum* (6.3%), and *Trichuris suis* (4%). The observed prevalence aligns with findings from previous studies reporting prevalence rates of 28% in Ghana (Atawalna et al., 2016), 57% in Rwanda (Tumusiime et al., 2020), 31% in Nigeria (Nwafor et al., 2014), 51% in India (Gupta et al., 2019), and 57% in Poland (Kochanowski et al., 2017). However, variation in prevalence rates may be attributed to differences in pig management practices, geographical locations, climatic conditions, sampling season, or methodological factors such as sample size used in estimating the prevalence of the infection. Nevertheless, the presence and intensity of GIH infection in household pigs in Mpwapwa emphasizes the need for comprehensive control measures such as deworming, improved hygiene and sanitation and public health education to mitigate the infection burden.

Although all pigs were confined during the survey, most pig pens in Gulwe and Igovu had large open spaces in their wall structures. These openings may allow pigs to roam outside the pens, increasing their risk of exposure to contaminated environments, including soil and feces containing helminth eggs. *Ascaris suum* was shown to have a very low prevalence which is slightly similar with the work of (Lekko et al., 2018). Additionally, the observed prevalence of *Trichuris suis* is slightly similar to findings from previous studies, with prevalence rates of 3.4% in Uganda (Roesel et al., 2017), 4.6% in Nigeria (Nnenna et al., 2018), and 0.5% Ghana (Atawalna et al., 2016). These variations in prevalence might highlight the influence of environmental factors, pig management systems, and regional veterinary interventions on the epidemiology of gastrointestinal helminths in pigs across different geographic locations (Unanam & Lekko, 2023).

Female pigs exhibited a higher prevalence and intensity of GIH infections compared to male pigs, likely due to their longer lifespan in breeding herds, which increases cumulative exposure. Male pigs are often sold earlier, reducing their risk of chronic parasitic infection, a trend similarly reported in Nigeria (Nathaniel et al., 2017). Younger pigs also had higher egg counts than adults, indicating greater susceptibility to infection. These patterns mirror those described by Kompi et al. (2023) and support the idea that age and sex can influence helminth infection dynamics

The effectiveness of parasite control is closely linked to routine deworming with drugs like albendazole and ivermectin, as well as improved pig management (Pettersson et al., 2021). This study identified deworming using modern drugs, pig management activities such as proper pig faeces management and proper pig pen design, and well water as effective practices that could reduce the risk of GIH infection in the pig population. Nevertheless, irregular deworming as a result of high drug costs, limited farmer knowledge, and restricted veterinary services remain significant barriers to effective parasite control in many rural areas. Addressing these constraints through farmer sensitization, community-based veterinary outreach, and improved access to affordable anthelmintics could significantly enhance control outcomes.

To the best of our knowledge, this is the first study to investigate both the prevalence and control practices of GIH in pigs in Mpwapwa District. The findings point to a notable GIH burden, which not only affects pig health but also threatens the economic sustainability of smallholder pig farming. Strengthening control strategies, including consistent deworming using modern drugs, proper pig faeces management, proper pig pen design, and safe water access , may offer a practical pathway to reducing infection risk in the study. These measures are essential to safeguarding pig health and enhancing productivity in rural pig production systems.

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

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