



Prevalence of Gastrointestinal Parasites in Sheep, Goats and Zoonotic Helminths in Maekel Region, Eritrea

Habtom Araya ^a, Fredrick Maloba ^{b*}, Mutiso Joshua ^b,
Efrem Ghebremeskel ^c, Goitom Teklay ^a
and Fissehaye Yebio ^a

^a Parasitology Laboratory, National Animal and Plant Health Laboratory, Ministry of Agriculture, Eritrea.

^b Department of Zoological Sciences, School of Applied Sciences, Kenyatta University, Kenya.

^c National Animal and Plant Health Laboratory, Ministry of Agriculture, Asmara, Eritrea.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajaar/2025/v25i4596>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/132059>

Original Research Article

Received: 12/01/2025

Accepted: 05/03/2025

Published: 07/03/2025

ABSTRACT

Aim: To determine the prevalence of GIT parasites in sheep and goats and zoonotic helminths from slaughter house in the Maekel region, Eritrea.

Study Design: The study involved firstly a cross-sectional study which screened 384 sheep and goats for GIT parasites from four study villages of Maekel region and a questionnaire survey on risk factors associated with GIT parasite infections. Secondly, retrospective data (2022,2023) on zoonotic helminths was also collected from slaughter house in Maekel region.

*Corresponding author: Email: malobafred@gmail.com;

Cite as: Araya, Habtom, Fredrick Maloba, Mutiso Joshua, Efrem Ghebremeskel, Goitom Teklay, and Fissehaye Yebio. 2025. "Prevalence of Gastrointestinal Parasites in Sheep, Goats and Zoonotic Helminths in Maekel Region, Eritrea". *Asian Journal of Advances in Agricultural Research* 25 (4):10-21. <https://doi.org/10.9734/ajaar/2025/v25i4596>.

Place and Duration of Study: Maekel region of Eritrea between January 5, 2024 to December 11, 2024.

Methodology: A total of 384 fecal samples were collected from sheep and goats to determine the prevalence of gastrointestinal parasites. Fresh fecal samples were collected and transported to National Animal and Plant health laboratory (NAPHL) in Eritrea, for analysis using floatation and sedimentation techniques for microscopic examination. Questionnaire survey was also carried out on 40 farmers to determine the risk factors associated with helminth infections in the region.

Results: Parasites identified included of *Haemonchus sp.* (27.2%), *Eimeria sp.* (19.79%), *Cooperia sp.* (15.9%), *Strongyloides sp.* (11.9%), *Monezia species* (7.8%), *Ascaris sp.* (5.5%), *Dictyocaulus filarial* (5.2%), *Paramphistomum cervi* (5.2%), *Oesophagostomum columbianum* (3.7%), *Chabertia ovina* (3.7%), *Trichuris globulosa* (3.4%), among others. The risk factors associated with GIT parasites included poor housing, mixed housing, sharing of water sources with other livestock, irregular deworming and illiteracy. Zoonotic parasites reported from slaughter house included *hydatid cysts*, *Strongyloides*, *Trichuris*, *Ascaris*, *Paraphastumun*, *Dictyocaulus filarial*, *Haemonchus sp.* and *Faciola sp.*

Conclusion: Maekel region had high prevalence of parasitic helminths in sheep and goats which negatively impact on the small ruminants' production. Most importantly are the zoonotic NTDs including Echinococcosis, *Strongyloides*, *Trichuris*, *Ascaris*, *Paraphastumun*, *Dictyocaulus filarial*, *Haemonchus sp.* and *Faciola sp.* which indicates that the animals could be reservoir hosts and play role of reinfection to humans.

Keywords: Zoonotic NTDs; sheep and goats; gastrointestinal parasites; risk factors, helminths.

1. INTRODUCTION

Small ruminants are the most essential animals among small-scale farmers in the livestock production industries worldwide. Sufficient production of small ruminants including sheep and goats, support farmers as a means of generating income and important animal derived products (milk, meat, food security, manure, skin, medicine, gifts, hair (Hiwot et al., 2020). Gastrointestinal parasites are one of the major sources of economic loss in small ruminant farming (Win et al., 2020). Most governments in Africa haven't invested in disease control for small ruminants. This coupled with high illiteracy levels among pastoralist farmers impacts negatively on their productivity. The gastrointestinal parasites include helminths and protozoa most of which are known to cause malnutrition to the animals (Dogo et al., 2017). This is a similar situation in Eritrea hence the current study aimed to determine the prevalence of gastrointestinal parasites in sheep and goats, associated risk factors and zoonotic helminths in Maekel region of Eritrea. The outputs from the study could provide insights into better control measures for the parasites put in place by the relevant authorities. This also sheds light on the role of small ruminants role on NTDs transmission.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in four villages of Maekel region (Adi Abieto, Adi Segudo, Kushet and Godaif-Semebel), of Eritrea (Fig. 1) of Eritrea. Maekel region lies at an elevation of 2,325 meters above sea level. It receives about 518mm of precipitation annually and average humidity of 51%. Long rainy season extends from June to September while short rainy season occurs from March to May. December to February are typically driest (Metrology units' ministry of Agriculture Eritrea, 2023).

2.2 Study Animals, Sample Size and Study Design

Study was conducted among 40 small-scale farmers who keep sheep and goats under traditional practice managements systems from four villages (Adi Abieto, Adi Segudo, Kushet and Godaif-Semebel) in Maekel region, Eritrea. Homesteads were selected randomly for sampling of the animals (sheep and goats). In this study, total sample of 384 animals (96 from each village) of both sheep and goats at different ages and sexes were used for assessing intestinal parasitic infections. Fecal samples were collected from both sheep and goats for the

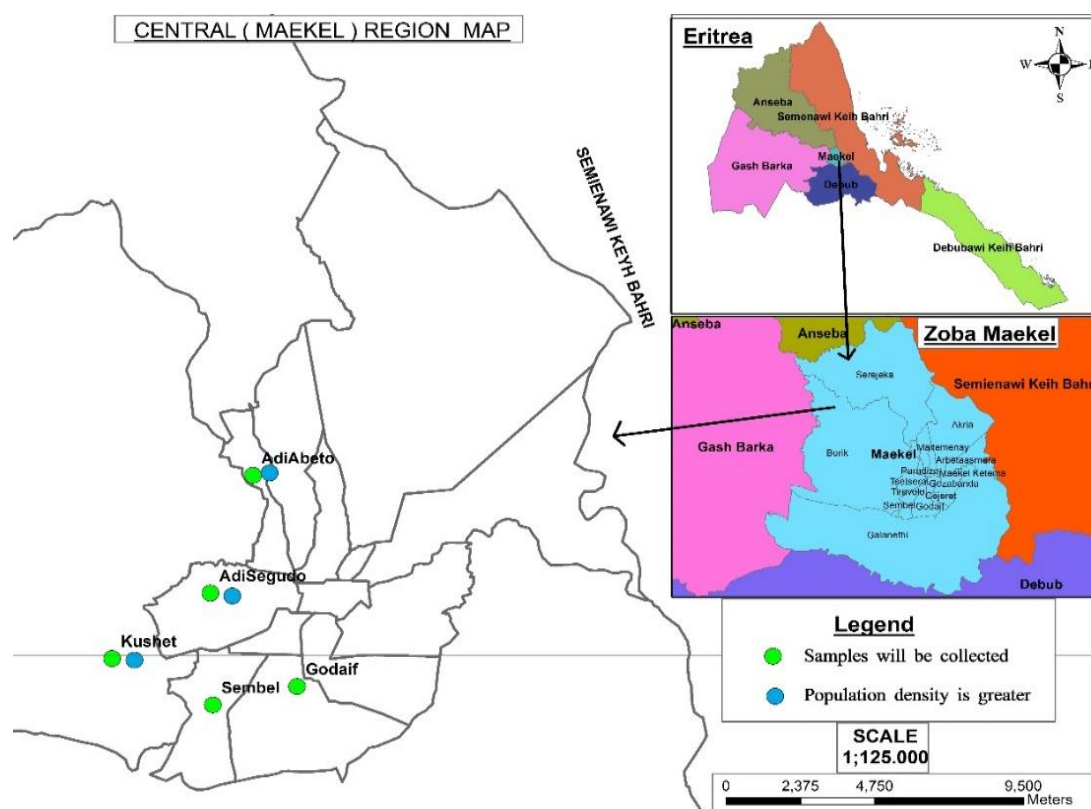


Fig. 1. Map of Maekel region, Eritrea (Map and information unit of Maekel administration region, state of Eritrea, 2023)

laboratory analysis of GIT-parasites using microscopy techniques. In addition, sampling was also carried out in the slaughter house of Maekel region and retrospective data on zoonotic helminths in the past two years (2022, 2023).

2.3 Sample Collection and Analysis

Fresh fecal samples of approximately 10g were collected from the rectum of selected animals, using a gloved finger after wetting with water for lubrication. Collected samples were placed in 30ml plastic bottles with waterproof screw cap. Sample bottles were labeled and then transported in a cool box to the National Veterinary Parasitology Laboratory unit in Eritrea. The flotation technique was used to detect and identify eggs of nematodes, cestodes and protozoa parasites, while sedimentation technique was used for detecting trematodes eggs as described by Janina and Mathew, (2021).

2.4 Data Management and Statistical Analysis

Data analysis was done using STATA version 12. One-Way Analysis of Variance (One-Way ANOVA) was used to compare the prevalence

rates of GIT parasites among the villages. The P values for significance was set at 95%.

3.RESULTS

3.1 Prevalence of Gastrointestinal Parasitic Infections among Sheep and Goats in Maekel Region, Eritrea

Overall the prevalence of GIT parasites in sheep and goats in the whole Maekel region was 91.41% (351/ 384). There was no significant difference in the prevalence of parasites among the four villages ($p = 0.69$). However, there was a significant difference between the different species ($p = 0.0001$) with *Haemonchus contortus* (26%) being the most abundant while the *Ostertagia circumcincta* (0.5%) was the least common (Table 1). Among the parasites reported include *Strongyloides*, *Hemonchus*, *Eimeria spp* among others (Table 1, Fig. 2).

3.2 Risk Factors of Gastrointestinal Parasitic Infections

Risk factors associated with helminth infections assessed included frequency of cleaning

animal's houses, water sources for the animals, knowledge of the farmers, screening for parasites, deworming frequencies in relation to GIT-parasites prevalence as explained below.

3.2.1 Water sources

Only 2.5% out of the farmers provided drinking water in a designated area, whereas 27.5% out of the participants did not avail water in a designated area for their animals. In addition, majority of the farmers (70 %) took their animal to dams for drinking (Fig. 3).

3.2.2 Animal house cleaning frequency

Only 5.0% of the farmers cleaned their animal houses regularly (the regularity was some of them in days and others in weeks), while 27.5% of the farmers were cleaning their animals' houses daily. Again, the results indicated the majority of the farmers (62.5%) were cleaning their animals' houses weekly, as 2.5% out of the farmers were cleaning monthly and 2.5%

confirmed that the farmers were cleaning their animal houses annually (Fig. 4).

3.2.3 Knowledge of gastro intestinal parasites by the farmers

Majority of the farmers (70.0%) had only elementary knowledge concerning GIT parasites, as 30% of these farmers had secondary level and none of the farmers from that area had beyond that level.

3.2.4 Frequency of deworming for sheep and goats by farmers

The analysis on the frequency of deworming for the small ruminants showed that only 5% of the farmers dewormed their animals every three months while 12.5% of them dewormed every biannually. Many farmers (42.5%) dewormed their sheep and goats annually whereas 35.0% attested that they dewormed their small ruminants irregularly while 5.0% of the farmers didn't deworm at all (Fig. 5).

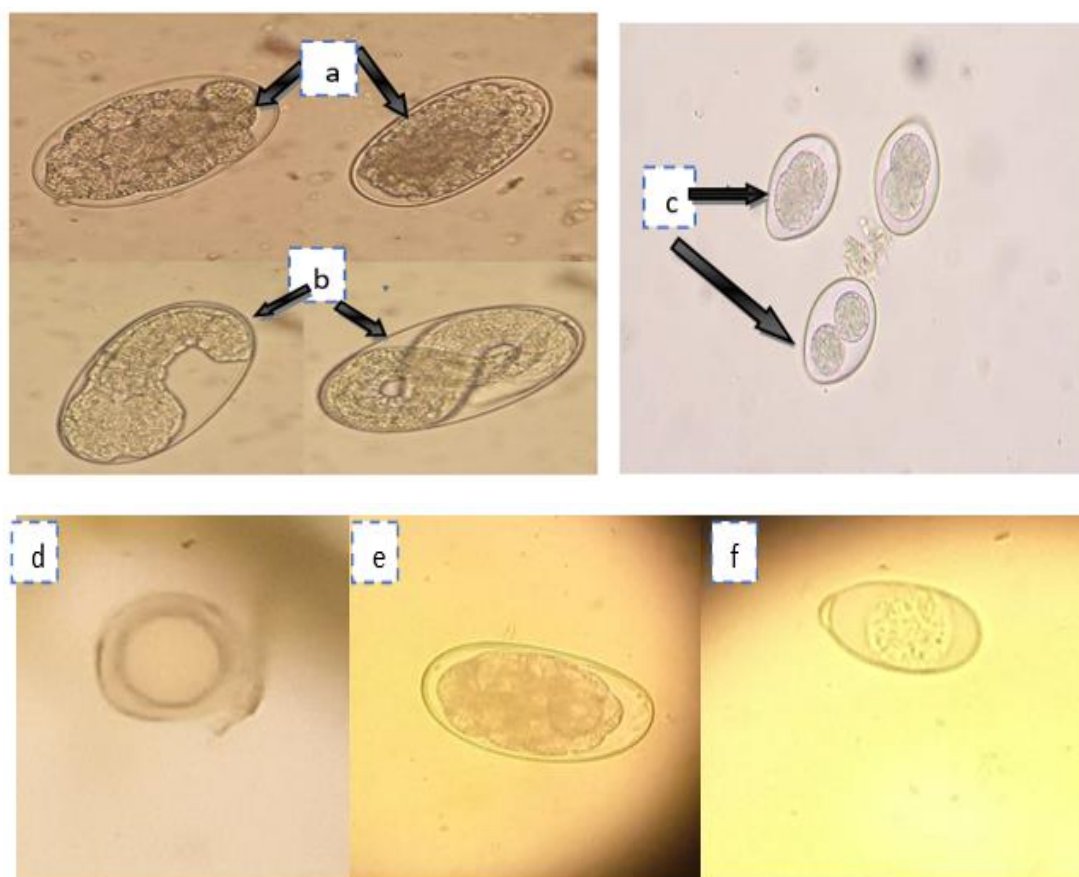


Fig. 2. Different species of gastrointestinal parasites (a-f) detected during diagnosis a) *Strongyl* eggs b) *Strongyloides* eggs c) *Eimeria* d) *Ascaris* egg (X10) e) *Haemonchus contortus* of sheep (X40), f) *Eimeria* spp (magnification X40)

Table 1. Prevalence of GI-parasites in Maekel region, Eritrea

Region		Adi-abeito (n=96)	Kushet (n=94)	Adi-segdo (n=97)	Sembel-Godaif (n=97)	Overall prevalent rate (Maekel region)	ratio	p-value
Infection status	Positive	91(94.79 %)	87(92.55 %)	88(90.72 %)	85(87.63 %)	351(91.41%)	t=40.827	0.0001
Gastrointestinal Parasite							Mean prevalence (%)	
<i>Haemonchus contortus</i>		54 (56.3%)	23 (24.5%)	16 (16.5%)	11 (11.2%)	104 (27.2%)	26	
<i>Eimeria species</i>		28 (29%)	21 (22.3%)	11 (11.3%)	16 (16.3%)	76 (19.79%)	19	
<i>Cooperia species</i>		22 (29.7%)	17 (18.1%)	9 (9.3%)	13 (13.3%)	61 (15.9%)	15.25	
<i>Strongylus species</i>		14 (14.6%)	9 (9.6%)	10 (10.3%)	13 (13.3%)	46 (11.9%)	11.5	
<i>Moniezia Benedini</i>		8 (8.3%)	7 (7.5%)	7 (7.2%)	8 (8.2%)	30 (7.8%)	7.5	
<i>Ascaris species</i>		4 (4.2%)	8 (8.5%)	6 (6.2%)	3 (3.1%)	21 (5.5%)	5.25	
<i>Trichuris globulosa</i>		3 (3.2%)	0 (0%)	5 (5.2%)	5 (5.1%)	13 (3.4%)	3.25	
<i>Dictyocaylus filarial</i>		5 (5.3%)	2 (2.1%)	8 (8.3%)	5 (5.1%)	20 (5.2%)	5	
<i>Osophagostomu Columbianum</i>		1 (1.1%)	2 (2.1%)	5 (5.2%)	6 (6.1%)	14 (3.7%)	3.5	
<i>Paramphistomum cervix</i>		2 (2.1%)	3 (3.2%)	8 (8.3%)	7 (7.1%)	20 (5.2%)	5	
<i>Bunostomum trigunocephelu</i>		2 (2.1%)	0 (0%)	0 (0%)	6 (6.1%)	8 (2.1%)	2	
<i>Chabertia ovina</i>		2 (2.1%)	0 (0%)	7 (7.2%)	5 (5.1%)	14 (3.7%)	3.5	
<i>Nematodirus species</i>		0 (0%)	2 (2.1%)	5 (5.2%)	0 (0%)	7 (1.8%)	1.75	
<i>Ostertagia circumcincta</i>		0 (0%)	2 (2.1%)	0 (0%)	0 (0%)	2 (0.5%)	0.5	
Aggregated						91.33%		

Key: n= number of samples tested

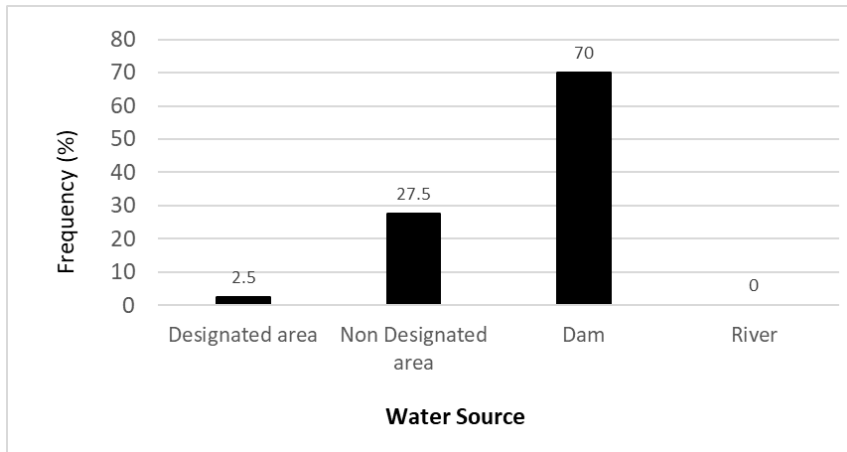


Fig. 3. Sources of water for sheep and goats

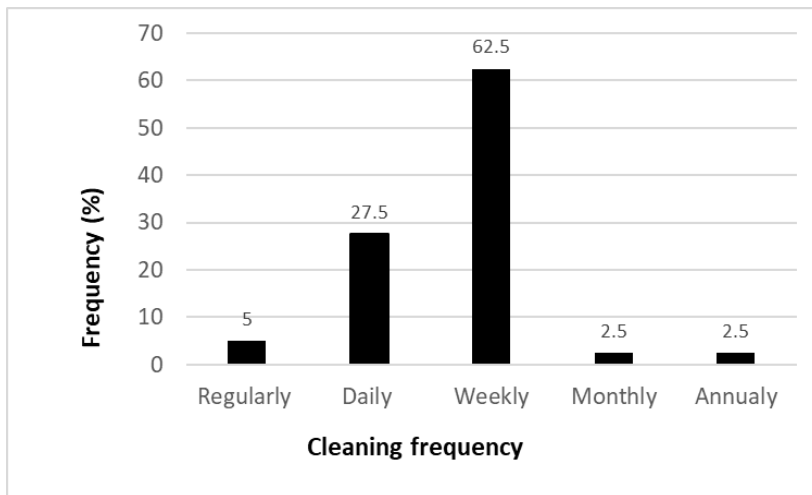


Fig. 4. Cleaning frequency as a possible risk factor for parasite infections

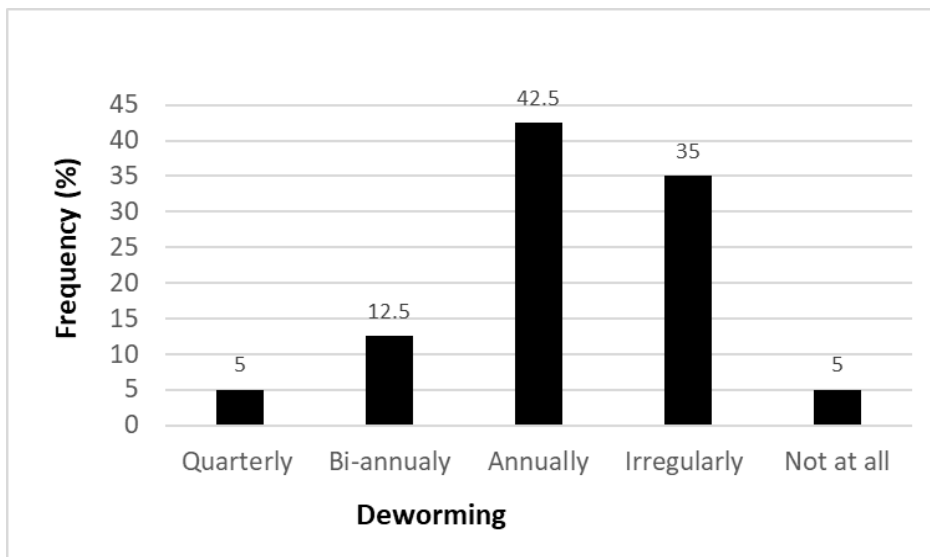


Fig. 5. Frequency of deworming for sheep and goats by farmers

Table 2. Zoonotic helminths parasites recorded in slaughter house of Maekel region, Eritrea within 2022, 2023, and a half year of 2024

Years	Variables		Records			Parasites detected
	Category	Type	Slaughtered	Infected	(%)	
		Sheep and goats	2,182	205	9.40	<i>hydatid cysts, Paraphastumun, Strongyloides, Ascaris, Eimeria sp.</i>
2022(January-December)	Sex	Male	1455	122	8.38	<i>Strongyloides, Ascaris, hydatid cysts, Haemonchus</i>
		Female	727	83	11.42	<i>Strongyloides, Fasciola sp, Moniezia benedini</i>
	Age range	1-3 months	209	31	14.83	<i>hydatid cysts, Haemonchus, Paraphastumun</i>
		4-8 months	745	67	8.99	<i>Trichuris, Paraphastumun, Dictyocaulus filarial, Ascaris</i>
		9months-6years	1228	107	8.71	<i>Hydatid cysts, Strongyloid, Ascaris</i>
2023 (January-December)		Sheep and goats	1,892	179	9.46	<i>Eimeria spp, Strongyloid, Fasciola spp, Ascaris, Paraphastumun, Haemonchus, Dictyocaulus filarial, hydatid cysts, Moniezia benedini</i>
	Sex	Male	1261	108	8.56	<i>Strongyloides, Ascaris, Fasciola sp.</i>
		Female	631	71	11.25	<i>Trichuris, Paraphastumun, Dictyocaulus filarial</i>
	Age range	1-3 months	229	27	11.79	<i>Hydatid cysts, Haemonchus, Eimeria sp., Strongyloides</i>
		4-8 months	528	49	9.28	<i>Strongyloid, Moniezia benedini</i>
		9months-6years	1135	103	9.07	<i>Fasciola sp. Strongyloides, Eimeria sp., Hydatid cysts, Strongyloides</i>
	2024(January-May)		Sheep and goats	743	98	13.19
Sex		Male	594	77	12.96	<i>Strongyloids, Ascaris, Haemonchus</i>
		Female	149	21	14.09	<i>Eimeria spp, Paraphastumun, Dictyocaulus filarial</i>
Age range		1-3 months	57	8	14.04	<i>Strongyloid, Haemonchus, Trichuris</i>
		4-8 months	288	26	9.03	<i>Fasciola spp, Moniezia benedini</i>
		9months-6years	398	64	16.08	<i>Ascaris, Strongyloides, Paraphastumun, Eimeria sp, Dictyocaulus filarial</i>

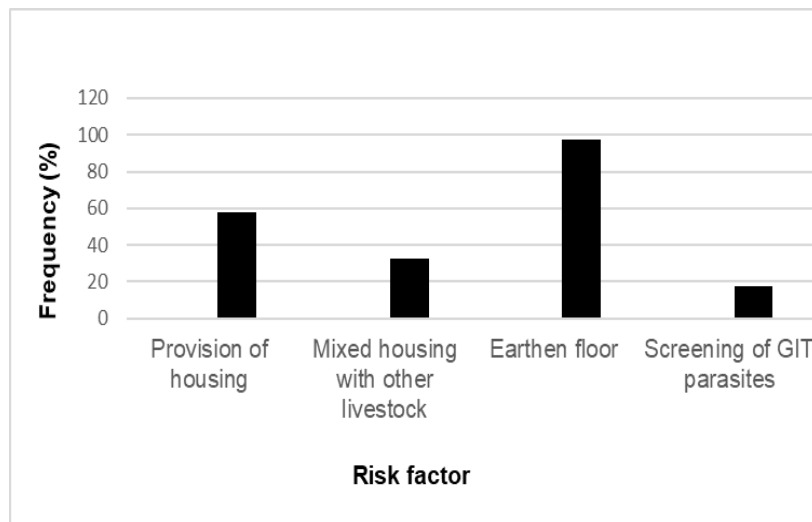


Fig. 6. Other risk factors (housing provision, mixed housing, earthen floor type, screening of GIT parasites)

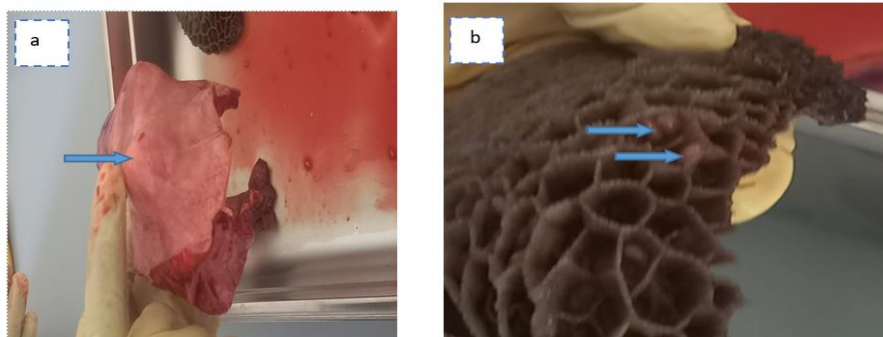


Fig. 7. Organs of sheep and goats, infected with zoonotic helminths. a) Hydatid cyst in lung of sheep (blue arrow), b) *Paraphistomum* egg from the stomach (reticulum) of sheep

3.2.5 Other risk factors

The results indicated that most of the farmers 57.5% provided housing for their animals (Fig. 5). Thirty two (32%) of the farmers indicated to that they mixed housing of small ruminants with other livestock (Fig. 5). In addition, the majority of the farmers (97.5%) had earthen floor type of housing for their sheep and goats while only 2.5% had concrete floor type. Conversely, only 17.5% out of the farmers frequently screened their animals for GIT parasites hence most of them were not aware of the infection status of their livestock (Fig. 6).

3.3 Detection of Zoonotic Helminths from Slaughter House of Maekel Region, Eritrea

The results of parasite infections were included *Strongyloides*, *Ascaris*, hydatid cysts,

Haemonchus, *Eimeria sp*, among the others. The result of parasite infection rates for males was 8.38% in 2022, 8.56% in 2023, and 12.96 % in 2024, while 11.42 % in 2022, 11.25 % in 2023, and 14.09 % in 2024 were the females' parasitic infections. Based on age groups, 4-8 months had an infection rate of 8.99 % in 2022, 9.28 % in 2023 and 9.03 % in 2024. Animals of ages 1-3 months of age had an infection rate of 14.83 % in 2022, 11.79 % in 2023 and 14.04 % in 2024. Animals of ages 9 months up to 6 years had an infection rate of 8.71 % in 2022, 9.07% in 2023 and 16.08 % in 2024 (Fig. 7 and Table 2).

4. DISCUSSION

The most dominant species of the parasites *Haemonchus contortus* while *Ostertagia circumcincta* had the lowest prevalence. The present study also indicated that female animals had a higher prevalence than male ones similarly

reported by Singh et al., (2017) and Islam et al., (2017). This is attributable to the fact that the females are prone to more stressors such as pregnancy and lactation hence weaker immunity during these periods. Another study however reported the opposite indicating high male susceptibility to parasites who attributed this to the genetic predisposition and differential susceptibility owing to hormonal control (Zvinorova et al., 2016). Similarly, the majority of the animals were positive with multiple parasites co-infections which has also been reported (Paul et al., 2020). Gastrointestinal parasites in sheep and goats are associated with diverse adverse effects including, reduced reproduction rate, low weight, low quality of animal products and even death (VanHoy, 2024, Metrology unit staff 2022).

In the current study, there were several risk factors that would contribute to gastrointestinal parasitic infections among sheep and goats. These included lack of provision of housing, mixed housing of small ruminants with other livestock, common water points-dams shared with other animals, irregular deworming, low screening rate by farmers, and low awareness among farmers with regard to GIT parasites. Proper housing of small ruminants is very key in improving animal health and shielding the animals from extreme weather conditions which would work negatively against animal general health. This coupled with concrete flooring would greatly increase control of parasites due to easy management of animal waste. Most of the farmers sourced or watered their small ruminants in dams. Unclean water sources would be a risk factor for animal infections due to faecal contamination of water from contaminated environments following run offs (Abayomi et al., 2018) as well as direct contamination during watering (Titcomb et al., 2021). Given that the watering points were also shared with other animals also increases the infection risks. This is due to the fact that there are also shared GIT infections from other livestock. In pastoralist communities, such watering points are also used by humans hence compounding the transmissions especially the zoonotic parasites (Wardrop et al., 2018). several of which were reported in this study.

Irregular cleaning of animal house causes accumulation of animal waste which contributes to good development ground for parasites including helminth eggs and larvae contributing to maintenance of parasites cycles. The same waste is likely to contaminate nearby grazing

grounds (Waktole et al., 2023). Most farmers in rural communities in Africa have low levels of education. This also limits them to the literacy in control of parasitic infections in livestock (Roshan et al., 2021). Despite small ruminant farming contributing greatly to economy of the several countries, there is limited investment by governments in provision of disease control measures including extension services and sensitization as compared to other livestock like cattle. In addition, small ruminant farmers don't invest in food security for their livestock and almost entirely depend on grazing hence malnutrition is a major setback in small ruminant farming. It has been shown that increasing community awareness has a great impact in control of GIT parasites (Solomon et al., (2021). Poor management/husbandry has been reported to contribute to high prevalence of GIT parasites (Dogo et al., 2017).

Most farmers, especially pastoralists are also known to self-prescribe and treat their livestock by themselves. For conventional drugs such as dewormers, this leads to abuse of drugs due to issues of either underdose or overdose and persistent use of few classes of antihelminth. This is a major contributor to antihelminth resistance (Antunes, 2022). However, farmers especially pastoralists are also known to use herbs for deworming (Hafiz et al., 2021). On a positive note, small ruminants especially goats are also known to self-medicate by feeding on herbs which makes them more resistant to helminths compared to other livestock.

Zoonotic parasites reported include *Strongyloides*, *Ascaris*, *hydatid* cysts, *Haemonchus*, *Fasciola* and *Eimeria* species among the others. These are both helminths and one protozoa *Eimeria* though other studies have also reported several protozoan zoonoses in goats including *Cryptosporidium* and *Giardia* among others (Ikpe et al., 2022, Roshan et al., 2021). Sheep and goats therefore serve as reservoir hosts for most human helminths (Karshima et al., 2018) such as hydatidosis and other soil transmitted helminths. The zoonotic transmission potential is also contributed by the complex interaction of animals, man and their environment which is sometimes pose a challenge to control (Andernice et al., 2021).

The reported high prevalence of sheep and goats with zoonotic parasites is worrying because these animals form the most preferred source of meat for the local communities. In addition, in

several communities it has been reported that people consume raw meat, milk (Ngoshe et al., 2022) and blood. This practice is a major source of zoonotic parasite transmission (Kiani et al., 2021) and can also contribute to the high prevalence in the study site as the parasite cycles are well maintained. One health approach would be a key approach in controlling such parasitic infections (Rushton and Bruce, 2017, Deiana et al., 2024). There have been efforts by WHO through Ministries of health in introducing one health approach in controlling NTDs by including this in their strategic plans. However, the uptake is still low since most NTDs control program officers are not well vast with the process. This is due to the fact that initially, human diseases control programs were very independent from livestock diseases programs yet humans and livestock inhabit same environment. In addition, despite many control measures in the human population including several rounds of mass deworming (Fenwick, 2011) water sanitation and hygiene (WASH) activities, there has still been new cases reported. If the livestock and environmental control measures are not well instituted, then livestock would continue being sources of transmission of zoonotic parasites to humans. Collaboration between livestock, medical and other professionals in control of GIT parasites therefore is inevitable.

5. CONCLUSION

There were several GI-parasitic infections in sheep and goats in the Maekel region including *Haemonchus* sp, *Eimeria* sp, *Cooperia* sp, *Strongylus* sp., *Monezia* sp, *Ascaris*, *Trichuris*, *Dictyocaulus filarial*, *Oesophagostomum columbianum*, *Paramphistomum cervi*, *Bunostomum trigunocephelum*, *Chabertia ovina*, *Nematodirus*, *Ostertagia circumcincta*. The risk factors associated with gastrointestinal parasitic infections included poor housing, mixed housing with other animals, dam or common water supply with other livestock, irregular deworming and poor knowledge of farmers on GIT parasites. Several zoonotic parasites were reported from slaughter house including *hydatid cysts*, *Strongyloides*, *Trichuris*, *Ascaris*, *Fasciola* sp, *Paraphastumun*, *Dictyocaulus filarial*, *Haemonchus* sp.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models

(ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

CONSENT AND ETHICAL APPROVAL

The study was approved by Maekel administration state of Eritrea (Ref No. 02/3/1245/24). The participation of farmers was through informed consent and voluntary. They were informed of their right to withdraw at any time. Any information obtained from the participants was kept strictly confidential. During sampling, animals were restrained following standard procedure to minimize discomfort and ensure animal welfare. Fecal samples were collected by trained animal health technicians and veterinary professionals while applying recommended precautions and safety procedures.

ACKNOWLEDGEMENT

I would like to sincerely thank to all the farmers for their participation and Maekel region officers for their permission and assistance during collecting the data and samples of my study. In addition I also appreciate Veterinary parasitology unit staffs at Villajo-Asmara Eritrea technical support and advice. The National Animal and Plant Health Laboratory under the Ministry of Agriculture State of Eritrea are also hereby acknowledged for providing the facilities for laboratory analysis and supplying the laboratory consumables for this research work. Finally, and mostly, I would like to thank staffs in the Department of Zoological Sciences, School of Pure and Applied Sciences and Graduate School of Kenyatta university.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Abayomi, E. A., Temitope, T. S., Azonchi, A. H., Folakemi, O. K., & Dana'an, A. D. (2018). Parasitic contamination of some vegetables sold at two major markets in Jos, Nigeria. *University of Sindh Journal of Animal Sciences*, 2(3), 01-09.
- Andernice, S. Z., Lucas, F. D., Marta, S. M. A., Herakles, A. G., Daniel, M. A., Omar, A. E., & Antonio, F. M. (2021). Diversity and

- prevalence of intestinal parasites of zoonotic potential in animal hosts from different biomes in central region of Brazil. *Annals of Parasitology*, 67(1), 95–105.
- Antunes, M. I., Lima, M. S., Stilwell, G., Romeiras, M. I., Fragoso, L., & Madeira de Carvalho, L. M. (2022). Anthelmintic efficacy in sheep and goats under different management and deworming systems in the region of Lisbon and Tagus Valley, Portugal. *Pathogens*, 11(12), 1457.
- Deiana, G., Arghittu, A., Dettori, M., & Castiglia, P. (2024). One World, One Health: Zoonotic diseases, parasitic diseases, and infectious diseases. *Healthcare*, 12(9), 922.
- Dogo, G. I., Abraham, K., Karaye, P., Gloria, P., Patrobas, M. G., Galadima, M., & Gosomji, I. J. (2017). Prevalence of gastrointestinal parasites and their impact in domestic animals in Vom, Nigeria. *Saudi Journal of Medical and Pharmaceutical Sciences*, 3(3), 211-216.
- Fenwick, A. (2011). The neglected tropical diseases: Current status of control and the UK contribution. In Institute of Medicine (US) Forum on Microbial Threats. *The Causes and Impacts of Neglected Tropical and Zoonotic Diseases: Opportunities for Integrated Intervention Strategies*. Washington (DC): National Academies Press.
- Hafiz, M. R., Muhammad, S. S., Asim, S., Haider, A., Abdu, Q., Mahvish, M., Muhammad, A. M., Zubaria, S. A. (2021). Sheep parasitism and its control by medicinal plants: A review. *Parasitologists United Journal*, 2(14), 1687-7942.
- Hiwot Desta Wodajo, Biruk Alemu Gameda, Wole Kinati, Annet Abenakyo Mulem, Anouka van Eerdewijk, & Barbara Wieland. (2020). Contribution of small ruminants to food security for Ethiopian smallholder farmers. *Small Ruminant Research*, 184, 106064.
- Ikpe, R. T., Agbendeh, L. N., & Akinsuyi, O. S. (2022). Prevalence study of zoonotic gastrointestinal parasitic infections in goats in Makurdi Metropolis, Nigeria. *Journal of Zoonotic Diseases*, 6(1), 11-16.
- Islam, M. S., Hossain, M. S., Dey, A. R., Alim, M. A., Akter, S., & Alam, M. Z. (2017). Epidemiology of gastrointestinal parasites of small ruminants in Mymensingh, Bangladesh. *J Adv Veterinary Animal Research*, 4(4), 356–362.
- Janina, M.-D., & Matthew, P. (2021). Evaluating methods for conducting fecal egg count reduction tests in sheep using McMaster technique, Mini-FLOTAC and pooled counts. *Australian Wool Innovation Limited*, 6, 68.
- Karshima, S. N., Maikai, B. V., & Kwaga, J. K. P. (2018). Helminths of veterinary and zoonotic importance in Nigerian ruminants: A 46-year meta-analysis (1970-2016) of their prevalence and distribution. *Infect Dis Poverty*, 7(1), 52.
- Kiani, B., Budke, C. M., Shams Abadi, E., et al. (2021). Evaluation of zoonotic platyhelminth infections identified in slaughtered livestock in Iran, 2015–2019. *BMC Vet Res*, 17, 185.
- Metrology unit staff. (2022). Annual work report on meteorological records. *Public relations ministry of agriculture Eritrea*, annual report magazine.
- MSD Veterinary Manual. (n.d.). Common gastrointestinal parasites of small ruminants. Retrieved from <https://www.msdsvetmanual.com/digestive-system/gastrointestinal-parasites-of-ruminants/common-gastrointestinal-parasites-of-small-ruminants>
- Ngoshe, Y. B., Etter, E., Gomez-Vazquez, J. P., & Thompson, P. N. (2022). Knowledge, attitudes, and practices of communal livestock farmers regarding animal health and zoonoses in far northern KwaZulu-Natal, South Africa. *Int J Environ Res Public Health*, 20(1), 511.
- Paul, B. T., Jesse, F. F. A., Chung, E. L. T., Che'Amat, A., & Mohd Lila, M. A. (2020). Risk factors and severity of gastrointestinal parasites in selected small ruminants from Malaysia. *Veterinary Sciences*, 7(4), 208.
- Roshan, B. A., Rajendra, P. P., Mahendra, M., & Tirth, R. G. (2021). Prevalence and risk factors of gastrointestinal parasites in the Chepangs in Nepal. *Annals of Parasitology*, 67(3), 387–405.
- Rushton, J., & Bruce, M. (2017). Using a One Health approach to assess the impact of parasitic disease in livestock: How does it add value? *Parasitology*, 144(1), 15-25.
- Singh, E., Kaur, P., Singla, L. D., & Bal, M. S. (2017). Prevalence of gastrointestinal parasitism in small ruminants in western zone of Punjab, India. *Vet World*, 10(1), 61–66.
- Solomon, G., Biruk, A., Hiwot, D., Tadiwos, A., Tesfaye, M., Mesfin, M., Asrat, A., &

- Barbara, W. (2021). Community-based approach for the control of gastrointestinal parasites under smallholder sheep farming systems. *International Livestock Research Institute (ILRI), Ethiopia*, Component 2 of the HEARD project.
- Titcomb, G., Mantas, J. N., Hulke, J., (2021). Water sources aggregate parasites with increasing effects in more arid conditions. *Nat Commun*, 12, 7066.
- VanHoy, G. (2024). Common gastrointestinal parasites of small ruminants.
- Waktole, T., Bersissa, K., Dinka, A., Anna, M., Cinzia, T., & Rudi, C. (2023). Epidemiology of gastrointestinal parasites of cattle in three districts in central Ethiopia. *Animals*, 13, 285.
- Wardrop, N. A., Hill, A. G., Dzodzomenyo, M., Aryeetey, G., & Wright, J. A. (2018). Livestock ownership and microbial contamination of drinking water: Evidence from nationally representative household surveys in Ghana, Nepal, and Bangladesh. *Int J Hyg Environ Health*, 221(1), 33-40.
- Win, S. Y., Win, M., Thwin, E. P., Htun, L. L., Hmoon, M. M., Chel, H. M., Thaw, Y. N., Soe, N. C., Phyo, T. T., Thein, S. S., Khaing, Y., & Than, A. A., Bawm, S. (2020). Occurrence of gastrointestinal parasites in small ruminants in the central part of Myanmar. *J Parasitol Res*, 8826327.
- Zvinorova, P. I., Halimani, T. E., Muchadeyi, F. C., Matika, O., Riggio, V., & Dzama, K. (2016). Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research*, 143, 75-83.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2025): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://pr.sdiarticle5.com/review-history/132059>