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Study on gastrointestinal nematode parasite infections of donkey in and around shone town, Hadiya zone, Southern Ethiopia

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ABSTRACT

One of the most common factors limiting donkey health and productivity is infection with gastrointestinal nematode parasites. From December 2021 to May 2022, a cross-sectional study was conducted in and around Shone town, Hadiya zone, southern Ethiopia, to estimate the prevalence of donkey GIT nematode parasite infection and to assess its associated risk factors. For the coprological examination, 384 simple randomly selected donkeys were sampled from four peasant associations. To identify parasitic eggs in feces, the standard flotation technique was used. In the donkeys examined, the overall prevalence of gastrointestinal nematodes was 75.26% Strongyles (48.17%), *Parascaris equorum* (11.45%), Strongyloides (5.99%), and mixed infection (Strongyles + Parascaris (9.11%) and Strongyles + Strongyloides (0.52%)) were the most commonly encountered nematodes. There was also a statistically significant difference in the prevalence of donkey gastrointestinal parasites by sex, body condition, and management system ($p < 0.05$). Donkeys with semi-intensified (OR = 8.99) and poor body condition (OR = 6.48) were at an increased risk of infection compared to intensive management and good body condition. In conclusion, the current study demonstrated that gastrointestinal nematodes are the major health challenges for donkeys in the study area. As a result, strategic regular deworming, improved housing, and feeding management were recommended to improve the health and productivity of donkeys in the study area.

1. Introduction

Ethiopia is a developing African country that is primarily agricultural, with more than 85% of its population engaged in farming activities [1]. The country has many agroecological zones, which has aided in the development of diverse agricultural production systems. Animal production is practiced across the country's ecological zones [2]. With 43.1 million cattle, 23.6 million sheep, 18.6 million goats, 4.5 million donkeys, 1.7 million horses, 0.33 million mules, 34.2 million chickens, and 4.9 million beehives, Ethiopia has the largest livestock population in Africa [3].

The *Equus asinus*, a member of the Equidae family, was domesticated around 5000 years ago in Africa and now has a global distribution [4,5]. The *Equus asinus* is thought to have descended from the Nubian wild assailant [6]. The world's donkey population is estimated to be over 44 million, with half of them living in Asia, a quarter in Africa, and the remainder mostly in Latin America [6]. They are used for work, breeding, milking, and meat production in 98% of Africa's semi-arid zones [4,7,34]. It is an excellent choice in

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areas where other terrains, such as mountains and cities with narrow streets, make it difficult to transport goods [8]. They are also vital in agriculture and industry [3]. They are kept and used for energy and soil fertility in tillage, cultivation, and threshing, as well as manure [8].

Donkeys are used to lend to neighbors, gain access to medical care, and sell in times of emergency [9]. Because they are peaceful and thus easier to handle by both women and children, they benefit women more than other working animals such as oxen [10]. Donkeys are known for their toughness and strength. They are, however, susceptible to parasitic diseases [11,12]. Parasitism is recognized as the leading cause of morbidity and mortality in these animals [12–14], including small strongyles (*Cylicocyclus elongatus* and *Cyathostomum pathratum*), large strongyles (*Strongylus vulgaris, Strongylus equinus*, and *Strongylus edentatus*), *Triodontophorus* species, *anoplocephalid* tapeworms, ascarids (*Parascaris equorum*) donkeys [15]. Nematode parasites cause poor condition, decreased efficiency, poor reproductive performance, stunted growth, and mortality in horses, donkeys, and mules [7,16].

Gastrointestinal nematodes pose a serious health risk, causing poor body condition, decreased power output, decreased productivity, and a short lifespan [7,15]. Donkeys are frequently referred to as study animals, although they are susceptible to a variety of diseases and are usually asymptomatic carriers [17]. Aside from a few studies in other parts of Ethiopia, no previous research on gastrointestinal (GIT) nematodes of donkeys in and around Shone town had been conducted. As a result, the current study was conducted to determine the prevalence and risk factors for gastrointestinal nematode infections in donkeys of the shone district, Hadiya zone, southern Ethiopia.

2. Materials and methods

2.1. Study area

The research was carried out in and around Shone town, Hadiya zone, Southern Ethiopia. This is 76 km from the zone capital of Hosanna and 334 km from Addis Ababa. The Wereda is one of the Hadiya zones' 11 Wereda. It is situated at 643'44 N latitude and 3745' 51″ E longitude, with an altitude range of 1500–2500 m.a.s.l. The shone district has an ecological zone of 100% midline. According to Shone Town, agricultural statistics information the animal population in Shone has about 747,76 chickens, mule 52, 428 horses, 834 donkeys, 123,19 goats, 457,15 sheep, and 93,040 cattle [18].

2.2. Study animals

The study populations consisted of indigenous donkey breeds with varying body conditions, ages, sex, management, and origin found in and around Shone town.

2.3. Study design

From December 2021 to May 2022, a cross-sectional study was carried out in Shone Town to estimate the prevalence and associated risk factors of the GIT Nematode parasite of donkeys.

2.4. Sample size determination

The sample size of the study was determined using the formula given by Thrusfield [19]. Because there was no research on gastrointestinal nematodes in the area, an expected prevalence of 50% was used to determine the sample size. The desired sample size for the study was calculated with a 95% confidence interval and 5% absolute precision used.

$$n = 1.96^2 \text{ x Pexp } (1 - \text{Pexp})/d^2,$$

where: n = required sample size; Pexp = expected prevalence (P = 50%), d = desired absolute precision, Z = 1.96 for 95% confidence interval.

$$n = 1.96^2 * 0.5(1 - 0.5)/\ 0.05^2$$

$$n = 3.84 \times 0.25/\ 0.0025 = 384$$

Therefore, a total of 384 donkeys were randomly selected for the study.

2.5. Sampling method and sample collection

The 384 fecal samples were collected from donkeys in the study area using a simple random sampling technique. The age of the study donkeys was determined based on dentition patterns (the twelve front incisors, the shape of the permanent upper corner of the incisors and table of the central incisors, and the disappearance of enamel ring) as described [20], and grouped Young (<5 years), adult (5–10 years) and old (>10 years). Body condition scoring (BCS) (poor, medium, and good) of the working donkey was estimated based on the deposition of body fat in different areas by separate examination of the neck, back, ribs, pelvis, and rump [21]. The donkeys were reared under semi-intensive, intensive, and extensive management systems, and the targeted donkey treatment history was gathered and excluded if it has deworming or treatment history for the past 2 weeks before collecting the sample. Then, donkeys were restrained during sample collection. After restraining, approximately 10 g of fecal samples were collected directly from the rectum or recently defecated feces with gloved hands. Each sample was labeled with the animal's identification (management, sex, age, BCS, and owner's name) and then transported in a cool box to the Sodo regional veterinary laboratory, department of Veterinary Parasitology, and stored at 4 °C until coprological analysis.

2.6. Coprological analyses

Flotation methods were used to examine feces [22]. The flotation fluid used in the study was a sodium chloride supersaturated solution made in the lab (NaCl). For fecal flotation, standard parasitological procedures were used [23]. Because only floatation methods were used to examine feces, other parasites were not detected like cestodes, protozoa, and trematodes.

The McMaster egg counting technique was also used to count the eggs [24]. The severity of helminth infection was determined by counting the number of eggs per gram of feces (EPG). Donkeys with an EPG of 500 or less were considered to have a mild infection, while those with an EPG of 500–1000, moderate, or greater than 1000 eggs/gram of feces were considered to have a severe infection [25].

Furthermore, the equine owner provided clinical symptoms that were used to classify the donkeys. Donkeys with a history of unthriftiness, depression, anorexia, emaciation, severe anemia, pruritis, severe colic, and diarrhea were classified as severe, whereas donkeys with a history of thin body condition, anemia, colic, and intermittent diarrhea were classified as moderate. Donkeys that had a history of moderate body condition and appeared to be in good health were classified as mildly infected [20].

2.7. Data management and analysis

The fecal examination data were coded and entered into a Microsoft Excel spreadsheet before being analyzed with STATA 13 (Stata Corp LP, College Station, TX) software. The prevalence of gastrointestinal parasites was calculated as a percentage of the affected donkeys out of the total examined. Logistic regression analyses (reporting odds ratio) were conducted using gastrointestinal nematode parasite infection as outcome variables against each of the explanatory variables of the hypothesized risk factors (origin, age, sex, and body condition score and management system. The explanatory variables with a p-value $\leq$0.25 in univariable analyses were selected for multiple logistic regression analyses. The final multiple logistic regression models were manually built using a forward stepwise selection approach. A variable was to be considered a confounder if it changed the coefficient of the significant variables by more than 25%. Variables with a significant odds ratio (OR) value at a 95% confidence interval were considered to have an association, and the level of significance was considered when the p-value was less than 0.05.

3. Results

3.1. Prevalence of GIT nematodes parasite

The 384 fecal samples were collected from donkeys and tested for the presence of various Gastrointestinal nematode parasites. The 289 donkeys tested positive, with an overall prevalence of 75.26% (95% CI: 70.67%–79.33%). Among the 384 donkeys examined,

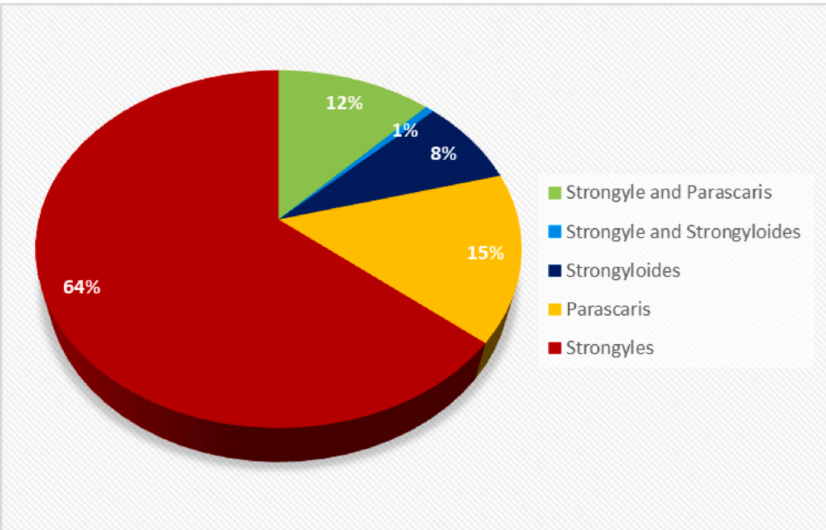

Fig. 1. Proportion of the different types of Gastrointestinal parasites.

48.17% were positive for strongyles, followed by 11.45% were positive for Parascaris, and 5.99% were positive for Strongyloides (Fig. 1).

3.2. Association of risk factors with the prevalence of gastrointestinal nematode infection

Risk factors such as donkey sex, management, and body condition all showed a statistically significant difference ($p < 0.05$) in the occurrence of GIT nematodes.

3.3. Univariable logistic regression analysis of risk factors with gastrointestinal nematode infection

A univariable regression analysis was performed on the study animals to estimate the strength of the association of risk factors with gastrointestinal parasite infection (see Table 1). The univariable logistic regression analysis of the risk factors revealed a strong relationship between the occurrence of GIT nematode infections and the risk factors of sex, management, and body condition (Table 2). (Table 2) displays the $p < 0.05$ for sex, management, and body conditions, which are all statistically significant. Females are three times more likely than males to become infected (OR = 2.83). Donkeys with poor body conditions are four times more likely to be infected than donkeys with good body conditions (OR = 4.46). Medium body conditions are two times more likely to be infected than good body conditions (OR = 2.22). Semi-intensified donkeys are eight times more likely to be infected than intensified donkeys, while extensively managed donkeys are seven times more likely to be infected than intensified (OR = 7.12) donkeys infected with good body mass conditions (Table 2).

3.4. Multivariable logistic regression analysis of risk factors with gastrointestinal nematode infection

The multivariable logistic regression analysis revealed a strong association between the occurrence of GIT nematode infections and management and body condition. Furthermore, as shown in (Table 3), management and BCS were found to be statistically significant ($p < 0.05$). Poor and medium body conditions are six and two times more likely to be infected than good body conditions, respectively. Semi-intensively and extensively managed donkeys are nine and six times more likely to be infected than intensively managed donkeys, respectively (Table 3).

4. Discussion

In the current study, the overall gastrointestinal nematode parasite counts in donkeys in and around Shone town was 75.26%. This result is consistent with the findings of [26] in the South Wollo zone (70.4%) [27]. reported a prevalence of 37.48% in donkeys in South Darfur state, which is lower than the current finding. The current findings were lower than the results of Mezgebu et al. [3], Sawsan et al. [27], Fesseha et al. [16], and Ayele et al. [1], for GIT helminths parasite infection of equine in the vicinity of Gondar, Hawassa Town, and Dugda Bora District, which were 92.71%, 96.9%, 100%, and 98.2%, respectively. This difference could be attributed to differences in the study areas; deworming strategy and access to the veterinary clinic, and nutritional status of the animal in the respective study area. It could also be the result of the owner's management issues.

Strongyle spp. had the highest prevalence, with 48.17% of the donkeys showing evidence of infection, followed by *Parascaris equorum* (11.45%), and Strongyloides (5.99%). Strongyles were found in 48.17% of the donkeys in the current study, which is higher than the result (32.6%) found in equines in Kombolcha town [29]. Strongyle infections are linked to the biology and epidemiology of these parasites because they take longer to complete their life cycle (small strongyle 2–3 months whereas large strongyle requires a longer period), and there is a significant change in worm population and burden over time under different anthelmintic pressures.

The prevalence of *Parascaris equorum* (11.45) in the current study is lower than in the study Mulate et al. [2], which reported

Table 1
Prevalence of gastrointestinal nematode parasite and risk factors in study districts.

Variables	Category	No of examined	No of positive	Prevalence (%)	95%CI
Origin	Arencha	93	63	67.74	57.53–76.50
	Lalogeribe	98	77	78.57	69.27–85.64
	Licha	110	79	71.81	62.641–79.48
	Gerebuligita	83	70	84.33	74.77–90.73
Sex	Male	348	257	73.85	68.96–78.22
	Female	36	32	88.88	73.53–95.84
Age group	Young	63	44	69.85	57.33–79.96
	Adult	254	195	76.77	71.15–81.58
	Old	67	50	74.62	62.78–83.68
Management system	Semi-intensive	244	206	84.42	79.29–88.47
	Intensive	80	33	41.25	30.94–52.39
	Extensive	60	50	83.33	71.56–90.86
Body Condition score	Poor	53	47	88.67	76.81–94.88
	Medium	196	156	79.59	73.33–84.69
	Good	135	86	63.79	55.21–71.42

Table 2
Univariable logistic regression analysis of potential risk factors associated with Gastrointestinal Nematode Infection.

Variables	Category	Prevalence (%)	OR	95%CI	*P*-value
Origin	Gerebuligita	84.33	2.56	1.23–5.34	0.012
	Lalogeribe	78.57	1.74	0.91–03.34	0.093
	Licha	71.81	1.21	0.66–2.21	0.52
	Arencha	67.74	Ref.	–	–
Sex	Female	88.88	2.83	0.97–8.23	0.034
	Male	73.85	Ref.	–	–
Age group	Adult	30.15	1.42	0.77–2.63	0.87
	Old	25.37	1.27	0.58–2.74	0.065
	Young	23.22	Ref	–	–
Management system	Semi-intensive	84.48	7.72	4.39–13.56	≤0.0001
	Extensive	83.33	3.16-	7.12–16.03	≤0.0001
	Intensive	41.25	Ref.	–	–
Body condition score	Poor	88.67	4.46	1.77–11.19	≤0.0001
	Medium	79.59	2.22	1.35–3.64	≤0.005
	Good	63.70	Ref.	–	–

Table 3
Multivariable logistic regression analysis of potential risk factors associated with the Gastrointestinal Nematode Infection.

Variables	Category	Prevalence (%)	OR	95%CI	p-value
Management system	Semi-intensive	84.48	7.72	4.39–13.56	≤0.0001
	Extensive	83.33	3.16-	7.12–16.03	≤0.0001
	Intensive	41.25	Ref.	–	–
Body condition score	Poor	88.67	4.46	1.77–11.19	≤0.0001
	Medium	79.59	2.22	1.35–3.64	0.005
	Good	63.70	Ref.	–	–

36.02% and 43.8% in the South and North Wollo zones, respectively. The current study's lower finding could be attributed to the age difference in the examined animals. After six months of age, equines typically develop significant resistance to *P. equorum*. The prevalence of Strongyloides in the study area, 5.99%, is less than Getachew et al. [30], who found 11% in the gastrointestinal tracts of working donkeys in Ethiopia. Also, the finding differs from the 24.5% prevalence found by Shrikhande et al. [32], in the incidence of helminth parasites in donkeys in Nappur. This difference is caused by variations in environmental temperature and humidity, as warm and moist environments favor their development. This study, like previous works by Ref. [30] discovered mixed infections. In the current study, poor management of donkeys and grazing pasture may have contributed to the mixed infection.

GIT nematode occurrence has been linked to risk factors such as donkey management, and body condition and statistically significantly ($p < 0.05$). Ayele et al. [1], and Yoseph et al. [31], supported these findings which point to a significantly different prevalence.

According to the current study, the prevalence was significantly higher in animals with poor body conditions, at 88.67%, than in donkeys with moderate and good body condition scores, at 79.59% and 63.70%, respectively. The observed difference was statistically significant ($p < 0.05$). This indicated that equines with poor body conditions were more likely to harbor the parasites. This could be because animals with poor body conditions have compromised immune systems, most likely as a result of malnourishment and increased workload, as well as parasitism exposure. Poor body condition score, on the other hand, could be due to parasitism, and in this case, body condition score is considered a dependent factor rather than a risk factor. However, according to the current research, it is a risk factor for parasitism. This is consistent with the findings of Ayele et al. [1], and Mathewos et al. [33], who discovered that animals with poor body conditions had a higher prevalence of helminth parasites than animals with good body conditions.

There was a highly statistically significant difference ($p < 0.05$) in terms of the management system. The prevalence of helminth infection was higher (84.48%) in semi-intensive systems, while it was 83.33% and 41.25% in extensive and intensive management systems, respectively. Animals kept in semi-intensive management systems and used for packing, transport, and carting had higher workloads than animals kept in extensive systems. Extensive animals used for packing and transport were found to have a higher parasitism prevalence than intensive animals used for cart pulling, which could be explained by the difference in management care provided to these groups of animals. The donkey used for cart pulling is given special care, such as deworming and supplementary feeding. Furthermore, because these animals were at work, they had less opportunity to graze, lowering their risk of infection.

Female donkeys were found to be three times more susceptible to gastrointestinal parasites than males in this study. Poor body condition donkeys were found to be four times more likely to be infected with parasites in this study. Infection is two times more likely in medium body conditions than in good body conditions. It is related to donkey immunity; donkeys with low and medium immunity have poor resistance to the parasite.

Semi-intensified donkeys were eight times more likely to be infected than intensified donkeys in this study. This meant that semi-intensified donkeys were more likely to be infected by the parasite. This could be because semi-intensified animals may be immune-compromised due to the high workload, and extensively managed donkeys were seven times more likely to be infected than intensified ones. The current study revealed that donkeys from the origins of Gerebuligita, Lalogeribe, and Licha are 2.56, 1.74, and 1.21 times more likely to be infected than the origin Arencha, respectively.

4.1. Limitations of the study

In the current study, there was no attempt at fecal culture or larval identification. This is due to the length of the study. The study periods were pressed to not culture faces and perform larval identifications. It is too short to put on a show of culture. The sample collected from the field and processing has also had an impact on culture, as the field is far from a laboratory. As the researcher returns to the laboratory for coprological examinations, the allowed time at the lab is scheduled, and without that schedule, following the cultured sample is not allowed. That is laboratory guidelines. Furthermore, because the study's objectives are prevalence estimations rather than culture and larval identifications, this is not included.

5. Conclusion

This study found a high prevalence of gastrointestinal parasites in donkeys of Shone and suburbs. According to the findings of this study, the major helminths in and around Shone town are gastrointestinal nematodes of donkeys (Strong*yles, Parascaris, Strongyle* + *Parascaris, Strongyloides, and Strongyle* + *Strongyloides* with a prevalence of 75.26% (48.17%, 11.45%, 9.11%, 5.99, and 0.52 for each Strongyles, Parascaris, Strongyloides, and Strongyloides, respectively). The most prominent risk factors associated with gastrointestinal nematode infection are management and body condition. Hence, extension programs on donkey management should be distributed to owners by governmental and non-governmental organizations. Strategic treatment and improved pasture management must be used to avoid excessive pasture contamination. It is necessary to remove manure from donkeys daily to avoid contamination of food and water by eggs and larvae that help suppress the life cycle. Further study should be done on larval identifications and awareness creation for owners.

Ethical approval

Ethical consent was perused from Wolaita Sodo University, Research Review Committee to collect research and conduct the research, and the committee approved this research work.

Authors' contributions

GB, ZT, HF, IA, and TT conceived and designed the experiments; performed the experiments, and wrote the paper. TT contributed reagents, materials, analysis tools or data; HF and IA; analyzed and interpreted the data; All authors contributed and approved the submission of the final manuscript.

Data availability

All the datasets generated or analyzed during this study are included in this manuscript.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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