OPEN ACCESS
Advances in Animal and Veterinary Sciences

Research Article

Identification and Occurrence Rate of Gastrointestinal Parasites in Slaughtered Sheep at the Alexandria Abattoir in Magelang, Central Java, Indonesia

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Abstract | Gastrointestinal (GI) parasites significantly reduce productivity and compromise health in sheep. This study aimed to identify GI parasites and determine their incidence in sheep slaughtered at the Alexandria Slaughterhouse, Magelang Regency, Indonesia, by tracing the origin of the livestock, all of which had been fattened and treated with anthelmintics only in the early stages of rearing. However, the dosages used were not documented. GI parasites were identified through post-mortem examination of digestive tracts based on morphological characteristics. The overall occurrence rate was calculated using the Wilson confidence interval method at a 95% confidence level via Epitools. Among 89 sheep examined, 30 were infected, giving a prevalence of 33.71% (95% CI: 24.74–44.02%). Detected parasites included *Haemonchus* sp., *Moniezia* sp., and *Fasciola* sp., with *Haemonchus* sp. accounting for over 90% of infections. Infection rates varied by origin, with sheep from Muntilan livestock market showing the highest proportion (48.6%), followed by Pengasih livestock market (27.3%) and Ambarketawang livestock market (21.9%). A chi-square analysis indicated that this difference approached statistical significance (χ^2 = 5.87, df = 2, p = 0.053). Females had a significantly higher infection rate (38.7%) than males (7.1%), a significant difference (χ^2 = 3.93, df = 1, p = 0.048), while age was not significantly associated with infection (χ^2 = 0.36, df = 1, p = 0.55). Despite the prior deworming, the relatively high prevalence suggests potential issues with anthelmintic efficacy or administration practices. These results underscore the need for enhanced animal health monitoring, standardized anthelmintic treatment protocols, and longitudinal studies that consider source-specific management factors and infection intensity to improve the understanding and control of GI parasite epidemiology in sheep.

Keywords | Abattoir, Gastrointestinal parasites, Infection, Occurrence, Post-mortem, Sheep

Received | November 03, 2025; **Accepted** | December 09, 2025; **Published** | January 10, 2026
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Citation | Awaludin A, Sawitri DH, Wardhana AH, Nugraheni YR, Mubarokah WW, Wibowo SE, Andityas M (2026). Identification and occurrence rate of gastrointestinal parasites in slaughtered sheep at the alexandria abattoir in Magelang, Central Java, Indonesia. Adv. Anim. Vet. Sci., 14(1):39-49.
DOI | https://dx.doi.org/10.17582/journal.aavs/2026/14.1.39.49
ISSN (Online) | 2307-8316

INTRODUCTION

Gastrointestinal parasites represent a significant challenge in small ruminant livestock production, particularly in sheep, as they can cause decreased performance, metabolic disorders, anemia, and even death if not effectively managed. Common parasitic infections in sheep include species such as *Haemonchus* spp., *Trichostrongylus* spp., *Oesophagostomum* spp., and *Strongyloides* spp. (Regassa *et al*., 2024). These have been widely reported in various tropical regions, including Indonesia. The incidence rates of these infections can vary based on climatic conditions, husbandry practices, and livestock health management. This parasite is typically transmitted through feed or water contaminated with eggs or infective larvae. Their life cycles are strongly influenced by environmental conditions and barn hygiene (Bautista-Garfias *et al*., 2022). In Jember, East Java, Indonesia, gastrointestinal parasites belonging to the nematode class have been identified in fat-tailed sheep, include *Strongyloides* sp. (20%), *Moniezia* sp. (8%), *Capillaria* sp. (4%), *Ostertagia* sp. (2%), *Cooperia* sp. (4%), and *Eimeria* sp. (8%) as reported by Awaludin *et al*. (2021). In sheep from the Secang sub-district of Magelang Regency, Central Java, Indonesia, gastrointestinal infections caused by parasites including *Haemonchus* sp., *Ostertagia* sp., *Moniezia* sp., *Trichuris* sp., and *Eimeria* sp. were identified (Purwono *et al*., 2025). Another report from Temanggung Regency in Central Java, Indonesia, identified gastrointestinal parasite infections in sheep as belonging to the species *Strongyloides* sp., *Strongylus* sp., *Eimeria* sp., and *Toxocara* sp. (Septian *et al*., 2025). Gastrointestinal parasites in sheep from Rio Grande do Sul, Brazil, sheep were found to be infected with *Strongylus* sp., *Moniezia expansa*, *Strongyloides papillosus*, and *Eimeria* spp. (Martins *et al*., 2022).

Sheep slaughtered in an abattoir often originate from different regions that employ various livestock management practices. This can affect the diversity and intensity of gastrointestinal parasite infections present at the abattoir. For example, sheep examined at the Torghondi, Islam Qala, and Herat abattoirs in Afghanistan were found to be infected with *Trichuris* spp., *Nematodirus* spp., *Strongylus* spp., and *Amphistome* spp. (Tookhy *et al*., 2025). Similarly, sheep from the Osina abattoir, Obinze abattoir, and Orieagu abattoir (Nigeria) were infected with a wide range of parasites, including *Trichuris* spp., *Haemonchus contortus*, *Schistosoma bovis*, *Strongylus* spp., *Strongyloides* spp., *Moniezia benedini*, *Ascaris* spp., and *Fasciola* sp. (Okoro *et al*., 2024). *Fasciola* sp. was observed with a prevalence of 22.73% in sheep that were slaughtered at the Sejnane abattoir in the Bizerte Governorate, located in Northwest Tunisia (Hammami *et al*., 2024).

Routine deworming practices prior to slaughter can significantly affect the profile of parasite infestations. However, research on the effectiveness of deworming treatments in sheep has not produced satisfactory results. The main idea behind using refugia-based methods for deworming is to help delay the development of anthelmintic resistance in gastrointestinal parasites of sheep. Nonetheless, the role of refugia under different sheep farming conditions is still not well understood (Hoglund and Gustafsson, 2023). Efficacy tests of several drugs, including albendazole, ivermectin, and macrocyclic lactones, in Southern Italy showed that gastrointestinal nematode (GIN) resistance to albendazole was confirmed in some farms. In contrast, ivermectin and macrocyclic lactones remained effective against the tested worm populations (Bosco *et al*., 2020). Reports on the therapeutic efficacy of common anthelmintics in sheep indicate that some gastrointestinal parasites have developed resistance to the tested medications. Following the administration of ivermectin to sheep, gastrointestinal parasites belonging to the species *Haemonchus* sp., *Trichostrongylus* sp., and *Teladorsagia* sp. were still detected. Similarly, after treatment with albendazole, parasites from the species *Haemonchus* sp., *Trichostrongylus* sp., and *Trichuris* sp. were also found. Furthermore, when tetramisole was administered, gastrointestinal parasites of the species *Teladorsagia* sp., *Trichostrongylus* sp., and *Haemonchus* sp. were still present (Ambaw *et al*., 2025).

Inspection of the digestive tract of animals slaughtered at slaughterhouses can provide insight into the dynamics of parasitic infections in animals that have been fattened and treated with antiparasitic medications. The Alexandria abattoir in Magelang serves as a key distribution point for lamb in the Magelang and Yogyakarta regions. Consequently, gastrointestinal parasite testing at this location holds significant epidemiological and public health relevance. Parasite testing results at the abattoir can serve as indicators of parasite infections in the field and assess the effectiveness of the deworming program implemented during the fattening process. Abattoirs play a critical role in public health surveillance, livestock disease monitoring, zoonotic disease control, animal welfare management, and resistance tracking of disease agents (Garcia-Diez *et al*., 2023).

Research on gastrointestinal parasites in sheep slaughtered at abattoirs in Indonesia over the past decade has been limited. Most studies have focused on cattle and goats as subjects, while similar research related to the origin of these livestock is still very rarely conducted. This study aimed to identify gastrointestinal parasites in sheep slaughtered at the Alexandria abattoir in Magelang, Indonesia, by tracing the origin data of the livestock, where all sheep had been fattened and treated with anthelmintics at the beginning of the rearing period before slaughter. However, this study had a limitation: It did not analyze the resistance of gastrointestinal parasites to anthelmintics. Therefore, this study is novel because it highlights the identification of gastrointestinal parasites and their occurrence levels in sheep that have undergone the fattening phase and were treated with anthelmintics at the beginning of rearing in the slaughterhouse, as well as data on the origin of the sheep. This study is the first to link ectoparasite profiles with the geographic origin of sheep entering a single abattoir, providing insights into inter-regional parasite movement and supply-chain level health risks. These findings offer a preliminary overview of the presence and distribution of parasites among sheep sourced from various regions supplied to the Alexandria abattoir, providing valuable insights for improving gastrointestinal parasite control programs.

MATERIALS AND METHODS

Study period and location

The study was carried out during March and May 2025. The Alexandria abattoir is a family-owned enterprise specializing in sheep slaughter. It features a holding pen used to house and fatten sheep sourced from local livestock markets prior to slaughter. All sheep slaughtered at the Alexandria abattoir from March to May 2025 (n = 89) were included in the study, representing the entire population of animals processed during this period.

This research was conducted at the Alexandria abattoir located in the Ngluwar sub-district of Magelang Regency, Central Java, Indonesia. Ngluwar is situated on the lower western slope of Mount Merapi and is surrounded by several mountains, including Merapi, Merbabu, Andong, Telomoyo, Sumbing, and the Menoreh highlands. The sub-district benefits from fertile volcanic soil, a result of past eruptions of Mount Merapi.

Experimental design

The research employed a cross-sectional design method. The research location was selected using a purposive sampling method (Thrusfield and Christley, 2018), specifically at the Alexandria abattoir in the Ngluwar District of Magelang Regency, Indonesia. The study was conducted at the Alexandria abattoir, which was selected for its reliable animal traceability system that documents the origins of all slaughtered sheep. Animals processed at this abattoir originate from three major livestock markets: The Muntilan livestock markets in Magelang Regency, the Ambarketawang livestock markets in Sleman Regency, and the Pengasih livestock markets in Kulon Progo Regency. Prior to slaughter, all sheep undergo a fattening period during which anthelmintics are routinely administered at the beginning of the rearing process. The abattoir operates with a daily slaughter capacity of 5 to 9 sheep, and all animals available on each sampling day were included without exception. Thus, the study did not rely on a subset of animals but instead assessed the full population of sheep slaughtered during the study days, effectively constituting a census. This ensured complete sampling coverage for the post-mortem gastrointestinal parasite examination. This study was based on post-mortem examination of the sheep digestive tract (Arsenopoulos *et al*., 2025). Specimens were collected and analyzed over a two-month period to identify the presence and types of gastrointestinal parasites.

The age of the sheep was estimated by examining the eruption and replacement patterns of their deciduous incisors (Albrkaty, 2024). Information regarding anthelmintic history was obtained from the slaughterhouse owner, who reported the use of albendazole. However, specific details regarding the brand, dosage, and administration date were not consistently available.

Post-mortem examination and parasite collection procedures

Post-mortem examinations were performed on adult worms in the digestive tract and liver of sheep slaughtered at the Alexandria abattoir. The digestive tract and liver were systematically examined following standard post-mortem procedures (incision, visual inspection, and palpation) to detect adult gastrointestinal parasites. During evisceration, the abomasum and other parts of the digestive tract were separated and then opened longitudinally to expose the lumen and mucosal surfaces, while the liver was incised and palpated to identify lesions and trematode infestations such as *Fasciola* spp. (Arsenopoulos *et al*., 2025). All adult worms found were collected, washed with NaCl, placed in tubes containing 70% alcohol, and labeled appropriately for further laboratory identification. These samples were then transported to the Parasitology Laboratory at the Faculty of Veterinary Medicine, Universitas Gadjah Mada, under refrigerated conditions (4 °C) for identification of gastrointestinal parasites based on their morphological characteristics. Morphological identification to the genus level was performed using stereomicroscopy and standard parasitological keys (Soulsby, 1982). During the gastrointestinal parasite collection activity, data were collected on the date of slaughter, the age of the sheep slaughtered, and the total number of sheep slaughtered each day.

Data analysis

Gastrointestinal parasite identification was conducted through descriptive analysis and comparison with relevant literature. The occurrence rate of infections was calculated using the Wilson confidence interval method, with a 95%

confidence level, via the Epitools online platform (https://epitools.ausvet.com.au/ciproportion, accessed October 20, 2025). This statistical approach was used to estimate the proportion of infected sheep within the sampled population and to assess the reliability of the findings. The correlation between sheep infected with gastrointestinal parasites and sheep origin, age, and sex was analyzed using the Chi-square test. Due to the imbalance in the number of male and female sheep examined (14 males and 75 females), Fisher's Exact Test was additionally performed to validate the association between sex and gastrointestinal parasite infection. The result confirmed the significance observed in the Chi-square test, thereby strengthening the reliability of the finding.

RESULTS

General conditions of the study area

Alexandria abattoir is located in the southern part of Ngluwar District, Magelang Regency, Central Java Province, Indonesia, at the coordinates 7°39'36" South Latitude and 110°17'40" East Longitude (Figure 1).

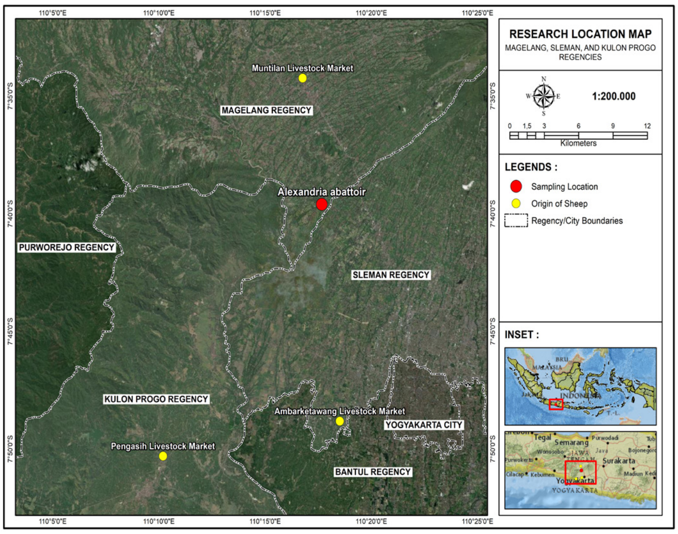

Figure 1: Map of the study sample collection Alexandria abattoir (Open Street Map).

Alexandria abattoir slaughtered 5–9 sheep per day during the study period, consistently sourced from three livestock markets: Muntilan livestock market (Magelang Regency), Ambarketawang livestock market (Sleman Regency), and Pengasih livestock market (Kulon Progo Regency). The majority of the sheep were young, fattened sheep with a history of anthelmintic administration (Albendazole) early in the rearing period, although specific dosage, brand, and date of administration were not recorded. Slaughtering was performed in a designated area separate from the gastrointestinal processing zone, with adequate access to running water to allow proper rinsing of offal before parasitological examination.

Identification of gastrointestinal parasites

A total of 89 sheep were slaughtered during the study period (March–May 2025) at the Alexandria abattoir. All slaughtered sheep were examined for the presence of gastrointestinal parasites. Based on morphological characteristics, three parasite genera were identified: *Haemonchus* sp. (Figure 2), *Moniezia* sp. (Figure 3), and *Fasciola* sp. (Figure 4).

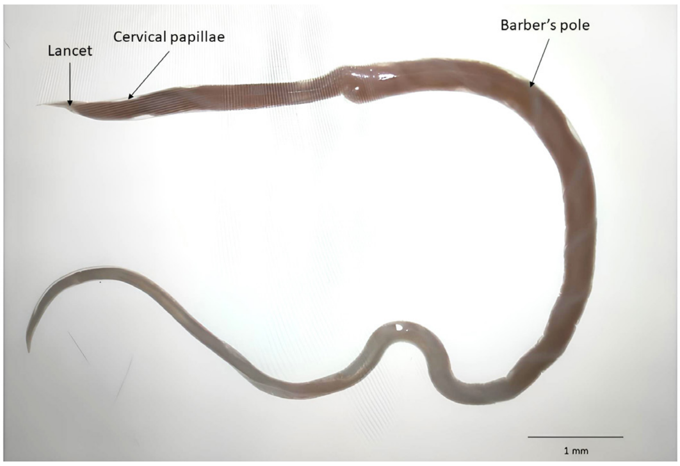

Figure 2: *Haemonchus* sp. identified in sheep at the Alexandria abattoir.

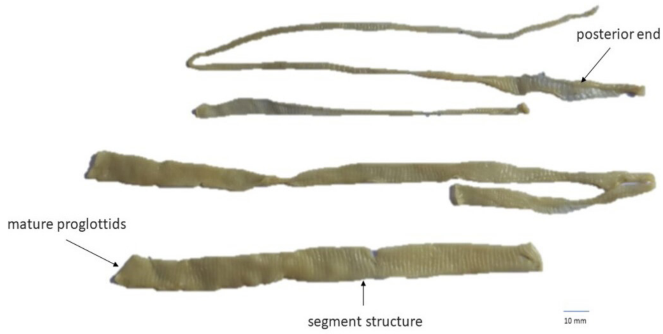

Figure 3: *Moniezia* sp. identified in sheep at the Alexandria abattoir.

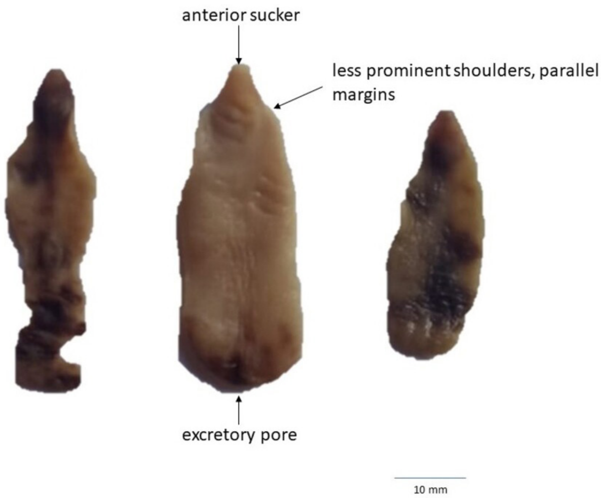

Figure 4: *Fasciola* sp. identified in sheep at the Alexandria abattoir.

Links Researchers

Haemonchus sp. was found in the abomasum (Figure 5), *Moniezia* sp. was located in the small intestine, and *Fasciola* sp. was identified in the liver (Figure 6).

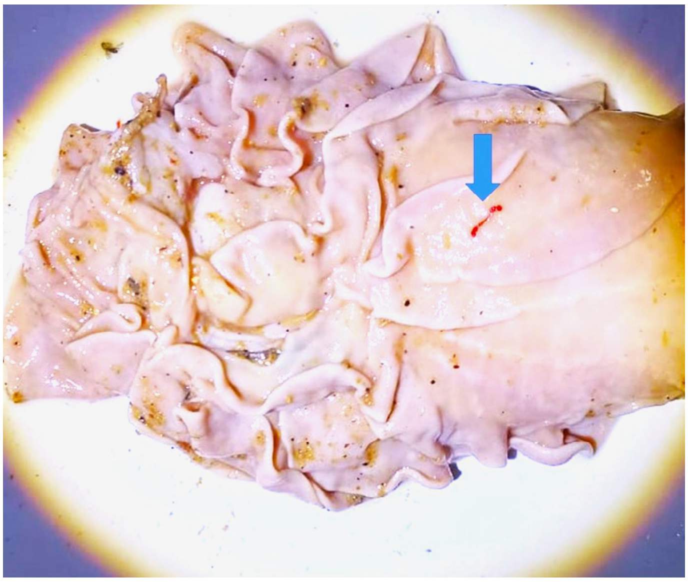

Figure 5: *Haemonchus* sp. in the abomasum of a sheep at the Alexandria abattoir.

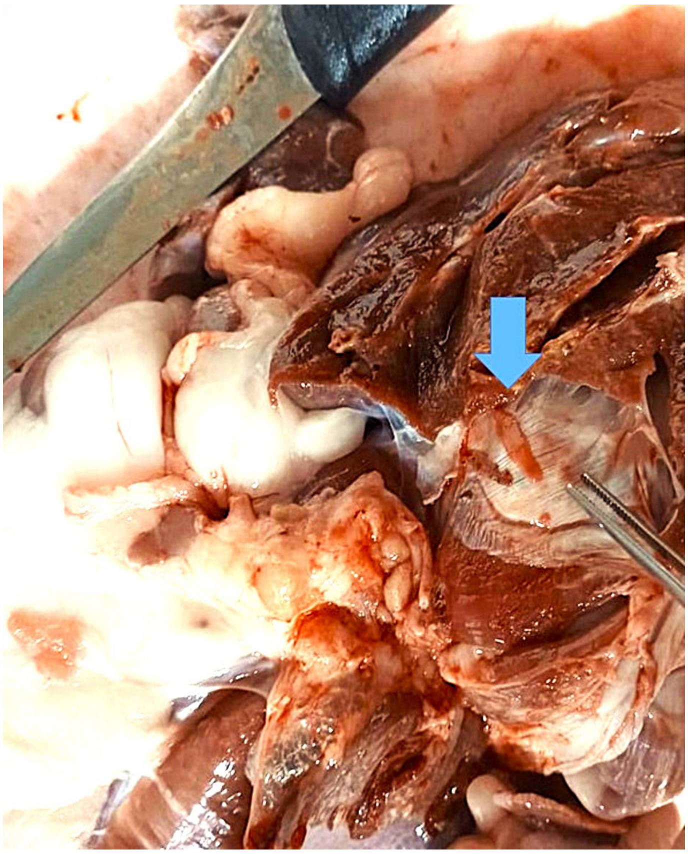

Figure 6: *Fasciola* sp. in the liver of a sheep at the Alexandria abattoir.

Thirty sheep, representing 33.71% (95% CI: 24.74–44.02%) of the total, were found to be infected with at least one gastrointestinal parasite (Table 1). *Haemonchus* sp. was detected in 30 sheep. *Moniezia* sp. and *Fasciola* sp. were each detected in one sheep, and both were mixed infections with *Haemonchus* sp.

Table 1: The proportion of sheep infected with gastrointestinal parasites using the Wilson confidence interval method.

Number of slaughter	Number of infected sheep	Proportion (%)	95% CI
89	30	33.71	24.74-44.02

CI: confidence level.

Table 2: The proportion of gastrointestinal (GI) parasites identified was calculated using the Wilson confidence interval method.

Parasite	Total number of GI parasites	Proportion (%)	95% CI
Haemonchus sp.	187/197	94.92	90.91-97.22
Moniezia sp.	3/197	1.52	0.52-4.38
Fasciola sp.	7/197	3.55	1.73-7.15

CI: confidence level.

The distribution of the 197 gastrointestinal parasites identified is presented in Table 2. *Haemonchus* sp. was overwhelmingly dominant, comprising 94.92% of all recovered parasites (95% CI: 90.91–97.22). In contrast, *Moniezia* sp. and *Fasciola* sp. contributed only 1.52% (95% CI: 0.52–4.38) and 3.55% (95% CI: 1.73–7.15), respectively. These estimates further highlight the apparent predominance of *Haemonchus* sp. in the parasite community of the examined sheep.

The relationship between the origin, age, and sex of sheep and their gastrointestinal (GI) parasite infestation is summarized in Table 3. The origin of the sheep showed a borderline significant association with GI parasitism (χ^2 = 5.87, df = 2, p = 0.053). Sheep sourced from the Muntilan livestock market had the highest infection rate at 48.6% (17/35), followed by those from Pengasih livestock market at 27.3% (6/22) and Ambarketawang livestock market at 21.9% (7/32). Age, on the other hand, was not significantly associated with infection status (χ^2 = 0.36, df = 1, p = 0.55). Among sheep younger than one year, the infection rate was 29.8% (14/47), while those older than one year had a slightly higher prevalence of 38.1% (16/42). In contrast, the sex of the sheep was significantly associated with GI parasite infection (χ^2 = 3.93, df = 1, p = 0.048). Female sheep exhibited a considerably higher infection rate of 38.7% (29/75) compared to males, who had an infection rate of only 7.1% (1/14). This finding remained statistically significant when reassessed using Fisher's Exact Test to account for the small male sample size (p = 0.045).

Table 3: Correlation between sheep origin, age, and sex with gastrointestinal (GI) parasite infestation in Alexandria Abattoir.

Category	Examined	Absence of GI parasites	Infected with GI parasites
Sheep origin			
Muntilan livestock market	35	18 (51.4%)	17 (48.6%)
Ambarketawang livestock market	32	25 (78.1%)	7 (21.9%)
Pengasih livestock market	22	16 (72.7%)	6 (27.3%)
χ^2 value			5.87
df			2
p-value			0.053
Age			
<1 year	47	33 (70.2%)	14 (29.8%)
>1 year	42	26 (61.9%)	16 (38.1%)
χ^2 value			0.36
df			1
p-value			0.55
Sex			
Male	14	13 (92.9%)	1 (7.1%)
Female	75	46 (61.3%)	29 (38.7%)
χ^2 value			3.93
df			1
p-value			0.048

$p < 0.05$, df: degree of freedom.

DISCUSSION

General conditions of the study area

Alexandria abattoir is located in a region with a basin topography with an average elevation of 120 to 450 meters above sea level and is surrounded by several mountains, including Merapi, Merbabu, Andong, Sumbing, Telomoyo, and the Menoreh Highlands. The area is known for its fertile land, especially due to the cold lava flows from Mount Merapi, which mainly affect the area through the Blongkeng River. Additionally, the area is traversed by the Putih River and the Krasak River.

Livestock commodities in the region include cattle, sheep, goats and buffalo. Sheep are widely farmed due to the high demand for lamb meat, especially in the surrounding areas of Ngluwar sub-district, including Magelang Regency and Yogyakarta City. Sheep are commonly raised due to their adaptability and are considered a valuable asset by farming communities because they are easy to manage and trade (Akbarrizki *et al*., 2024).

The Alexandria abattoir is a slaughterhouse specializing in lamb, this business has been passed down through generations, providing meat products to the surrounding areas and the city of Yogyakarta. The primary market consists of satay food vendors who operate on a regular order system. On average, the abattoir slaughters 5-9 sheep daily, with the number of orders increasing during special occasions, such as the holiday season. The sheep are sourced from local animal markets, Muntilan livestock market (Magelang Regency), Ambarketawang livestock market (Sleman Regency), and Pengasih livestock market (Kulon Progo Regency). Sheep sourced from three different livestock markets may represent heterogeneous backgrounds in terms of parasite burden, previous treatments, and farm management systems. Livestock markets serve as central mixing points, potentially facilitating cross-transmission of gastrointestinal parasites among animals from various farms. After purchasing new sheep, they receive a deworming treatment with an Albendazole group medication. They are raised with intensive care to ensure they are well-fed. Unfortunately, however, anthelmintic administration is not properly recorded, and the accuracy of the dosage and brand of anthelmintic used cannot be evaluated. Farmers often lack attention to the importance of proper parasite control in their herds. Many farmers still administer incorrect dosages, administer inaccurate medications, and make errors in drug storage (Kovalcuka *et al*., 2022).

Identification of gastrointestinal parasites

This study revealed that the occurrence rate of gastrointestinal parasite infections in sheep slaughtered at the Alexandria abattoir, Magelang, reached 33.71% (95% CI: 24.74–44.02%). The occurrence rate of gastrointestinal parasite infections in sheep at the Alexandria abattoir is lower compared to the occurrence rates observed in sheep in Secang sub-district (Magelang regency, Indonesia) which reached 92% (Purwono *et al*., 2025), in fat-tailed sheep in Jember regency (Indonesia) which reached 42% (Awaludin *et al*., 2021), in small ruminants in Nigeria which reached 69.64% (Eke *et al*., 2019), in Myanmar which reached 98.4% (Win *et al*., 2020), in India which reached 95% (Chikweto *et al*., 2018), and in cattle and small ruminants in Ghana which reached 90.8% (Squire *et al*., 2019). However, this difference may be due to different management systems and the influence of anthelmintic use carried out during the initial sheep maintenance in Alexandria abattoir during the fattening process. Agroclimatic conditions in an area as well as population density and management of rearing young animals mixed with adult animals together provide ideal conditions that influence the level of GI parasite transmission (Gadahi *et al*., 2009).

The gastrointestinal parasites identified in this study included *Haemonchus* sp. (187 parasites), *Moniezia* sp. (3 parasites), and *Fasciola* sp. (7 parasites). Based on these findings, *Haemonchus* sp. was the most dominant species, accounting for over 90% of all parasites detected, with a primary predilection for the abomasum (Figure 5). This finding is consistent with previous reports that *Haemonchus contortus* is the most common hematophagous nematode found in sheep in tropical and subtropical regions (Regassa *et al*., 2024; Carson *et al*., 2023). Gastrointestinal parasites, including *Haemonchus* spp., *Strongyles* spp., and *Trichostrongyles* spp., were reported in sheep slaughtered at Keffi abattoir, Nasawara State, Nigeria (Abdullahi *et al*., 2020). Gastrointestinal parasites found in sheep at Obinze, Osina, and Orieagu abattoirs (Nigeria) include *Haemonchus contortus*, *Ascaris* spp., *Trichuris* spp., *Moniezia benedini*, *Schistosoma bovis*, *Strongyloides* spp., *Strongylus* spp., and *Fasciola* sp. (Okoro *et al*., 2024). Another report stated that gastrointestinal parasites in sheep at a slaughterhouse in Banda Aceh, Indonesia, were identified as consisting of *Haemonchus* spp., *Oesophagostomum* spp., *Bunostomum* spp., *Strongyloides* spp., *Chabertia* spp., *Trichuris* spp., and *Gaigeria* sp. (Hanafiah *et al*., 2002). In Faisalabad, Punjab, Pakistan, gastrointestinal parasites in sheep were predominantly composed of *Eimeria* spp. (11.2%). Among the worm species, the most prevalent are *Haemonchus* sp. (10.4%), *Trichuris* sp. (9.4%), *Echinococcus* sp. (8.3%), *Ostertagia* sp. (8.1%), *Trichostrongylus* sp. (4.4%), *Paramphistomum* sp. (3.9%), *Toxocara* sp. (3.7%), *Strongyloides* sp. (3.1%), and *Fasciola* sp. (1.6%) (Rizwan *et al*., 2023).

The high incidence of *Haemonchus* sp. infections is likely associated with traditional sheep husbandry system, namely, grazing. Prior to slaughter at the Alexandria abattoir, sheep are sourced from various regions where open grazing systems are commonly employed. The humid climate and high rainfall in Magelang Regency and its surroundings also support the development of infective larvae in pastures. *Haemonchus* sp. has a direct life cycle, characterized by a free-living larval phase that requires moist environments for survival. Therefore, lowland areas with dense grass vegetation and high humidity tend to be ideal habitats for the development of this parasite (Regassa *et al*., 2024). In addition to *Haemonchus* sp., *Moniezia* sp. and *Fasciola* sp. were also found in much smaller numbers. *Moniezia* sp. were identified in the small intestine (jejunum), which is consistent with their biological characteristics as cestodes that use oribatid soil mites as intermediate hosts (Muqaddas *et al*., 2024). *Moniezia* sp. infections generally do not cause severe clinical symptoms, except when they occur at high intensity in lambs. In this study, *Moniezia* sp. was found in 9 month old lambs originating from Muntilan livestock market (Magelang Regency) (Figure 5), which are considered young lambs. Young lambs are more susceptible to *Moniezia expanza* infection, including *Eimeria* sp. infection (Martins *et al*., 2022). *Fasciola* sp. was detected in one sheep liver originally from Muntilan livestock market (Magelang Regency) (Figure 6), indicating subclinical fasciolosis within the sheep population. This trematode parasite relies on the aquatic snail *Lymnaea* sp. as an intermediate host. Additionally, the prevalence of *Fasciola* sp. is significantly affected by humid environmental conditions and waterlogged areas (Corrales *et al*., 2021).

Mixed gastrointestinal parasite infections (*Haemonchus* sp. and *Moniezia* sp.) in sheep in this study were found in one sample originating from Muntilan livestock market (Magelang Regency) and mixed infections between *Haemonchus* sp. and *Fasciola* sp. were also found in one sample originating from Muntilan livestock market (Magelang Regency). Mixed gastrointestinal parasite infections are common in livestock, including sheep. Various gastrointestinal parasites, including those from the nematode, cestode, and protozoa groups, have been identified in sheep (Salgado et al., 2018; Ferraz *et al*., 2019; Osorio *et al*., 2021).

The correlation between sheep origin and gastrointestinal parasite incidence approached significance (χ^2 = 5.87, df = 2, p= 0.053). Despite not reaching the conventional threshold, the variation in infection proportion among the markets (48.6% in Muntilan, 27.3% in Pengasih, and 21.9% in Ambarketawang) suggests a relevant biological trend. This indicates relevant biological variation that may arise from differences in husbandry practices, environmental exposure levels, and animal health management among these sources. The variability in infection rates across the livestock markets is consistent with previous research, which has shown that management factors, livestock density, and sanitation significantly influence gastrointestinal parasite infections in small ruminants (Cai *et al*., 2023). Additionally, market dynamics, including the mixing and transportation of animals from various locations, may heighten the risk of parasite exposure due to increased stress and changing environmental conditions (Motta *et al*., 2019). While all sheep received anthelmintic treatment at the beginning of their fattening, the persistently high prevalence of infection especially among animals from the Muntilan livestock market raises concerns about possible treatment ineffectiveness, improper drug administration practices, or the emergence of anthelmintic resistance in local parasite populations. This issue has been widely documented for *Haemonchus* spp. (Höglund *et al*., 2023). However, a limitation of this study is the lack of detailed information on environmental conditions or husbandry practices at the source farms. Although variations in parasite burden were noted among sheep from the Muntilan, Ambarketawang, and Pengasih livestock markets, we cannot directly link these differences to specific management or environmental factors. Nevertheless, these findings do suggest potential hypotheses for future research, such as the possible effects of pasture moisture, housing density, feeding practices, and the frequency of anthelmintic treatments on parasite exposure (Hoste *et al*., 2010).

Correlation analysis of age with gastrointestinal parasite infection showed that age was not significantly associated with gastrointestinal parasite infection status in sheep (χ^2 = 0.36, df= 1, p= 0.55). Although the proportion of sheep aged ≥1 year (38.1%) was slightly higher than that of the <1 year group (29.8%), this difference was not large enough to be considered statistically significant. This finding aligns with several epidemiological reports indicating that the impact of age on gastrointestinal nematode infection is not consistently observed across populations, particularly when environmental exposure, husbandry management, and anthelmintic administration practices are relatively uniform (Win *et al*., 2020). Biologically, acquired immunity to nematodes increases with age; however, the rate of development of this immunity is strongly influenced by the intensity of exposure and the parasite species (McRae *et al*., 2015). Because all sheep in this study were fed and received anthelmintic treatment before slaughter, this homogeneity of management likely reduced differences in infection risk between age groups. This variability in age response to infection has also been reported in studies of other ruminant populations, suggesting that factors such as rearing system, nutritional conditions, and anthelmintic efficacy can modify the age infection relationship (Regassa *et al*., 2024). Therefore, these results suggest that age is not a significant risk factor in the context of sheep populations entering the Alexandria abattoir. Further studies with larger sample sizes or specific analyses for each parasite species are needed to clarify the actual epidemiological pattern.

The correlation analysis indicated a significant association between sex and gastrointestinal parasite infections in sheep (χ^2= 3.93, df= 1, p= 0.048). Females exhibited a higher prevalence of infections (38.7%) compared to males (7.1%). Although the male sample size was relatively small, the robustness of this finding was confirmed using Fisher's Exact Test, which supported the significant difference between sexes. This suggests that the higher susceptibility of females is consistent across different analytical approaches. This difference may be influenced by physiological factors, such as hormonal modulation of the immune response, which increases susceptibility to helminth infections (Gonzalez-Garduno *et al*., 2021). Additionally, certain helminth species, such as Haemonchus sp., are significantly affected by the female reproductive status and can lead to a higher infection burden during the peripartum period (Nisbet *et al*., 2016). Management factors, including the duration of rearing and variations in anthelmintic administration practices between males and females, may also play a role in the differences in prevalence. However, it is important to consider the imbalance in sample size between the male and female groups when interpreting these results.

This study has several limitations. There is an imbalance in the sample size between males and females. Additionally, there are incomplete records regarding anthelmintic dosage and compliance. The cross-sectional design and post-mortem measurements taken at a single time point restrict our ability to evaluate infection dynamics over time or across different seasons. The variability in the sheep population originates from various livestock markets with differing husbandry practices, and the absence of quantitative measurements of worm burdens hinders our ability to interpret the severity of the infections. Therefore, further studies are necessary, featuring more balanced samples, longitudinal monitoring, and assessments of infection intensity, to achieve a more comprehensive understanding of the epidemiology of gastrointestinal parasites.

Overall, these findings highlight the need to evaluate and improve monitoring of animal health and treatment history to prevent the entry of highly infected animals into the slaughterhouse supply chain.

CONCLUSIONS

Gastrointestinal parasite infections in sheep at the Alexandria abattoir were found to be common, with *Haemonchus* sp. as the dominant species and a higher prevalence in females than males, while age has no significant effect. Despite initial anthelmintic treatment, the high proportion suggests the need for further studies with longitudinal monitoring and measurement of gastrointestinal parasite infection intensity to gain a more comprehensive understanding of the epidemiology. To improve gastrointestinal parasite control and reduce the risk of anthelmintic resistance, farmers and slaughterhouse owners are advised to implement routine fecal monitoring during the fattening period to inform evidence-based anthelmintic treatment decisions and establish appropriate standards for administering deworming. For small-scale farmers, periodic group-level sampling and basic training on clinical signs offer a practical and cost-effective way to carry out such monitoring.

ACKNOWLEDGEMENT

The author would like to express his deepest gratitude to the Health Research Organization of the National Research and Innovation Agency for funding the In-House Research Activities of the Program in the Health Research Organization of the National Research and Innovation Agency in 2025 with the Decree of the Head of the Health Research Organization of the National Research and Innovation Agency No. 6/III.9/HK/2025.

NOVELTY STATEMENT

The main novelty of this study lies in linking post-mortem identification of gastrointestinal parasites with the geographic origin of slaughtered sheep. This approach provides insight rarely explored in abattoir-based research in Indonesia. Additionally, the identification of parasite gastrointestinal infections in animals that had undergone pre-slaughter deworming provides an important incidental observation, highlighting the need for further assessment of treatment effectiveness.

AUTHOR'S CONTRIBUTION

AA: Conceptualization, methodology, sampling, investigation, validation, writing original draft, review, and editing. DHS: Methodology, sampling, investigation, validation, and review. AHW: Methodology, validation, and review. YRN: Methodology, investigation, validation, data curation, and editing. WWM: Review and editing. SEW: Validation, formal analysis and review. MA: Formal analysis, review, and editing.

Availability of data and materials

All the generated data are included in the manuscript.

Generative AI and AI-assisted technology statement

The text, tables, and figures in this manuscript were not written/created by AI and AI assisted technologies. The author declares that the generative AI tool (Grammarly) was used solely to improve the language quality of this manuscript.

Conflicts of interest

The authors have declared no conflict of interest.

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