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Original Article

A Retrospective Survey of Gastrointestinal Parasites in Livestock of Hilly Areas in Mymensingh

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Abstract

Gastrointestinal parasites (GIP) have a profound impact on livestock farming because they can significantly overshadow the productivity of animals. Retrospective study of diseases is an evidence-based and cost-effective study to understand the prevalence of a disease in a particular population and to outline effective treatment and prevention measures. This retrospective survey was carried out to estimate the prevalence of GIP and to identify risk factors of GIP infections in livestock (cattle, sheep and, goats). Fecal samples of 1733 livestock were examined using the simple sedimentation and floatation technique in the present survey from January 2018 to December 2018 at Haluaghat Upazila, the hilly part of Mymensingh. The overall prevalence of GIP in ruminant livestock was 49.7% (861/1733). GIP were more prevalent in goat (51.1%, 384/751) than cattle (48.9%, 425/870) and sheep (46.4%, 52/112). Twelve different GIP were recorded, where *Eimeria* (13.8%), *Fasciola* (12.1%), *Paramphistomum* (10.0%), *Toxocara* (4.2%), and *Strongyloides* (3.7%) were predominant. Amid sexes, infection was significantly higher in female (60.4%, 508/841) than male (39.6%, 353/892) counterparts. Age-wise prevalence showed the highest infection in young animals of goat (68.0%), sheep (60.0%), and cattle (53.2%). GIP infection was significantly higher in the rainy season collectively (64.1%, 452/705). GIP is highly prevalent in livestock of the study area therefore; proper attention must be given to outplay the causal association and risk factors between host and parasites.

Introduction

Parasitic diseases are designated as a major concern in the health and food safety of animal origin and cause financial losses in nations where the ruminant industry is a linchpin of the agricultural commodities (Wadhawa et al., 2011). Livestock, especially ruminants (Cattle, sheep, and goats) play a vital role in the economy of Bangladesh, contributing 1.53% of total gross domestic product (GDP), and are a major source of animal protein (Bangladesh Economic Review, 2019). Bangladesh has a tropical monsoon climate, which favors the growth and development of parasites (Zahan et al., 2018). Gastrointestinal Parasites (GIP) are very important in ruminants (Figure 1) but the magnitude of infection varies in different niches as temperature, humidity, rainfall, and vegetation may influence the severity and prevalence of the infection (Naqvi et al., 2012; Singh et al., 2017). The development of anthelmintic resistance against GIP is becoming a major problem (Pawar et al., 2019).

Gut dwelling helminths and protozoa affect the livestock industry and jeopardize their optimum productions (Choubisa and Jaroli, 2013). Among gastrointestinal nematodes, *Toxocara*, strongyles, *Trichuris* is the major concern for growth and productivity of ruminants (Dey et al., 2020). Trematode infections, particularly fascioliasis, paramphistomiasis, and schistosomiasis are the most important trematodiasis in different countries, including Bangladesh (Choubisa and Jaroli, 2013; Yasin et al., 2018; Squire et al., 2019). Previous studies suggested that fascioliasis is caused by *Fasciola gigantica* in Bangladesh and prevalence ranged from 10- 50% (Yasin et al., 2018; Rahman et al., 2017). *Paramphistomum*, is another most commonly reported parasitic infection

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(20-60%) in livestock of Bangladesh (Yasin et al., 2018; Ghosh et al., 2013). Schistosomes have been reported to livestock and prevalence ranges from 23-40% in Bangladesh (Yasin et al., 2018; Sardar et al., 2006). *Moniezia* is the principal cause of cestodiasis in livestock, particularly for young sheep and goats (Rahman et al., 2017). Among protozoa, *Eimeria* is the most significant parasite in livestock, however, *Balantidium* and other flagellates have also been reported (Paul et al., 2019; Islam et al., 2017).

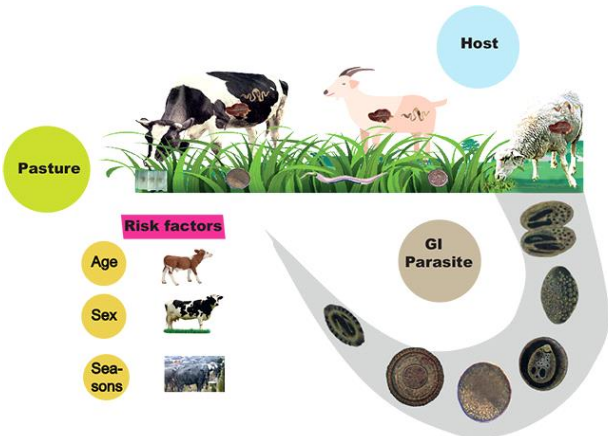

Figure 1. Graphical illustration on interaction of gastrointestinal parasites, host, environment, and risk factors

GIP causes economic losses through disposing of the infected liver, reduced animal productivity, low birth weight, and stunted growth in infected animals (Soulsby, 1982). Although GIP in livestock of the selected study areas has been reported frequently, they are not assessed properly through epidemiological or survey-based methods, which is essential to portray the real scenario of GIP and take fruitful control programs against them.

Retrospective study of animal disease is a quick and inexpensive way to outline an effective disease control strategy. Evaluation of this data helps to know the parasites in a particular animal population and to identify the risk factors along with demographic distribution in a specific area. It has also been used for detecting animal health surveillance (Abiola et al., 2016). Therefore, this survey was designed to estimate the prevalence and identification of risk factors of GIP in livestock, aiming to update the current status of them in the study area.

Materials and Methods

Animal Ethics

It is a hospital-based retrospective study. Animals were handled following the guidelines of the hospital. No animals were harmed during sample collection.

Study area and animals

This research was conducted at Haluaghat Upazila in Mymensingh, which is the north-central part of Bangladesh (Figure 2). Haluaghat is located at a latitude and longitude of 25.1250°N 90.3500°E with an area of 356.07 sq km on the foot of the Garo Hills of the Meghalaya, India. Most part of the Upazila is the medium highland of Old Brahmaputra or the North-western Plains and Basins. About 68% of rainfall is concentrated in this area during the rainy season. Seasons of the year were divided into three prominent seasons such as summer, rainy, and winter. This survey included cattle, sheep, and goats of all ages that have brought to a veterinary hospital for treatment purposes in 2018.

Sampling and data collection

This study was a retrospective survey covering a period of one year from January to December 2018. Fecal samples were collected aseptically by a designated veterinary surgeon at the hospital premises. Retrospective data were collected from the patient register of a veterinary hospital, Haluaghat, Mymensingh. The age, sex, and seasonal data were also collected from the register of the hospital. The age of the animal was calculated using an established dental eruption chart (Klevezal, 2007). Age was categorized into three groups; calves/kid/lamb (≤6 months), young (>6 months to 1 year), and adults (>1 year).

Coprological investigation

Fecal samples were examined carefully by the hospital veterinarian in the course of his routine duties. Sedimentation and floatation method was performed for investigation of ova, cyst, or oocyst of parasites. In the case of sedimentation, 3g of feces were mixed with 47 ml tap water to make a homogenous suspension. The suspension was then filtered with a sieve and allowed to stand for 30 minutes at room temperature. The supernatant of the suspension was poured off and sediment was re-suspended with tap water and washing procedures were repeated until the suspension become clear. Thus, one drop of sediment was placed in a clean glass slide, covered with a cover grid slip, and examined under a microscope using ×10 objective (Soulsby, 1982; Gupta and Singla 2012). For the floatation technique, 5g of feces were mixed with 45 ml floatation fluid (saturated sodium chloride solution) in a beaker. The suspension was then filtered with a sieve, taken into a clean test tube and filled up to the brim of the tube and covered with a clean coverslip, and allowed to stand for 30 minutes at room temperature. The coverslip was then removed and placed on a clean glass slide keeping the wet side down and examined under a microscope using ×10 objective (Soulsby, 1982). At least three slides were prepared and examined from each sample for both techniques.

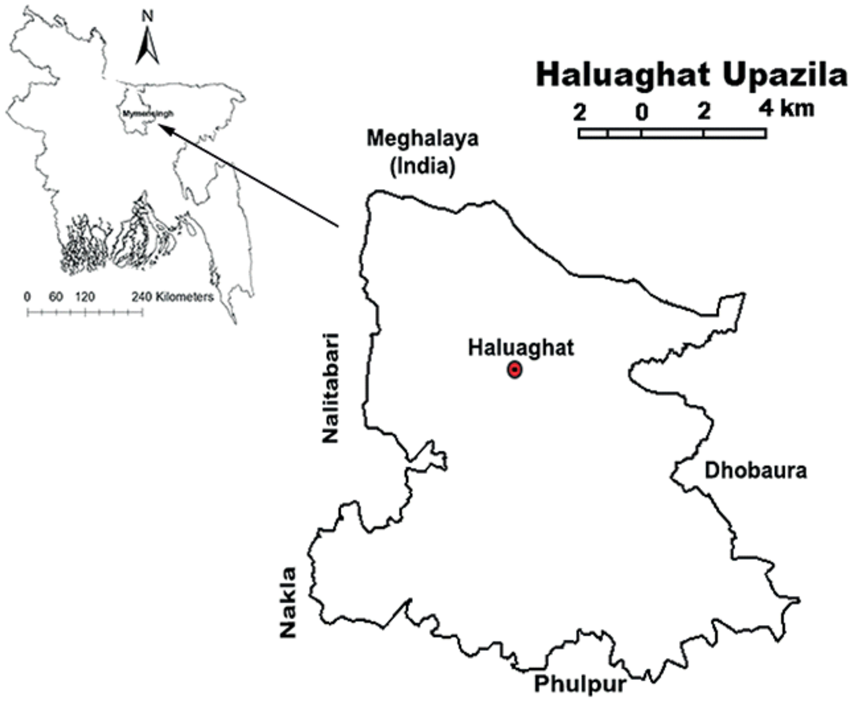

Figure 2. The study area of gastrointestinal parasites in ruminants

Parasite identification

Ova, cysts, and oocysts of parasites were identified following the morphological characteristics as described previously (Soulsby, 1982).

Statistical analyses

All data were analyzed by z-test using Statistical Package for Social Science (SPSS, version 26). A *p*-value of less than 0.05 was considered statistically significant.

Results

Half of the ruminants had infections with GIP

In this study, out of 1733 livestock examined, 861(49.7%) were found positive for the GIP. The prevalence of GIP in livestock in this study was summarized in Table 1. The infection rates with *Eimeria* (13.8%), *Fasciola* (12.1%), and *Paramphistomum* (10.0%) were almost similar and comparable. Among nematodes, *Toxocara* was the most prevalent (4.2%), but *Strongyloides* (3.7%) and strongyles (2.0%) were also comparable. *Moniezia* was the only cestode found in this study, of which prevalence was 1.0%. However, collectively the lowest prevalence was recorded for *Schistosoma* (0.2%) and *Giardia* (0.1%). Identified eggs/oocyst/cyst is depicted in figure 3.

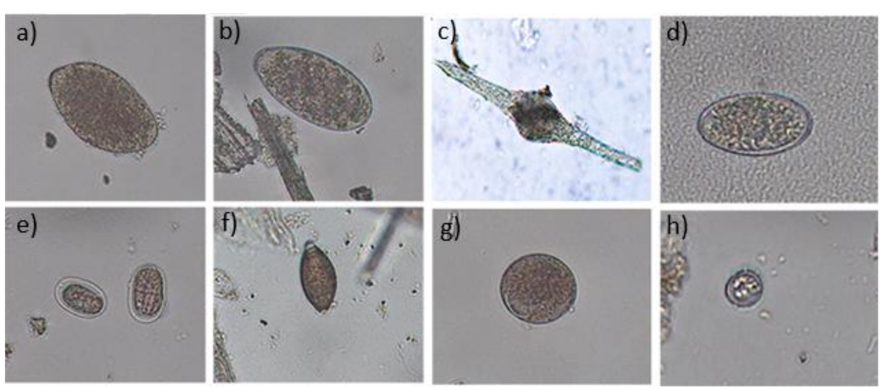

Figure 3. Identified eggs/oocyst/cyst of gastrointestinal parasites from ruminants (100×): a) *Fasciola,* b) *Paramphistomum,* c) *Schistosoma,* d) Strongyles, e) *Strongyloides,* f) *Trichuris,* g) *Balantidium coli,* h) *Eimeria*

GIP was more prevalent in goats

The prevalence of GIP was higher in goats (51.1%) than that in cattle (48.9%) and sheep (46.4%) (Figure 4). Goats had a higher prevalence of *Eimeria* and *Strongyloides* than cattle and sheep. Both *Fasciola* and *Paramphistomum* were comparable among different ruminants. *Schistosoma* was not found in the case of cattle and goats while strongyles were not found in the case of cattle and sheep. Also, flagellated and ciliated protozoans were absent in cattle and sheep. Detailed information is in table 2.

Table 1. Prevalence of GIP genera in ruminants at the study area

Class	Parasites	Number positive (%)
Trematoda	*Fasciola*	209 (12.1)
	Paramphistomum	174 (10.0)
	Schistosoma	4 (0.2)
	Subtotal	**387 (44.9)**
Nematoda	*Toxocara*	73 (4.2)
	Strongyles	34 (2.0)
	Trichuris	20 (1.2)
	Strongyloides	64 (3.7)
	Subtotal	**191 (22.2)**
Cestoda	*Moniezia*	18 (1.0)
	Subtotal	**18 (2.1)**
Protozoa	*Eimeria*	240 (13.8)
	Balantidium	11 (0.6)
	Entamoeba	13 (0.8)
	Giardia	1 (0.1)
	Subtotal	**283 (32.9)**

Table 2. Animal-wise prevalence of GIP infections

Parasites	Infected (%)		
	Cattle (870)	Goat (751)	Sheep (112)
Fasciola	158 (12.5)[a]	37 (4.9)[a]	14 (12.5)[b]
Paramphistomum	71 (14.3)[a]	87 (11.6)[a]	16 (14.3)[a]
Schistosoma	0[b]	0[b]	4 (3.6)[a]
Toxocara	73 (8.4)[a]	0[b]	0[b]
Strongyles	0[b]	34 (4.5)[a]	0[b]
Trichuris	11 (1.3)[a]	7 (0.9)[a]	2 (1.8)[a]
Strongyloides	14 (2.6)[a]	47 (6.3)[a]	3 (2.6)[a]
Moniezia	11 (1.3)[a]	5 (0.7)[a]	2 (1.8)[a]
Eimeria	87 (10.0)[a]	142 (18.9)[a]	11 (9.8)[a]
Balantidium	0[b]	11 (1.5)[a]	0[b]
Entamoeba	0[b]	13 (1.7)[a]	0[b]
Giardia	0[b]	1 (0.1)[a]	0[b]
Total	**425 (48.9)[a]**	**384 (51.1)[a]**	**52 (46.4)[a]**

[a,b] Values with the different superscript in the same animal group are statistically significant (p<0.05).

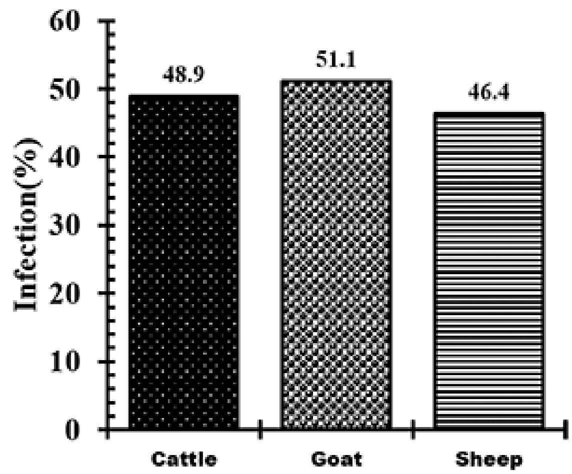

Figure 4. Animal-wise prevalence of GIP infections in ruminants

Two important biotic factors were associated with GIP infections

In relation to sex, GIP infection was significantly (p<0.05) higher in female (62.4% in cattle, 58.7% in goat and 55.0% in sheep) than in male (36.5% in cattle, 43.9% in goat and 36.5% in sheep). Further, *Eimeria* infection was the highest in both male and female animals (Table 3).

On the other hand, the prevalence of GIP varied at different ages of ruminants. Comparatively, a higher infection rate was observed in young (53.2%) cattle than calves (51.1%) and adults (42.1%). However, in goat, higher rate was found in young (68.0%) than adult (47.7%) and kids (25.3%) and likewise in sheep (young-60.0%; adult-52.0%; lamb- 8.7%) (Table 4). Liver and rumen fluke showed a marked infection rate in calves, kids, and lamb. Schistosomes, *Strongyloides,* and *Entamoeba* showed the highest prevalence in adult ruminants. *Trichuris* is only prevalent at a young age. Coccidian infection was mostly prevalent in calves/kids/lambs and young animals. Also, flagellated and ciliated protozoa were absent in calves/kids/lamb.

The abiotic factor is the key to GIP infection

In case of season, the highest infection rate of GIP was observed in rainy season (cattle-64.3%; goat-64.1%; sheep-62.5%) than in summer (cattle-46.9%; goat-49.8%; sheep-49.0%) and winter (cattle-24.3%; goat-28.5%; sheep-13.0%). Amidst all host species, coccidian infection was the most common and infection rates peaked during the rainy season. Liver fluke and rumen fluke were constantly present throughout the seasons among all ruminants but *Schistosoma* was only prevalent during monsoon. Among nematodes, *Strongyloides* also showed a similar seasonal pattern. Detail is in table 5.

Table 3. Prevalence of GIP infections in different sexes of ruminants

Parasites	Sex category infected (%)					
	Cattle		Goat		Sheep	
	Male (n=455)	Female (n=415)	Male (n=385)	Female (n=366)	Male (n=52)	Female (n=60)
Fasciola	62 (13.6)	96 (23.1)	17 (4.4)	20 (5.5)	6 (11.5)	8 (13.3)
Paramphistomum	53 (11.6)	18 (4.3)	36 (9.4)	51 (13.9)	5 (9.6)	11 (18.3)
Schistosoma	0	0	0	0	0	4 (6.7)
Toxocara sp.	17 (3.7)	56 (13.5)	0	0	0	0
Strongyles	0	0	10 (2.6)	24 (6.6)	0	0
Trichuris	7 (1.5)	4 (1.0)	1 (0.3)	6 (1.6)	2 (3.8)	0
Strongyloides	3 (0.7)	11 (2.7)	34 (8.8)	13 (3.6)	2 (3.8)	1 (1.7)
Moniezia	4 (0.9)	7 (1.7)	5 (1.3)	0	0	2 (3.3)
Eimeria	20 (4.4)	67 (16.1)	45 (11.7)	97 (26.5)	4 (7.7)	7 (11.7)
Balantidium	0	0	9 (2.3)	2 (0.5)	0	0
Entamoeba	0	0	11 (2.9)	2 (0.5)	0	0
Giardia	0	0	1 (0.3)	0	0	0
Total	**166 (36.5)^{a}**	**259 (62.4)^{b}**	**169 (43.9)^{a}**	**215 (58.7)^{b}**	**19 (36.5)^{a}**	**33 (55.0)^{b}**
OR	**2.95**		**1.82**		**2.12**	

^{a,b} Values with the different superscript in the same animal group are statistically significant (p<0.05).

Table 4. Prevalence of GIP infections in different age groups of ruminants

Parasites	Age category infected (%)								
	Cattle			Goat			Sheep		
	Calves (n=270)	Young (n=310)	Adults (n=290)	Kids (n=150)	Young (n=291)	Adults (n=310)	Lamb (n=23)	Young (n=45)	Adults (n=44)
Fasciola	8 (3.0)	71 (22.9)	79 (27.2)	0	13 (4.5)	24 (7.7)	0	5 (11.1)	9 (20.5)
Paramphistomum	11 (4.1)	41 (13.2)	19 (6.6)	9 (6.0)	47 (16.2)	31 (10.0)	1 (4.3)	10 (22.2)	5 (11.4)
Schistosoma	0	0	0	0	0	0	0	1 (2.2)	3 (6.8)
Toxocara	50 (18.5)	20 (6.5)	3 (1.0)	0	0	0	0	0	0
Strongyles	0	0	0	13 (8.7)	14 (4.8)	7 (2.3)	0	0	0
Trichuris	0	11 (3.5)	0	0	5 (1.7)	2 (0.6)	0	2 (4.4)	0
Strongyloides	2 (0.7)	4 (1.3)	8 (2.8)	3 (2.0)	13 (4.5)	31 (10.0)	0	1 (2.2)	2 (4.5)
Moniezia	0	2 (0.6)	9 (3.1)	0	5 (1.7)	0	0	0	2 (4.5)
Eimeria	67 (24.8)	16 (5.2)	4 (1.4)	13 (8.7)	88 (30.2)	41 (13.2)	1 (4.3)	8 (17.8)	2 (4.5)
Balantidium	0	0	0	0	8 (2.7)	3 (1.0)	0	0	0
Entamoeba	0	0	0	0	4 (1.4)	9 (2.9)	0	0	0
Giardia	0	0	0	0	1 (0.3)	0	0	0	0
Total	**138 (51.1)^{a}**	**165 (53.2)^{a}**	**122 (42.1)^{b}**	**38 (25.3)^{b}**	**198 (68.0)^{b}**	**148 (47.7)^{a}**	**2 (8.7)^{b}**	**27 (60.0)^{b}**	**23 (52.0)^{a}**

^{a,b} Values with the different superscript in the same animal group are statistically significant (p<0.05).

Table 5. Prevalence of GIP infections in different season of ruminants

Parasites	Season category infected (%)								
	Cattle			Goat			Sheep		
	Summer (n=290)	Rainy (n=370)	Winter (n=210)	Summer (n=305)	Rainy (n=295)	Winter (n=151)	Summer (n=49)	Rainy (n=40)	Winter (n=23)
Fasciola	56 (19.3)	76 (20.5)	26 (12.4)	13 (4.3)	17 (5.8)	7 (4.6)	9 (18.4)	3 (7.5)	2 (8.7)
Paramphistomum	19 (6.6)	43 (11.6)	9 (4.3)	56 (18.4)	20 (6.8)	11 (7.3)	12 (24.5)	3 (7.5)	1 (4.3)
Schistosoma	0	0	0	0	0	0	0	4 (10.0)	0
Toxocara sp.	18 (6.2)	49 (13.2)	6 (2.9)	0	0	0	0	0	0
Strongyles	0	0	0	7 (2.3)	25 (8.5)	2 (1.3)	0	0	0
Trichuris	7 (2.4)	3 (0.8)	1 (0.5)	2 (0.7)	5 (1.7)	0	0	2 (5.0)	0
Strongyloides	5 (1.7)	9 (2.4)	0	11 (3.6)	27 (9.2)	9 (6.0)	1 (2.0)	2 (5.0)	0
Moniezia	3 (1.0)	7 (1.9)	1 (0.5)	0	5 (1.7)	0	0	2 (5.0)	0
Eimeria	28 (9.7)	51 (13.8)	8 (3.8)	50 (16.4)	79 (26.8)	13 (8.6)	2 (4.1)	9 (22.5)	0
Balantidium	0	0	0	7 (2.3)	4 (1.4)	0	0	0	0
Entamoeba	0	0	0	5 (1.6)	7 (2.4)	1 (0.7)	0	0	0
Giardia	0	0	0	1 (0.3)	0	0	0	0	0
Total	**136 (46.9)^{a}**	**238 (64.3)^{b}**	**51 (24.3)^{b}**	**152 (49.8)^{a}**	**189 (64.1)^{b}**	**43 (28.5)^{b}**	**24 (49.0)^{a}**	**25 (62.5)^{b}**	**3 (13.0)^{b}**

^{a,b} Values with the different superscript in the same animal group are statistically significant (p<0.05).

Discussion

Sustainable ruminant production is the key to the economic growth and development in agri-food based developing countries, like Bangladesh. GIP is one of the major obstacles to their growth and optimal production (Kaur et al., 2009). Moreover, some GIP of ruminants like *Schistosoma*, *Trichuris*, *Strongyloides*, *Entamoeba*, *Giardia*, *Balantidium*, and *Cryptosporidium*, has a potential zoonotic impact (Wegayehu et al., 2013). In this study, we surveyed the prevalence of GIP in livestock raised by smallholder farmers in the Haluaghat, Mymensingh coupled with an analysis of risk factors linked to the infections. We tracked GIP in this study area through coprological examination, which is suitable, cheap, and readily available at the field level. Also, it does not require any sophisticated instruments. However, serology and molecular-based study provide more specific identification of GIP than coprology.

Almost half of the ruminants (49.7%, 861/1733) of the studied population were infected with GIP. Approximately, a similar rate of infection was observed earlier in a retrospective study of GIP in ruminants (51.5%, 2052/3988) of Khagrachari, Bangladesh (Ali et al., 2011). Although, some other studies in ruminants conducted in Mymensingh (74.8%) and Tangail (63.4%), Bangladesh showed higher prevalence than the current study (Rahman et al., 2017; Islam et al., 2017). Comparably, a large-scale epidemiological study on small ruminants in Bangladesh also reported a higher infection rate (62.1%, 1241/1998) (Dey et al., 2020). In the neighboring country, India, the prevalence of GIP in ruminants was 71.3%, which was higher than current findings (Choubisa and Jaroli, 2013). However, the overall infection rate was comparatively lower than the prevalence recorded (69.6%-90.8%) in Ghana and Ethiopia (Squire et al., 2019). Tangibly, this difference is possibly due to variation in the amount of rainfall, animal management, soil topography, land use, and agro-ecology (Zvinorova et al., 2016). For instance, heavy rainfall, high humidity, and higher temperature enhance the survival rate of cysts and oocyst and faster egg/larvae development on soil and grass (Dey et al., 2020; Hunter, 2003). The study area is fairly a high land in north-central parts of Bangladesh; therefore, it is quite rational that the overall prevalence of GIP would be low.

In this study, the highest prevalence was recorded for *Eimeria* followed by *Fasciola* and *Paramphistomum*. Coccidiosis is one of the most prevalent parasitic diseases caused by different species of gut-dwelling *Eimeria* in livestock (Bruhn et al., 2012). The prevalence of *Eimeria* in livestock of Bangladesh was 24%-27% in several previous studies (Rahman et al., 2017; Islam et al., 2017). A higher prevalence of *Eimeria* was also reported in livestock of different parts of the world (Squire et al., 2019; Hassan et al., 2019; Pinilla Leon et al., 2019). It can be deduced that immunosuppression of animals due to high temperature and humidity, overstocking, and overgrazing along with mixing age groups may enhance more shedding of oocyst, resulting in a high level of *Eimeria* infection (Squire et al., 2019). *Eimeria* has good adaptability to various climatic conditions along with a high rate of water contamination through oocyst than other protozoa (Bruhn et al., 2012). However, this result differs from studies conducted in India and Pakistan that revealed a higher prevalence of *Fasciola* than *Eimeria* in ruminants (Choubisa and Jaroli, 2013; Khan et al., 2010). After coccidiosis, *Fasciola* and *Paramphistomum* infection rate was higher than other GIP recorded in this study, which might be due to the extremely prolonged existence of the metacercariae, the infective stage for livestock. For example, in straw or hay metacercariae can survive up to six months (Soulsby, 1982). Further, *Schistosoma* had the lowest prevalence amidst GIP and was consistent with the previous study (Nath et al., 2015). It most likely occurred due to the unavailability of suitable vector snail, geoclimatic conditions, or improved management (Hassan et al., 2019). Amid nematode, the prevalence of *Toxocara* was the highest, however, the infection was absent in sheep and goats. *Toxocara* solely infects cattle and buffaloes and sheep and goats are refractory to the infection (Soulsby, 1982). Also, *Strongyloides* and strongyles had a higher prevalence that was in line with a previous report (Dey et al., 2020). *Strongyloides* prefers moist and warm condition, which enhances the accumulation of infective larvae in the environment (Thamsborg et al., 2017). *Moniezia* showed lower prevalence in our study that probably due to lack of intermediate host (*Galumna*). Besides, we identified *Balantidium*, *Entamoeba,* and *Giardia*, which have public health significance and could cause zoonosis (Hassan et al., 2019). The low prevalence of flagellated and ciliated protozoans and some helminths that maintain the faeco-oral route of transmission may be due to good management and improved feeding and water supply. Presently, most of the farmers use tube well water instead of water from natural water bodies.

In this study, the highest rate of infection was found in goats, which conforms to the result observed in Khagrachhari, Bangladesh (Ali et al., 2011). Goats grazing and browse a variety of forage resources which might increase chances of infection with GIP (Ayaz et al., 2018). Additionally, poor management of animals is an important factor for getting an infection with any parasites. It is notable that, some authors observed lower GIP load in goats (Zvinorova et al., 2016).

We found a higher load of GIP in females than males, which coincided with preceding studies (Dey et al., 2020; Islam et al., 2017). This disparity may be due to physiological, reproductive, and hormonal variations. The female animal has lower resistance to GIP due to hormonal change during gravidity, parturition, and lactation (Squire et al., 2019). Additionally, periparturient-rise of GIP during early lactation and after parturition is responsible for higher infection in females (Dey et al., 2020). Additionally, does are voracious eaters and consume more, which results in higher infection.

We found that young animals had the highest prevalence, which was supported by the earlier findings (Dey et al., 2020; Islam et al., 2017). For coccidiosis, a higher prevalence was observed in young animals than adults, which was supported by a previous study (Bangoura et al., 2012). It probably occurs due to early exposure of animals to *Eimeria*, which may develop cellular immunity in the later stage of age (Hassan et al., 2019). *Fasciola* and *Paramphistomum* are commonly found in young and adult ruminants, although we identified both of them in calves of cattle. Metacercariae of both flukes are developed in grass blades and cause infection during grazing, therefore, calves of the pre-ruminal stage are less likely to be infected. However, in Bangladesh, calves start nibbling due to a lack of sufficient milk and become infected. *Toxocara* is more common in calves than young (within 1 year) and adults, although we found considerable infection in young age groups also which was reported in previous studies (Akyol, 1993; Avcioğlu and Balkaya, 2011). Additionally, we found toxocariasis in adults also, which is rare and may be due to cross-contamination with other age groups. *Strongyloides* had a higher prevalence in adults as young animals develop protective immunity rapidly and short-lived effects (Thamsborg et al., 2017). Among Protozoa, *Entamoeba* showed higher prevalence in the adult because stressful factors such as pregnancy, lactation, and hormonal imbalance may suppress the host immunity and increase exposure to them (Hassan et al., 2019).

Seasons of the year have a great impact on the animal condition and host-parasite interactions. In this study, the highest infection rate was observed in the rainy season than summer and least in winters which were similar to other studies (Choubisa and Jaroli, 2013; Dey et al., 2020, Rahman et al., 2017). Generally, the seasonal prevalence of GIP may vary across different countries depending upon weather conditions. Bangladesh has three seasons; winter (November to February), summer (March to June), and rainy (July to October) (Zahan et al., 2018). However, the rainy season often covers the summer with a combination of high temperature and humidity, increasing the infective stage of GIP in the pasture (Dey et al., 2020). Furthermore, an abundance of vector snail population with contaminated drinking water and fodder during monsoon possibly enhance GIP infection (Choubisa and Jaroli, 2013; Squire et al., 2019; Rahman et al., 2017). Arguably, infections during other seasons may also be possible because worms are continuously present in the host even during the dry season, although the level of infection is low (Pinilla Leon et al., 2019).

Conclusion

Collectively, our study suggests that GIP is still the foremost problem in the livestock sector. GIP infection is considered as the biomarker of development and is an indicator of farmer's knowledge, attitude, and practice (KAP) towards modern livestock farming. Farmers of the study area warrant basic training to boost up their knowledge regarding the harmful effects of GIP. Sex, age, and season have a profound effect on the prevalence of GIP. Knowledge of these GIP species and of the epidemiological parameters is important to chalk out appropriate control strategies.

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Competing interests

The authors have declared that no competing interests exist.

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