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Epidemiology of Gastrointestinal Parasites of Sheep in Three Agroecological Zones in West Shewa Zone, Oromia State, Central Ethiopia

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Abstract

Background: Gastrointestinal parasites are one of the globally occurring most important diseases that include the groups of cestodes, trematodes, the coccidian and gastrointestinal nematodes, particularly the strongyles are the most pathogenic parasites and limit the production of sheep, goats, cattle, equine.

Methods: Across sectional study was carried out in West Shewa zone of the Oromia regional state from August 2019 to November 2021. Flotation and McMaster techniques were used to recover and quantify Nematode, *Monezia* eggs and Eimeria oocysts from 659 rectally collected faeces. The parasite causing the infection was identified by the floating method, and the infection intensity was calculated by the modified McMaster method. The severity of infection was classified as mild (50-799 EPG), moderate (800-1200 EPG), or severe (>1200 EPG). Coproculture was conducted to identify strongyle species.

Results and discussion: Out of 659 overall prevalence of gastrointestinal parasites in sheep was 546 (82.7%) (95% CI=79.8-85.6). Among the gastrointestinal parasites genera found in the study, Strongyle spp. 354 (53.72%), *Eimeria* sp. 375(56.90%), *Monezia* 120 (18.21%), *Strongyloides* sp. 113 (17.15%) and *Trichuris* spp. 76 (11.53%) were identified. The EPG/OPG count showed 2080.96, 1424.78, 240.64, 107.91 and 17.45 burdens of *Eimeria*, Strongyle spp., *Monezia*, *Strongyloides* and *Trichuris* spp. respectively in decreasing order. Among the positive fecal samples, 204 (30.96%) had single infection and while 342(51.89%) samples had mixed infections. Among sheep population (28.07%) had showed a light infection, followed by (21.85%) heavy infection and (6.98%) moderate infection intensity with gastrointestinal nematodes. The most frequently occurring nematodes were *Trichostrongylus* spp. (33.4%), followed by *Haemonchus* spp. 581 (30.7%), *Bunosstomum* spp. 387 (20.5%), *Osephagostomum* spp. 158 (8.4%) and *Teladorsagia* 84 (4.4%), whereas, *Chabertia* spp. 49 (2.6%) was the least identified gastrointestinal nematode. Among the potential risk factors considered in the study, body condition, season, age and sex were associated with the occurrence of *Nematode* species; season, age, study areas and body condition with the occurrence of *Eimeria* species whereas only body condition and agro ecology were associated with the occurrence of *Monezia* infections ($p<0.05$). In general, the occurrences of high prevalence of gastrointestinal parasites in the study area suggest that they are major constraints for production and productivity of sheep.

Conclusion: The present study indicated that gastrointestinal parasitic strangle nematodes, *Monezia* and *Eimeria* are highly prevalent in sheep in the study areas. This study identified that season, study area, age and body condition of the sheep as risk factors for GIT parasites in sheep were significantly associated with the prevalence of git strongyle nematode, *Eimeria* and *Monezia* species infections of sheep.

Keywords: Epidemiology • Gastrointestinal parasites • Infection intensity • Prevalence • Gastrointestinal nematodes

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Introduction

Sheep production in Ethiopia, with 42.9 million heads [1]. And a diverse genetic resource including 15 local and two exotic breeds estimated at 99.6% and 0.3% for local breeds and hybrids, respectively, is a major livestock enterprise contributing to the country's economic development, food and nutrition security, and poverty reduction. Sheep in particular are a major source of livelihoods for smallholder farmers in the sub-moist highlands and for pastoralists. In spite of huge population and importance of small ruminants, Ethiopia has benefited little from this enormous resource owning to a multitude of problems like poor nutrition, poor animal production systems, reproductive inefficiency, management constraints, lack of veterinary care, and disease being the most important [2-5].

One of the most important diseases that limit the production of ruminants globally are the groups of the Gastrointestinal Parasites (GIP) that include cestodes, trematodes, the coccidian and Gastrointestinal Nematodes (GIN), particularly the strongyles are the most pathogenic parasites that cause high mortality rates, as well as losses resulting from subclinical infections that are reflected in low productivity [6-8], but their impact is greater in sub-Saharan Africa in general and Ethiopia in particular due to the availability of a wide range of agro-ecological factors suitable for diversified hosts and parasite species [9,10].

Among the GIPs, gastrointestinal nematodes, mainly the strangles are the most pathogenic and economically important species affecting small ruminants worldwide [11]. Losses due to infection by helminths parasites occur through mortalities, reduced production due to sub-clinical parasitism, and direct cost associated with control measures. In Ethiopia, helminthiasis is responsible for 25% mortality and 3.8%weight loss in highland sheep [12].

GIP infections can be associated with several factors such as animal's age, breed, parasite species involved, and degree of parasitic infection [13]. There are many associated risk factors such as host age, physiological status, breed, parasite species involved, and the epidemiological patterns (husbandry practices and climate variables) determine the degree of infection [14]. More importantly, environmental conditions such as temperature, rainfall and humidity are conducive to the development of nematode eggs and free living stages [15].

For the rational and sustainable control of gastrointestinal parasitism in sheep, a thorough knowledge of the parasites epidemiology and their interaction with the host in a specific environment is required [16]. Therefore, knowledge of the parasite species found in a specific region, their prevalence, degree of infection, characteristics of the local climate, average flock size, and local management practices are considered essential information [17].

There have been numerous studies on internal parasites of sheep in different regions of Ethiopia. These studies had shown that the predominant GI parasites in sheep were *Hemonchus* spp., *Oesophagostomum* spp., *Strongloides* spp., *Trichostrongylus* spp., *Trichostrongylus* spp, *Bunostomum* spp, *Chabertia* and *Trichuris* spp nematodes; *Fasciola*, *Paraphistomum* spp, *Monezia* spp trematodes and *Eimeria* spp protozoan with a prevalence ranged from 2.3-100%. Gastrointestinal (GI) nematode infection rates are high in Ethiopia with an average prevalence of 75.8% [18].

Although, many studies have been conducted to estimate the prevalence of Gastrointestinal Tract (GIT) parasites of sheep in Ethiopia, most of them were conducted using simple fecal egg examination rather than larval identification to identify the nematodes and gastrointestinal parasites burden estimation. Moreover, there is limited information or report about the infection prevalence of coccidia in sheep in the country and most of the epidemiological studies conducted on the GI parasites in the country tended to be in the east, south, and northern regions of Ethiopia and majorly focused on the GIH and very little is known about the epidemiology of GI coccidia infecting sheep in West Shewa zone, Oromia, Ethiopia. Thus, the aim of the present study was to estimate the prevalence of gastrointestinal nematodes, cestodes and coccidia infections of sheep in selected areas of West Shewa zone, and to identify potential risk factors associated with the occurrence of the parasites and to estimate the burden of parasitic infections.

Materials and Methods

Study area

The study was conducted in three selected districts (one district each from highland, midland and lowland agroecology) of West Shewa zone of the Oromia regional state from August 2019 to November, 2021 G.C. West Shewa zone is located in the central part of Ethiopia at 9° 08' 22.1" N (9.1394800°) latitude (width), 37° 51' 00.6" E (37.8501600°) longitude (length) and has larger livestock population which was estimated at 2,294,593 cattle; 1,074,939 sheep; 264,931 goats; 263,558 horses; 11,210 mules;265,736 donkeys. The predominant production system is mixed crop livestock farming in the area.

The three districts were located west of Addis Ababa and along the highway from Addis Ababa to Nekemete, they were selected purposively from a list of all accessible districts of the zone in representation of three different agroecological areas, namely a highland area (Ejersa lafo district) is located around 47 km west of Addis Ababa with an altitude of about 2300 meters above sea level (m.a.s.l). The average annual temperature 21° degrees and there is about 1350 mm of rain in a year with an average humidity of 64%. The district lies between 98° 43' 0" N to 10° 03' 0" N latitudes and 41° 51' 0" E to 42° 80' 0" E longitude. In the district the livestock populations found are 94,955 cattle, 30,678 goats, 47,481 sheep, 10,945 horses, 6,513 donkeys, 574 mules and 37,305 poultry. The 2nd study district Toke kutaye is with midland agroecology which is located about 128 km West of Addis Ababa and 12 km West direction of Ambo town along the highway from Addis Ababa to Nekemete. Geographically, the district lies between 08° 52' 30" N to 9° 3' 0" N latitudes and 37° 31' 30" E to 37° 42' 0" E longitude and the altitude and rainfall of the area ranges from 1600-3194 m above sea level and 800-1100 mm respectively and has temperature range of 10-29°C, it has 185,596 heads of cattle, 27,349 sheep, 24,782 goats, 84,530 chickens, 10,850 horses, 2,371 mules, and 1,398 donkeys according to Tokekutaye woreda livestock and fisheries rural development office. A lowland area representative Ilu Gelan district, geographically, lies between 08° 49' 0" N to 9° 5' 30" N latitudes and 37° 9' 30" E to 37° 25' 0" E longitude. It is located around 200 km West of Addis Ababa. As most parts of the district are found in the low land, the mean annual temperature of the area is relatively high. The highest mean annual rainfall was 1351 mm and recorded in July whereas the lowest mean annual rainfall was 11.2 mm and recorded in February. The average temperature of the district is 27.3°C with average altitude of 1665-1790 m.a.s.l. Total livestock population of the district was 108,732 (cattle), 37780 (sheep) and 38980 (goats) [19].

Similarly, a list of Peasant Associations (PAs) was prepared based on the following inclusion criteria:

- Accessibility for vehicle all year round.
- Availability of veterinary clinics and animal health assistants from the ministry of agriculture.
- Willingness of peasant farmers representatives to participate in the study.
- Availability of small ruminants in the study sites.

Accordingly, a total of six PAs (two per each selected district) were purposively selected.

Study animal and sample size determination

The study animals were 659 sheep of both sexes (316 male and 343 female), under traditional management production systems. In this study the risk factors such as animal's species, age, sex, body condition, and peasant association were included. Those animals with the age of between three months and less than one year were considered as young while those greater than or equal to one year were included as adults as described by Kumsa B. The age of the animal was estimated by looking at the dentition pattern of the animals according to Frandson RD, et al., and also by owner's response. Body condition score was done according to Hansen J and Kumsa B. And recorded as poor, medium or good. Simple random sampling technique was employed to select the study animals. The sample size was determined by the formula described by Frandson RD, et al., at 95% confidence level and 5%precision, and considering 50% estimated prevalence as there was no previous such combined study at the current study area. However, to increase the precision of the study sample size was increased to 659 [20].

$N=(1.962 \text{ Pexp } (1\text{-Pexp}))/d^2$

Where, N=sample size;
Pexp=expected prevalence;
D=desired absolute precision.

Study design

A cross sectional study was carried out from August 2019 to November 2021 to collect data on events associated with gastrointestinal parasites of sheep and identifies nematode parasites, *Cestodes* and *Coccidia*. The study animals in each selected districts and peasant association are categorized into two age groups, that is, less than 1 year as young and above 1 year as adult.

For all sampled animals, simple floatation and modified McMaster egg counting technique was carried out to determine the prevalence and the number of eggs (oocysts) per gram (EPG/OPG) burdens in the faecal samples. The degree of infections was determined by counting the eggs per gram faeces through modified McMaster technique and classified as light infection level as (50-800 FEC), medium (801-1,200 FEC) and heavy (>1,200 FEC) according to Hansen J given for a mixed infection in small ruminants fecal culture of pooled gastrointestinal strongyles positive samples and L3 identification was also carried out according to Van-Wyk A, et al [21].

Study methodology

Faecal sample collection and examination: About 5-10 g faecal samples were collected from each animal directly from the rectum using disposal gloves and coded with the animal identification number by permanent marker [22]. After collection, fecal samples were transported to the veterinary laboratory of college of agriculture and veterinary sciences, Mamo Mezamir Guder campus of Ambo university and processed for qualitative and quantitative coprological examination and coproculture on the day of collection or stored in refrigeration at +4°C to be processed on the next day. In the laboratory, the samples were processed by both centrifugal floatation and McMaster technique to detect the presence of GIP and determine faecal egg count (EPG)/faecal oocyst count (OPG) following the procedure described by Hansen J.

During sampling, data with regard to age, sex, species, body condition and other relevant factors were collected for each sampled animal. The age of the animals was determined based on the farmers response and teeth inspection. Body Condition Scoring (BCS) were made according to Morgan ER, et al., and recorded as 1 (poor), 2 (average or medium) or 3 (good). Faecal samples were analyzed for helminthic eggs, and coccidial oocysts using a modified McMaster technique [23]. Identification of characteristic helminthic eggs of strongyle type egg, *Trichuris*, *Strongyloides*, *Monezia* species, and *Eimeria* oocysts were done at genus level only and were based on the morphological features as described by Urquhart GM [24].

The McMaster egg counting technique was carried out for each faecal sample in order to determine the number of eggs per gram of faeces as described by Taylor MA, et al. Briefly, 3 g of the faeces were mixed in 42 ml of saturated NaCl and sugar solution (by the ratio of 400 g of NaCl+1 liter of tap water+500 g of sugar=1.28 specific gravity) with a sensitivity of 50 EPG of faeces [25].

Fecal culture and L3 identification: At present, the only practical method available for routine laboratory estimation of the proportions of GIT worm genera present in the living animal is to identify the larvae that develop in faecal cultures [26]. Fecal samples positive for strongly type eggs were subjected to coproculture and the infective 3rd stage larvae (L3) were identified to genus level. Fecal samples from nematode eggs positive animals were pooled and cultured for harvesting of third stage larvae and identification of genera of nematode eggs. Pooled fecal samples were then finely broken using stirring device, kept moist and brittle; the mixtures were transferred to petri dishes and placed at 27°C in an incubator for 7 to 10 days. The culture was kept moist by adding water every 2 days. During this period, the larvae was hatched from the eggs and developed into L3. Finally, larvae were recovered using the modified Baermann technique [27]. The presence of larvae was assessed by using a stereomicroscope, when present; two drops of larval suspension were mixed with drop of lugols iodine on glass slide, and examined at low magnification power for identification. From each culture, the third-stage larvae (L3) were morphologically differentiated and identified according to [28,29]. Conventional characteristics for identification (total length, esophagus length, tail sheath length, filament length and the number of intestinal cells) of infective larvae from gastrointestinal nematode genera/species were microscopically examined.

Data analysis

All collected data were entered into a Microsoft excel spreadsheet, edited and coded; and then summarized by descriptive statistics like mean and proportion. Multivariate logistic regression analysis was used to see the association of the potential risk factors considered for the study with infection by nematodes, cestodes and *Eimeria* species infection. Finally, the model fitness was assessed by the Hosmer-Lemeshow goodness-of-fit test [30]. For the data analysis STATA 14.2 software was used. The study considered a 95% level of confidence and 5% desired level of precision [31].

Results

Prevalence and parasite burden of gastrointestinal nematodes, cestodes and *Eimeria*

From the fecal examination results, it can be seen that the GIP infection rate of sheep in west Shewa zone was very high. Of the 659 Sheep examined, 82.7% (n=546; 95% CI=79.8-85.6) were found to harbor one or more parasite species. The gastro-intestinal parasites infecting sheep in the sampled areas in this study were emeriasis, strongyliasis, moneziasis, strongloidiasis and trichuriasis (Table 1). Table 1 shows the gastrointestinal parasites genera found in the study, are Strongyle spp 354 (53.72%), *Eimeria* sp. 375(56.90%), *Monezia* 120(18.21%), *Strongyloides* sp. 113(17.15%) and *Trichuris* spp. 76 (11.53%) the prevalent infections. Out of the ovine infected by gastrointestinal parasites 204 (30.96%) had single infection and 342 (51.89%) ovine had mixed infections. The present study revealed that most of the samples were found with multiple infections than single infection with gastrointestinal nematodes and *Eimeria* coinfection being high. The further more indicated the mean burdens EPG/OPG count and prevalence rates of 2080.96 (56.90%), 1424.78 53.72%), 240.64 (18.21%), 107.91 (17.15%) and 7.45 (11.53%) *Eimeria*, Strongyle spp., *Monezia*, *Strongyloides* and *Trichuris* spp. respectively in decreasing order.

Parasite genera/ species	Frequency	%	Std. err.	95% Conf. interval	Mean	Std. err.	95% Conf. interval
Strongyle spp.	354	53.72	1.94	49.9-57.5	1424.78	121.9	1185.4-1664.1
Trichuris spp.	76	11.53	1.25	9.1 -14	17.45	2.5	12.51-22.4
Strongloides	113	17.15	1.47	14.3-20.0	107.91	18.7	71.3-144.5
Ginematodes	379	57.51	1.93	53.7-61.3	1529.15	129.1	1275.6-1782.7
Monezia	120	18.21	1.5	15.3-21.2	240.64	50.6	141.3-340
Eimeria	375	56.9	1.93	53.1- 60.7	2080.96	220.3	1648.3-2513.6
Overall gitparasites	545	82.7	1.47	79.8-85.6			

Table 1. Prevalence and burden of ovine gastrointestinal parasites in West Shewa zone.

Table 2 shows the prevalence and abundance of GIP species infection varied across agroecologies, age category, and sex, season and body condition. The overall mean faecal egg/oocyst count for gastrointestinal nematode, *Eimeria* spp. and *Monezia* spp. positive animals combined was generally in the highland having a highest mean faecal egg/oocyst count than the midland and lowland [32]. The prevalence of GIS and *Eimeria* in High land and mid lands were higher than in lowland agroecology. Young sheep had overall mean faecal egg count of (2977.3) *Eimeria*, (2505.8) Nematode spp. and (319.1) *Monezia* spp. which is significantly higher than that of adults. The overall mean faecal egg/ooctst count of gastrointestinal parasites species infections for positive animals was high for categories of risk factors like highland, poor body conditions, wet season and when animals are young.

Risk factors	Variables category	No. examined	GIS spp.			*Monezia* spp.			*Eimeria* spp.		
			No (%) positive	Mean output (EPG)	Min-Max	No (%) positive	Mean output (EPG)	Min-Max	No (%) positive	Mean output (OPG)	Min-Max
Study area	Ilugeln	244	83 (34.0)	350.2	0-14000	36 (14.8)	224	0-14000	105 (42.2)	3055.1	0-52000
	Tokekutaye	166	102 (61.4)	830.5	0-12500	27 (16.3)	128.9	0-4000	115 (69.3)	1432.5	0-10000
	Ejersalafo	249	169 (67.9)	2874	0-16200	57 (22.9)	331.4	0-22000	155 (63.5)	1558.6	0-80000
Body condition	Poor	242	199 (81.2)	2921.2	0-16200	52 (21.2)	456.5	0-22000	155 (63.3)	2467.8	0-52000
	Medium	253	116 (46.4)	748.5	0-12500	47 (188)	140.6	0-4000	154 (61.6)	2236.8	0-80000
	Good	164	39 (23.8)	259.8	0-6200	21 (12.8)	76.5	0-3000	66 (40.2)	1269.8	0-50000
Age category	Young	216	130 (58.0)	2337.9	0-16200	49 (21.9)	319.1	0-22000	142 (63.4)	2977.3	0-80000
	Adult	443	224 (51.5)	979.5	0-15800	71 (16.3)	202.4	0-14000	233 (53.6)	1643.9	0-50000
Sex	Female	343	209 (60.9)	1764.1	0-15800	67 (19.5)	311.8	0-22000	174 (50.7)	1332.9	0-80000
	Male	316	145 (45.9)	1056.5	0-16200	53 (16.8)	163.4	0-8000	201 (63.6)	2892.9	0-52000
Season	Dry	335	137 (40.9)	368.209	0-8800	56 (16.7)	193.9	0-22000	178 (53.1)	878.7	0-10000
	Wet	324	217 (67.0)	2517.22	0-16200	64 (19.8)	289	0-14000	197 (60.8)	3324.1	0-80000

Table 2. Prevalence and abundance (mean output) of selected parasitic taxa in the subgroups identified by the individual (BCS, age and sex) and environmental (season and agroecology) factors in sheep.

The coproculture of infected faecal samples reveled that, the about third of most identified type of GIS was *Trichostrongylus* spp. followed *Haemonchus* spp., by *Bunosstomum* spp., *Osephagostomum* spp. and Teladorsagia, whereas, *Chabertia* spp. was the least observed GIS (Table 3).

	Haemonchus	*Trichostrongylus*	*Bunostomum*	*Oesophagostomum*	*Teladorsagia*	*Chabertia*
n larvae	581	631	387	158	84	49
Relative %	30.70%	33.40%	20.50%	8.40%	4.40%	2.60%

Table 3. Number and relative percentage of third-stage larvae of the different genera of GIS identified in the whole study area (n=1,890). Larvae ascribable to strongyloides were not considered here.

The intensity of infection with GIN in sheep was graded into four categories and presented in Table 4, out of the infected sheep (28.07%) showed a light infection, followed by (21.85%) heavy infection and (6.98%) moderate infection intensity with GIN; whereas 43.10% were with no infection [33-36].

Infection degrees	Freq.	Percent (proportion)	Std. err.	95% Conf. interval)	
No infection	284	43.1	1.93053	39.30486	46.88634
Light	185	28.07	1.75177	24.63311	31.51257
Medium	46	6.98	0.99337	5.02972	8.93083
Heavy	144	21.85	1.61097	18.68804	25.01454
Total	659	100			

Table 4. Estimation of infection degrees of ovine gastrointestinal nematodes.

Logistic regression analysis of potential risk factors for GIP infection

The multivariable logistic regression analysis revealed that among the potential risk factors considered in the study, body condition, season and agroecology were associated with the occurrence of strongyle nematode species (Table 5); season, age, study areas and body condition were associated with the occurrence of *Eimeria* species in sheep (Table 6) whereas only body condition and agroecology are associated with the occurrence of *Monezia* infections (Table 7). The odds of occurrence of gastrointestinal strongyle nematodes infection in sheep reduces about 5.6 times when the agroecology is lowland (Ilugalan) than being highland (Ejersalafo) (P=0.000). Similarly, the odds of gastrointestinal strongyle nematodes in sheep reduces about 16.2 times and 5.8

times when the body condition is good or medium respectively than in sheep with poor body condition (P=0.000) [37-41]. The odds of acquiring gastrointestinal strongyle nematodes infection in sheep increases about 4.0 times when it's wet season than being in dry season (P=0.000).

The odds of acquiring *Monezia* infection by sheep in Ejersa lafo were 1.63 times higher as compared to Ilugelan (Table 6). The odds of acquiring *Eimeria* infection by sheep with good body conditions is 3.49 times lower as compared to sheep with poor body conditions and the odds of acquiring *Eimeria* infection by young sheep was 2.55 times higher as compared to adult sheep. The odds of acquiring *Eimeria* infection was 4.368604 and 2.09 times higher in Ilugelan and Tokekutaye respectively as compared to sheep in highlands (Ejersa lafo); the odds of acquiring *Eimeria* infection by sheep in Mutullu village was 3.77 times high as compared to Birbirsa village (Table 7).

Strongly		Odds ratio	Std. err.	z	P>|z|	95% Conf. interval	95% Conf. interval
						Lower	Upper
Season	Dry	Reference					
	Wet	4.04713	0.814344	6.95	0	2.728176	6.003739
Bodycondition	Poor	Reference					
	Medium	5.812142	0.03975	-7.62	0	3.695554	9.140985
	Good	16.23266	0.016788	-10.23	0	9.515418	27.69186
Agroecology	Ejersalafo	Reference					
	Tokekutaye	1.538172	0.161206	-1.74	0.082	0.946104	2.500752
	Ilugelan	5.630523	0.041601	-7.38	0	3.557673	8.911099
Cons		5.212705	1.208576	7.12	0	3.309104	8.211375

Table 5. Multivariate logistic regression analysis of ovine strongly nematodes prevalence.

Monezia	Odds ratio	Std. err.	z	P>|z|	(95% Conf. Interval)	
Agro ecology						
Tokekutaye	1.496131	0.173675	-1.55	0.121	0.89907	2.489691
Ilugelan	1.628949	0.145547	-2.06	0.04	1.023524	2.59249
Body condition						
Midium	1.150242	0.196667	-0.62	0.536	0.738304	1.79202
Good	1.729696	0.163856	-1.93	0.053	0.992479	3.014521
Cons	0.345096	0.065556	-5.6	0	0.237816	0.500768

Table 6. Multivariate logistic regression analysis of *Monezia* of ovine.

Eimeria	Odds ratio	Std. err.	z	P>|z|	(95% Conf. Interval)	
Agro ecology						
Tokekutaye	2.08504	0.657641	2.33	0.02	1.123666	3.868935
Ilugelan	4.368604	1.462641	4.4	0	2.266491	8.420371
Wetseason	1.142272	0.256914	0.59	0.554	0.735058	1.775078
Adultage	2.549556	0.078805	-4.66	0	1.719663	3.779949
Bodycondition						
Midium	1.103247	0.180672	-0.49	0.622	0.74646	1.63057

Good	3.493298	0.065407	-5.47	0	2.232281	5.466668
Kebele						
Olankomibobe	1.228982	0.226401	-0.74	0.459	0.712369	2.120245
Mutullu	3.773676	1.390298	3.6	0	1.83301	7.768988
Birbirsa	1(omitted)					
Ilaalaa	1.373184	0.263301	-0.88	0.38	0.676033	2.789263
Allewarailu	1(omitted)					
Cons	1.523978	0.376923	1.7	0.088	0.93854	2.474598

Table 7. Multivariate logistic regression analysis of ovine Eimeria.

Discussion

The gastrointestinal parasites of sheep are one of the major important parasitic diseases that reduce the productivity of sheep raised by farmers using traditional husbandry management system in West Shewa zone. GIH and *Eimeria coccidia* infections in sheep are globally present however with differences in the prevalence rate and infection intensity attributed to variations in sheep's immunity, climate, and feeding and management conditions and remains a major problem to sheep keepers [42]. The present study demonstrated the overall prevalence of gastrointestinal parasitic infection was 82.7%, and an average infection intensity and prevalence rates of GIP *Eimeria*, Strongyle spp., *Monezia*, *Strongyloides* and *Trichuris* spp. were 2080.96 (56.90%), 1424.78 (53.72%), 240.64 (18.21%), 107.91 (17.15%) and 17.45 (11.53%), respectively in decreasing order. Our results on prevalence of GIPs were in line with the reports of a previous study in Regassa F, Moje N, et al., who also found high prevalence of GIP that ranges 71-87% in different places in Ethiopia. Similarly, Jatau ID reported overall prevalence 74.76% GI parasitic infection in sheep in northern-Nigeria; Gizaw S in Kenya the GI parasite prevalence in the sheep populations reached as high as (75.7%) reported (72%) prevalence of GIP of sheep in and around Rawalpindi and Islamabad, Pakistan.

However, our result is less than the report of Tesfaheywet Z in Eastern and Southern part of Ethiopia who found the overall prevalence of 90-97.8%; elsewhere of Djallonke sheep in Ayeduase, Kumasi, Ghana a prevalence rate of 98.2% with the total infection rate of GIT nematodes and coccidia oocysts were 94.5% and 51.8%, respectively; where the GIN and coccidial infection rates and an average infection intensity in Kazakh sheep, China was (96.96%). The overall higher prevalence of GIP infections of sheep in the surveyed areas could be attributed to lower immunity of hosts as a result of malnutrition, dependence on grazing in deteriorated grazing lands, use of the same contaminated pasture for grazing throughout the year by different mixed species of animals, grazing of young and adult animals together and existence of good agro-climatic conditions that might provide ideal conditions for development and transmission of the endoparasites [43-48].

The present finding in sheep was higher than the prevalence rates reported in other areas of Ethiopia Dawit I in sheep in Hawasa town, southern Ethiopia that showed a GIN infection rate of (51.3%); Ousman A in Adami Tulu Jiddo Kombolcha district, East Shoa zone of Oromia region, Ethiopia 117 (60.9%);Southern Ethiopia an infection rate of 43.5% by Belina D the infection rate of (63.33%) in ovine in East and Western Hararghe, Ethiopia; Aga TS who reported (24.7%) prevalence of gastrointestinal nematodes in sheep in West Oromia, Ethiopia; Menkir S in Wayu Tuka and Diga district West Ethiopia (44.0%); Ousman A in sheep in kurmuk woreda, Assosa Zone of Benishangul Gumuz regional state, Western Ethiopia (26%); Fayisa O prevalence rate of 185 (59.11%) *Monezia* (2.5%), *Emeria* spp. (0.260%) in sheep in and around Gondar town, Northwest, Ethiopia; infection rate of (63.16%) gastrointestinal parasites were detected in sheep in Minna Abattoir, Niger sate, Nigeria; Poddar PR in Bangladesh revealed (67.9%) sheep were infected with various types of GI helminths; Mahlehla MA, et al., in Brazil the overall prevalence rates of nematodes, coccidia, and cestodes were 53.9%, 46.5%, and 4.3% in the Maseru district, respectively and for the Quthing district he also indicated the prevalence rates of 65.0%, 38.2%, and 0.9% for nematodes, coccidia, and cestodes, respectively; The observed differences in prevalence could be attributed to factors such as different management practices, breeds, and the difference of health care activities, sample size and the variation in geographical and climatic conditions and season under which the various studies were carried out. Among the factors influencing strongyle infections, geographical conditions, temperature, climate, rainfall, humidity, soil conditions and farm management have been described Knapp et al. This could be related to the country's extremes temperature and rainfall which is the most important factor that influence the development, distribution and survival of nematode parasites [49].

The present study revealed that most of the samples were found with multiple infections 342 (51.89%) than single infection with 204 (30.96%) gastrointestinal nematodes and *Eimeria* coinfection being high. The findings of present study are in close agreement with the reports of in Brazil where 68.61% mixed infection prevalence rate of gastrointestinal parasites was detected in sheep herds, between helminths and protozoans [50]. The overall prevalence rates of nematodes, coccidia, and cestodes were 53.9%, 46.5%, and 4.3% in the Maseru district, respectively [51].

Our present infection intensity record of *Eimeria* Strongyle spp., *Monezia*, *Strongyloides* and *Trichuris* spp. were 2080.96, 1424.78, 240.64, 107.91 and 17.45, respectively in sheep from West Shewa is in general agreement with the average infection intensity reported by Yan X; Martins NS, et al., in Kazakh sheep and sheep herds from the Brazilian Pampa biome, Rio Grande do Sul state, Brazil who found similar findings. Though the GIN and coccidial infection rate were higher than our result the average infection intensity was in general agreement [52-55].

Our results to classify the severity of infection based on the level of EPG as proposed by Hansen J revealed that 28.07% of the infected sheep had light nematode faecal egg counts per gram (50 to 800), 21.85% of the animals had heavy (>1200) EPG counts and 6.98% showed moderate (800 to 1200)degree of infection, are on the same line with west Ethiopia; Hansen J from Southern Ethiopia and Owusu M, in Kumasi, Ghana who also reported sheep were lightly, highly, and moderately infested, respectively; but it disagrees with reports of Ousman A, et al. in sheep from different parts of Ethiopia. The difference in degrees of infections could be due to the variations in animal managments, breed differences, immunity, season, agroecology, feed etc.

The coproculture of infected faecal samples reveled that, the most identified type of GIS was *Trichostrongylus* spp. 631 (33.4%), followed by *Haemonchus* spp. 581 (30.7%), *Bunosstomum* spp. 387 (20.5%), *Osephagostomum* spp. 158 (8.4%) and *Teladorsagia* 84 (4.4%), whereas, *Chabertia* spp. 49 (2.6%) was the less frequently observed GIS. A predominance of *Haemonchus* spp. and *Trichostrongylus* spp. nematodes was observed in this study. The considerably high prevalence of *Trichostrongylus* and *Haemonchus* in West Shewa was consistent with the reports presented in studies conducted by Abebe W, et al., in Ethiopia who has also reported similar findings. Whereas higher proportion of Haemonchus followed by *Trichostrongylus* in sheep were reported by Woldemariam, DL; Aga TS in Ethiopia and Eke SS, et al., in Nigeria; and Martins, NS in Brazil Poddar PR. The variation in these reported findings could be attributed to differences in management system, topography, de-worming practices, and climatic condition that favor the survival of infective stage of the parasite.

In our findings *Eimeria* spp. was the most frequently 56.90% recovered GIP followed by 53.72% Strongyles spp., *Monezia* 18.21%, *Strongyloides* spp. 17.15% and *Trichuris* spp. 11.53%. Among the gastrointestinal parasites observed in this study, *Coccidia* have the highest prevalence. This is in conformity with the findings of Owusu M, who also reported a high prevalence of *Coccidia* and gastrointestinal strongyle from different countries.

In our findings *Eimeria* spp. was the most frequently 56.90% recovered gastrointestinal parasites and this prevalence of infection by *Eimeria* species is in agreement with previous reports of Owusu M who found infection rate of coccidia oocysts (51.8%), in Ayeduase, Kumasi, Ghana; Asif M in sheep in and around Rawalpindi and Islamabad, Pakistan *Coccidia* (51.61%) and Mahlehla MA, et al., in Brazil who recorded the overall prevalence rates of *Coccidia* was 46.5% in the Maseru district. The high prevalence of *Coccidia* obtained in this study could be as a result of the management system operated by most small ruminant's owners especially during the rainy season when animals are confined to avoid damage to crops. Consequently, such animals are with the pens not properly cleaned. These factors with the high humidity of the rainy season predispose them to the parasitic infections.

However, our result of *Eimeria* spp. prevalence disagrees with the very high records of (89.32%) Jatau ID, et al., in Northern-Nigeria; (90.89%) of coccidia infection rate by Poddar, et al., of China; (70.55%) by Martins NS in Brazil; and with the previous *Eimeria* prevalence reports in sheep which were lower than our results in Regassa F 26.7% reported in sheep in West Oromia; prevalence rate of (12.5%) *Eimeria* spp. Parasites of sheep and goat in and around Gondar town, Northwest, Ethiopia; Singh et al. Prevalence of (26.47%) coccidian parasites in sheep in and around Mathura, India harbored coccidian. The observed difference could be attributed to the difference in the sample size, age, host management situations like feeding, housing and watering and hygiene status of animals, difference in environmental factors, like season, humidity and temperature of study areas.

The cestode observed in the sheep in the present study was *Monezia* with prevalence of 18.21%, the occurrence of these parasites is low as compared to *Eimeria* and strongyles parasites. The present report of Moniezia infection rate was in conformity with reports of Sibhatu et al., in Jeldu district, West Showa zone of Oromia regional state, Ethiopia 20.2% *Moniezia expansa* (20.39%) from sheep herds in Brazil. However, our result is less than the report of Abebe W, et al., in sheep in Eastern part of Ethiopia during the dry season 27.65%, and greater than the prevalence reported in Abebe W, et al., in Dire Dawa, East Ethiopia (13.67%); Bedada H in the Afar, Ethiopia (8.53%) *Monezia* infection; Fayisa O (0.26%) *Monezia* of sheep in and around Gondar town, Northwest; Mahlehla MA in Brazil the overall prevalence rates of cestodes was 4.3% in the Maseru district; 8 (6.8%) detected *Moniezia* spp. in sheep in Minna Abattoir, Niger sate, Nigeria; Specific prevalence of *Moniezia* species infections (4.85%) in in sheep at slaughter in Kano central abattoir, Northern-Nigeria and *Moniezia* sp. (3.8%) of sheep in Sherpur, Bangladesh was reported. This might be due to the fact that the climatic condition is not equally suitable for survival of the intermediate host (oribatid mite) and transmission of *Moniezia* in different study areas.

The multivariable logistic regression analysis revealed that among the potential risk factors considered in the study, body condition, season and agroecology were associated with the occurrences of GIS nematode and *Eimeria* species; whereas only agroecology is associated with the occurrence of *Monezia* infections. The odds of occurrence of gastrointestinal strongyle nematodes infection in sheep reduces about 5.6

times when the agroecology is lowland (Ilugalan) than being highland (Ejersalafo) (P=0.000. Similarly, the odds of gastrointestinal strongyle nematodes in sheep reduces about 16.2 times and 5.8 times when the body condition is good or medium respectively than in sheep with poor body condition (P=0.000). The odds of acquiring gastrointestinal strongyle nematodes infection in sheep increases about 4.0 times when it's wet season than being in dry season (P=0.000).

The odds of occurrence of gastrointestinal strongyle nematodes infection in sheep reduces about 16.233 times and 5.812 times when the body condition is good or medium respectively than in sheep with poor body condition. The odds of acquiring gastrointestinal nematodes infection in sheep increases about 4.05 times when it's wet season than being in dry season. Sheep in good and medium body condition were more likely to be free from GIN infection by (P=0.000) about 16.373 and 5.81 times, respectively than in sheep with poor body condition.

The odds of occurrence of gastrointestinal strongyle nematodes infection in sheep showed no significant associations (p>0.05) in prevalence between different sex male and female sheep this finding conforms to Farooq, U who found in South, Afar and West Hararge of Ethiopia respectively no significant difference (p>0.05) in prevalence between different sex Eke SS, et al., in Minna Abattoir, Niger sate, Nigeria reported that there was no significant difference (p>0.05) on the infection rate in relation to gender. Our findings disagrees with Belina D who reported high ocurrence of gastrointestinal nematodes infection in female than in male sheep at significant difference (P<0.05), and with Dawit I, et al., whose findings revealed the prevalence was high in male than in female and The differences may be related with sample size variation, physiologic conditions like pregnancies, lactating state in female genders in the study.

The multivariable logistic regression analysis revealed that among the potential risk factors considered in this study, agro-ecology was associated with the occurrence of all GIP (Strongyle, *Monezia* and *Eimeria*) species in sheep. In this study there was significant strongyle nematode variation among PAs and districts (p>0.05) of the study areas in West Shewa zone. The odds of occurrence of gastrointestinal strongyle nematodes infection in sheep reduces about 5.6 times when the agroecology is lowland (Ilugalan) than being highland (Ejersalafo) (P=0.000). The odds of acquiring gastrointestinal strongyle nematodes infection in sheep increases about 4.0 times when it's wet season than being in dry season (P=0.000).

The odds of acquiring *Monezia* infection by sheep in Ejersa lafo were 1.63 times higher as compared to Ilugelan. The odds of acquiring *Eimeria* infection by sheep in mutullu village was 3.77 times high as compared to Birbirsa village, the odds of acquiring *Eimeria* infection was 4.368604 and 2.09 times higher in Ilugelan and Tokekutaye respectively as compared to sheep in Highlands (Ejersa lafo). This findings conforms with Regassa F, et al., who reported association between prevalence rates and EPG with agro-ecology where higher values were recorded for lowland areas followed by mid altitude areas with owest values in highland areas in West Ethiopia; who reported significant nematode variation among Pas (p>0.05) of the four districts of the two zones, West Hararghe (Chiro and Tullo districts) and East Hararghe (Meta and Haramaya districts) East, Ethiopia and Bedada H who reported significant variation in overall parasite prevalence was observed between the two study districts (OR=0.169, p=0.000) of Afar. These findings may be attributed to the fact that areas receiving high annual rainfall provide optimum conditions of humidity and temperature required for development and dissemination of infective stages but disagrees with who reported that there was no significant association between study areas and GIP infection occurrence in southern Ethiopia [53]. The difference between this and ours could be that the sampling was from similar rainfall, ecology and environmental factors in their survey.

The multivariable logistic regression analysis revealed that among the potential risk factors considered in this study, body conditions was associated with the occurrence of gastrointestinal strongyle nematodes and *Eimeria* species in sheep. In this study, a significant difference (P<0.05) was observed in GIT nematode infection in relation to body condition where a higher prevalence of strongyle nematodes was recorded in sheep with poor body condition and odds of occurrence of gastrointestinal strongyle nematodes in poor body condition is about 16.2 times and 5.8 times higher than animals with the good or medium body condition respectively. Similarly, the odds of gastrointestinal strongyle nematodes in sheep reduces about 16.2 times and 5.8 times when the body condition is good or medium respectively than in sheep with poor body condition (P=0.000). The odds of acquiring *Eimeria* infection by sheep with good body conditions is 3.49 times lower as compared to sheep with poor body conditions and the odds of acquiring *Eimeria* infection by young sheep was 2.55 times higher as compared to adult sheep. This poor body condition might be due to malnutrition, other concurrent disease or the current parasitic infection which lead to poor immunological response to infective stage of the parasite. This finding agrees with Belina D, et al., in Ethiopia and Poddar PR in Bangladesh who revealed also helminth infection was significantly (P<0.05) higher in poor body conditioned sheep as contrasted to good body conditioned sheep but contradicts the findings of Handiso T, et al., who reported that body condition of the animal did not show significant association with prevalence of the parasite. This could be explained by the fact that loss of body condition in the study animals could be due to other factors, such as seasonal change of forageable feedstuff and the presence of other concurrent disease conditions.

Results of the present study in sheep showed seasonal variation in the prevalence and burden of gastrointestinal nematodes, and *Eimeria* with the prevalence and level of burden of infection being higher during the rainy season than the dry season. The prevalence and burden of gastrointestinal strongyle nematodes and *Eimeria* parasites 2517.2 (67.0%), 3324.1 (60.8%), were higher during wet season than the dry season 368.2 (40.9%), 878.7 (53.1%) respectively with occurrence of strong association OR 4.047 (P=0.000, CI=2.7-6) for gastrointestinal strongyle nematodes. This agrees with Fayisa O, et al. During the rainy season, high humidity and moderate temperature are factors that facilitate the survival and sporulation of the oocysts. Climatic conditions, particularly rainfall, frequently are considered to account for differences in the prevalence of GI-parasitic infection, since infective stages such as eggs, cysts and oocysts are known to survive longer in cool, moist conditions.

The high prevalence and burden of gastrointestinal strongyle nematodes, *Monezia* and *Eimeria* parasites 2337.9 (58.0%), 319.1(21.9%), 2977.3 of GIS, in young sheep were observed than in adult sheep 979.5 (51.5%), 202.4 (16.3%), 1643.9 (53.6%) respectively, though no significant association occurred. The odds of occurrence *Eimeria* infections in sheep increase about 2.549556 times in young sheep than when the age category is adult. This agrees with which showed that the susceptibility and pathogenicity *Eimeria* infections were greater in young animals than in mature animals; but disagrees with Bedada H, et al., in the Afar, Ethiopia; in and around Hirna, Western Hararghe, Ethiopia; Handiso T, et al., in and around Yabello, South Ethiopia in and around Alage Ethiopia had no statistical association (p>0.05) for parasitic infection between different age groups; In Bangladesh parasitic counts in lambs, young and adult showed no significant variations (P=0.511) from one other; Eke SS, et al., in Minna Abattoir, Niger sate, Nigeria reported that there was no significant difference (p>0.05) on the infection rate in relation to age. These observed associations could be related to the immunological immaturity, age specific susceptibility in lambs, or might be due to a limited previous exposure and immaturity of the immune system that resulted in higher development of the parasite and adult animals may acquire immunity to the parasites through frequent challenge and expel the ingested parasite before they establish infection. The overall higher incidence of nematodes infestation in the areas surveyed could be attributed to lower immunity of hosts as a result of malnutrition.

Conclusion

In conclusion, our study has confirmed gastrointestinal parasitic infections are highly prevalent in West Shewa. This study identified that season, study area, age and body condition of the sheep as risk factors for GIT parasites in sheep were significantly associated with the prevalence of GIT Strangle Nematode, *Eimeria* and *Monezia* species infections of sheep. We therefore recommend regular monitoring and management of infections in traditional sheep herds as well as the parasitological study using the molecular techniques and monthly dynamics distribution study for further to provide more epidemiological information.

Ethical Clearance

All the participants in this study were treated according to the ethical standards of Addis Ababa University, and the protocol was assessed and approved with certificate reference number: VM/ERC/17/05/13/2021 by the Addis Ababa university research ethics review committee. The participants were informed about the purpose and the methods of the study. Oral consent was obtained from each owner and participant before commencement of the study.

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