Epidemiology of Small Ruminant External Parasites: in the Case of Chemical Control Campaign in Welkait District, Tigray Region, Ethiopia

ABSTRACT

A cross-sectional study was conducted from November 2015 to May 2016 in nine peasant associations of Welkait district Western part of Tigray region to determine the epidemiology of major external parasites and associated risk factors in small ruminants. Out of the 102 sheep and 324 goats clinically examined, 75(73.53%) sheep and 246 (75.93%) goats were found to be infested with one or more external parasites. The rate of different external parasites infestation revealed that a prevalence of 71(69.61%) hard tick and 7(6.86%) fleawere observed in sheep whereas 211(65.12%) hard tick, 84(25.93%) lice, 60(18.52%) flea and 4(1.23%) mange species were recorded in goats. Statistically significant variation ($P< 0.05$) was found in case of lice and flea between the two species. In the present finding the prevalence of mixed types of external parasite infestation in sheep and goats were 5(4.9%) and 104(32.1%) respectively. Even though there were difference in prevalence of lice and flea between different risk factors, the difference in prevalence was not statistically significant ($P>0.05$) in goats except in case of lice by body condition score and flea by agro-ecology and age respectively. Considering the potential risk factors that affect tick infestation in goats, there were statistically significant association with agro-ecology, body condition, age and flock type of the animal studied where as the prevalence of external parasites were not significantly affect by most of the risk factors considered ($P>0.05$) in sheep except in case of ticks which were affected by agro-ecology and flea by the age of sheep. The logistic regression analysis of risk factors indicated that the prevalence of lice was 2.936 and 2.159 times higher in poor and medium body condition ($P<0.05$) than good body condition of goats respectively where as in case of flea goats being in high land 2.600 more likely ($P<0.05$) to be infected by flea than goats in low land respectively. Goat being young age 3.73 times to be infested by flea than adult age. Similarly, in ticks' goats in high land and midland agro-ecology were 6.498 and 5.200 times more infested by tick than lowland respectively and 0.335, 2.187, 4.828 and 3.101 times adults than young, mixed than single rearing and goats being poor and medium body condition than good body condition respectively. In case of sheep the only potential risk factor which affect tick infestation was agro-ecology with sheep live in highland have 4 times higher in

harboring ticks than lowland. Species level logistic analysis result indicated that, goats were 3.084 times more infested by flea than sheep.

Key words: External parasites, Goat, Prevalence, Risk factors, Sheep, Welkait

1. INTRODUCTION

Ethiopia is a country with an extremely diversified topography, a wide range of climatic features and with different agro-ecological zones, which makes it suitable for different agricultural production systems and has large diversity of farm animal genetic resources. The livestock production systems of Ethiopia are broadly characterized as low input, mixed crop-livestock, agro-pastoral and pastoral systems; as well as medium input, peri-urban and urban enterprises [2]. Data from the estimation of [8] indicates that the country is a home for about 56.71 million cattle, 29.2 million sheep and 29.3 million goats, 9.9 million equines, 1.2 million camel, 56.9 million poultry and Tigray region accounts for 4.6 million cattle, 1.8 million sheep, 4.3 million goats, 0.8 million equines, 0.6 million camel and 6.2 million poultry of the country.

The livestock subsector has great contribution to the national economy and livelihood of many Ethiopians. The subsector currently support and sustain livelihoods for about 80% human population and it also contributes about 16.5% of the national Gross Domestic Product (GDP), 35.6% of the agricultural GDP as described by [27] and also contribute for 15% of export earnings and provides employment to over 30% of the agricultural labor force [5]. According to [13] livestock is the second major source of foreign currency through export of live animals, skin and hide to Ethiopia. Cattle, sheep and goats are the three most important livestock species that have a considerable importance to the GDP of the country [27]. Small ruminants constitute about 30% of the total livestock population of the country and providing 35% and 14% of meat and milk consumption respectively [3 and7].. In addition to above contribution, livestock provides about half of the domestic wool requirements and 92% of the value of semi-processed skin and hides export trade. Skin from goats and sheep are contributing for the largest share to the total and agricultural export commodities in Ethiopia [21, 24 and55].

Although Ethiopia has large number of small ruminant's population and existing favorable environmental conditions for small ruminant's production, the current level of contributions obtained from small ruminants is below the expected potential. This is because of a number of different factors such as inadequate feed and nutrition, widespread diseases, poor genetic potential of local breeds, inefficiency of livestock development services with respect to credit, poor extension services, marketing problem and problem related with infrastructure [6, 19, 32 and 42].

External parasites including lice, sheep keds, ticks, fleas, and mange mites are the most important parasitic disease which affect the production and productivity of small ruminants by wide range of health problems [34 and 36]. External parasites infestation induce great economic losses due to reduction of meat and milk yield, losses as a result of culling, cost of treatment and prevention of the disease. External parasites are also responsible for great pre-slaughter skin defects which resulting in downgrading and rejection of small ruminant skins [26 and 54].

To reduce the economic losses due to external parasites on small ruminants, the Ministry of Agriculture and Rural Development of Ethiopia designed treatment and control campaign program against external parasites in 2005 and launched in Tigray, Amhara and Afar regions in the past from 2006 to 2008 [28]. During the campaign program a number of sheep and goats were treated using spraying and dipping majorly using organophosphates (Diazinon 60%) and in fewer cases using Ivermectin in Tigray Region. This campaign addressed all peasant associations in the region with the objective of reduction of the prevalence of all external parasites from 55% to 2-3%. During the campaign program an average of 99%, 85.5% and 63.7% animal are treated from the target population in the first, second and third round respectively in the three implementation years [45]. The control and treatment campaign resulted in the reduction of external parasites infestation by 29.9%, 18.9% and 10.6% in the1st, 2nd and 3rd implementation years respectively. However, the interaction was interrupted due to lack of integration among stakeholders, neighboring regions and shortage of budget. As a result there was high re-infestation (73%) of sheep and goats to external parasites. In 2009 a field assessment based on clinical examination was made in 17 districts of Tigray region and 899 sheep and goats were randomly examined for the presence of external parasites, of which 817(90.9%) were found to be positive 657(73.08%) for lice, 290(32.3%) for ticks, 130(14.5%) for sheep ked, 39 (4.3%) for fleas and 29 (3.2%) for sarcoptic mange.The control program again started in 2012 in Tigray with the objective of awareness creation and expected output of major external parasites

prevalence reduction below 10% excluding ticks[45]. The second control campaign program was completed in 2015 in the study district. Despite such long term intervention conducted in our region and the study district, the impact of this control campaign on the reduction of external parasites prevalence was not yet studied, assessment of status of external parasites in related to risk factors is very important, this is because the outcome contribute to make an objective decision on the future external parasite control strategy.

2. MATERIAL AND METHODS

2.1. Study Area

The study was carried out in Welkait district. It located in western part of Tigray region surrounded by Tselemti east, TahtayAdiabo north, Asgede Tsimbla north eastern, Kafta Humera north and north western, Tsegede south and south western districts.Welkait district has three agro-ecological zones which constitutes 3% highland, 37% midland and 60% lowlands areas. The district is found 437 km away from central city of Tigray Regional State and 1220 km far from Addis Ababa. The annual temperature fluctuation and unimodal rainfall of the district is 17.5-25 ^{0}c and 700-1800 mm respectivelyand total an estimated area of 3811.18 square kilometers [35].

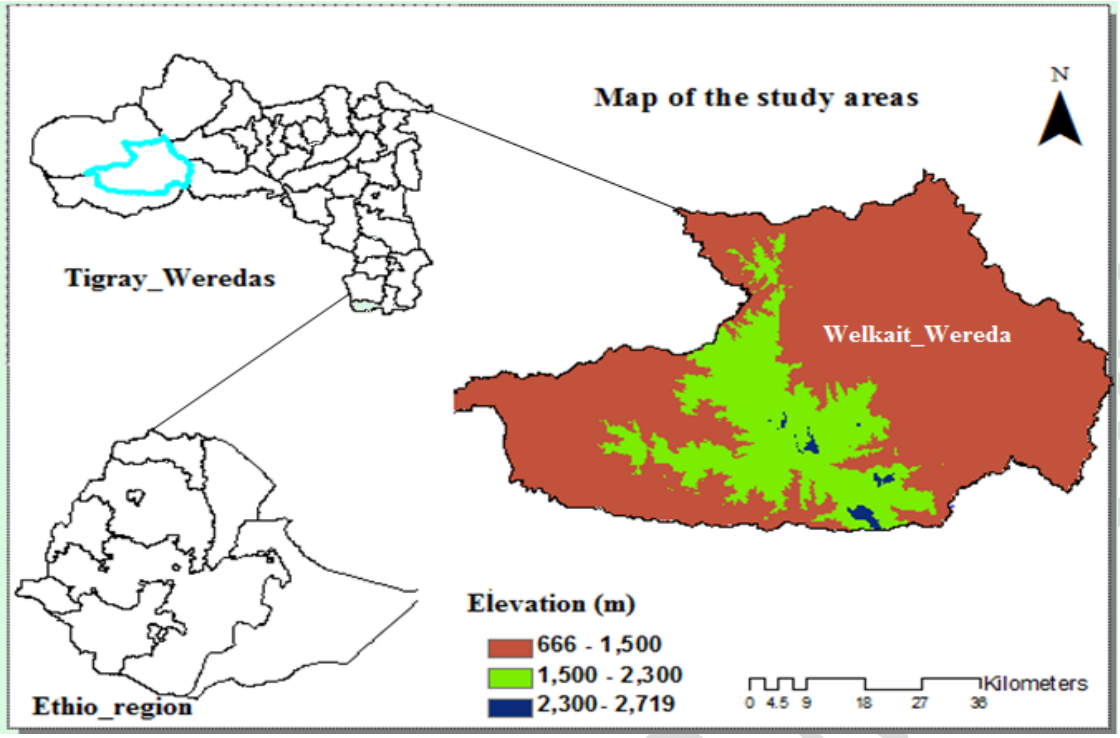

Figure 1: Administrative map of Welkait district

2.2. Study Animals

The agricultural sample survey on livestock and livestock characteristics showed that the district had 239,682 livestock population of which 440,131 were cattle, 367,877 goats and sheep, 23,330 equines, 2445 camels, 406,899 poultry (CSA, 2014). Therefore, 426 Small holders' indigenous sheep (n=102) and goats (n=324) managed under the traditional extensive production system was included in this study.

2.3. Study Design

2.3.1 Cross sectional study

Cross-sectional study and two-stage sampling technique was conducted from November 2015 to May 2016 to address the objective of this study. First the twenty eight (28) peasant association of the district was stratified in three strata as high land is above 2300 m.a.s.l., midland from 1500-2300 m.a.s.l. and lowland below 1500 m.a.s.l.based on [17]. Secondly three (3) study site localities (peasant associations) were selected purposively from each stratum mainly to include all the species of goats and sheep and conveniently based on accessibility to transportation. The number of representative

sample animals was proportionally allocated to the selected peasant associations and village based on the number of sheep and goats and simple random sampling technique was used to select the animals from their flock. As previous study was not conducted on external parasites in the study area, the expected prevalence was assumed to be 50%. The required sample size was determined based on the assumption of expected prevalence of 50% and by the formula given by [49] and the study was considering 95% confidence interval and 5% of absolute precision.

$$\frac{n = 1.96^2 Pexp\ (1 - Pexp)}{d^2}$$

Where, n= sample size

1.96= the value of Z at 95% confidence interval

Pexp= expected prevalence (50%)

d= desired absolute precision (5%)

Therefore, by substituting the values of the variables in the formula the sample size required was 384 but in order to increase precision a total of 426 sheep and goats were studied.

2.4. Data collection

Agro-ecology of the selected peasant association, sex, species, age, and flock type and body condition score of the small ruminants was considered as explanatory variables. Age categorization into young (lamb/kid) and adult was determined according to the classification of age group described by [15] for sheep and goats. Accordingly sheep and goats up to one year were categorized as young and the rest as adult. Age was determined as indicated by owner's information and estimated by dentition. Body condition scoring was considered as modifying system utilized by [14] sample animals as poor, medium, and good classes following 1 up to 5 grading system. Based on this poor body condition score was given to sheep and goats having body condition score of 0 and 1, medium body condition for sheep and goats with 2 body condition score while good body condition score was given to sheep and goats having body condition score of 3 and above.

2.5. Data Analysis

The collected raw data was entered into Microsoft Excel data sheets and analyzed using STATA 11.1 statistical software. Descriptive statistics, percentages and 95% confidence intervals were used to summarize the proportion of infested and non-infested animals. The effects of different environmental

and host risk factors were analyzed by regression and Pearson chi-square ($\chi 2$) test. Statistical significance was set at $P< 0.05$.

3. RESULT

3.1. External parasites identification and prevalence

In the present study, out of the total 426 sheep and goats examined for external parasites infestation 75(73.53%) sheep and 246 (75.93%) goats were found to be infested with one or more external parasites. There was no statistically significant difference ($P>0.05$) between the two animal species in overall prevalence of external parasites infestation. The current result revealed that a prevalence rate of 0(0.00%) and 84(25.93%) lice and prevalence rate of 7(6.86%) and 60(18.52%) flea in sheep and goats were found respectively. There was a statistical significant variation ($P< 0.05$) in prevalence of lice and flea between the two species of animals (Table 1). In the present finding the prevalence of mixed types of external parasite infestation in sheep and goats were 5(4.9%) and 104(32.1%) respectively as indicated in (Table 2).

Table 1: Type based prevalence of external parasites on both hosts

External parasites	Sheep (n=102)	Goats(n=324)	X^2	P value
	Positive (%)	Positive (%)		
Lice	0(0.00%)	84(25.93%)	32.940	0.000
Tick	71(69.61%)	211(65.12%)	0.697	0.404
Flea	7(6.86%)	60(18.52%)	7.952	0.005
Mite	0(0.00%)	4(1.23%)	1.262	0.262
Over all	75 (73.53)	246 (75.93%)	0.240	0.624

Table 2: Intensity of external parasites on both hosts

Intensity of parasite species/host	Sheep(=102)	Goat(=424)	Total (n=426)
	Positive (%)	Positive (%)	Positive (%)
Single	70 (68.63%)	142(43.83%)	212(49.76%)
Multiple	5(4.9%)	104(32.1%)	109(25.59%)
Over all	75 (73.53%)	246(75.93%)	321(75.35%)

According to the present finding the major external parasite identified was tick with a prevalence of rate of 71(69.61%) and 211(65.12%) in sheep and goats respectively. In the present study, agro-ecology, sex of the animal, body condition score, age and flock type of sheep and goats were considering as a risk factors for external parasites infestation. As shown in (Table 3) the overall prevalence of external parasites of sheep and goats was significantly affected ($P<0.05$) by risk factors such agro-ecology, body condition score and flock type.

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	128	116(90.63%)	54.438	0.000
	midland	127	108(85.04%)		
	Low land	171	97(56.73%)		
Sex	Male	145	110(75.86%)	0.031	0.861
	Female	281	211(75.09%)		

Body-condition	poor	96	84(87.50%)	22.243	0.000
	Medium	166	133(80.12%)		
	Good	164	104(63.41%)		
Age	Young	218	156(71.56%)	3.458	0.063
	Adult	208	165(79.33%)		
Flock type	Single	227	157(69.16%)	10.022	0.002
	Mixed	199	164(82.41%)		

Table 3: Association of risk factors and prevalence of external parasites based on host and at different levels

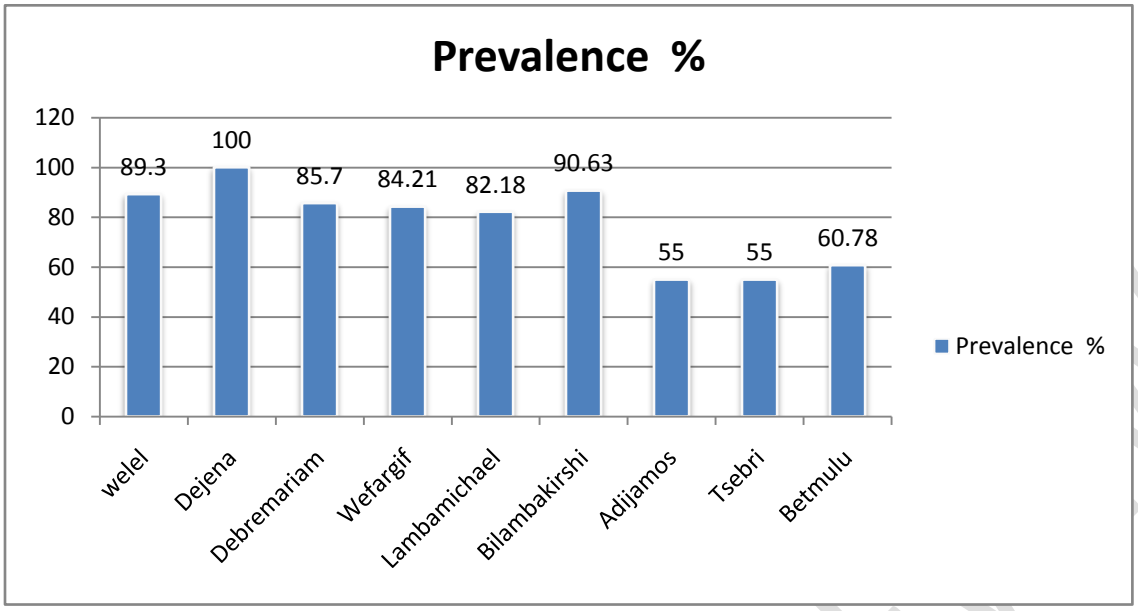

Figure 2: Prevalence rate of external parasite between study peasant associations

The present result indicated that there was difference in prevalence of external parasites between study peasant associations. As shown in (Figure 2) above the highest infestation of external parasites were found in highland followed by midland and lowest prevalence in low.

In addition, to the effect of the risk factors on the overall prevalence of external parasites, the effect of these risk factors was also considered on the prevalence of individual external parasite in goats. Even though there were difference in prevalence of lice and flea between different risk factors, the difference in prevalence was not statistically significantly association ($P>0.05$) in goats except in case of lice by body condition score and flea by agro-ecology and age respectively (Table 4 and 5).

Table 4: Association of goat lice prevalence to different categories and risk factors

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	106	36(33.96%)		
	Midland	119	25(21.01%)	5.437	0.066
	Low land	99	23(23.23%)		
Sex	Female	212	48(22.64%)	3.445	0.063
	Male	112	36(32.14%)		
Body condition	Poor	69	25(36.23%)		
	Medium	132	39(29.55%)	10.700	0.005
	Good	123	20(16.26%)		
Age	Young	156	45(28.85%)	1.336	0.248
	Adult	168	39(23.21%)		
Flock type	Single	163	39(23.93%)	0.683	0.409
	Mixed	161	45(27.95%)		
	Over all	324	84(25.93%)		

Table 5: Association of goat flea prevalence to different categories and risk factors

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	106	26(24.53%)		
	Midland	119	23(19.33%)	6.189	0.045
	Low land	99	11(11.11%)		
Sex	Female	212	35(16.51%)	1.641	0.200
	Male	112	25(22.32%)		
Body condition	Poor	69	15(21.74%)		
	Medium	132	21(15.91%)	1.151	0.563
	Good	123	24(19.51%)		
Age	Young	156	44(28.21%)	18.709	0.000
	Adult	168	16(9.52%)		
Flock type	Single	163	36(22.09%)	2.767	0.096
	Mixed	161	24(14.91%)		
	Over all	324	60(18.52%)		

As indicated in (Table 1) above ticks were highly prevalent in goats in the present study. Considering the potential risk factors that affect tick infestation in goats, there were statistically significant

association with agro-ecology of the study area, body condition, age and flock type of the animal studied (Table 6).

Table 6**:** Association of goat ticks prevalence at different categories and to different risk factors

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	106	84(79.25%)		
	Midland	119	90(75.63%)	48.655	0.000
	Low land	99	37(37.37%)		
Sex	Female	212	142(66.98%)	0.932	0.334
	Male	112	69(61.61%)		
Body condition	Poor	69	56(81.16%)		
	Medium	132	97(73.48%)	29.361	0.000
	Good	123	58(47.15%)		
Age	Young	156	82(52.56%)	20.894	0.000
	Adult	168	129(76.79%)		
Flock type	Single	163	92(56.44%)	10.886	0.001
	Mixed	161	119(73.91%)		
	Over all	324	211(65.12%)		

The prevalence of external parasites were not significantly affect by most of the risk factors considered (P>0.05) in sheep except in case of ticks which were affected by agro-ecology and flea by the age of sheep (Table 7 and 8).

Table7: Association of sheep fleas' prevalence at different categories to different risk factors

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	21	2(9.5)		
	Midland	11	(0.00%)	1.052	0.591
	Low land	70	5(7.14%)		
Sex	Female	68	6(8.82%)	1.227	0.268
	Male	34	1(2.94%)		
Body condition	Poor	25	2(8.00%)		
	Medium	36	3(8.33%)	0.425	0.809
	Good	41	2(4.88%)		
Age	Young	61	7(11.48%)	5.052	0.025
	Adult	41	0(0.00%)		
Flock type	Single	62	4(6.45%)	0.042	0.838
	Mixed	40	3(7.50%)		
	Over all	102	7(6.86%)		

Table8: Association of sheep ticks prevalence at different categories to different risk factors

Risk factors	Categories	Animal examined	Positive (%)	X^2	p-value
Agro-ecology	High land	21	18(85.71%)	10.4324	0.005
	Midland	11	11(100.0%)		
	Low land	70	42(60%)		
Sex	Female	68	45(66.18%)	1.1354	0.287
	Male	34	26(76.47%)		
Body condition	Poor	25	20(80.00%)	2.8367	0.242
	Medium	36	26(72.22%)		
	Good	41	25(60.98%)		
Age	Young	61	39(63.93%)	2.3090	0.129
	Adult	41	32(78.05%)		
Flock type	Single	62	42(67.74%)	0.2602	0.610
	Mixed	40	29(72.50%)		
	Over all	102	71(69.61%)		

The strength of association among the different risk factors on the prevalence of external parasites was analyzed using logistic regressions. The logistic regression analysis of risk factors showed that agro-

ecology, body condition and flock type had statistically significant association with the prevalence of overall external parasites (*P<0.05*). The risk factors analysis results are shown in (Table 9).

Table 9: Strength of association of risk factors with the overall prevalence of external parasites

Risk factors	Categories	Animal examined	Positive (%)	P-value	OR	95% CI for OR
Agro-ecology	High land	128	116(90.3%)	0.000	7.37	2.443-7.697
	midland	127	108(85.04)	0.000	4.034	3.785 - 14.367
	Low land	171	97(56.73%)			
Body condition	poor	96	84(87.50%)	0.000	4.04	2.039-7.997
	Medium	166	133(80.12)	0.001	2.33	1.415- 3.819
	Good	164	104(63.41%)			
Flock type	Single	227	157(69.16%)			
	Mixed	199	164(82.41%)	0.002	2.10	1.317-3.313

Among goats, body condition, agro-ecology, age of the animal and flock type were significantly associated with the prevalence of licespecies, flea and tick infestation. The prevalence of lice was 2.936 and 2.159 times higher in poor and medium body condition (P<0.05) than good body condition of goats respectively where as in case of flea goats being in high land 2.600 more likely (P<0.05) to be infected by flea than goats in low land respectively. Goat being young age 3.73 times to be infested by flea than adult age. Similarly, in ticks' goats in high land and midland agro-ecology were 6.498 and 5.200 times more infested by tick than lowland respectively and 0.335, 2.187, 4.828 and 3.101 times adults than young, mixed than single rearing and goats being poor and medium body condition than good body condition respectively (Table 10).

Table 10: Logistic analysis results of risk factors for external parasites prevalence in goats

External parasites	Risk factors	Category	Prevalence (%)	P-value	OR	95%CI for OR
Licespecies	Body condition	Poor	25(36.23%)	0.002	2.936	1.473- 5.809
		Medium	39(29.55%)	0.013	2.159	1.176- 3.965
		Good	20(16.23%)			
Flea species	Agro-ecology	High land	26(24.53)	0.015	2.600	1.207-5.600
		Midland	23(19.33%)	0.100	1.92	0.883-4.158
		Low land	11(11.00%)			
	Age	Young	44(28.21%)	0.000	3.73	2.004-6.932
		Adult	16(9.52%)			
Ticks species	Agro-ecology	High land	84(79.25%)	0.000	6.498	3.437 - 11.910
		Midland	90(75.63%)	0.000	5.200	2.901- 9.324
		Low land	37(37.37%)			
	Age	Young	82(52.56%)			
		Adult	129(76.77%)	0.000	0.335	0.208 -0.539
	Flock type	Single	92(56.44%)			
		Mixed	119(73.9%1)	0.001	2.187	1.369 -3.493
	Body condition	Poor	56(81.16%)	0.000	4.828	2.398 -9.718
		Medium	97(73.48%)	0.000	3.106	1.839-5.246
		Good	58(47.13%)			

In case of sheep the only potential risk factor which affect tick infestation was agro-ecology with sheep live in highland have 4 times higher in harboring ticks than lowland (Table 11).

Table 11: Logistic analysis results for the prevalence of tick in sheep

External parasites	Risk factors	Category	Prevalence (%)	P-value	OR	95%CI for OR
Ticks	Agro-ecology	High land	21	0.038	4.000	1.077-14.861
		Midland	11			
		Low land	70			

Species level logistic analysis result indicated that the infestation of flea was higher in goats than sheep. Goats were 3.084 times more infested by flea than sheep (Table 12).

Table 12: Logistic analysis results for the prevalence of flea in sheep and goats

External parasites	Sheep (n=102)	Goat(n=324)	P value	OR	95% CI for OR
Flea	7(6.86)	60(18.52)	0.007	3.084	1.36-6.983

4. DISCUSSION

The present study revealed an overall prevalence of external parasites (75.35%) in which **(**73.53%**)** and **(**75.93%) prevalence were in sheep and goats respectively. The present result is more or less comparable to the report of [48] who reported an overall prevalence of 78.38% (80.95% in sheep and 78.38% goats) in and around Gonder town and [46] (73.3%) prevalence in and around Kombolcha.But,it is numerically less compared to the study of [14] who reported a total prevalence of 93.02% (94.62% in sheep and 91.86% in goats) from pastoral district of Afar region; 98.67% (99.38% of sheep and 96.92% in goats) from Wolmera District of Oromia region by [21]. However, the prevalence of external parasites in this study is higher than works carried out 56.6% (55.2% for sheep and 58% in goats) from selected site of Tigray Region by [31] and (44.9%) in sheep and (43.5%) [41] from North West Amhara after extensive control program conducted and a prevalence of (57.43%) in sheep from external parasites control area of Arsi in Oromia Regional state by [15].

Ticks were the most frequent and higher external parasite recorded in sheep and goats with an overall prevalence of (66.19%) with the rate of (69.61%) in sheep and (65.12%) in goats. Similar to this study, [12] had reported the prevalence of (69.86%) in sheep in Dhas district of Borena pastoral area. However, the prevalence of this study was lower than prevalence of (77.8%) in goats and (81.7%) in sheep as reported by [23] from Fafen Zone, Eastern Ethiopia and compared to the report of [1] in Miesso district, Western Harargie, recorded a prevalence of (87.5%) in goats and (89.9%) in sheep. Even more the report of [12] indicated the prevalence of (97.58%) in goats in Southern Rangelands of Ethiopia and (94.62%) in sheep and (91.86%) in goat by [14] were highest. However, when compared with studies of different parts of Ethiopia the prevalence of tick infestation was higher than (23.8%) in sheep and (10.0%) in goats reported by [47] from Sidama zone; (31.78%) in sheep and (18.63%) in goats from Wolayta Sodo reported by [53]; (16.0%) in sheep and (29.7%) in goats from Tigray region stated by [31] and a prevalence of (9.7%) and (17.97%) from control and uncontrolled area of Arsi in sheep by [15]. A lower prevalence was also reported by [9]from aroundKombolchaand Sisay *et al*. (2013) North Western Amahara with the prevalence of (7.35%) and (3.9%) in sheep and (13.7%) and (17.7%) in goats respectively. Over all the differences in the prevalence might be due to the geographical difference and season of the study period.

The prevalence of tick infestation was not statistically significant (P>0.05) between sheep and goats. Numbers of ticks count on these studied small ruminants did not differ significantly between host

species, this suggesting that whether wool covered the body of the animals completely or left parts of the body uncovered, tick infestation could not differ between sheep and goats and comply with study of [11].The prevalence of tick was found to be significantly higher ($P<0.05$) associated with the different risk factors in goats namely agro-ecology, body condition, age and flock type but, agro-ecology was only the risk factor which affect the infestation of tick in sheep in the present study. There was statistical significant association between the prevalence of adult (76.79%) and young small ruminants having the rate of (52.56%) (OR=0.335, P=0.00) which is similar with the report of [31] from Tigray region the prevalence of tick (38.4%) in adults and (20.2%) in young, and [46] an infestation rate of (54.2%) and (51.05%)) respectively infestation of ticks. These results showed disagreement with [37] who reported that young animals are heavily infested with external parasites and number of external parasites decrease as the animals mature. These could be due to breed differences and young were placed in house and adults were released always for grazing land in this study as supported by [38].[25] also observes that greater susceptibility of young animals to external parasites than adults but the current finding is in contrary with finding of [15] and[14] who found that insignificant association($P>0.05$) of tick infestation between age group of sheep and goats. In relation to body condition of goats significant difference of ticks infestation ($P<0.05$) was found. Based on this the prevalence were (81.16%), (73.48%) and (47.13%) in goats with poor, medium and good body condition respectively. Goats with poor and medium body condition have 4.828 and 3.106 times infested by tick than good body condition. This didn't agree with report of [14] who reported ($P>0.05$) prevalence of tick (89.89%), (90.70%) and (95.52 %) in poor, medium and good body condition. The reason explained as highest infestation of tick in poor and medium body condition of goats may be due to the consumption of high amount of blood and body fluid by those ticks by [23] may apply to the present study.

The odds of tick infestation in highland and midland were 6.498 and 5.2 times compared to lowland goats and sheep in highland were 4 times higher in harboring ticks than lowland sheep which was significant association on tick infestation and agro-climatic location of study sheep and goats. The result is disagreement with report of [41] who stated that the odds of tick infestation on lowland goats were 1.74 times compared to midland goats. This may be partially due to difference in vegetation cover that exists between study areas that controls the moisture content of the environment which is important factor for the survival of ticks as similarly reasoned by [29 and 51]. Moreover, the flock type had significant effect on prevalence of tick in goats in the current study. The prevalence of the

tick infestation in single and mixed flock was recorded as (56.44%) and (73.91%) respectively where mixed flock goats had 2.187 times infected by tick than single flock of goats. This study is in agreement with report of [21] who clearly showed significantly higher prevalence of external parasites in mixed flock of sheep and goats than in the single flock. Possibly this may be due to transmission of non-host specific external parasites from other domestic animals to small ruminants.

The current result revealed that lice infestation was the second most prevalent external parasites with an overall prevalence of (25.93%) in goats and (0.00%) in sheep. The prevalence of lice in this study was in line with the observations made in southern range land (0.00%) in sheep but, higher than (1.55%) in goats[33]. This finding disagrees with [48]in composition of lice which were found overall prevalence (33.69%) and (26.12%) in sheep and goats. Additionally and recently [15] found an overall prevalence of lice (49.85%) and (82.35%) *D. ovis* in sheep and 0% in goats of controlled and uncontrolled areas respectively while comparing external parasites following governmental intervention in Arsi was higher the preset finding. Another report by [56]from in and around Sekela, Amhara region indicated that *L. ovillus* (14.2 %) and *D.ovis* (8.9%) were predominant in sheep and the lower rate of *L. stenopsis* (17.7%) was recorded in goats than this study. The highest prevalence of lice was reported by [16], (75.5%) for *Linognathus*spp and (67.1%) *D.ovis*inin sheep. Lower rates were also reported by [4] whereby (14.6%) for *L. ovillus* and (36.1%) *D.ovis*inin sheep but, difference in species. Along with above findings more similar report from Wolayta Sodo by [53] indicated an overall prevalence of lice (25.7%) in sheep and (0.00%) in goats but contrary to the present finding. These discrepancies could be because of difference in agro-ecological and climatic conditions and favorability to different species of louse of those study areas. Management and animal husbandry systems, usage of acaricides and increase in animal trafficking or movements may also contribute to the changes in the prevalence (emergence) of lice infestation in certain areas [40]. There was a statistical significant prevalence ($p<0.05$) of lice between sheep and goats in the present study.

Agro- ecology, sex, age and flock type were the risk factors which had not association with the infestation of lice ($P>0.05$) in goats. However the prevalence of lice (36.23%) in poor body condition, (29.55%) in medium body condition and (16.26%) in good body condition of goats were found in present study. There was statistical significant association between the prevalence of lice and their body condition in goats. The Lice infestation in goats were significantly higher ($P<0.05$) in poor and medium body condition than in good body condition of goats (OR=2.936, P=0.002 and OR=2.159,

P=0.013) in poor and medium body condition respectively. This meant that the infestation of lice with poor and medium body condition of goats 2.936 and 2.159 higher than good body condition of goats respectively. The present result agree with report of [41] who reported significant higher prevalence of lice in poor body condition score than good body condition. This might be due to lowered immune response as a predisposing factor and the highest infestation in poor body condition could be the result of chronic external parasites infestation which is similarly supported [20]. Animals in poor condition and that are improperly fed and exposed to cold and debilitating diseases carried the heaviest infestations of lice, since debilitated animals do not groom themselves and leave the lice undisturbed [30 and 44]

Flea infestation was one of the external parasites problem encountered in small ruminants of the study area with a prevalence of (6.86%) and (18.52%) in sheep and goats respectively. The present finding revealed lower prevalence of Ctenocephalidus species when compared with Amhara region in and around Gonder (37.12%) in sheep and (30.63%) in goats reported by [48].But in turn the current prevalence is higher compared to the (1.1%) in sheep and (2.6%) in goats[41]. In additionthis finding was almost comparable with the report of [31] who reported prevalence of (9.00%) and (11.1%) in sheep and goats and by [40] reported (12.88%) and (10.25%) in sheep and goats respectively although higher in number in alternate host types. Fleas are generally not considered to be important external parasites of livestock; however, this may not be true particularly when livestock live in close association with farm cats and dogs. Prevalence of Ctenocephalidus species is said to increase if the humidity is higher. Temperatures of 21 °C to 30 °C (70 °F to 85 °F) and 70% humidity is required for ovipostion of flea eggs to take place. Once a flea infestation has become established, management efforts both on the host and in the environment must be made simultaneously. Mechanical control is the most important flea control which involves maintaining environmental hygiene. To control flea's sanitation is critical in areas where the animal sleeps or rests [10 and 52]. When it is looked the prevalence of fleas based on host goats had higher prevalence than sheep (OR=3.084, P=0.0.007). This is in agreement with the report of [21] there was higher prevalence of flea in goats than sheep and also [39] reported such a tendency of high abundance of flea in goats than sheep but not statistically associated (P>0.05) which were (32.31%) in goats and (6.83%) in sheep. From the predictor variables considered for association with the presence of flea in goats only agro-ecology and age affect significantly the prevalence of flea in goats. With respect to the status of age relationship young goats were 3.732 times higher infested by flea than adult age. This was in agreement with report of Yacob *et*

al. (2008) who reported a prevalence of (11.21%) in goats and (8.2 %) in sheep ($P<0.05$) significant higher prevalence of flea in young than adults and as same time goats in highland and midland agro-climate 2.6 and 1.922 times higher in harboring flea compared to lowland in the result of the present study.

In the current findings, mange mites were the lowest examined external parasites next to flea infestation with overall of prevalence of (0.94%) of which (0.00%) in sheep and (1.23%) in goats. The result of this study was in line with report of [47] from Sidama Zone who reported overall prevalence of mange mite (0.94%) and [14] from Afar region who indicated the prevalence of (0.65%) but lower than the prevalence of (30.32%) in Tigray [4] respectively. This variation in prevalence might be due to climatic changes, breed variation, immune responses of sampled goats and sheep and due to control campaign conducted. In contrary to the present finding reports so far indicated that, mange mites were the most prevalent in four national regional states of Ethiopia namely, the Amhara, Oromia, Tigray and Southern Nation and Nationalities regional states. Sarcoptes mange, Psoroptes and Demodex mange three genera of mites which are mostly reported to affect small ruminants in Ethiopia [4, 31 and 53].

Generally the observed differences in the prevalence of external parasites between study areas could be due to difference in agro-ecology (environmental condition), study season, and management. More ever when compared to the past works done specific to Tigray region and as most were studied within the chemical controlling campaign the higher occurrence seems to be contributed due to poor efficiency and improper application when looked at mainly to the specific study area. These reasons are also supported by [14] as indicated and being because of lack of effectiveness of the diazinon in use, method of acaricides application, animal husbandry and nature of the external parasites and absence of environmental control.

Characteristic of external parasites and means of breeding (life cycle) and movements are other conditions that can be considering as determinants factor for external parasite infestations as flea (Emmanuel *et al*., 2012). Ticks are other external parasites that can live on the ground for up to 300 days without feeding in the environments and only spend short period of time on the host animals and re-infection of the host occurs continuously (Johnson *et al*, 1987; Wall and Shearer 2001). However, in the study areas the control campaign focused on the application of the acaricides (diazinon 60%) on the sheep and goat body but no more application to environmental. Control of external parasites in many countries of the world becomes less reliable, due to partly development of resistance [18] which might be one reason of the study area. According the complain of small ruminant owners and the information obtained from veterinary experts of study site, sheep and goats treated using acaricides (Diaznone 60%) did not cure in especially for tick during the long term external parasites control campaign. Round of treatment and interval between treatments can also affect the effectiveness of external parasites control campaign.According the general information obtained from Welkait District Bureau of Agriculture and Rural Development during the implementation of the control and treatment program, shortage of equipment's and transportation was the major logistic problems that had encountered. Spraying small ruminants than can be sprayed, spraying animals from distance and sending of sheep and goats by children to the treatment site and engaging of farmer in other activity during the campaign might be also other important factors that contribute to an inefficacy of the control intervention practiced.

6. CONCLUSION AND RECOMMENDATIONS

From this study it can be concluded although the overall external parasites prevalence in both hosts was lower than few areas of Ethiopia was higher infestation than studies made in Tigray and specifically to the study area. Among the external parasites ticks were the highest findings. When looked at in relation to that had similar campaign, the prevalence was more alarming. Among risk factors ticks were associated considerably with agro-ecology and age of both study hosts. Lice were the second which had highest prevalence in goats but with variation of infested type of species. Poor and medium body conditions in goats were found to be major risk factors for higher prevalence occurrence of lice even specific to the study area. Fleas were the third type affecting external parasites recorded on both hosts but with much higher prevalence in goats and were importantly associated with agro-ecology, age and more higher degree on young. Mites had the lowest prevalence found only in goats and also lowest from other studies specifically done in Tigray. Based on the above information the following recommendations were forwarded

- Designing and implementing proper annual chemical control campaign in relation to the efficiency of periodic interval, increased frequency of application and address efficient chemical application method to reduce the burden of external parasites by the responsible agricultural extension services
- Developing clear animal movement policy and regulation mainly attached to the reduction of introduction of infested small ruminants and other animals
- Appling integrated control method that focuses not only chemical application on the host but also management practices (feeding, follow up, housing, isolation)
- Investigating more further on the socioeconomic impact of the control mainly in the improvement of quality skin and all detail parameters of production in order to come with appropriate control strategy specific to the study area

Data Availability

All relevant data generated and analyzed during this study are available within the article

Consent and Ethical approval

Local ethics committee ruled that no official ethics approval was needed to conduct this research. Before conducting the research, informed consent was obtained from the owners or managers of the dairy farms used in this study.

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