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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A cross-sectional study and simple random sampling technique was conducted to determine the epidemiology of major external parasites and associated risk factors in small ruminants in Welkait, Western part of Tigray from November 2015 to may 2016. The collected data was analyzed using STATA 11.1stastical soft ware and descriptive statistics, percentages and 95% confidence intervals were used to summarize the proportion of infested and non-infested animals. 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 parasite infestations revealed that a prevalence of 71(69.61%) hard ticks and 7(6.86%) fleas were observed in sheep, whereas 211(65.12%) hard ticks, 84(25.93%) lice, 60(18.52%) fleas and 4(1.23%) mange species

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was recorded in goats. Statistically significant variation (P< 0.05) was found in the cases of lice and flea between the two species. Even though there were differences 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 the case of lice by body condition score and flea by agro-ecology and age, respectively. Tick infestation in goats, statistically associated with agro-ecology, body condition, age, and flock type of the animal studied, whereas most risk factor considered were not significantly significant (P>0.05) in sheep except in the case of ticks, by agro-ecology and flea by the age of sheep. The prevalence of lice was 2.936 and 2.159 times higher in poor and medium body conditions (P<0.05) than in good body conditions of goats respectively, where as in the case of flea, goats in high land were 2.600 more likely (P<0.05) to be infected by flea than goats in low land, respectively. Young age goats are 3.73 times more likely to be infested by fleas than adults. Similarly, tick's in goats in highland 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 conditions than in good body conditions, respectively. Sheep living in highland were 4 times higher in harboring ticks than lowland. The species level logistic analysis result indicated that goats were 3.084 times more infested by fleas than sheep.

Keywords: 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 different agro-ecological zones, which makes it suitable for different agricultural production systems and a 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" [1]. Data from the estimation of [2] indicates that "the country is a home to 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 the 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 in the country".

The livestock subsector has made a great contribution to the national economy and the livelihood of many Ethiopians. The subsector currently supports and sustains livelihoods for about 80% of the 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 [3], and contributes 15% of export earnings, and provides employment to over 30% of the agricultural labor force [4]. According to [5], "livestock is the second major source of foreign currency through the 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" [3]. "Small ruminants constitute about 30% of the total livestock population of the country, providing 35% and 14% of meat and milk consumption respectively" [6,7]. "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 contributes for the largest share to the total and agricultural export commodities in Ethiopia" [8,9,10].

"Although Ethiopia has a large number of small ruminant's populations 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 problems, and problems related with infrastructure" [11,12,13,14].

"External parasites including lice, sheep keds, ticks, fleas, and mange mites are the most important parasitic diseases that affect the production and productivity of small ruminants by wide range of health problems" [15,16]. "External parasite infestations induce great economic losses due to reductions in meat and milk yields, losses as a result of culling, and cost of treatment and prevention of the disease. External

parasites are also responsible for great pre-slaughter skin defects which result in the downgrading and rejection of small ruminant skins" [17 and 18].

"To reduce the economic losses due to external parasites on small ruminants, the Ministry of Agriculture and Rural Development of Ethiopia designed a treatment and control campaign program against external parasites in 2005 and launched it in the Tigray, Amhara, and Afar regions from 2006 to 2008" [19]. "During the campaign program a number of sheep and goats were treated using spraying and dipping primarily using organophosphates (Diazinon 60%) and in fewer cases using Ivermectin in the 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% of animals are treated from the target population in the first, second and third, round respectively, in the three implementation years" [20]. "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 a shortage of budget. As a result, there was a high re-infestation (73%) of sheep and goats with external parasites. In 2009 a field assessment based on clinical examination was made in 17 districts of the 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 the Tigray with the objective of creating and expected output of major external parasite prevalence reductions below 10% excluding ticks" [20]. 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 has yet been studied, assessment of the status of external parasites in relation to risk factors is very important, because the outcome contributes making an objective decision on the future external parasite control strategy.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in the Welkait district. It is located in the western part of the Tigray region surrounded by Tselemti East, Tahtay

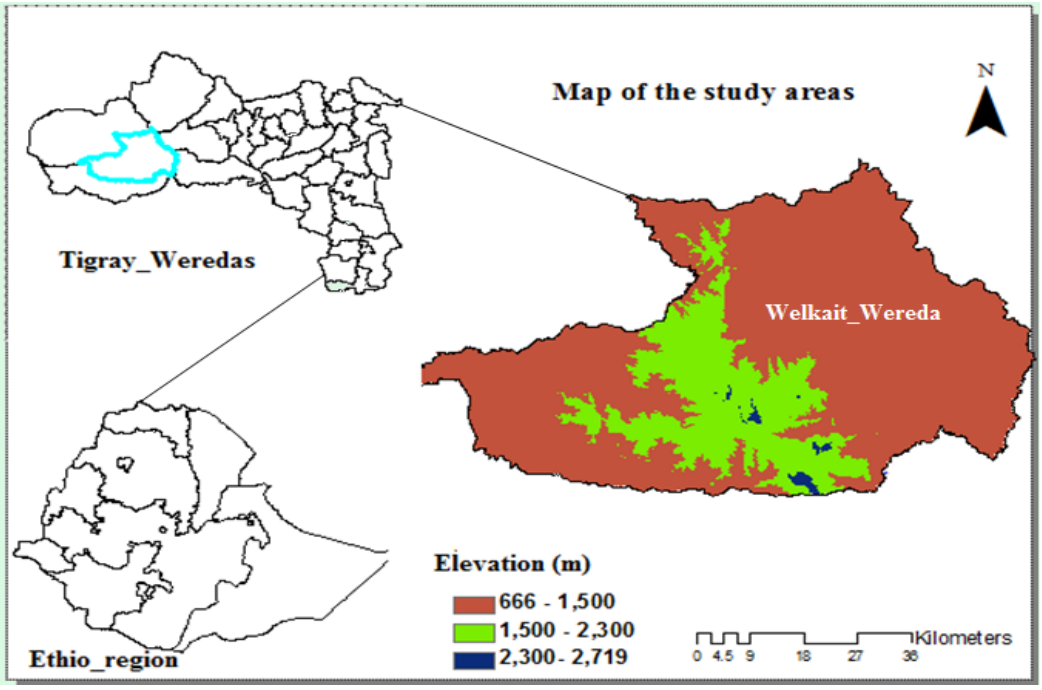

Fig. 1. Administrative map of Welkait district (2016)

Adiabo 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 constitute 3% highland, 37% midland, and 60% lowlands areas. The district is located 437 km from central city of Tigray Regional State and 1220 km from Addis Ababa. The annual temperature fluctuation and unimodal rainfall of the district is 17.5-25^{0}c and 700-1800 mm respectively and total an estimated area of 3811.18 square kilometers [21].Welkait district was selected as study area for this research because of budget limitation and the district has different agro ecology to evaluate the external parasites control campaign in different location.

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

A cross-sectional study and two-stage sampling technique were conducted from November 2015 to May 2016 to address the objective of this study. First the twenty eight (28) peasant associations of the district were stratified into 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 [22]. Secondly, three (3) study site localities (peasant associations) were selected purposefully 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 a simple random sampling technique was used to select the animals from their flock. As the 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 an expected prevalence of 50% and by the formula given by [23] and the study considered a95% confidence interval and 5% 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

The agro-ecology of the selected peasant association, sex, species, age, flock type, and body condition score of the small ruminants were considered as explanatory variables. Age categorization into young (lamb/kid) and adult was determined according to the classification of age group described by [24] for sheep and goats. Accordingly, sheep and goats up to one year old were categorized as young and the rest as adults. Age was determined as indicated by the owner's information and estimated by dentition. Body condition scoring was considered a modifying system utilized by [25] sample animals as poor, medium, and good classes following 1 - 5 grading system. Based on this poor body condition score was given to sheep and goats with body condition score of 0 and 1, a medium body condition for sheep and goats of 2 body condition score while good body condition score was given to sheep and goats with a 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. RESULTS

3.1 External Parasites Identification and Prevalence

In the present study, out of the total 426 sheep and goats examined for external parasite 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 the overall prevalence of external parasites infestation. The current result revealed that a prevalence rate of 0(0.00%) and 84(25.93%) lice and a prevalence rate of 7(6.86%) and 60(18.52%) flea in sheep and goats were found, respectively. There was 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 was 5(4.9%) and 104(32.1%) respectively, as indicated in (Table 2).

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 considered as risk factors for external parasite infestation. As shown in (Table 3) the overall prevalence of external parasites in sheep and goats was significantly affected (P<0.05) by risk factors such as agro-ecology, body condition score, and flock type.

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

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

External parasites	Sheep (n=102) Positive (%)	Goats(n=324) Positive (%)	X^2	P value
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

Source: Field survey (2015-2016)

Table 2. Intensity of external parasites on both hosts

Intensity of parasite species/host	Sheep(=102) Positive (%)	Goat(=424) Positive (%)	Total (n=426) 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%)

Source: Field survey (2015-2016)

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

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%)		

Source: Field survey (2015-2016)

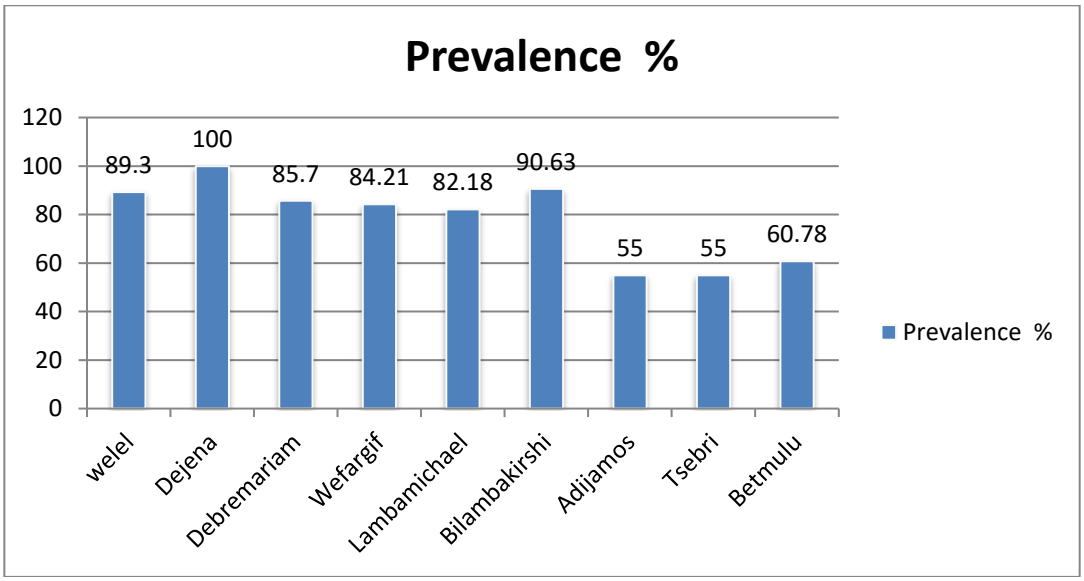

Fig. 2. Prevalence rate of external parasite between study peasant associations
Source: Field survey (2015-2016)

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%)	5.437	0.066
	Midland	119	25(21.01%)		
	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%)	10.700	0.005
	Medium	132	39(29.55%)		
	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%)		

Source: Field survey (2015-2016)

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%)	6.189	0.045
	Midland	119	23(19.33%)		
	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%)	1.151	0.563
	Medium	132	21(15.91%)		
	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%)		

Field survey (2015-2016)

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%)		0.000
	Midland	119	90(75.63%)	48.655	
	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%)	29.361	0.000
	Medium	132	97(73.48%)		
	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%)		

Source: Field survey (2015-2016)

Table 7. 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)	1.052	0.591
	Midland	11	(0.00%)		
	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%)	0.425	0.809
	Medium	36	3(8.33%)		
	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%)		

Source: Field survey (2015-2016)

Table 8. 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%)		

Field survey (2015-2016)

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 parasites in goats. Even though there were differences 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 the case of lice by body condition score and flea by agro-ecology and age, respectively (Tables 4 and 5).

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).

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 (Tables 7 and 8).

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).

Among goats, body condition, agro-ecology, age of the animal, and flock type were significantly associated with the prevalence of lice species, flea and tick infestations. The prevalence of lice was 2.936 and 2.159 times higher in poor and medium body conditions (P<0.05) than in good body conditions of goats respectively where as in the case of flea goats being in high land were 2.600 more likely (P<0.05) to be infected by flea

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

Source: Field survey (2015-2016)

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
Lice species	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%)			

Source: Field survey (2015-2016)

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			

Source: Field survey (2015-2016)

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

Source: Field survey (2015-2016)

than goats in low land, respectively. Goats being young age are 3.73 times to be infested by fleas than adults. Similarly, ticks' goats in high land and midland agro-ecology were 6.498 and 5.200 times more infested by ticks than lowland respectively and 0.335, 2.187, 4.828 and 3.101 times more adults than young, mixed than single rearing and goats were in poor and medium body condition than good body conditions respectively (Table 10).

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).

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).

4. DISCUSSION

The present study revealed an overall prevalence of external parasites (75.35%) of which **(**73.53%**)** and **(**75.93%) were in sheep and goats, respectively. The present result is more or less comparable to the report of [26] who reported an overall prevalence of 78.38% (80.95% in sheep and 78.38% in goats) and around Gonder town and [27] (73.3%) prevalence in and around Kombolcha But, it is numerically less compared to the study of [25] who reported a total prevalence of 93.02% (94.62% in sheep and 91.86% in goats) from the pastoral district of the Afar region; 98.67% (99.38% of sheep and 96.92% in goats) from the Wolmera district of the Oromia region by [8]. However, the prevalence of external parasites in this study is higher than works carried out 56.6% (55.2% for sheep and 58% for goats) from the selected sites of the Tigray Region by [28] and (44.9%) in sheep and (43.5%) [29] From North West Amhara after an extensive control program was conducted and a prevalence of (57.43%) in sheep from the external parasite control area of Arsi in Oromia Regional State by [24].

Ticks were the most frequent and highest external parasite recorded in sheep and goats, in an overall prevalence of (66.19%) - and (69.61%) in sheep and (65.12%) in goats. Similar to this study, [30] 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 the prevalence of (77.8%) in goats and (81.7%) in sheep, as reported by [31] from Fafen Zone, Eastern Ethiopia, and compared to the report of [32] in Miesso district, Western Harargie, which recorded a prevalence of (87.5%) in goats and (89.9%) in sheep. Even more the report of [30] indicated the prevalence of (97.58%) in goats in the Southern Rangelands of Ethiopia and (94.62%) in sheep and (91.86%) in goat by [25] 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 [33] from Sidama zone; (31.78%) in sheep and (18.63%) in goats from Wolayta Sodo reported by [34]; (16.0%) in sheep and (29.7%) in goats from Tigray region stated by [28] and a prevalence of (9.7%) and (17.97%) from control and uncontrolled area of Arsi in sheep by [24]. A lower prevalence was also reported by [35] from around Kombolcha and Sisay *et al*. (2013) in 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 difference 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. The number of ticks counted on these

studied small ruminants did not differ significantly between host species, 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 the study of [36].The prevalence of ticks was found to be significantly higher than (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 that affect the infestation of tick in sheep in the present study. There was a statistically 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 [28] from Tigray region the prevalence of tick (38.4%) in adults and (20.2%) in young, and [27] 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 people were placed in house and adults were released always for grazing land in this study as supported by [38]. Lehman et al, [39] also observes that greater susceptibility of young animals to external parasites than adults but the current finding is in contrary with finding of [24] and [25] who found that insignificant association(P>0.05) of tick infestation between age group of sheep and goats. In relation to the body condition of goats a 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 [25] who reported (P>0.05) prevalence of tick (89.89%), (90.70%) and (95.52 %) in poor, medium and good body conditions. The reason explained as the highest infestation of ticks in poor and medium bodied goats may be due to the consumption of a high amount of blood and body fluid by those ticks which [31] may apply to the present study.

The odds of tick infestation in highland and midland were 6.498 and 5.2 times higher compared to lowland goats and sheep in highland were 4 times higher in harboring ticks than lowland sheep which was a significant association between tick infestation and agro-climatic location of study sheep and goats. The result is in disagreement with report of [29] 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 [40 and 41]. 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 flocks 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 [8] that 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 parasite 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 [42]. This finding disagrees with [26] in composition of lice which an overall prevalence (33.69%) and (26.12%) in sheep and goats. Additionally and recently [24] 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 [43] 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 [44], (75.5%) for *Linognathus* spp. and (67.1%) *D. ovi*s sheep. Lower rates were also reported by [45] whereby (14.6%) for *L. ovillus* and (36.1%) *D. ovis* sheep but, differences in species. Along with above findings more similar report from Wolayta Sodo by [34] 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 the favorability of different species in 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 infestations in certain areas [46]. There was a statistically 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 was 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 conditions than in good body conditions of goats (OR=2.936, P=0.002 and OR=2.159, P=0.013) in poor and medium conditions 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 [29] 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 [47]. Animals in poor conditions 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 [48 and 49]

Flea infestation was one of the external parasite problems encountered in small ruminants in 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 [26].But in turn the current prevalence is higher compared to the (1.1%) in sheep and (2.6%) in goats [29]. In addition this finding was almost comparable with the report of [28] who reported prevalence of (9.00%) and (11.1%) in sheep and goats and by [46] reported (12.88%) and (10.25%) in sheep and goats respectively although number was higher 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 form of flea control which involves maintaining environmental hygiene. To control flea's sanitation is critical in areas where the animal sleeps or rests [50 and 51]. When it is looked at the prevalence of fleas based on the host goats had higher prevalence than sheep (OR=3.084, P=0.0.007). This is in agreement with the report of [8] there was higher prevalence of flea in goats than sheep and also [52] 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 significantly affect 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 ($P<0.05$) with a 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 to harbor flea compared to lowland in the result of the present study.

In the current findings, mange mites were the least examined external parasite next to flea infestation with an 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 [33] from Sidama Zone who reported overall prevalence of mange mite (0.94%) and [25] from the Afar region who indicated the prevalence of (0.65%) but lower than the prevalence of (30.32%) in Tigray [45] 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. Contrary to the present findings reports so far indicate 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 are three genera of mites that are mostly reported to affect small ruminants in Ethiopia [45, 20 and 34].

Generally the observed difference in the prevalence's of external parasites between study areas could be due to difference in agro-ecology (environmental conditions), 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 [25] as indicated and being because of lack of effectiveness of the diazinon in use, method of acaricides application, animal husbandry the nature of the external parasites and the absence of environmental control.

Characteristics of external parasites and means of breeding (life cycle) and movements are other conditions that can be considered 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 environment and only spend a 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 bodied but no more application to environmental. Control of external parasites in many countries of the world becomes less reliable, due to the partly developed of resistance [53] which might be one reason for the study area. According to 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. Rounds of treatment and interval between treatments can also affect the effectiveness of external parasites control campaign. According to the general information obtained from the Welkait District Bureau of Agriculture and Rural Development during the implementation of the control and treatment program, shortages of equipment's and transportation was the major logistic problems that were 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 activities during the campaign might also other important factors that contribute to the inefficacy of the control intervention practiced [54-56].

5. CONCLUSION AND RECOMMEN-DATIONS

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

- Designing and implementing a proper annual chemical control campaign in relation to the efficiency of periodic interval, increased frequency of application and efficient chemical application methods 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 the infested small ruminants and other animals

- Appling in integrated control method that focuses not only chemical application on the host but also the management practices (feeding, follow up, housing, isolation)

- Investigating 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 up with an 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

Before conducting the research, the objectives, expected results and benefits of the study were clearly explained to goat and sheep owners and informed written consent

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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