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Source: Environmental Health Insights, 17(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/11786302231211076

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Environmental Health Insights
Volume 17: 1–8

DOI: 10.1177/11786302231211076

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ABSTRACT

BACKGROUND: Ticks are blood-sucking external parasites of livestock and humans; and can transmit pathogens beyond their direct effect during biting. Ticks are distributed in different agro-ecological zones. The study's objectives were to determine the species of ixodid ticks, estimate prevalence, and link the presumptive risk variables.

MATERIAL AND METHODS: A cross-sectional study was conducted from November 2022 to June 2023 in Selamago district, Southern Ethiopia. A total of 384 cattle managed under extensive grazing systems were selected proportionally based on cattle population, from 3 kebeles, which is the lowest administrative structure of government, and individual animals were selected using systematic random sampling techniques at an interval of 5 animals; as the results, 153, 128, and 103 cattle were selected from Hana, Marsiyo, and Geyo kebeles, respectively.

RESULTS: 262 animals (68.2%) were found to be infested with one or more tick species. In this study, there was a statistically significant difference in prevalence between sexes and age groups ($P < .05$). A higher prevalence was recorded in female and adult cattle than respective group. A total of 579 ticks were collected; 4 genera and 7 tick species were identified. As a result, *Ambylomma variegatum*, *Amblyomma gemma*, *Amblyomma lepidum*, *Rhipicephalus (Boophilus) decoloratus*, *Rhipicephalus pulchellus*, *Rhipicephalus evertsi evertsi*, and *Hyalomma truncatum* were observed. Among the species identified in the study area, *Ambylomma variegatum* was the most abundant tick (32.3%) and *Hy. truncatum* was the least prevalent (4.3%). Ticks on animals' body were recovered more dominantly around the perineum region, udder, scrotum, and dewlap, followed by the belly, head, and neck. Male ticks were more frequently encountered than females.

CONCLUSION: The finding shows a high tick infestation, and adult age groups were more affected and had a serious problem. Hence, prompt control measures are required to rescue the livelihood of the community and economic loss.

KEYWORDS: Cattle, hard tick species, prevalence, predilection site, risk factors

RECEIVED: July 25, 2023. **ACCEPTED:** October 9, 2023.

TYPE: Original Research

FUNDING: The author received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Animal production is the backbone of the agriculture subsector in Ethiopia, as it is in many other countries in Sub-Saharan Africa.[1] Communities living in Ethiopia's Selamago district depend on livestock production. Therefore, social, cultural, and economic existence depends on livestock production despite all livestock production constraints.[2,3] Ethiopia has the largest livestock population in Africa, with an estimated 65 million cattle. Goats, sheep, equines, and camels are the main animals produced throughout the country, with cattle, goats, and camels kept dominantly in pastoral areas.[4] Despite the large quantity of animals, the subsector has low productivity, and hence, money from this sector cannot play a significant part in the country's economic development.[5] Inadequate productivity is linked to indigenous cattle's limited genetic potential, poor nutrition and reproductive performance, high illness incidence and parasite burden (endoparasites and ectoparasites), insufficient management, and inadequate veterinary services.[6]

Ticks are ectoparasites that can transmit infections that cause bovine illnesses. These can cause skin damage, weight loss, mastitis, abortion, and even death, resulting in significant economic losses.[7-10] Ticks are found all across the world, especially in tropical and subtropical areas.[11,12]

Amblyomma, *Rhipicephalus(Boophilus)*, *Haemaphysalis*, *Hyalomma*, and *Rhipicephalus* were among the most common tick genera reported in Ethiopia, with more than 60 species capable of infesting and transmitting disease to both domestic and wild animals.[13] The most prevalent pathogens transmitted by ticks are *Anaplasma* spp., *Babesia* spp., and *Theileria* spp., as well as rickettsia including virus infect several domestic animal species.[14,15] Ticks can also induce non-specific symptoms such as anemia, dermatitis, toxicosis, and paralysis.[16] Ticks can transmit infections to humans, particularly who have close relationships with animals.

Tick infestation in Ethiopia causes significant economic losses via direct infliction on sensitive body parts like the udder and

scrotum, which causes skin damage and disease transmission,[17,18] affecting the economies of Ethiopian farmers as well as international markets.[12]

It is critical to keep up research on tick distribution in the area to the level of tick species identifications, which will be transformed into maps to indicate the distribution of species likely to be found and contribute to plan control strategies in the region. Recent research in the Selamago district revealed the presence of 4 tick genera: *Amblyomma*, *Rhipicephalus (Boophilus)*, *Hyalomma*, and *Rhipicephalus*; however, tick species and major affected body sites were not adequately addressed.[19]

Despite significant negative impacts on livestock products and productivity due to direct and indirect consequences of tick and tick-borne pathogens, little information is documented in the Selamago district of the South Omo zone. Selamago district is far distance from the center of Southern Nation and Nationalities People Regional State (SNNPRS) Hawassa. Which is one of the districts occupied by pastoral communities, and these populations rely on cattle raising for their livelihood. Livestock moves from one grazing area to another in search of feed. This will provide opportunities to maintain the tick life cycle, especially for 2- and 3-host ticks. Tick harbored livestock disease pathogens are likely to be spread between herds, which is easily maintained by close contact at any time. There is a need for appropriate strategies for the management of tick and tick-borne diseases, and this requires up-to-date information on the prevalence and distribution of tick species on different hosts, particularly cattle. The objectives of this study was to understand the tick population in the study area, identify tick species, and associate risk factors with the prevalence of tick infestation.

Material and Methods

Study area description

The study was conducted in the South Omo zone of Selamago district. The study district is located 870 km southwest of Addis Ababa and 507 km from Hawassa, the capital of Ethiopia and the Southern Nations and Nationalities People Regional State (SNNPRS), respectively. The study area lies between 6°19′ and 7°10 N latitude and 15°12 and 22°25′ E longitude, with a total land coverage of 451.12 km^2 and an altitude range of 600 to 2560 m.a.s.l. The area receives bimodal rainfall, in which the long rainfall season occurs from March to June. The short rainfall season is from August to October. The annual average temperature of the area was recorded at 29°C, with a range of 20°C to 37.5°C.[2]

Selamago district is geographically bordered from the south by Nyangatom district and from the west and north by the Omo River. Whereas from the northeast by Gamo Gofa and from the east by Basketo and Bako Gazer districts, and tributaries of the Mago River. This separates Selamago district from Bena Tsemay; the Mago River defines part of the boundary with Bako Gazer. The administrative center of Selamago is Hana Town, shown in Figure 1.

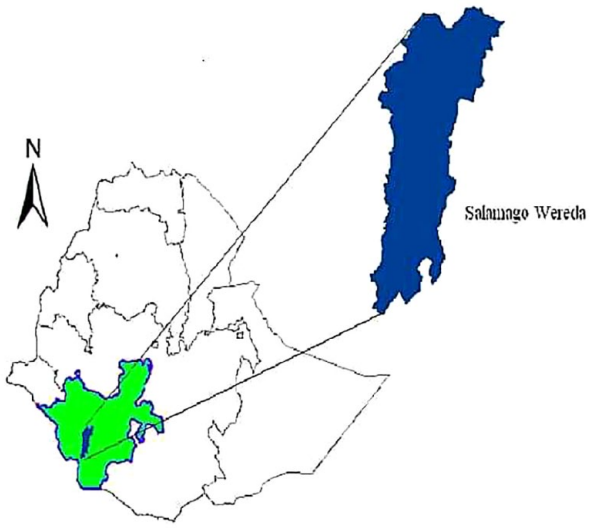

Figure 1. Map of Selamago district located under SNNPRS region of Ethiopia.

According to the Selamago district Agricultural Bureau's annual report of 2022 on livestock population records, the cattle population is about 408 000, sheep about 21 600, goats about 33 200, equines about 1525, and poultry about 52 035.

Study population

The study animals were all cattle, regardless of age category, sex, breed, or body condition scores, found in 3 selected Kebeles of Selamago district. All study animals are kept under extensive management system, which is common practice among pastoral community.

Study design

A cross-sectional study was designed from November 2022 to June 2023 to estimate the prevalence of ixodid ticks, identify genera and species of ticks, appreciate predilection sites, and estimate the associated risk factors of tick infestation. Tick samples were collected from selected individual animals for laboratory investigation in separate sample bottles with 70% ethyl alcohol (ethanol). All cattle were local East African zebu breeds in the study area. Each selected cattle's age, sex, and body conditions, including the extensive production system in selected Kebeles were recorded parallel to the sample collection using a prepared format. The age of selected animals grouped into 2 categories: young (age less than or equal to 1 year) and adult (age older than 1 year old).[20] Whereas, the body condition scores (good, medium, and poor) were used based on the criteria set.[21] All the animals selected as sampling units checked for any tick infestation and the number of ticks found on them recorded separately. Each predilection site also recorded.

Sample size determination

The total number of cattle required for the study is calculated based on the formula given by Thrusfield[22] for the simple random sampling method. By rule of thumb, if there is no record in the study area, 50% of the expected prevalence will be used to get the maximum sample size. In this study, 50% expected prevalence, 5% desired level of precision, and 95% confidence level (CI) were used to calculate the sample size. Therefore, a sample size of 384 animals was used in this study.

Sampling strategy and study methodology

Individual animals were selected from 3 selected Kebeles, namely Hana, Marsiyo, and Geyo, with a cattle population of 793, 642, and 535, respectively; number of samples collected proportionally from each kebele and individual animals were selected using systematic random sampling techniques at an interval of 5 animals; accordingly, 153, 128, and 103 cattle were selected from Hana, Marsiyo, and Geyo Kebeles, respectively. Kebele is the lowest government administrative structure in Ethiopia.

After proper physical restraint, the study animals were examined. All parts of the external body from head up to tail-head were examined from both left and right sides for any tick infestation. All visible ticks were collected from the host skin for identification using tweezers to grasp the tick to its head or mouth and pulled horizontally with gentle force. Ticks collected from different parts of the body (head, ear, belly, dewlap, udder/scrotum, perineum, and under the tail) were preserved in a separate universal bottle containing 70% ethyl alcohol and labeled for both body site and animal identification. Then samples were transported to the Jinka Regional Veterinary Laboratory for tick identification. Information about each selected animal's age, sex, body condition score, and animal identification number was recorded. The collected ticks were identified using a stereomicroscope and classified into different genera and species levels based on size, mouth parts, the color of the scutum and leg, position, and the presence or absence of punctuations on the body used. In addition, different tick morphologies, such as the shape of the scutum, leg color, body, festoon, and ventral plates, were considered for species-level identification based on the guidelines given for ticks of domestic animals of Africa.[12,23]

Data management and analysis

The data collected were entered in Microsoft Excel spread sheet and then coded. Descriptive statistics were summarized. For further statistical analysis the coded data imported to Stata 14 statistical software. The overall prevalence of ticks was estimated by dividing the number of positive animals over the total sample size and multiplied by 100. The presence of tick infestation (dependent variable) analyzed with independent variable (age, sex, kebele, and body condition score) univariable and multivariable logistic regression analysis conducted to determine strength of assumed risk factors. The fitness of the model was checked by Hosmer and Lemeshow test. Effects were reported as statistically significant in all cases if the p value was less than 5% ($P < .05$).

Results

Overall prevalence of tick population and associated risk factor

In the present study, 384 cattle were examined for the prevalence and identification of ixodid ticks. Out of 384 cattle examined, 262 cattle had one or more ticks with an overall prevalence of 68.2%. Univariable logistic regression analysis result that showed different output between the prevalence of tick infestation with assumed risk factors (age, sex, kebele, and body condition score). There was a statistically significant association ($P < .05$) with age and sex. A higher tick infestation was seen in the adult age group with a prevalence of 76.2% than in the young with a prevalence of 49.5%. Whereas females had a prevalence of 75.5% which was greater than males with prevalence of 60.6%. There were no statistically significant ($P > .05$) differences between Kebele and body condition score (Table 1). Those significant variables were checked by stepwise backward analysis using multivariable logistic regression. Age and sex categories showed statistically significant in multivariable logistic regression. Hosmer-Lemeshow goodness of fit model evaluation suggested that estat gof $\chi^2 = 4.43$ with $P = .035$ and estat class evaluation correctly classified 67.71% as well as Receiver operating characteristics (ROC = 0.6679) for best fitted model shown in Table 2.

A total of 579 ixodid ticks were collected from the 262 cattle, which were identified in 4 genera and 7 different species. The genera of ticks that were encountered in the study period were *Amblyomma, Rh.(Boophilus), Rhipicephalus*, and *Hyalomma*, with proportions of 64.9%, 15.7%, 15.1%, and 4.3%, respectively, as shown in Table 3.

Tick species identified and their distribution on the skin of cattle

Among tick species identified in this study, *Amblyomma spp.*, particularly *A. variegatum*, was the predominant tick species that was collected (187 with a prevalence of 32.2%), followed by *A. gemma* and *A.lepidum* while *Hyalomma truncatum* showed the least prevalence (25 count with prevalence of 4.3%) as shown in Table 4. Some of tick species captured for the purpose of this study shown in Figure 2.

In this study, the most frequently observed ticks were in the perineum (30.4%) region, followed by the udder/scrotum (24.5%), dewlap (14.3%), belly, head/neck, ear (14.3%), and leg (9.1%), as shown in Table 4. A soft and hairless region looks more preferred by ticks to attach to (Table 5).

Table 1. Prevalence and univariable logistic regression of ixodid tick and its associated risk factors.

RISK FACTOR	VARIABLES	NO. EXAMINED	NO. POSITIVE	PREVALENCE 95% CI	OR[CI]	*P*-VALUE
Kebele	Hanna	153	102	66.6[58.5, 73.9]	1	
	Marsiyo	128	92	71.8[63.1,79.2]	1.3[0.7,2.1]	.34
	Geyo	103	68	66 [55.9, 74.9]	1.0[0.6, 1.8]	.91
Age	Young	115	57	49.5[40.1,58.9]	1	
	Adult	269	205	76.2[70.6, 81.1]	3.3[2.1, 5.3]	.000
Sex	Female	196	148	75.5[68.8,81.2]	1	
	Male	188	114	60.6[53.2, 67.6]	2.0[1.3,3.1]	.002
Body condition	Poor	103	76	70.3[60.4,78.7]	1	
	Medium	96	68	66.6[56.2,75.7]	1.2[0.7, 2.2]	.52
	Good	185	134	69.5[62.2,75.9]	1.0[0.62, 1.7]	.88
Total		384	262	68.2[63.3,72.8]		

Table 2. Multivariable logistic regression analysis of age and sex risk factors.

RISK FACTOR	VARIABLES	NO. EXAMINED	NO. POSITIVE	PREVALENCE 95% CI	OR[CI]	*P*-VALUE
Age	Young	115	57	49.5[40.1,58.9]	1	
	Adult	269	205	76.2[70.6, 81.1]	2.9[1.8, 4.7]	.000
Sex	Female	196	148	75.5[68.8,81.2]	1	
	Male	188	114	60.6[53.2, 67.6]	1.6[1.01,2.53]	.047

Log likelihood = –225.32 >Ho null model, estat gof $\chi^2 = 4.43$ with $P = .035$, estat class = 67.71% and ROC = 0.6679.

Table 3. Proportion of ixodid tick genus identified in Salamago district.

GENUS	NUMBER	PROPORTION (%)
Amblyomma	376	64.9
Rh.(Boophilus)	88	15.7
Hyalomma	25	4.3
Rhipicephalus	90	15.1
Total	579	100

Table 4. Proportion of ixodid tick species identified in the study area.

TICK SPECIES	NUMBER	PROPORTION (%)
Ambylomma gemma	102	17.6
Ambylomma lepidum	87	15
Ambylomma variegatum	187	32.3
Rh. (Boophilus) decoloratus	88	15.2
Hyalomma truncatum	25	4.3
Rhipicephalus evertsi evertsi	29	5.0
Rhipicephalus pulchellus	61	10.6
Total	579	100.0

Three species of *Ambylomma (A. lepidum, A. variegatum, and A. gemma*) were identified predominantly in the udder/scrotum, followed by the dewlap, perineum, belly/back, legs/tail, and head regions. Whereas *Rh.*(*Boophilus) decoloratus* predominantly attaches around the dewlap, belly/back, legs/tail, udder/scrotum, heads, ears, and perineum regions sequentially. *Hy. truncatum* preferred the dewlap, head/neck, and perineum shown in Table 6. A high proportion of ticks were observed in the perineum, udder, and scrotum, followed by the dewlap region, regardless of tick species identified during study period.

Out of the total ticks collected 365 (63.1%) were male and 214 (36.9%) were female ticks (Table 7). The ratio shows more male were recovered than female tick. The difference between sexes were statistically significant ($P < .05$).

Discussion

Studies indicate that different tick species reported in Ethiopia in various agro-climatic and ecological zones of the country. A systematic review using 35 published articles showed about 19 tick species under the genus *Amblyomma*, *Rhipicephalus (Boophilus*), *Rhipicephalus*, *Hyalomma*, and *Haemaphysalis* reported in various domestic animals in Ethiopia during the period of 2001 up to October 30, 2020.[24] Recently published articles from Gondar, Eastern Hararghe, and Selamago support the current and previous studies finding in Ethiopia,

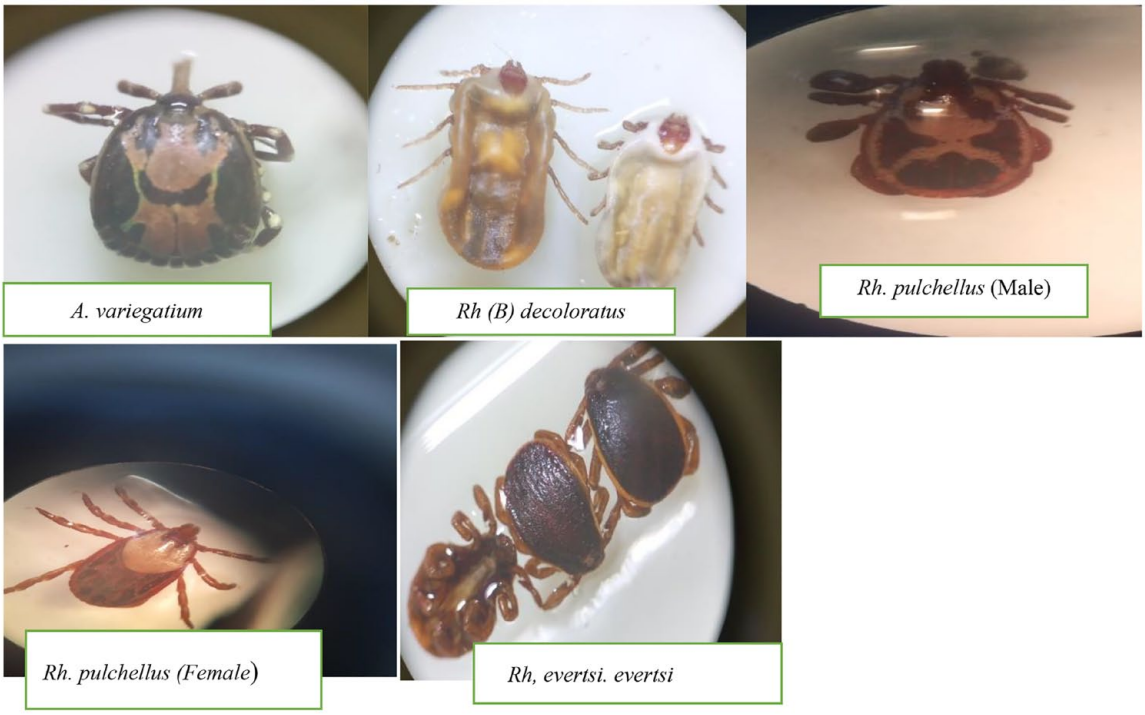

Figure 2. Specimens that shown tick species observed during study period.

Table 5. Distributions of ixodid ticks and their proportion on different predilection site of animals body.

PREDILECTION SITE	NUMBER	PROPORTION (%)
Belly, head/neck, ear	83	14.3
Dewlap	126	21.7
Leg	53	9.1
Perineum	176	30.4
udder/scrotum	141	24.5
Total	579	100.0

where *Amblyomma* is the predominant genus.[19,25,26] The overall prevalence of tick populations in the Selamago district was significantly ($P < .05$) higher compared to non-infected ones. The tick species identified were the same as those reported in various parts of Ethiopia. This finding was comparable with Kebede et al,[27] who recorded a prevalence of 69% in Lalo Assabi District, West Ethiopia. Study reports of 61.98% and 61.5% prevalence were recorded in the Humbo and Hetosa districts, respectively, in the SNNPRS and Eastern Arsi zones.[14,28] However, it was higher than the report from Holetta and Bench Maji zone, with an overall prevalence of 25.6% and 27.3%, respectively.[29,30] The difference could be associated with various factors, such as the season of study, whether it was after the wet season when arthropods are populous or during the dry season, that significantly affect the tick population in a given area. The agro-climatic condition of the study area also matters in the distribution of tick infestations. The length of observation could also affect the prevalence; in a longitudinal study, the tick population could vary within the study period, whereas in a cross-sectional study, for instance, a point prevalence at that time is explained. The fact that the current study is a cross-sectional study might be the reason for the discrepancy in the tick population among other similar studies' finding.[23] In the same study district, higher tick population counts were observed in the wet season than in the dry season.[19] However, the current study was limited to one season and was not possible to compare between seasons. It is stated that agro-climate associated with temperature and rainfall significantly affects tick survival.[23]

The present study showed a statistically significant difference ($P < .05$) in the prevalence of tick infestation between females and males. This finding was in agreement with reports from Pakistan[31,32] and Colombia,[33] reported that female cattle had a significantly higher tick burden than males. However, the finding disagree with another study, which reported a higher tick infestation in male than females animals.[14,34] Management differences between females and males were explained as a factor in closed experimental research in Colombia. However, in Pakistan and Egypt, such a management factor wasn't explained like in the Selamago district, where cattle were kept in a communal grazing system regardless of their sex. The prevalence difference between sexes is difficult to explain in terms of biology though statistically significant. Hence the difference is not biologically plausible and therefore, the difference might be by chance.

Table 6. Proportion of ixodid tick species identified in different predilection site on the body of cattle.

TICK SPECIES	DEWLAP	BELLY/BACK	EAR	HEAD/NECK	LEG/TAIL	PERINEUM	UDDER/SCROTUM	TOTAL
A.gemma	25	0	0	0	15	21	41	102
A. lepidum	19	0	0	0	14	26	28	87
A.variegatum	45	0	6	3	17	64	52	187
Hy.truncatum	6	0	0	12	0	11	0	25
Rh.(Boophilus)decoloratus	18	14	15	0	10	19	8	88
Rh.ev. evertsi	3	3	8	3	0	12	0	29
Rh.pulchellus	10	2	17	6	0	13	13	61
Total Proportion	126 21%	19 3%	46 8%	24 4%	56 10%	166 29%	142 25%	579 100

Abbreviations: *A. gemma*, *Amblyomma gemma* etc.; *Hy. truncatum*, *Hyalomma truncatum; Rh. ev.evertsi*, *Rhipicephalus evertsi evertsi*.

Table 7. Observation on ixodid tick male to female ratio in the study period.

SEX OF TICKS	NO. OF TICKS	MALE TO FEMALE RATIO	χ^2	*P*-VALUE
Male	365 (63.1%)			
Female	214 (36.9%)	1.7:1	37	.001
Total	579 (100%)			

Statistics showed that the prevalence of ticks varied by age group ($P < .05$). Adult cattle had a higher tick infestation than young cattle, and similar differences were reported in other similar studies. It stated that a higher proportion of tick was observed in adult cattle than in young cattle.[31,33,35,36] This higher proportion of tick infestation in adults may be due to outdoor management and the long-distance movement of adult animals to search for feed and water when compared to younger animals, especially calves that remain around the homestead and are less exposed than adult cattle. It was also suggested that the grooming of calves and the smaller surface area of animals may be factors in the lower tick burdens.[32]

There was no significant difference between the body condition score in this study and previous observations in the same area.[19] A significantly higher prevalence was observed in poor-body-conditioned animals than in medium- and good-body-conditioned animals.[37] High prevalence in body-wasted animals is associated with low refraction to tick infestation, whereas animals with good body condition showed reasonable defense capacity against the infestation.[33]

Moreover, a relatively high tick infestation was recorded at Marsiyoa compared to Geyo and Hanna Kebele. A slight difference in tick infestation was observed in both body condition scores and among kebeles in this study, but it was not statistically significant ($P > .05$). A study in Colombia, indicated the higher-live-weight animals had a higher tick burden[35]; this might be confounding with age group, where adult animals have a higher live weight than young animals. In addition, as the animals get older and older, they might suffer from tick burden because of compromised immunity as their age increases.

Seven species of ticks, with respective prevalences, *Amblyomma variegatum* (32.3%), *Amblyomma gemma* (17.6%), *Amblyomma lepidum* (15%), *Rhipicephalus (Boophilus) decoloratus* (15.2%), *Rhipicephalus pulchellus* (10.6%), *Rhipicephalus evertsi evertsi* (5%), and *Hyalomma truncatum* (4.3%), were identified during the study period. The finding is in agreement with reports from other studies. Among the most commonly reported tick genera in Ethiopia, *Amblyomma* species are predominantly distributed in different regions of Ethiopia,[38-42] in the study areas of Nekemte, Hararghe, Asella, Awassa, Mizan Teferi, and Jimma. The second most predominantly distributed tick species is under the genus *Rhipicephalus*, with the maximum incidence reported in Gamo-Gofa, Bale and Southern Sidama; accordingly.[43-45]

Although *Amblyomma* and *Rhipicephalus* ticks are predominant in many parts of the country, *Rh. (Boophilus)* and *Hyalomma* ticks have also been reported significantly. A high prevalence (55%) was reported in Hawassa.[46] This difference is probably due to different climate conditions.

The tick populations are significantly affected by climatic changes, which affect the rate of tick populations on the ground, host resistance, and biological enemies.[16,23] Studying ticks on livestock under their natural conditions without any control measures is important to understand the host-parasite relationship and the variation of tick populations in different agro-ecological zones.

Rhipicephalus (Boophilus) decoloratus was the second most abundant tick species (15.2%) identified in the present study.

Most other studies have reported this tick species as the second most abundant tick infestation.[28,37,47,48] Although there is a prevalence difference from place to place, it is associated with climatic differences, as in *Rh. (Boophilus). decoloratus* is abundant in humid highlands and sub-highlands that receive more than 800 mm of annual rainfall.[49]

Rh. pulchellus was found to be the third most abundant tick, with a prevalence of 10.3%. It is reported as the most prevalent tick species on camels in Eastern Ethiopia, on small ruminants in the eastern part of Ethiopia, and on cattle in the Borena zone in the Oromia region. The present finding was higher than Haramaya Eastern Hararge, which reported 6%.[50] *R. evertsi evertsi* was the other tick species identified in the study area with a prevalence of 5%; however, the prevalence was lower than 21.5% in Bako, Western Ethiopia.[32] Belew and Mekonnen[36] reported a prevalence of 29.3% in and around Holetta and an equivalent prevalence of 30.5% in and around Asossa.[51] The native distribution of *Rh. evertsi evertsi* in Ethiopia is related to middle-high dry savannas and steppes. In association with zebra and ruminants, it was reported that this species did not show specific preferences for a particular altitude, rainfall zone, or season.,[49] but ticks more prefer large animals like cattle and others than small animals.[24]

With a prevalence of 4.3%, *Hy. truncatum* was found to be the least abundant tick species collected in this study. This finding was higher than the 0.9% prevalence.[48] The high frequency of this tick species in the Selamago district may be attributable to the fact that *Hy. truncatum* is generally found in arid parts of tropical Africa with annual rainfall ranging from 250 to 650 mm, where this ecology is more common in Selamago than in central Ethiopia.[24] The low incidence in Ethiopia's central highlands may be due to considerable rainfall.[49]

Tick infestation in different parts of the animal body shows that the perineum region, followed by udder/scrotum and dewlap had a high proportion of tick burden sequentially. The back, belly, head, and neck body regions showed the lowest tick burden. A longitudinal study findings corroborated this current study, where the perineum region had a higher tick burden than the belly region.[33,52] Other studies have shown that the lowest number of ticks were observed around the eyes, neck, and chest,[53] which is in line with the current findings. Ticks prefer hidden and warm anatomical zones on the animal's body. Therefore, a suitable environment for their survival might be the reason ticks were populous under the tail in the perineal region and between the lower flank of the udder and the scrotum. Similarly, the hind legs, udder, abdomen, forearm, and rear are more exposed to grass and hence more accessible to tick infestation.[31] The length of grass where the animals graze, whether the grazing style is rotational or confined to a single restricted grazing location influence tick burden in various body parts of the animal's.

Male ticks outnumbered female ticks in the current study by a ratio of 1.7:1. This study discovery of a higher number of male ticks is consistent with earlier research.[46,54] The finding is biologically plausible because male ticks stay longer on the host than female ticks. This is because of the wide scutum, or shield, at the back of the abdomen in males, that doesn't allow them to engorge blood sufficiently at one time and will not drop in the first blood feeding, unlike female ticks.[55] Similar findings were reported in Pakistan,[32] where male tick counts were higher and their species identified, whereas immature and engorged female ticks were difficult to count and identify because of morphological deformity. This might be fully engorged female ticks drop to the ground to lay eggs, and some identification traits are obscured, while males tend to stay on the host to continue feeding and mating with other females. In addition, host grooming removes semi-engorged females more easily than males.[46,56]

Conclusion and Recommendations

In this study, ticks were found to be widely prevalent, and 4 tick genera and 7 species were identified in the study area. *A. variegatum* was the most prevalent tick species found in the study area. The perineum was also the most tick infested body area, followed by the udder, scrotum, and dewlap. Appropriate tick control program taking the findings of this study into account should be designed and implemented in the study area. Further researches addressing the economic and public health significance of the identified ticks are recommended.

Acknowledgements

The authors have deepest appreciation to the local community who were willing to participate in restraining animals and allowed us to use their animals for this research. District veterinarian and development agent at each sample collection village facilitated the study and hence are highly acknowledged.

Authors' Contributions

W B. contributed on research design, entirely collected field data, entered the data into Microsoft Excel, and drafted the manuscript. **S M.** designed the research, mentored and monitored data collection, proof read the data entered, worked on data analysis, interpreted the result, edited the drafted manuscript, and took responsibility to submit the manuscript.

Availability of Data and Materials

Data available with corresponding author and will be provided upon request.

Consent for Publication

Not applicable

Ethics Approval and Consents of the Participants

All methods were carried out in accordance with relevant guidelines and regulations.

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REFERENCES

1. Catry B, Opsomer G, Decostere A, et al. Fatal meningitis in a calf caused by Mannheimia varigena. *Vet Sci Res*. 2004;77:187-188.
2. Terefe E, Dessie T, Haile A, Mulatu WMWAI. Husbandry and breeding practices of cattle in Mursi and Bodi pastoral communities in southwest Ethiopia. *Afr J Agric Res*. 2012;7:5986-5994.
3. Tadesse B, Woldehana T. Prevalence and associated risk factors of tick infestation on cattle in selected Kebeles of Damot Woyde Woreda, Wolaita zone, Southern Ethiopia. *Int J Adv Res Biol Sci*. 2019;6:114-121.
4. Central Statistical Agency (CSA). Ethiopia agricultural sample enumeration. *Central Statistical Agency of the Federal Democratic Republic of Ethiopia, Addis Ababa*, 2020, 2:48–50
5. Welinol K, Dame MB, Amanuel AW. Review on pneumonic pasteurellosis in cattle. *Microbiology*. 2020;53:275-287.
6. Wikse SE, Baker JC. The bronchopneumonia. In: By Smith BP, ed. *Large Animal Internal Medicine*. 2nd ed. Mosby-Year Book; 2016:632–655.
7. Jongejan F, Uilenberg G. The global importance of ticks. *Parasitology*. 2004;129:S3-S14.
8. Sonenshine DE, Roe RM. *Biology of Ticks*. 2nd ed. Oxford University Press; 2014:353-381.
9. Kaur D, Jaiswal K, Mishra S. Studies on prevalence of ixodid ticks infesting cattle and their control by plant extracts. *IOSR J Pharm Biol Sci Ver III*. 2015;10:1-11.
10. Rajput ZI, Hu S, Chen W, Arijo AG, Xiao C. Review on importance of ticks and their chemical and immunological control in livestock. *J Zhejiang Univ Sci*. 2006;7:912-921.
11. Kibruyesfa B, Achuna A. Prevalence and identification of ixodid ticks on cattle in Kimbibit district, North Shoa Zone, Ethiopia. *Adv Biol Res*. 2017;11: 271-277.
12. Walker A, Bovattour J, Camicas I, Horak A, Latif A, et al. Ticks of domestic animals in Africa: A guide to identification of species. *Bio Science Report*. 2003: 1-227. https://bit.ly/3DMFhY3
13. Tadese GB, Gadise SD. Prevalence of bovine ticks in and around Ambo District, West Shoa Zone, Oromia Regional State. *Biomed J Sci Tech Res*. 2022;45(3):1-5.
14. Pawlos W, Derese D. Study on prevalence and identification of ticks in Humbo district, Southern Nations, Nationalities, and People's Region (SNNPR), Ethiopia. *J Vet Med Anim Health*. 2013;5:73-80.
15. Blood DC, Radostits OM, Gay CC, eds. *Veterinary Medicine of the Diseases of Cattle, Sheep, Pig, Goat and Horse*. 10th ed. Black Well Science Ltd; 2007:829.
16. Solomon G, Nigist M, Kassa B. Seasonal variation of ticks on calves at Sebeta in Western Shoa zone. *Ethiop Vet J*. 2001;7:17-30.
17. Bekele J, Tarikua M, Abebe R. External parasite infestation in small ruminants in Wolmera district, Oromia region, Central Ethiopia. *J Anim Vet Adv*. 2011;10:518-523.
18. Kassa B. Standard Veterinary Laboratory Diagnostic Manual. *Veterinary Diagnostic Laboratory, College of Veterinary Medicine at the University ofvt6 Illinois, Urba IL*, 2005, 1:23–30.
19. Haben F, Mesfn M, Eyob E, Bereket T. Babesiosis in cattle and ixodid tick distribution in Dasenech and Selamago districts, southern Ethiopia. *Sci Rep*. 2022;12:6385.
20. Gatenby R. *The Tropical Agriculture*. McMillan Education; 1991.
21. Nicholson M, Butterworth T. *A Guide to Body Condition Score in Zebu Cattle International Livestock Center for Africa (ILCA)*. Addis Ababa; 1986.
22. Thrusfield M, ed. *Veterinary Epidemiology*. 4th ed. John Wiley and sons Ltd, The Atrium, South Gate; 2018:219–435.
23. Walker AR, Bouattour A, Camicas JL, et al. Ticks of Domestic Animals in Africa: a Guide to Identification of Species Bioscience Reports, Edinburgh Scotland, U.K., 2014 www.biosciencereports.pwp.blueyonder.co.uk
24. Kaba T. Geographical distribution of ixodid ticks and tick-borne pathogens of domestic animals in Ethiopia: a systematic review. *Parasit Vectors*. 2022; 15:108.
25. Abdifetah M, Muhammed F, Taju N, Mahamed AW. Prevalence, seasonal dynamics and associated variables of ixodid tick cattle infestation in Gondar, northwestern Ethiopia. *Parasite Epidemiol Control*. 2023;21:1-6.
26. Anteneh W, Yehualashet B. Identification and prevalence of ixodid ticks of cattle in case of Haramaya Eastern Hararghe, Ethiopia. *Hindawi Veterinary Medicine International*. 2021;2021:1-7.
27. Kebede A, Lemmi E, Dugassa J. Prevalence and identification of ixodide ticks in cattle in LaloAssabi district, West Wollega Zone, West Oromia, Ethiopia. *J Vet Sci Res*. 2018;3:3.
28. Hussein M, Melaku M, Bekele T. Study on prevalence and identification of bovine tick species in Hetosa District of East Arsi Zone, eastern Ethiopia. *Int J Adv Res Biol Sci*. 2018;5:105-114.
29. Tiki B, Addis M. Distribution of ixodid ticks on cattle in and around Holetta town, Ethiopia. *Glob Vet*. 2011;7:527-553.
30. Haile S, Zeryehun T. Prevalence of ectoparasite infestations of cattle in Bench Maji zone, Southwest Ethiopia. *Vet World*. 2013;6:291-294.
31. Rehman A, Nijhof AM, Sauter-Louis C, et al. Distribution of ticks infesting ruminants and risk factors associated with high tick prevalence in livestock farms in the semi-arid and arid agro-ecological zones of Pakistan. *Parasit Vectors*. 2017;10:190.
32. Khan SS, Ahmed H, Afzal MS, et al. Epidemiology, distribution and identification of ticks on livestock in Pakistan. *Int J Environ Res Public Health*. 2022;19(5):3024.
33. Rocha JF, Martínez R, López-Villalobos N, Morris ST. Tick burden in *Bos taurus* cattle and its relationship with heat stress in three agroecological zones in the tropics of Colombia. *Parasit Vectors*. 2019;12:73.
34. Hussein U. Survey of cattle tick species and tick burden in and around Bako town DVM thesis, College of Agriculture and Veterinary Medicine, Jimma University; 2009
35. Tessema T, Gashaw A. Prevalence of ticks on local and crossbred cattle in and around Asella town, southeast Ethiopia. *Ethiop Vet J*. 2011;14:79-89.
36. Belew T, Mekonnen A. Distribution of ixodid ticks on cattle in and around Holeta town, Ethiopia. *Glob Vet*. 2011;7:527-531.
37. Jelalu K, Nateneal T, Temesgen T. Infestation and identification of ixodid tick in cattle: the Case of Arbegona District, southern Ethiopia. *J Vet Med*. 2016;2016:1-8.
38. Mekuria B. *A preliminary survey of ticks on four species of domestic animal in Nekemte province*. DVM thesis, FVM, AAU, Debre zeit Ethiopia; 1987
39. Asrat G. *A preliminary survey of ticks on domestic animals in Hararghe administrative region*. DVM thesis, FVM, AAU, Debre zeit, Ethiopia; 1987
40. Assefa B. *A survey of ticks and tick-borne blood protozoa in cattle at Assela, Arsi Zone*. DVM thesis, FVM, AAU, Debrezeit, Ethiopia; 2004
41. Birhane M. *Distribution of livestock tick species in Awassa Area*. DVM thesis, FVM, AAU, Debrzeit, Ethiopia; 2004
42. Belay S. *Survey of cattle tick species in and Around Mizan Teferi, Bench Maji Zones of SNNPS*. DVM thesis, FVM, AAU, Debrezeit, Ethiopia; 2004
43. Abdo J. *A survey of tick and tick borne diseases in Gamo-Gofa administrative region*. DVM thesis, FVM, AAU, Debrezeit, Ethiopia; 1986
44. Garedie D. *A preliminary survey of ticks on domestic animals in Bale administrative region*. FVM, AAU, Debrezeit, Ethiopia; 1988
45. Birru S. *A preliminary survey of tick distribution in southern Sidamo*. DVM thesis, FVM. AAU, Debre zeit; 1988.
46. Terefe M. A study on ticks (Ixodidae) infesting cattle in Hawassa, shashemene and Arsi Negele districts. *Ethiop Acta Parasitol Glob*. 2020;11:126-132.
47. Alekaw S. Distribution of ticks and tick-borne diseases at Metekel Ranch. *Ethiop Vet World*. 1998;4:30.
48. Tamru T. *Survey of Bovine tick species in and around Asela Town*. DVM Thesis, School of Veterinary Medicine, Jimma University, Jimma, Ethiopia; 2008:15–39
49. Pegram RG, Hoogstraal H, Wassef HY. Ticks (Acari: Ixodoidea) of Ethiopia. I. Distribution, ecology and host relationships of species infesting livestock. *Bull Entomol Res*. 1981;71:339-359.
50. Anteneh W, Yehualashet B. *Identification and Prevalence of Ixodid Ticks of Cattle in case of Haramaya Eastern Hararghe*. Ethiopia College of Agriculture and Natural Resource, Bonga University; 2021.
51. Bossena F, Abdu M. Survey on the distribution of tick species in and around assosa town, Ethiopia. *Res J Vet Sci*. 2012;7:124-131.
52. Mapholi NO, Maiwashe A, Matika O, et al. Genetic parameters for tick counts across months for different tick species and anatomical locations in South African Nguni cattle. *Trop Anim Health Prod*. 2017;49:1201-1210.
53. Katiyatiya CL, Muchenje V, Mushunje A. Seasonal variation in coat characteristics, tick loads, cortisol levels, some physiological parameters and temperature humidity index on Nguni cows raised in low- and high-input farms. *Int J Biometeorol*. 2015;59:733-743.
54. Desalegn T, Fikru A, Kasaye S. Survey of tick infestation in domestic ruminants of Haramaya District, Eastern Hararghe, Ethiopia. *J Bacteriol Parasitol*. 2015;06:6-246.
55. Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW, eds. *Veterinary Parasitology*. 2nd ed. Blackwell Science Ltd; 1996:224-234.
56. Constable PD, Hinchcliff KW, Done SH, Grünberg W. *Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs and Goats*. Elsevier Health Sciences; 2017:953–973.