



Research Article

Prevalence, Species Composition, and Risk Factors of Ectoparasite Infestations in Small Ruminants in Maiduguri, Borno State, Nigeria

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ABSTRACT

This present study investigated the prevalence, species composition, and risk factors associated with ectoparasite infestations in small ruminants in Maiduguri, Nigeria. A cross-sectional survey of 200 sheep and goats was conducted over a 12-month period (October 2024–September 2025) using multistage sampling across household and market systems. Standard clinical examination and parasitological techniques were employed for ectoparasite collection and identification. The overall prevalence of ectoparasite infestation was 62.0% (124/200; 95% CI: 55.1–68.4). Goats (68.0%) exhibited a higher infestation rate than sheep (56.0%), although the difference was not statistically significant ($p > 0.05$). Animals sourced from markets showed significantly higher infestation compared to those from households ($p < 0.05$), highlighting the role of livestock aggregation in parasite transmission. Ticks were the predominant ectoparasites, with *Rhipicephalus* spp. (40.3%) being the most prevalent, followed by *Amblyomma variegatum* (19.4%) and *Hyalomma* spp. (11.3%). Lice (*Linognathus* spp. and *Damalinea* spp.), fleas (*Ctenocephalides* spp.), and mites, particularly *Sarcoptes scabiei*, were also identified at moderate levels, while mixed infestations occurred in 9.7% of animals. Infestation burden was strongly associated with poor body condition and intensive (confined) management systems, whereas sex had no significant influence. Adults showed higher tick burdens, while some lice and mites were more frequent in younger animals. The findings demonstrate a high burden and diverse composition of ectoparasites driven by management practices, host condition, and animal movement. Targeted control strategies integrating improved husbandry, biosecurity, and routine parasite management are essential to reduce production losses and zoonotic risks in the region.

Keywords: Ectoparasites; Maiduguri; Prevalence; Risk factors; Small ruminants

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INTRODUCTION

Small ruminants, particularly sheep (*Ovis aries*) and goats (*Capra hircus*), are integral to livestock production systems in Nigeria and across sub-Saharan Africa. They contribute substantially to household

food security, income generation, and socio-cultural practices through the provision of meat, milk, hides, and manure. In resource-limited settings, these animals also function as readily convertible financial assets, providing economic resilience during periods

of hardship (Coster *et al.*, 2024; Nemukula *et al.*, 2026).

Nigeria hosts one of the largest populations of small ruminants in Africa, with estimates exceeding 80 million goats and 40 million sheep (Ijoma *et al.*, 2025). A significant proportion of this population is concentrated in the northeastern region, where agro-ecological conditions and cultural preferences favor small ruminant husbandry. Urban and peri-urban centers such as Maiduguri serve as important nodes for livestock production and trade, characterized by intensive animal–human interactions and diverse management systems ranging from extensive grazing to semi-intensive and household-based rearing.

Despite their importance, the productivity of small ruminants is substantially constrained by parasitic infestations, particularly ectoparasites. These include ticks (family Ixodidae), lice (order Phthiraptera), fleas (order Siphonaptera), and mites (subclass Acari), which exert both direct and indirect impacts on host health and productivity. Direct effects include blood loss, skin irritation, dermatitis, reduced weight gain, and damage to hides and skins. Indirectly, ectoparasites act as vectors for a range of pathogens, including *Anaplasma*, *Babesia*, *Theileria*, and *Rickettsia* species, thereby amplifying disease burden and, in some cases, posing zoonotic risks (Insyari'ati *et al.*, 2024).

The economic implications of ectoparasitism are considerable. Infested animals often exhibit reduced market value, while damage to skins compromises the quality of raw materials for the leather industry. In addition, the widespread and often indiscriminate use of acaricides has contributed to the emergence of resistance among ectoparasite populations, undermining control efforts and increasing production costs (Muhammad *et al.*, 2021).

The epidemiology of ectoparasite infestations is strongly influenced by environmental and management factors. Maiduguri lies within a semi-arid Sahelian zone characterized by high temperatures, seasonal rainfall, and prolonged dry periods. These climatic conditions, combined with extensive grazing practices, peri-urban livestock density, and shared watering points, create favorable conditions for the survival, reproduction, and transmission of ectoparasites. Practices such as open-range grazing, tethering, and animal mixing at communal resources further enhance host–parasite contact rates and facilitate parasite dissemination (Leul *et al.*, 2020; Kyari and Kure, 2026).

Globally, the prevalence of ectoparasite infestations in small ruminants varies widely, typically ranging

from 20% to over 80%, depending on ecological conditions, host factors, and management practices (Leul *et al.*, 2024). In Nigeria, commonly reported ectoparasites include *Amblyomma variegatum*, *Rhipicephalus (Boophilus) decoloratus*, *Hyalomma* species, lice such as *Linognathus* spp., and mange mites. Variations in infestation patterns have been linked to differences in host species, with goats often exhibiting higher tick burdens than sheep, potentially due to their browsing behavior and habitat use (Suleiman *et al.*, 2025).

Despite the recognized burden of ectoparasites, there is a paucity of recent, location-specific data on their prevalence, species composition, and associated risk factors in Maiduguri metropolis. Most existing studies in Borno State and other parts of Nigeria have focused on rural settings, with limited attention to urban and peri-urban production systems where livestock–environment interactions are increasingly complex. This gap limits the development of targeted, evidence-based control strategies and hampers effective veterinary extension services.

In this context, generating baseline epidemiological data on ectoparasite infestations in small ruminants within Maiduguri is essential. Such information will support informed decision-making on parasite control, improve animal health and productivity, and contribute to sustainable livestock management in the region. Therefore the aim of this study is to determine the prevalence, species composition, and associated risk factors of ectoparasite infestations in small ruminants (sheep and goats) in Maiduguri, Borno State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Maiduguri, the capital of Borno State, northeastern Nigeria (11°50'N, 13°09'E). The city lies within the Sahelian ecological zone at an average elevation of approximately 320 m above sea level and is characterized by a hot semi-arid climate with distinct wet (June–September) and dry (October–May) seasons. Annual rainfall averages about 452 mm, with peak precipitation typically occurring between July and August, while the dry season is marked by high temperatures, low humidity, and Harmattan winds.

Maiduguri is located within the Ngadda River floodplain of the Lake Chad Basin, an ecological setting that promotes seasonal wetland formation, influencing livestock movement, aggregation, and grazing patterns. These environmental conditions contribute to increased interactions among small

locations were selected using simple random sampling.

In the second stage, households, flocks, and market pens within the selected locations were identified and sampled systematically. Eligible sheep and goats were selected at regular intervals based on the available sampling frame until the required sample size was achieved.

A total of 200 animals, comprising approximately equal numbers of sheep and goats, were examined across the different management systems. Inclusion criteria included owner consent and the ability to safely restrain animals for physical examination and sample collection. Animals that had received ectoparasiticide treatment within seven days prior to sampling, as well as those in critical health condition, were excluded to minimize potential bias in prevalence estimates and to ensure animal welfare.

Data Collection

Data were collected using a structured questionnaire in conjunction with a standardized clinical examination checklist to ensure uniformity and completeness. Information obtained encompassed host-related variables, including species, age, sex, and body condition score, as well as management-related factors such as housing type, grazing system, acaricide use, and access to veterinary care.

Age classification was determined through a combination of dentition assessment and owner recall, with animals categorized as juveniles (<12 months) or adults (≥12 months) as described by Herzog *et al.* (2019). Body condition was evaluated using a standardized scoring system on a scale of 1 to 5, based on visual assessment and palpation, to provide an objective measure of the nutritional and health status of each animal as described by Clingerman and Summers (2012) and Wagener *et al.* (2024).

Clinical Examination and Ectoparasite Collection

All animals were subjected to a thorough clinical examination following humane and species-appropriate restraint to ensure both animal welfare and examiner safety. A systematic whole-body inspection was performed for each animal, proceeding in a standardized sequence from the head to the extremities. Particular attention was given to established predilection sites for ectoparasite infestation, including the ears, neck, axillary regions, groin, tail base, and interdigital spaces, where parasites are most commonly harbored.

Ectoparasites were collected using conventional parasitological techniques tailored to the specific parasite groups. Ticks were carefully detached using

forceps applied close to the skin to ensure complete removal without damaging important morphological structures required for identification (Syamsul *et al.*, 2020; Samson and Temesgen, 2023). Lice and fleas were recovered through a combination of fine-toothed combing and direct visual inspection of the hair coat and skin surface (Samson and Temesgen, 2023). Mites were obtained using appropriate diagnostic methods based on lesion presentation, including deep skin scrapings, adhesive tape impressions, and ear swab collection for suspected otic infestations (Yin *et al.*, 2024). These methods are widely employed in veterinary parasitological investigations for the detection and identification of ectoparasites in livestock.

All recovered specimens were immediately preserved in 70% ethanol to maintain structural integrity and prevent degradation. Each sample was appropriately labeled with relevant identification details and transported to the Department of Veterinary Parasitology and Entomology research laboratory, University of Maiduguri under controlled conditions to ensure optimal preservation prior to identification and analysis.

Laboratory Identification

All collected ectoparasite specimens were processed and examined in the laboratory using standard entomological procedures. Initial sorting and gross examination were conducted under a stereomicroscope to separate parasite groups based on size and general morphology, after which detailed identification was performed using a compound light microscope at appropriate magnifications.

Identification of ectoparasites was based on established morphological criteria and guided by standard taxonomic keys. Ticks were characterized using features such as the structure and ornamentation of the scutum, the morphology of the capitulum (including palps and basis capituli), and the configuration of spiracular plates. Lice were differentiated primarily by head shape and the nature of their mouthparts, distinguishing chewing from sucking forms. Fleas were identified based on their laterally compressed body, the presence or absence of genal and pronotal combs (ctenidia), and other external anatomical features. Mites were classified according to body shape, the arrangement and distribution of setae, and the morphology of appendages, including legs and mouthparts as described by Ruenchit (2021).

Where morphological resolution permitted, identification was carried out to species level; otherwise, classification was limited to the genus

level. This approach ensured accurate and reproducible identification of ectoparasite taxa within the constraints of morphological diagnostics.

Data Analysis

Data obtained from the field and laboratory were first entered into Microsoft Excel for coding, cleaning, and validation, after which they were exported to SPSS software (version 25) for statistical analysis. Descriptive statistics were computed and presented as frequencies and percentages to summarize the distribution of variables.

Epidemiological indices were determined using standard parasitological definitions. Prevalence was calculated as the proportion of animals infested with at least one ectoparasite species. Mean intensity and mean abundance were also estimated to describe the burden of infestation among infected animals and across the entire study population, respectively. In addition, levels of infestation were categorized as light, moderate, or heavy based on the number of ectoparasites recovered per host.

To assess associations between ectoparasite infestation and potential risk factors, inferential statistical tests were applied. The Chi-square test or Fisher's exact test, as appropriate, was used for categorical comparisons. Furthermore, logistic regression analysis was conducted to identify independent predictors of infestation. Results were expressed as odds ratios (OR) with corresponding 95% confidence intervals (CI), and statistical significance was set at $p < 0.05$.

RESULTS

As presented in Table 1, the overall prevalence of ectoparasites was 62.0% (124/200; 95% CI: 55.1–68.4). Goats recorded a higher infestation rate of 68.0% (68/100) compared to sheep with 56.0% (56/100). Although the observed difference suggests a higher burden in goats, the association between host species and infestation status was not statistically significant ($\chi^2 = 3.056$, $p = 0.0804$). The estimated relative risk (RR = 1.302) and odds ratio (OR = 1.670) further indicate a moderately increased likelihood of infestation in goats compared to sheep. Table 2 presents the distribution of ectoparasite infestation according to sampling source. Among animals sampled from households, infestation prevalence was 55.0% (55/100), with goats (62.0%) exhibiting a higher proportion of infestation than sheep (48.0%). In contrast, animals obtained from markets recorded a higher overall prevalence of 69.0% (69/100), with goats again showing greater infestation (74.0%) compared to sheep (64.0%).

However, within each sampling source, the differences between sheep and goats were not statistically significant ($p > 0.05$).

When comparing sampling locations, a significantly higher prevalence of ectoparasite infestation was observed in animals sampled from markets (34.5%; 69/200) compared to those from households (27.5%; 55/200) ($\chi^2 = 4.160$, $p = 0.0414$). The relative risk (RR = 0.749) and odds ratio (OR = 0.549) indicate that animals from household settings had a lower likelihood of infestation compared to those sourced from markets.

The species composition of ectoparasites recovered from infested small ruminants is presented in Table 3. A total of 124 infested animals were identified, with ticks constituting the most dominant ectoparasite group across both host species. Among the tick species, *Rhipicephalus spp.* recorded the highest overall occurrence (40.3%; 50/124; 95% CI: 32.1–49.1), followed by *Amblyomma variegatum* (19.4%; 24/124; 95% CI: 13.3–27.5) and *Hyalomma spp.* (11.3%; 14/124; 95% CI: 6.8–18.3).

Within lice infestations, *Linognathus spp.* (sucking lice) had a prevalence of 16.1% (20/124; 95% CI: 10.6–23.9), while *Damalinia (Bovicola) spp.* (chewing lice) showed a slightly higher occurrence of 17.7% (22/124; 95% CI: 12.0–25.3).

Among mites, *Sarcoptes scabiei* was the most frequently detected species (7.3%; 9/124; 95% CI: 3.8–13.4), whereas *Chorioptes spp.* (4.8%; 6/124) and *Psoroptes ovis* (2.4%; 3/124) were less commonly observed. *Demodex spp.* recorded the lowest prevalence (1.6%; 2/124).

For other ectoparasite groups, fleas (*Ctenocephalides spp.*) were detected in 12.9% (16/124) of animals, while keds (*Melophagus ovinus*) accounted for 7.3% (9/124). Biting flies and myiasis-associated agents, including *Oestrus ovis*, *Stomoxys calcitrans*, and *Hippobosca spp.*, collectively contributed lower but notable proportions ranging from 3.2% to 4.0%. Mixed infestations involving two or more ectoparasite taxa were recorded in 9.7% (12/124) of animals.

Table 4 presents the distribution of ectoparasite species according to sampling source. Animals obtained from markets exhibited consistently higher infestation rates across most ectoparasite taxa compared to those sampled from households. For example, *Rhipicephalus spp.* was more prevalent in market-sourced animals (46.4%) than household animals (32.7%), a trend similarly observed for *Amblyomma variegatum*, *Hyalomma spp.*, and lice species. Fleas (*Ctenocephalides spp.*) and keds

(*Melophagus ovinus*) also showed higher proportions in market-derived animals. Mixed infestations were slightly more frequent in market animals (10.1%) compared to household animals (9.1%), suggesting increased parasite aggregation associated with animal trade and congregation points.

The distribution of ectoparasites by age group is presented in Table 5. Adult animals (n = 78) demonstrated a higher overall burden of most ectoparasite species compared to younger animals (n = 46). *Rhipicephalus* spp. remained the dominant tick species in both age categories, but with a higher prevalence in adults (46.2%) than in young animals (30.4%). A similar pattern was observed for *Amblyomma variegatum* and *Hyalomma* spp.

In contrast, certain lice and mite species showed variable age-related distribution. *Linognathus* spp. was more prevalent in young animals (21.7%) compared to adults (12.8%), while *Damalinia (Bovicola)* spp. showed comparable distribution across both age groups. Mite infestations, particularly *Chorioptes* spp. and *Sarcoptes scabiei*, were more frequently observed in younger animals than adults, although at generally lower overall prevalence levels. Fleas (*Ctenocephalides* spp.) and keds (*Melophagus ovinus*) were more commonly recorded in adults, consistent with greater exposure and cumulative infestation risk over time.

Mixed infestations were observed in both age groups, with a slightly higher proportion in young animals (13.0%) compared to adults (7.7%), indicating early-life exposure to multiple ectoparasite taxa within the study population.

As presented in Table 6, ectoparasite infestation was widely distributed across both sexes of small ruminants, with a comparable overall prevalence between males and females. Ticks constituted the dominant ectoparasite group, with *Rhipicephalus* spp. recording the highest prevalence in both males (37.9%) and females (42.4%), contributing to an overall prevalence of 40.3%. *Amblyomma variegatum* and *Hyalomma* spp. were also frequently observed, albeit at lower proportions, with no marked sex-associated variation in their distribution.

Among lice, *Linognathus* spp. and *Damalinia (Bovicola)* spp. showed relatively similar infestation rates between male and female hosts, indicating limited sex-related susceptibility. Mite infestations were comparatively less prevalent; however, *Sarcoptes scabiei* showed a slightly higher occurrence in males (10.3%) than females (4.5%), whereas *Chorioptes* spp. were more frequently detected in males.

Fleas (*Ctenocephalides* spp.) exhibited comparable infestation levels across sexes, while *Melophagus ovinus* was more prevalent in females (10.6%) than males (3.4%). Biting flies and myiasis-associated agents were generally infrequent, with marginal variations between sexes. Mixed infestations were also observed, with a slightly higher proportion recorded in males (12.1%) compared to females (7.6%). Overall, statistical comparison indicated no significant sex-associated differences in total ectoparasite prevalence, suggesting that host sex had limited influence on infestation patterns in the study population.

Results presented in Table 7 reveal a clear gradient in ectoparasite burden across body condition categories. Animals with poor body condition exhibited the highest overall infestation rates across nearly all ectoparasite groups, particularly for *Rhipicephalus* spp., which recorded the highest prevalence in this category (46.9%). A progressive decline in infestation levels was observed with improving body condition, with the lowest prevalence generally recorded in animals with good body condition.

Ticks remained the predominant ectoparasite group across all BCS categories, followed by lice species (*Linognathus* spp. and *Damalinia* spp.), which also showed higher occurrence in poorly conditioned animals. Mite infestations, particularly *Sarcoptes scabiei*, were more frequently detected in poor and moderately conditioned animals, while being rare or absent in animals with good body condition.

Similarly, flea infestations (*Ctenocephalides* spp.) and *Melophagus ovinus* were more pronounced in animals with poor body condition. Biting flies and associated myiasis agents were generally low in prevalence but were predominantly associated with poor and moderate body condition categories. Mixed infestations were also most frequent in poorly conditioned animals, indicating a strong association between reduced body condition and increased susceptibility to multiple ectoparasite taxa.

As shown in Table 8, ectoparasite distribution varied across different management systems, with confined animals exhibiting the highest overall infestation burden compared to semi-intensive and extensive systems. *Rhipicephalus* spp. remained the most prevalent tick species across all management categories, with the highest proportion recorded in confined systems (43.8%).

Other tick species, including *Amblyomma variegatum* and *Hyalomma* spp., showed relatively consistent distribution across management systems with

minimal variation. Lice infestations (*Linognathus* spp. and *Damalinia* spp.) were similarly widespread across all systems, indicating their adaptability to diverse husbandry conditions.

Mite infestations, particularly *Sarcoptes scabiei*, were present in all management systems but showed slightly higher proportions in semi-intensive and confined systems. Fleas (*Ctenocephalides* spp.) and

Melophagus ovinus were also detected across all systems, with marginally higher prevalence in semi-intensive management. Biting flies and myiasis agents occurred at low frequencies, with no pronounced management-associated clustering.

Mixed infestations were consistently observed across all systems, with confined animals exhibiting a relatively higher burden.

Table 1: Prevalence of Ectoparasites in Small Ruminants in Maiduguri, Borno State, Nigeria

Host Species	No. animals Examined	No. (%) of animals Infested	Prevalence (%)	95% CI: LL – UL	χ^2	P-value	RR	OR
Goats	100	68 (68.0)	34.0 ^a	27.8 – 40.8	3.056	0.0804	1.302	1.670
Sheep	100	56 (56.0)	28.0 ^a	22.2 – 34.6				
Total	200	124 (62.0)	62.0	55.1 – 68.4				

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit; χ^2 = Chi – square; OR = Odd ratio; RR = Relative risk
^{a,b} Values with different superscripts indicate significant ($p < 0.05$) difference in prevalence rate

Table 2: Prevalence of Ectoparasites infestation among small ruminants based on Source of Sampling in Maiduguri, Borno State, Nigeria

Sampling Source	No. (%) of animals Examined	No. (%) of animals Infested	Prevalence (%) 95% CI (LL – UL)	χ^2	P value	RR	OR
Households							
Sheep	50	24 (48.0)	24.0 ^a (16.7 – 33.2)	1.980	0.1594	1.334	1.768
Goats	50	31 (62.0)	31.0 ^a (22.8 – 40.4)				
Total	100	55 (55.0)	55.0 (45.2 – 64.4)				
Markets							
Sheep	50	32(64.0)	32.0 ^a (23.7 – 41.7)	1.169	0.2797	1.279	1.601
Goats	50	37 (74.0)	37.0 ^a (28.2 – 46.8)				
Total	100	69 (69.0)	69.0 (59.4 – 77.2)				
Households	100	55 (55.0)	27.5 ^a (21.8 – 34.1)	4.160	0.0414	0.7491	0.5491
Markets	100	69 (69.0)	34.5 ^b (28.3 – 41.3)				
Overall	200	124 (62.0)	62.0 (55.1 – 68.4)				

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit; χ^2 = Chi – square; OR = Odd ratio; RR = Relative risk

^{a,b} Values with different superscripts indicate significant ($p < 0.05$) difference in prevalence rate

Table 3: Species composition and prevalence of ectoparasites among infested small ruminants in Maiduguri, Borno State, Nigeria

Ectoparasite species	No. (%) of Goats infested (n = 68)	Prevalence (%) 95% CI (LL – UL)	No. (%) of Sheep infested (n = 56)	Prevalence (%) 95% CI (LL – UL)	Total No. (%) of Animal Infested (n = 124)	Prevalence (%) 95% CI (LL – UL)
Ticks						
<i>Rhipicephalus</i> spp.	28 (41.2)	30.3 – 53.0	22 (39.3)	27.6 – 52.4	50 (40.3)	32.1 – 49.1
<i>Amblyomma variegatum</i>	14 (20.6)	12.5 – 32.3	10 (17.9)	9.2 – 31.4	24 (19.4)	13.3 – 27.5
<i>Hyalomma</i> spp.	8 (11.8)	6.0 – 22.4	6 (10.7)	4.8 – 21.8	14 (11.3)	6.8 – 18.3
Lice (<i>Phthiraptera</i>)						
<i>Linognathus</i> spp. (sucking lice)	12 (17.6)	10.0 – 28.9	8 (14.3)	7.3 – 26.4	20 (16.1)	10.6 – 23.9
<i>Damalinea (Bovicola)</i> spp. (chewing lice)	10 (14.7)	8.1 – 25.5	12 (21.4)	12.3 – 34.5	22 (17.7)	12.0 – 25.3
Mites (Acari)						
<i>Chorioptes</i> spp.	6 (8.8)	3.9 – 18.7	0 (0.0)	0.0 – 6.3	6 (4.8)	2.1 – 10.6
<i>Sarcoptes scabiei</i>	4 (5.9)	2.3 – 14.6	5 (8.9)	3.9 – 18.9	9 (7.3)	3.8 – 13.4
<i>Psoroptes ovis</i>	0 (0.0)	0.0 – 5.3	3 (5.4)	1.8 – 14.9	3 (2.4)	0.8 – 6.8
<i>Demodex</i> spp.	1 (1.5)	0.2 – 8.1	1 (1.8)	0.3 – 9.6	2 (1.6)	0.4 – 5.8
Fleas and Keds						
<i>Ctenocephalides</i> spp. (fleas)	10 (14.7)	8.1 – 25.5	6 (10.7)	4.8 – 21.8	16 (12.9)	8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	0 (0.0)	0.0 – 5.3	9 (16.1)	8.5 – 28.7	9 (7.3)	3.8 – 13.4
Biting flies / Myiasis agents						
<i>Oestrus ovis</i> (sheep nasal bot)	0 (0.0)	0.0 – 5.3	4 (7.1)	2.7 – 17.7	4 (3.2)	1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (2.9)	0.8 – 9.9	3 (5.4)	1.8 – 14.9	5 (4.0)	1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	3 (4.4)	1.5 – 12.2	2 (3.6)	0.9 – 11.8	5 (4.0)	1.7 – 9.1
Mixed infestations (≥2 taxa)	8 (11.8)	6.1 – 21.5	4 (7.1)	2.8 – 17.0	12 (9.7)	5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

Table 4: Species Composition of Ectoparasites Identified in Small Ruminants by Source of Sampling in Maiduguri, Borno State, Nigeria

Ectoparasite species	Households: No. (%) of animals infested (n = 55)	Prevalence (%) 95% CI (LL – UL)	Markets: No. (%) of Animals Infested (n = 69)	Prevalence (%) 95% CI (LL – UL)	Total No. (%) of Animals Infested (n = 124)	Prevalence (%) 95% CI (LL – UL)
Ticks						
<i>Rhipicephalus</i> spp.	18 (32.7)	21.7 – 45.9	32 (46.4)	34.4 – 58.8	50 (40.3)	32.1 – 49.1
<i>Amblyomma variegatum</i>	8 (14.5)	7.2 – 26.8	16 (23.2)	14.7 – 34.2	24 (19.4)	13.3 – 27.5
<i>Hyalomma</i> spp.	5 (9.1)	3.9 – 19.8	9 (13.0)	6.9 – 22.9	14 (11.3)	6.8 – 18.3
Lice (Phthiraptera)						
<i>Linognathus</i> spp. (sucking lice)	7 (12.7)	6.3 – 24.2	13 (18.8)	11.3 – 29.7	20 (16.1)	10.6 – 23.9
<i>Damalinia (Bovicola)</i> spp. (chewing lice)	8 (14.5)	7.2 – 26.8	14 (20.3)	12.3 – 31.5	22 (17.7)	12.0 – 25.3
Mites (Acari)						
<i>Chorioptes</i> spp.	2 (3.6)	1.0 – 12.3	4 (5.8)	2.3 – 13.8	6 (4.8)	2.1 – 10.6
<i>Sarcoptes scabiei</i>	3 (5.5)	1.9 – 14.7	6 (8.7)	4.1 – 17.6	9 (7.3)	3.8 – 13.4
<i>Psoroptes ovis</i>	1 (1.8)	0.3 – 9.6	2 (2.9)	0.8 – 9.9	3 (2.4)	0.8 – 6.8
<i>Demodex</i> spp.	1 (1.8)	0.3 – 9.6	1 (1.4)	0.2 – 7.7	2 (1.6)	0.4 – 5.8
Fleas and Keds						
<i>Ctenocephalides</i> spp. (fleas)	6 (10.9)	5.1 – 21.9	10 (14.5)	7.9 – 25.1	16 (12.9)	8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	2 (3.6)	1.0 – 12.3	7 (10.1)	4.8 – 19.8	9 (7.3)	3.8 – 13.4
Biting flies / Myiasis agents						
<i>Oestrus ovis</i> (sheep nasal bot)	1 (1.8)	0.3 – 9.6	3 (4.3)	1.5 – 11.9	4 (3.2)	1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (3.6)	1.0 – 12.3	3 (4.3)	1.5 – 11.9	5 (4.0)	1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	2 (3.6)	1.0 – 12.3	3 (4.3)	1.5 – 11.9	5 (4.0)	1.7 – 9.1
Mixed infestations (≥2 taxa)	5 (9.1)	3.9 – 19.8	7 (10.1)	4.8 – 19.8	12 (9.7)	5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

Table 5: Species Composition of Ectoparasites Identified in Small Ruminants based on Age group in Maiduguri, Borno State, Nigeria

Ectoparasite species	Young: No. (%) of Animals Infested (n = 46)	Prevalence % (95% CI) LL – UL	Adult: No. (%) of Animals Infested (n = 78)	Prevalence % (95% CI) LL – UL	Total No. (%) of animals infested (n = 124)	Prevalence % (95% CI) LL – UL
Ticks						
<i>Rhipicephalus</i> spp.	14 (30.4)	18.9 – 45.0	36 (46.2)	35.1 – 57.7	50 (40.3)	32.1 – 49.1
<i>Amblyomma variegatum</i>	6 (13.0)	6.1 – 25.9	18 (23.1)	14.7 – 34.0	24 (19.4)	13.3 – 27.5
<i>Hyalomma</i> spp.	4 (8.7)	3.4 – 20.5	10 (12.8)	7.1 – 22.0	14 (11.3)	6.8 – 18.3
Lice (Phthiraptera)						
<i>Linognathus</i> spp. (sucking lice)	10 (21.7)	12.0 – 36.6	10 (12.8)	7.1 – 22.0	20 (16.1)	10.6 – 23.9
<i>Damalinia (Bovicola)</i> spp. (chewing lice)	8 (17.4)	8.9 – 31.4	14 (17.9)	11.0 – 28.0	22 (17.7)	12.0 – 25.3
Mites (Acari)						
<i>Chorioptes</i> spp.	4 (8.7)	3.4 – 20.5	2 (2.6)	0.7 – 9.0	6 (4.8)	2.1 – 10.6
<i>Sarcoptes scabiei</i>	4 (8.7)	3.4 – 20.5	5 (6.4)	2.7 – 14.3	9 (7.3)	3.8 – 13.4
<i>Psoroptes ovis</i>	2 (4.3)	1.2 – 14.5	1 (1.3)	0.2 – 7.0	3 (2.4)	0.8 – 6.8
<i>Demodex</i> spp.	1 (2.2)	0.3 – 11.5	1 (1.3)	0.2 – 7.0	2 (1.6)	0.4 – 5.8
Fleas and Keds						
<i>Ctenocephalides</i> spp. (fleas)	4 (8.7)	3.4 – 20.5	12 (15.4)	8.9 – 25.3	16 (12.9)	8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	1 (2.2)	0.3 – 11.5	8 (10.3)	5.2 – 19.4	9 (7.3)	3.8 – 13.4
Biting flies / Myiasis agents						
<i>Oestrus ovis</i> (sheep nasal bot)	0 (0.0)	0.0 – 7.6	4 (5.1)	2.0 – 12.6	4 (3.2)	1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (4.3)	1.2 – 14.5	3 (3.8)	1.3 – 10.9	5 (4.0)	1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	1 (2.2)	0.3 – 11.5	4 (5.1)	2.0 – 12.6	5 (4.0)	1.7 – 9.1
Mixed infestations (≥2 taxa)	6 (13.0)	6.1 – 25.9	6 (7.7)	3.5 – 15.8	12 (9.7)	5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

Table 6: Species Composition of Ectoparasites in Small Ruminants According to Sex of Host in Maiduguri, Borno State, Nigeria

Ectoparasite species	Male: animals (n = 58)	No. (%) of infested	Prevalence % (95% CI) (LL – UL)	Female: No. (%) of animals infested (n = 66)	Prevalence % (95% CI) (LL – UL)	Total No. animals (n = 124)	(%) of infested	Prevalence % (95% CI) (LL – UL)
Ticks								
<i>Rhipicephalus</i> spp.	22 (37.9)		26.4 – 50.8	28 (42.4)	30.7 – 54.9	50 (40.3)		32.1 – 49.1
<i>Amblyomma variegatum</i>	10 (17.2)		9.3 – 29.7	14 (21.2)	12.4 – 33.8	24 (19.4)		13.3 – 27.5
<i>Hyalomma</i> spp.	7 (12.1)		5.9 – 23.0	7 (10.6)	5.1 – 20.9	14 (11.3)		6.8 – 18.3
Lice (Phthiraptera)								
<i>Linognathus</i> spp. (sucking lice)	9 (15.5)		8.1 – 27.4	11 (16.7)	9.1 – 28.5	20 (16.1)		10.6 – 23.9
<i>Damalinia (Bovicola)</i> spp. (chewing lice)	11 (19.0)		10.6 – 31.8	11 (16.7)	9.1 – 28.5	22 (17.7)		12.0 – 25.3
Mites (Acari)								
<i>Chorioptes</i> spp.	4 (6.9)		2.7 – 16.7	2 (3.0)	0.8 – 10.3	6 (4.8)		2.1 – 10.6
<i>Sarcoptes scabiei</i>	6 (10.3)		4.8 – 20.9	3 (4.5)	1.6 – 12.5	9 (7.3)		3.8 – 13.4
<i>Psoroptes ovis</i>	2 (3.4)		0.9 – 11.8	1 (1.5)	0.3 – 8.1	3 (2.4)		0.8 – 6.8
<i>Demodex</i> spp.	1 (1.7)		0.3 – 9.1	1 (1.5)	0.3 – 8.1	2 (1.6)		0.4 – 5.8
Fleas and Keds								
<i>Ctenocephalides</i> spp. (fleas)	8 (13.8)		6.8 – 25.8	8 (12.1)	5.9 – 22.9	16 (12.9)		8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	2 (3.4)		0.9 – 11.8	7 (10.6)	5.1 – 20.9	9 (7.3)		3.8 – 13.4
Biting flies / Myiasis agents								
<i>Oestrus ovis</i> (sheep nasal bot)	1 (1.7)		0.3 – 9.1	3 (4.5)	1.6 – 12.5	4 (3.2)		1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (3.4)		0.9 – 11.8	3 (4.5)	1.6 – 12.5	5 (4.0)		1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	3 (5.2)		1.8 – 14.1	2 (3.0)	0.8 – 10.3	5 (4.0)		1.7 – 9.1
Mixed infestations (≥2 taxa)	7 (12.1)		5.9 – 23.0	5 (7.6)	3.2 – 16.9	12 (9.7)		5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

Table 7: Species Composition of Ectoparasites in Small Ruminants According to Body Condition Score of Host in Maiduguri, Borno State, Nigeria

Ectoparasite species	Poor BCS: No. (%) of animals infested (n = 64)	Prevalence % 95% CI (LL – UL)	Moderate BCS: No. (%) of animals Infested (n = 49)	Prevalence % (95% CI) (LL – UL)	Good BCS: No. (%) of animals Infested (n = 11)	Prevalence % (95% CI) (LL – UL)	Total No. (%) of Animals infested (n = 124)	Prevalence % (95% CI)
Ticks								
<i>Rhipicephalus</i> spp.	30 (46.9)	35.4 – 58.8	18 (36.7)	23.9 – 51.2	2 (18.2)	5.1 – 47.7	50 (40.3)	32.1 – 49.1
<i>Amblyomma variegatum</i>	14 (21.9)	13.5 – 33.6	8 (16.3)	8.0 – 29.8	2 (18.2)	5.1 – 47.7	24 (19.4)	13.3 – 27.5
<i>Hyalomma</i> spp.	8 (12.5)	6.5 – 22.9	5 (10.2)	4.0 – 23.4	1 (9.1)	1.6 – 37.7	14 (11.3)	6.8 – 18.3
Lice (Phthiraptera)								
<i>Linognathus</i> spp. (sucking lice)	12 (18.8)	10.9 – 30.4	7 (14.3)	6.6 – 27.9	1 (9.1)	1.6 – 37.7	20 (16.1)	10.6 – 23.9
<i>Damalinia</i> (Bovicola) spp. (chewing lice)	10 (15.6)	8.5 – 26.6	10 (20.4)	11.1 – 34.3	2 (18.2)	5.1 – 47.7	22 (17.7)	12.0 – 25.3
Mites (Acari)								
<i>Chorioptes</i> spp.	5 (7.8)	3.4 – 17.0	1 (2.0)	0.4 – 10.2	0 (0.0)	0.0 – 28.5	6 (4.8)	2.1 – 10.6
<i>Sarcoptes scabiei</i>	5 (7.8)	3.4 – 17.0	3 (6.1)	2.1 – 16.5	1 (9.1)	1.6 – 37.7	9 (7.3)	3.8 – 13.4
<i>Psoroptes ovis</i>	2 (3.1)	0.9 – 10.6	1 (2.0)	0.4 – 10.2	0 (0.0)	0.0 – 28.5	3 (2.4)	0.8 – 6.8
<i>Demodex</i> spp.	1 (1.6)	0.3 – 8.3	1 (2.0)	0.4 – 10.2	0 (0.0)	0.0 – 28.5	2 (1.6)	0.4 – 5.8
Fleas and Keds								
<i>Ctenocephalides</i> spp. (fleas)	8 (12.5)	6.5 – 22.9	6 (12.2)	5.4 – 24.9	2 (18.2)	5.1 – 47.7	16 (12.9)	8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	6 (9.4)	4.3 – 19.3	3 (6.1)	2.1 – 16.5	0 (0.0)	0.0 – 28.5	9 (7.3)	3.8 – 13.4
Biting flies / Myiasis agents								
<i>Oestrus ovis</i> (sheep nasal bot)	2 (3.1)	0.9 – 10.6	2 (4.1)	1.1 – 13.7	0 (0.0)	0.0 – 28.5	4 (3.2)	1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (3.1)	0.9 – 10.6	2 (4.1)	1.1 – 13.7	1 (9.1)	1.6 – 37.7	5 (4.0)	1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	2 (3.1)	0.9 – 10.6	2 (4.1)	1.1 – 13.7	1 (9.1)	1.6 – 37.7	5 (4.0)	1.7 – 9.1
Mixed infestations (≥2 taxa)	8 (12.5)	6.5 – 22.9	3 (6.1)	2.1 – 16.5	1 (9.1)	1.6 – 37.7	12 (9.7)	5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

Table 8: Species Composition of Ectoparasites Identified in Small Ruminants by Management Practices in Maiduguri, Borno State, Nigeria

Ectoparasite species	Confined: No. (%) of animals infested (n = 64)	Prevalence % (95% CI)	Semi-intensive: No. (%) of Animals Infested (n = 33)	Prevalence % (95% CI) (LL – UL)	Extensive: No. (%) of animals infested (n = 27)	Prevalence % (95% CI) (LL – UL)	Total No. (%) of Animals Infested (n = 124)	Prevalence % (95% CI) (LL – UL)
Ticks								
<i>Rhipicephalus</i> spp.	28 (43.8)	32.0 – 56.3	12 (36.4)	21.6 – 53.5	10 (37.0)	20.7 – 56.7	50 (40.3)	32.1 – 49.1
<i>Amblyomma variegatum</i>	12 (18.8)	11.1 – 29.9	7 (21.2)	10.7 – 37.8	5 (18.5)	8.2 – 36.7	24 (19.4)	13.3 – 27.5
<i>Hyalomma</i> spp.	7 (10.9)	5.4 – 20.9	4 (12.1)	4.3 – 28.0	3 (11.1)	3.4 – 28.1	14 (11.3)	6.8 – 18.3
Lice (Phthiraptera)								
<i>Linognathus</i> spp. (sucking lice)	10 (15.6)	8.5 – 26.8	6 (18.2)	8.1 – 35.0	4 (14.8)	5.9 – 32.5	20 (16.1)	10.6 – 23.9
<i>Damalinia (Bovicola)</i> spp. (chewing lice)	11 (17.2)	9.7 – 28.8	6 (18.2)	8.1 – 35.0	5 (18.5)	8.2 – 36.7	22 (17.7)	12.0 – 25.3
Mites (Acari)								
<i>Chorioptes</i> spp.	4 (6.3)	2.5 – 15.2	2 (6.1)	1.7 – 19.6	0 (0.0)	0.0 – 12.5	6 (4.8)	2.1 – 10.6
<i>Sarcoptes scabiei</i>	5 (7.8)	3.4 – 17.2	3 (9.1)	3.2 – 23.6	1 (3.7)	0.7 – 18.3	9 (7.3)	3.8 – 13.4
<i>Psoroptes ovis</i>	1 (1.6)	0.3 – 8.4	1 (3.0)	0.5 – 15.3	1 (3.7)	0.7 – 18.3	3 (2.4)	0.8 – 6.8
<i>Demodex</i> spp.	1 (1.6)	0.3 – 8.4	1 (3.0)	0.5 – 15.3	0 (0.0)	0.0 – 12.5	2 (1.6)	0.4 – 5.8
Fleas and Keds								
<i>Ctenocephalides</i> spp. (fleas)	8 (12.5)	6.4 – 22.9	5 (15.2)	6.7 – 31.7	3 (11.1)	3.4 – 28.1	16 (12.9)	8.1 – 19.8
<i>Melophagus ovinus</i> (keds)	3 (4.7)	1.6 – 13.1	4 (12.1)	4.8 – 28.2	2 (7.4)	1.8 – 23.0	9 (7.3)	3.8 – 13.4
Biting flies / Myiasis agents								
<i>Oestrus ovis</i> (sheep nasal bot)	1 (1.6)	0.3 – 8.4	2 (6.1)	1.7 – 19.6	1 (3.7)	0.7 – 18.3	4 (3.2)	1.2 – 8.0
<i>Stomoxys calcitrans</i> / other biting flies	2 (3.1)	0.9 – 10.6	2 (6.1)	1.7 – 19.6	1 (3.7)	0.7 – 18.3	5 (4.0)	1.7 – 9.1
<i>Hippobosca</i> spp. (louse flies / keds)	2 (3.1)	0.9 – 10.6	2 (6.1)	1.7 – 19.6	1 (3.7)	0.7 – 18.3	5 (4.0)	1.7 – 9.1
Mixed infestations (≥2 taxa)	6 (9.4)	4.3 – 19.5	4 (12.1)	4.8 – 28.2	2 (7.4)	1.8 – 23.0	12 (9.7)	5.6 – 16.2

Key: CI= Confidence Interval; LL – UL = Lower limit – Upper limit

DISCUSSION

The present study demonstrates that ectoparasite infestation remains highly endemic in small ruminants in Maiduguri, Borno State, with an overall prevalence of 62.0%. This level of infestation reflects a persistent epidemiological burden comparable to earlier reports from northern Nigeria and other Sahelian environments, where prevalence rates in small ruminants commonly exceed 50% (Biu *et al.*, 2018; Suleiman *et al.*, 2025). The sustained high burden across studies suggests that ectoparasite transmission is strongly maintained by ecological suitability, particularly the hot semi-arid climate, combined with extensive husbandry practices that limit effective vector control and biosecurity implementation.

Although goats showed a higher infestation rate than sheep, the absence of statistical significance indicates that both host species are similarly exposed under the prevailing management conditions. Nonetheless, the consistently elevated risk estimate for goats agrees with previous observations that goats may be more susceptible to ectoparasite establishment due to behavioural and anatomical factors, including browsing habits, increased environmental contact, and relatively sparse hair coverage compared to sheep (Orpin *et al.*, 2020; Sarkawt *et al.*, 2021). However, contrasting reports in other ecological zones suggest that host susceptibility is not fixed but influenced by management intensity, breed composition, and environmental exposure (Wahab *et al.*, 2021; Suleiman *et al.*, 2025). The finding of the present study is inconsistent with the report of Suleiman *et al.* (2025) who reported higher prevalence in sheep than in goat from a similar study in Kastina State. The findings therefore reinforce the concept that host species differences in ectoparasite burden are context-dependent rather than universal.

Market-sourced animals exhibited significantly higher infestation levels than household animals, underscoring the epidemiological importance of livestock aggregation points in ectoparasite transmission dynamics. Markets function as convergence nodes where animals from diverse ecological backgrounds mix under crowded conditions, facilitating rapid horizontal transfer of ectoparasites (Muhammad *et al.*, 2021; Rizwan *et al.*, 2023; Insyari'ati *et al.*, 2024). This pattern has been widely documented in African livestock systems and highlights markets as critical control points for intervention strategies aimed at reducing parasite dissemination across production chains.

The ectoparasite fauna recorded was diverse, with ticks representing the dominant group. The predominance of *Rhipicephalus* spp. is consistent with its well-documented ecological plasticity and adaptability to savanna environments, where it thrives under a wide range of host and climatic conditions (Elati *et al.*, 2024). Its predominance is epidemiologically significant given its role as a vector of major haemoparasitic pathogens such as *Babesia* and *Anaplasma* species, which are responsible for substantial productivity losses in small ruminants across sub-Saharan Africa (Elati *et al.*, 2018).

The detection of *Amblyomma variegatum* and *Hyalomma* spp., although at lower frequencies, remains important from a veterinary public health perspective. *Amblyomma variegatum* is a known vector of *Ehrlichia ruminantium*, the causative agent of heartwater, a disease of significant economic importance in tropical livestock systems (Makwarela *et al.*, 2025). The presence of *Hyalomma* spp. further indicates ecological suitability for multi-vector tick assemblages, particularly under semi-arid conditions characterized by seasonal vegetation fluctuations. The finding of the present study agrees with Ude *et al.* (2024) who also reported this species of ectoparasites in small ruminants in Eboyin State.

Louse infestations, particularly *Linognathus* spp. and *Damalinea (Bovicola)* spp., were moderately prevalent and reflect typical ectoparasite assemblages in small ruminants in Africa. The relatively higher occurrence of chewing lice in sheep compared to goats is consistent with their adaptation to wool-covered hosts, which provide a favourable microenvironment for survival and reproduction (Ajith *et al.*, 2017). Conversely, sucking lice appear more opportunistic and are often associated with host stress and suboptimal nutrition (Al-Azizz *et al.*, 2025). These patterns reinforce the interaction between host physiology, husbandry, and parasite ecology.

Mite infestations were comparatively less frequent but remain epidemiologically relevant due to their pathogenic and zoonotic implications. The predominance of *Sarcoptes scabiei* aligns with previous reports identifying sarcoptic mange as a widespread condition associated with poor hygiene, overcrowding, and immune suppression (Fesseha *et al.*, 2022). The sporadic detection of *Chorioptes*, *Psoroptes*, and *Demodex* spp. is consistent with their generally opportunistic and low-prevalence distribution in small ruminant populations (Hailu *et al.*, 2025).

A notable epidemiological feature of this study is the strong association between ectoparasite burden and

body condition score. Animals with poor body condition carried disproportionately higher parasite loads, indicating a bidirectional relationship in which ectoparasitism both contributes to and is exacerbated by poor physiological status. Malnutrition is known to impair immune competence, thereby increasing susceptibility to ectoparasitic establishment and persistence (Adang *et al.*, 2015; Risa *et al.*, 2024). Conversely, chronic ectoparasitism exacerbates weight loss through blood loss, skin damage, and reduced feed efficiency, creating a self-reinforcing cycle of deterioration.

Management system also emerged as a critical determinant of infestation risk. Confined animals exhibited higher parasite burdens than those under semi-intensive or extensive systems. This is consistent with the well-established role of stocking density, humidity accumulation, and reduced sunlight exposure in enhancing ectoparasite survival and transmission (Kimeli *et al.*, 2025). In contrast, extensive systems may reduce infestation pressure through increased dispersion and environmental exposure that disrupts parasite life cycles. The intermediate levels observed in semi-intensive systems reflect mixed exposure pathways, combining risks associated with both confinement and grazing. Sex-related differences in infestation were generally minimal, indicating limited influence of sex under field conditions. However, slightly higher burdens in females for certain parasites may reflect physiological stress associated with reproduction and lactation, which can transiently reduce immune responsiveness (Adang *et al.*, 2015). Such effects are typically subtle under natural grazing systems where environmental exposure overrides intrinsic host factors.

Mixed infestations observed across categories highlight the polyparasitic nature of ectoparasite ecology in small ruminants. Co-infestation is of particular concern because it can exacerbate clinical severity, increase transmission efficiency, and complicate control strategies (Elati *et al.*, 2024; Ude *et al.*, 2024). The presence of multiple ectoparasite taxa within the same host further underscores the need for integrated control approaches rather than single-parasite interventions.

CONCLUSION

This study recorded an overall ectoparasite prevalence of 62.0% (124/200; 95% CI: 55.1–68.4) among small ruminants in Maiduguri. Goats showed a higher infestation rate (68.0%) compared to sheep (56.0%), although this difference was not statistically significant ($\chi^2 = 3.056$, $p = 0.0804$). Animals sourced

from markets recorded higher infestation (69.0%; 69/100) than those from households (55.0%; 55/100), with a significantly higher risk associated with market-derived animals ($\chi^2 = 4.160$, $p = 0.0414$). Across ectoparasite taxa, ticks were the most dominant group (*Rhipicephalus* spp. 40.3%; *Amblyomma variegatum* 19.4%; *Hyalomma* spp. 11.3%), followed by lice including *Linognathus* spp. (16.1%) and *Damalinia* spp. (17.7%). Mites were less frequent, with *Sarcoptes scabiei* (7.3%), *Chorioptes* spp. (4.8%), *Psoroptes ovis* (2.4%), and *Demodex* spp. (1.6%). Other ectoparasites included *Ctenocephalides* spp. (12.9%), *Melophagus ovinus* (7.3%), and biting flies/myiasis agents (3.2–4.0%). Mixed infestations were recorded in 9.7% of animals. Market-sourced animals showed consistently higher proportions of most ectoparasites, including *Rhipicephalus* spp., and higher mixed infestation levels. Age-related distribution showed higher tick burdens in adults (*Rhipicephalus* spp. 46.2% compared to 30.4% in young animals), while lice and mites such as *Linognathus* spp. (21.7% in young compared to 12.8% in adults) and *Sarcoptes scabiei* were more frequent in younger animals. Mixed infestations were higher in young animals. Sex-based distribution showed no significant difference in total infestation; however, *Rhipicephalus* spp. occurred in 37.9% of males and 42.4% of females, while *Sarcoptes scabiei* was higher in males (10.3%), and *Melophagus ovinus* higher in females (10.6%). Body condition showed a clear gradient, with animals in poor condition recording the highest infestation levels across all ectoparasite groups, particularly *Rhipicephalus* spp. (46.9%), followed by moderate and good condition animals with progressively lower burdens. Mixed infestations were also most frequent in poor body condition animals. Regarding management systems, confined systems recorded the highest overall infestation levels, particularly for *Rhipicephalus* spp. (43.8%), with semi-intensive and extensive systems showing comparatively lower but widespread infestations across all parasite groups.

Overall, ectoparasite infestation in small ruminants in the study area was widespread, with ticks dominating the parasite spectrum, significant influence of animal source, and clear variation across age, body condition, and management systems, while sex had minimal effect on infestation patterns.

Effective control of ectoparasites in small ruminants in Maiduguri requires an integrated and context-specific approach. Routine strategic use of acaricides and insecticides should be implemented under veterinary supervision, with emphasis on correct

dosing, rotation of active ingredients, and adherence to withdrawal periods to minimize resistance development. Improvement of husbandry practices is essential, including regular cleaning and disinfection of housing, reduction of stocking density, and provision of adequate ventilation and sunlight exposure in confined systems. Nutritional management should be strengthened to improve body condition and enhance host resistance to infestation. Particular attention should be given to young and poorly conditioned animals, which are more vulnerable to infestation. In addition, routine surveillance and periodic screening for ectoparasites should be institutionalized at both farm and community levels.

Given the significantly higher infestation rates observed in market-sourced animals, biosecurity measures at livestock markets should be reinforced. This includes pre-sale inspection, quarantine or isolation of newly introduced animals, and establishment of designated treatment points for ectoparasite control. Awareness programs and extension services should be intensified to educate farmers and livestock handlers on parasite transmission dynamics, early detection, and appropriate control practices. Policymakers and veterinary authorities should support coordinated control programs and strengthen access to veterinary services, particularly in peri-urban and rural areas. Such combined efforts are critical to reducing ectoparasite burden, improving productivity, and limiting the risk of zoonotic transmission in the region.

Conflict of Interest

Authors declares no conflict of interest

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