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Assessment of hard tick prevalence and infestation in sheep and goats in Buksan city

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Abstract Hard ticks, as carriers and significant reservoirs of pathogens, play a crucial role in the transmission and persistence of severe bacterial, protozoal, and viral infectious diseases in humans, domestic animals, and wildlife. The continuity of disease cycles is associated with their blood-feeding activities, leading to substantial economic losses in livestock. For the present study, 384 sheep and goats were clinically examined in equal numbers, and their data were subjected to statistical analysis. The prevalence of infection in the study population was reported as 24.7%. Statistical analysis did not show a significant correlation between the prevalence of infection and factors such as animal species (P: 0.076 > 0.05 / CI: 0.049 - 0.097), age of animals (P: 0.876 > 0.05 / CI: 0.806 - 0.945), and gender of animals (P: 0.318 > 0.05 / CI: 0.190 - 0.342). However, there was a significant statistical relationship between the prevalence of infection and the month of sampling (P: 0.001 < 0.05). The current study indicates that infestation with hard ticks poses serious challenges to the livestock health sector and, without control and prevention measures can result in significant economic losses.

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Introduction

Livestock production stands as one of the agricultural activities that are both highly profitable and sustainable on a global scale. Dating back to ancient times, sheep and goats were among the earliest animals to be domesticated by humans. The domestication of sheep is estimated to have occurred between 11,000 and 9,000 BC, while goats were domesticated between 6,000 and 7,000 Before Christ (BC) [1]. These early practices not only shaped the course of human history but also laid the foundation for modern-day livestock farming. Today, sheep and goats continue to play an important role in agricultural economies worldwide, providing essential resources such as meat, milk, and wool while sustaining livelihoods and contributing to food security [2].

Ticks serve as key vectors of economically significant pathogens affecting ruminants worldwide, thriving in favorable climates [3]. They directly threaten livestock health and cause significant economic losses by transmitting diseases. [4]. Effective management of tick-borne diseases necessitates substantial investments in prevention and research to safeguard small ruminant welfare and ensure agricultural sustainability globally [2]. Losses

resulting from tick infestations can manifest as both direct and indirect impacts [5]. Direct losses encompass various factors such as hide and skin damage caused by tick bites in heavily infested animals, blood loss due to a high tick load, anemia, severe allergic reactions triggered by toxins within tick saliva, and decreased energy levels due to incessant movement. Chronic stress and irritation further compound these issues, leading to immune suppression [4]. Indirect economic losses stem from multiple sources, including expenses related to treatment, tick control measures, and the disposal of animal products contaminated with acaricides. Additionally, economic repercussions arise from the effects of tick-borne pathogens, further exacerbating financial burdens within the livestock industry [2].

Hard ticks have adapted and coexisted permanently with their animal hosts in different environments and climates worldwide for thousands of years [6]. Compared to soft ticks that feed for a few hours on their hosts, hard ticks continually feed for several days on host animals, resulting in a deterioration in animal health [7]. Lyme disease, Rocky Mountain spotted fever, tularemia, anaplasmosis, babesiosis, bartonellosis, cytauxzoonosis, ehrlichiosis, hepatozoonosis, theileriosis, and life-threatening arboviruses are among the major hard tick-borne diseases [8]. Crimean-Congo hemorrhagic fever (CCHF) is particularly noteworthy for its high mortality rates compared to other tick-borne diseases [9].

Materials and Methods

Geographical Context

This study was conducted to assess the prevalence of hard tick infestation in the sheep and goat population of Bukan City. Bukan City, located in the West Azerbaijan province of northwest Iran (36° 32’ N, 46° 13’ E), is depicted in Figure 1 along with the nearby air quality monitoring station. Currently, the city has only one air quality monitoring station. Bukan city covers an area of 306.2541 km² [10]. The climate in the west Azerbaijan province is defined by an average annual rainfall of 73.1 mm, a mean monthly relative humidity of 77%, and temperatures ranging from -3.8 ºC to +23.4 ºC, as reported by the Iranian Meteorological Organization [11].

Animals

The study aimed to assess the prevalence of hard tick infestation in the sheep and goat population of Bukan City. Sampling was conducted on 384 animals (192 sheep and 192 goats), categorized by age, gender, species, and sampling months. The semi-random sampling method and sample size for the current study were determined using EpiInfo software version 7.2.5.0 obtained from the Centers for Disease Control and Prevention (CDC) website. Considering that sampling is both random and cluster-based, assuming an estimated population of 500,000 sheep and goats in Bukan County, sampling is conducted from 12 sheep and goat breeding centers throughout various months of the year. With a 95% confidence level, the software output reports a study population of 384 individuals [12].

Method of sampling

Sampling was carried out by visiting villages surrounding Bukan city and livestock breeding centers. Initially, data regarding the animals, including age and, gender were collected through an animal ownership questionnaire. Subsequently, the animals were examined with latex gloves in a stress-minimized environment. The examination focused on the thigh folds, perianal region, and udder in female sheep and goats, and testicles in male sheep and goats. After macroscopic examination, ticks were isolated from the animals' body surfaces and placed in glass containers with lids. Detailed information about the sampled animals, including the precise date of visit, owner's name, sampling site, and animal age, was recorded. To isolate the ticks, a cotton swab soaked in 70% alcohol was applied to the tick's body surface, followed by removal using surgical forceps. The collected ticks were then placed in sampling containers,

and a solution of glycerin and 70% alcohol in a precise ratio of 1:9 was added to prevent drying and accidental breakage [13]. Subsequently, the samples were dispatched to the parasitology laboratory at the Faculty of Veterinary Medicine, Urmia branch, Islamic Azad University, Urmia, for further analysis.

In the laboratory, the ticks were washed and fixed before being placed in a freezer for additional studies. For species identification, the ticks were removed from the sampling containers and placed on clean paper. They were then cleaned with a fine paintbrush, and genus and species identification were performed using a laboratory magnifying glass and diagnostic keys [14]. In some cases, a 5% potassium solution was used to remove sediment and improve clarity. Additionally, to ensure accurate identification, other reputable diagnostic keys such as the Russian hard tick diagnostic key were consulted.

Statistical analysis

Data analysis was performed using Excel version 2013 and SPSS version 19 software. Fisher's test was employed to assess data normality, while Pearson, Kendall, and Chi-square (X2) correlation tests were conducted to evaluate the significance of relationships, determined based on the P-value.

Results

The study aimed to assess the prevalence of hard tick infestation in the sheep and goat population of Bukan City. Sampling was conducted on 384 animals (192 sheep and 192 goats), categorized by age, gender, species, and sampling months. Male sheep accounted for 42.2%, while male goats totaled 45.8%. Female sheep numbered 57.8%, and female goats totaled 54.2%. Overall, 44% of the samples were male, and 56% were female. Regarding age distribution, the majority of sheep (22.9%) and goats (30.2%) fell into the age group of two to three years (Table 1). In terms of infestation by month, positive cases ranged from 1.8% in April to 4.4% in September, totaling 24.7% of the study population (Table 2). Of the positive cases, 20.8% were in sheep, and 28.9% were in goats (Table 1). The most common hard tick species in goats were *Rhipicephalus annulatus*, *Hyalomma asiaticum*, *Rhipicephalus bursa*, and *Hyalomma anatolicum*, while in sheep, they were were *Rhipicephalus annulatus*, *Hyalomma asiaticum*, *Hyalomma anatolicum*, and *Hemaphysalis concinna* (Table 3).

Statistical analysis was conducted to investigate the relationship between the prevalence of infestation and variables such as species, age, and gender of the examined animals. Based on Table 1, the association between the prevalence of infestation with hard ticks and the animal species under study was examined. However, statistical analysis did not reveal a significant relationship between the prevalence of infestation with hard ticks and the animal species (P: 0.076 > 0.05 / CI: 0.049 - 0.097). Based on Table 1, the relationship between the prevalence of infestation with hard ticks and the age of the studied sheep was examined. However, statistical analysis did not reveal a significant relationship between the prevalence of infestation with hard ticks and the age of the sheep (P: 0.427 > 0.05 / CI: 0.378 - 0.477). Based on Table 1, the relationship between the prevalence of infestation with hard ticks and the age of the studied goats was examined. However, statistical analysis did not reveal a significant relationship between the prevalence of infestation with hard ticks and the age of the goats (P: 0.302 > 0.05 / CI: 0.256 - 0.348). Additionally, Table 1 explores the relationship between the prevalence of infestation with hard ticks and the gender of the studied animals. Statistical analysis did not show a significant relationship between the prevalence of infestation with hard ticks and the gender of the animals (P: 0.318 > 0.05 / CI: 0.190 - 0.342). Moreover, Table 2 examines the relationship between the prevalence of infestation with hard ticks and the sampling months.

Statistical analysis revealed a significant relationship between the prevalence of infestation with hard ticks and the sampling months (P: 0.001 < 0.05).

Table 1: Tick infestation levels in sheep and goats based on age and gender

Species	Variables	Positive (Percentage)	Negative (Percentage)	Total	Pearson Chi-Square	P-Value
Sheep	**Age (Year)**	-	-	-	1.215	0.427
	1>X	5 (2.6)	23 (12.0)	28 (14.6)		
	1-2	9 (4.7)	35 (18.2)	44 (22.9)		
	2-3	11 (5.7)	33 (17.2)	44 (22.9)		
	3-4	6 (3.1)	31 (16.2)	37 (19.3)		
	4<X	9 (4.7)	30 (15.6)	39 (20.3)		
	Total	40 (20.8)	152 (79.2)	192 (100.0)		
	Gender	-	-	-		
	Male	19 (9.9)	62 (32.3)	81 (42.2)	0.585	0.475
	Female	21 (10.9)	90 (46.9)	111 (57.8)		
	Total	40 (20.8)	152 (79.2)	192 (100.0)		
Goats	Age (year)	-	-	-	0.655	0.302
	1>X	10 (5.2)	32 (16.6)	42 (21.9)		
	1-2	12 (6.2)	29 (15.2)	41 (21.4)		
	2-3	18 (9.4)	40 (20/9)	58 (30.2)		
	3-4	15 (7.8)	36 (18.7)	51 (26.6)		
	Total	55 (28.6)	137 (71.4)	192 (100.0)		
	Gender	-	-	-		
	Male	27 (14.1)	61 (31.8)	88 (45.8)	0.329	0.632
	Female	28 (14.6)	76 (39.6)	104 (54.2)		
	Total	55 (28.6)	137 (71.4)	192 (100.0)		
	Infestation	-	-	-		
Total	Sheep	40 (10.4)	152 (39.6)	192 (50.0)	3.147	0.076
	Goat	55 (14.3)	137 (35.7)	192 (50.0)		
	Gender	-	-	-		
	Male	46 (12.0)	123 (32.1)	169 (44.1)	0.997	0.318
	Female	49 (12.7)	166 (43.2)	215 (55.9)		

Table 2: Analysis of tick infestation patterns across months in sheep and goats

Month	Positive (Percentage)	Negative (Percentage)	Total	Pearson Chi-Square	P-Value
April	7 (1.8)	64 (16.7)	71 (18.5)	22.090	0.001
May	14 (3.7)	60 (15.6)	74 (19.3)		
June	12 (3.1)	52 (13.6)	64 (16.7)		
July	21 (5.5)	34 (8.9)	55 (14.4)		
August	24 (6.2)	46 (12.0)	70 (18.2)		
September	17 (4.4)	33 (8.6)	50 (13.0)		
Total	95 (24.7)	289 (75.3)	384 (100.0)		

Table 3: Frequency of detected ticks classified by species (sheep and goats)

Tick Species	Sheep		Goats		Total (Percentage)
	Frequency	Percentage	Frequency	Percentage	
Dermacentor marginatus	15	3.00	26	5.21	41 (8.21)
Haemaphysalis concinna	29	5.81	38	7.61	67 (13.42)
Hyalomma anatolicum	30	6.01	39	7.81	69 (13.82)
Hyalomma asiaticum	30	6.01	43	8.61	73 (14.62)
Ixodes ricinus	17	3.40	25	5.01	42 (8.41)
Rhipicephalus annulatus	34	6.81	44	8.81	78 (15.63)
Rhipicephalus bursa	27	5.41	41	8.21	68 (13.62)
Rhipicephalus sanguineus	25	5.01	36	7.21	61 (12.22)
Total	207	41.48	292	58.52	499 (100.00)

Discussion

Currently, animal husbandry plays an important role in providing meat and dairy products, especially in rural regions of various countries. Nonetheless, a primary obstacle to the advancement of animal husbandry lies in addressing health and environmental concerns. the presence of hard ticks among sheep and goats poses a formidable challenge, threatening their well-being and productivity. Conditions such as temperature and humidity can influence the growth and distribution of ticks. Additionally, herd management and hygiene can also play a significant role in controlling and preventing tick infestations, including the use of acaricides and implementing animal health programs. These factors can contribute to the improvement or reduction of tick prevalence so studies on the prevalence of infestation by hard ticks in farm animals have been conducted extensively. For instance, Yakhchali and Hosseini (2006) conducted a study in West Azerbaijan to assess the infestation rate of hard ticks in a population of goats, sampling 849 goats and reporting an infestation rate of 9.9% [11]. In another study, Rahbari et al. (2007) investigated the infestation rate of hard ticks in Iran among a population of 3200 goats, reporting a rate of 57% [15]. Similarly, Telmadarraiy et al. (2010) conducted a study in Yazd province, sampling 583 goats and reporting an infestation rate of 10.8% [16]. Rezaei et al. (2011) conducted a study in the East Azerbaijan province, sampling 1668 goats and reporting an infestation rate of 18.9% [17]. Additionally, Yakhchali et al. (2011) conducted a study in Khuzestan and Mazandaran provinces, sampling 5706 goats and reporting an infestation rate of 29.5% [13]. Furthermore, Fakoorziba et al. (2012) conducted a study in Kurdistan province, sampling 790 goats and reporting an infestation rate of 55% [18]. Finally, Haghi et al. (2013) conducted a study in Mazandaran province, sampling 1068 goats and reporting an infestation rate of 35.8% [19]. In a study conducted by Sohrabi et al, in 2013 to examine the infestation rate of hard ticks in Kermanshah province among a population of goats, 1031 goats were sampled, reporting an infestation rate of 25.3% [20]. In another study, Ganjali et al. (2014) investigated the infestation rate of hard ticks in Sistan and Baluchestan province in 2014 among a population of goats, sampling 469 goats and reporting an infestation rate of 38.6% [21]. Jafarbekloo et al. (2014) conducted a study in 2014 to assess the infestation rate of hard ticks in South Khorasan and Sistan and Baluchestan provinces among a population of goats, sampling 446 goats and reporting an infestation rate of 17% [22]. Additionally, Riabi and Atarodi (2014) conducted a study in 2014 to examine the infestation rate of hard ticks in Razavi Khorasan province among a population of goats, sampling 612 goats and reporting an infestation rate of 6.4% [23]. Sofizadeh et al. (2014) conducted a study in 2014 to investigate the infestation rate of

hard ticks in Golestan province among a population of goats, sampling 386 goats and reporting an infestation rate of 77.3% [24]. Furthermore, Sarani et al. (2014) conducted a study in 2014 to examine the infestation rate of hard ticks in Golestan province among a population of goats, sampling 498 goats and reporting an infestation rate of 44.7% [25]. Finally, in a study conducted by Loui Monfared et al. (2015) in 2014 to assess the infestation rate of hard ticks in Ilam province among a population of goats, 1316 goats were sampled, reporting an infestation rate of 49.6% [25].

In a study conducted by Rahbari et al. (2007), to examine the prevalence of infestation by hard ticks in the sheep population of Iran, an infestation rate of 55% was reported [15]. Nasibeh et al. (2010) reported an infestation rate of 28.3% in Mazandaran province [26]. Nasiri et al. (2010) reported an infestation rate of 11.4% in the sheep population of Ilam County [27]. Rasouli et al. (2010) reported an infestation rate of 22.2% in the sheep population of West Azerbaijan province [28]. Tahmasebi et al. (2010) reported an infestation rate of 24.9% in Hamadan county in 2010. The results of the present study also indicate an infestation rate of 24.7%, which is consistent with previous studies [15, 26, 28, 29]. The statistics regarding infestation prevalence reported in different regions vary and are influenced by management, hygiene factors, and seasonal variations. These data indicate that the occurrence of hard tick infestations varies, with reported rates ranging from 1.9% in Kerman [30] to 85% in Kermanshah province [31]. It is noteworthy that there has been an increase in the prevalence of infestation over the years, indicating that preventive strategies have largely failed. For example, while a prevalence rate of 11.4% was reported in Ilam province in 2010, Monfared et al, reported a prevalence rate of 23.5% in the same province in 2015 [32], and in 2019, Ghashghaei et al. reported a prevalence rate of 51.2% [33]. This trend is also evident in other provinces; for instance, in Kurdistan province, Fakoorziba et al. (2012) reported a prevalence rate of 39.4% [18], Banafshi et al. (2018) reported a rate of 55.4% [34], and, Rahravani et al. reported a prevalence rate of 93.9% [35].

In the present study, no statistically significant correlation was observed between the prevalence of infection and the species of animals under investigation, which is consistent with previous studies [26, 35]. Additionally, the prevalence of infection did not show a significant correlation with the age of the animals, and it may occur at any age, consistent with previous studies [33, 35].

The findings of this study reveal a notable disparity in infection rates across different months, peaking notably in August. This surge can be attributed to the optimal temperature and humidity levels that foster tick proliferation. This finding is consistent with the study by Davari et al. (2017) [36] and Rasouli et al. (2021) [3].

Conclusion

Infection with external parasites, especially ticks, poses one of the fundamental challenges in the livestock industry, accompanied by significant economic losses. Studies have shown that despite efforts to control and prevent ticks through increased access to veterinarians and veterinary pharmacies, the prevalence of tick infestation continues to rise. This trend may be attributed to the increased resistance of parasites, failure to adopt preventive strategies, and even incomplete implementation of these strategies. Clinically, Iran faces endemicity of many diseases transmitted by ticks, a situation not exempting West Azerbaijan province. Urgent measures are therefore necessary to control these parasites and subsequently manage the diseases transmitted by them in this geographical region.

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Not applicable

Conflict of interest

There is no conflict of interest.

Ethical approval

All ethical considerations were followed based on the Islamic Azad University ethical committee.

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