A survey of tick infestation of animals before Eid-al-Adha as suspected cases of Crimean-Congo Hemorrhagic Fever (CCHF) in Kabul city’s streets and live animal markets

A Samadi\textsuperscript{a}, M Amiri\textsuperscript{b}, A J Abi\textsuperscript{a}, H Hakim\textsuperscript{a}, MN Alizada\textsuperscript{a}, M Sangary\textsuperscript{a}, SS Rahpaya\textsuperscript{a}

\textsuperscript{a}Department of Paraclinic, Faculty of Veterinary Science, Kabul University, Jamal Mina, Kabul, Afghanistan

\textsuperscript{b}Global Health Development | The Eastern Mediterranean Public Health Network (GHD|EMPHNET), Amman, Jordan
assad.samadi@gmail.com

Received: 7/4/2021 Revised: 10/5/2020 Accepted: 31/5/2021

DOI: https://doi.org/10.31559/VMPH2021.2.2.5

This file is licensed under a Creative Commons Attribution 4.0 International
A survey of tick infestation of animals before Eid-al-Adha as suspected cases of Crimean-Congo Hemorrhagic Fever (CCHF) in Kabul city’s streets and live animal markets

A Samadi*, M Amirib, AJ Abic, H Hakimc, MN Alizadaa, M Sangarya, SS Rahpayaa

a Department of Paraclinic, Faculty of Veterinary Science, Kabul University, Jamal Mina, Kabul, Afghanistan
b Global Health Development | The Eastern Mediterranean Public Health Network (GHD|EMPHNET), Amman, Jordan

* Corresponding author: Assadullah Samadi. Email: assad.samadi@gmail.com

How to cite this article: Samadi, A. et al., A survey of tick infestation of animals before Eid-al-Adha as suspected cases of Crimean-Congo Hemorrhagic Fever (CCHF) in Kabul city's streets and live animal markets. Veterinary Medicine and Public Health Journal 2(2); 2021: 57-63.

DOI: https://doi.org/10.31559/vmph2021.2.2.5 Received Date: 7/4/2021 Revised Date: 10/5/2021 Accepted Date: 31/5/2021

Abstract

Ticks are considered the crucial vectors of many infectious agents and considered the main vectors and reservoirs of Crimean-Congo Hemorrhagic Fever (CCHF) virus which is endemic in Afghanistan. The main objective of this study was to determine the prevalence of tick infestation in animals brought to Kabul city streets and live animal markets before Eid-al-Adha days as suspected cases of CCHF. Totally, 4,200 animals were examined in a four-day survey to estimate the prevalence of infested animals and related risk factors in Kabul city streets and live animal markets before Eid-al-Adha days in August 2019. The animals originated from 85.3% of provinces (29/34) and consisted of sheep (66.5%), goats (14.8%), cattle (14.9%), buffalos (1.9%) and camels (0.008%). The overall prevalence of the tick infestation was 25.2% and the mean number of ticks per animal was 2.6. The prevalence was 18.2% in animals <1 year old, 23.4% in animals 1-2 years old and 33.5% in animals > 2 years old (p<0.05), but it was 27.1% in female and 25.1% in male respectively (p>0.05). From the total 2,101 ectoparasites collected, Hyalomma was the dominant genus (40.7%), followed by Rhipicephalus (6.1%), Amblyomma (5.4%), Dermacentor (1.3%), Boophilus (1.0%), Ixodes (0.05%) and Argas (0.1%). The overall awareness about CCHF among sellers/farmers was low, and only 5% just had heard about the disease. It has been concluded that tick infestation is very prevalent in animals brought to Kabul city before Eid-al-Adha days and low awareness about zoonotic diseases including CCHF among society greatly threaten the health of people.

Keywords: Tick infestation; Eid-al-Adha; CCHF; Kabul city.
1. Introduction

Ectoparasites that derive their nutrition through blood feeding (hematophagous) are efficient vectors of livestock and human pathogens (Walker et al., 2003). Among them, ticks that are obligatory hematophagous, of reptiles, birds, livestock, companion and wild animal species and humans are considered one of the most important vectors of infectious agents including viruses, bacteria, and protozoa (Getiso and Geinoro, 2019; Greay et al., 2016; Grøva, 2011). Ticks belong to the phylum of Arthropoda, class of Arachnida, order of Acari, sub-order of Ixodida, families of Ixodidae and Argasidae (Getiso and Geinoro, 2019; Walker et al., 2003). From the 900 known species of the ticks (Chen et al., 2014), approximately 10% of them are recognized as significant medical or veterinary importance, transmitting various types of pathogens to animals and humans (Smith et al., 2011) and tick-borne diseases are currently of a great concern for animal and human health (Grøva, 2011).

It has been estimated that more than 80% of the world domestic animals are infested with ticks (Alexander et al., 2020; Getiso and Geinoro, 2019), and annually tick infestation can cause up to 18.7 billion USD loss to cattle industries (Abebe et al., 2010). Tick infestation reduces the productivity of livestock in a number of ways, such as: direct effect of attachment and feeding “tick worry”; injection of toxins; damage of the skin due to their bites; reduction in weight gaining; reduction in milk production and milk quality; reduction in meat product and morbidity and mortality associated with the diseases they transmit (Alexander et al., 2020; Solomon and Tanga, 2020).

Lots of studies have been conducted on ticks and tick-borne diseases, along with their negative impacts on the productivity of livestock around the world, including the neighboring countries of Afghanistan such as Iran and Pakistan, (Sofizadeh et al. 2014; Alam et al., 2013; Barker & Walker, 2014; Karim et al., 2017; Nijhof et al., 2007; Rehman et al., 2017; Salim Abadi et al., 2010; Tavassoli, 2013; Walker et al., 2003). However, to the best of our knowledge, only few studies have been conducted on Afghanistan’s ticks and tick-borne diseases (Amiri et al., 2021, Samadi et al., 2021; Samadi et al., 2020; Mustafa et al., 2011; Bulman et al., 1979). A four-day survey (from August 6 to 9, 2019) was conducted at the live animal markets, Kabul city; in order to find-out the prevalence of tick infestation in animals, present at the live animal market and streets. Since majority (71%) of the total population of Afghanistan (about 30 million), live in rural areas (CSO, 2018) and raise animals mainly ruminants as the main source of income (Samadi et al., 2019), the livelihood and socio-economic stability of the farmers rely on ruminants (Chakraborty et al., 2014). About 26.63 million ruminants are present in Afghanistan which are reared for milk, meat and wool production and considered as ready cash for the farmers (Samadi et al., 2019; Samadi et al., 2020). For such purpose, thousands of sheep, goats and cattle, and few numbers of camels that might be infested by ticks or infected by infectious agents are brought to Kabul city markets especially before Eid-al-Adha (an Islamic festival). Traditionally, the animals are slaughtered by the family members themselves in their houses or nearby streets and most of the family members participate in the slaughter and carcass cutting process and meat distribution to poor families and relatives. These activities could pose high risk of zoonotic infection especially CCHF and rift valley fever (RVF) for all of those participating in such activities. It is worth to be mentioned that CCHF is endemic in Afghanistan, and on average, about 50 cases have occurred annually in Afghanistan in recent outbreaks of the disease, which were accompanied with high mortality, were probably the result of exposure with infected ticks or infected animal’s blood and tissues especially during Eid-al-Adha feast (WHO, 2018; Samadi et al., 2020).

2. Materials and Methods

Study area:

The study area was Kabul city streets and live animal markets. Most of the famous livestock markets are located in Kabul, and people from Kabul and other neighboring provinces sell and buy their animals in these markets. Based on the normal custom of people in Afghanistan, many people (farmers, sellers) bring their animals on the streets and live animal markets of Kabul city before Eid-al-Adha days. They select/occupy a specific location on the streets/local markets, and they stay there up to the third day of Eid. People buy the animals for Eid festival and sacrifice the animals during Eid days in their houses or streets.

Sample size and sampling methodology:

For the survey purpose, systematic random sampling design was applied for sample selection. Since there was no any information available about the number of animals on the streets and live markets during Eid days in Kabul city to be considered for random sample selection of animals, the team leader estimated the total number of animals on the street and live markets every day. Since every team was intended to examine about 100 animals every day, the total estimated number was divided by 100 to get the interval of sampling unit for that day.

Data collection methods:

This survey was conducted by 7 professors/lecturers, 4 technicians and 129 students of the Veterinary Science Faculty of Kabul University...
Tick collection and identification:
The presence of ticks on the sampled animal were identified visually by naked eyes. After confirmation of tick presence on the animals, ticks were removed by forceps, kept in 70% ethanol and were transferred to Parasitology lab of VSFKU for further identification. Identification of ticks was carried-out to the genus level following the standard identification procedures described by Barker et al. (2003) and Barker and Walker (2014) using specific illustrated morphological taxonomic keys present in both; dorsal and ventral views, under stereomicroscope (SZ760-DM320, NANBEI, China).

Statistical analysis:
All necessary data were collected using EpiInfo which were installed in smart phones. The collected data were then transferred to computers using Microsoft excel, for data management, cleaning and validation and final statistical analysis was performed using SPSS software (IBM, version 20).

3. Results
Animal sources and their demography:
The animals on the streets and live animal markets in Kabul city before Eid-al-Adha were originated from 85.3% of provinces (29/34) and more than 150 districts of Afghanistan that were brought by 809 farmers/sellers. Meanwhile, three sellers brought the animals from Pakistan. From the total number of animals present on the street and live animal markets before Eid day (23,687), 66.5% of them were sheep, 14.8% goats, 14.9% cattle, 1.9% buffalos and 0.008% were camels. The median number of animals per seller/farmers was 63.

The number of sellers/farmers and the total number of animals in the streets and live animal's markets of Kabul city before Eid-al-Adha dramatically increased from the days before Eid when the time closes to the Eid days. The number of farmers/sellers increased from the first day of survey to the 4th day of survey 50%, 80.2% and 308.3% respectively. Meanwhile, the number of animals also increased from the first day of survey to the 4th day of survey 61.7%, 57.5% and 266.5% respectively. The mean age of the animals was 22.8 ± 7.4 months, but based on the age categories, 3.6% of surveyed animals were less than one-year-old, 78.7% were 1-2 years old and 17.7% were more than 2 years old.

Prevalence of tick infestation of animals:
The overall prevalence of the tick infestation in surveyed animals was 25.2% and the mean number of ticks per animal was 2.6 (range = 1-6). Based on the age categories, the prevalence was 18.2% in animals less than one years old, 23.4% in 1-2 years old and 33.5% in animals more than 2 years old (p<0.05). Based on the species, the prevalence of tick infestation was 23.9% in sheep, 26.4% in goats and 33.1% in cattle. In addition, 27.1% of female and 25.1% of male were infested by ticks (p>0.05) (Table 1).

Tick infestation varied based on location body surface of infested animals. Abdominal region (29.8%), under the tail (29.5%) and in the ear (25.7%) were the most infested sites of animals respectively, but location of ticks in infested animals also varied based on the species, age and sex of the animals (data not shown).
Microscopic identification of ticks:

Totally 1,108 tubes/samples were collected during the four days of survey. From the total of 1,108 collected tubes/samples, 1,767 (84.1%) ticks, 328 (15.6%) melophagus, 5 (0.24%) louse and 1 flea (0.047%) were recognized morphologically under stereomicroscope. Furthermore, from the total of 1,767 identified ticks; 855 (48.4%) were Hyalomma, 129 (7.3%) were Rhipicephalus, 114 (6.45%) were Amblyomma, 28 (1.58%) were Dermacentor, 21 (1.19%) were Boophilus, 1 (0.05%) was Ixodes, and 2 (0.11%) were Argas But 617 (34.9%) ticks were not possible to identify due to lysis, dryness, head removal and blood feeding (488, 27.61%); and immaturityness (129; 7.3%). To consider just the identified hard tick genera, the percentage distribution of Hyalomma, Rhipicephalus, Amblyomma, Dermacentor, Boophilus and Ixodes was 74.54, 11.3, 9.8, 2.45, 1.83 and 0.08 respectively. In addition, although the sex distribution varied based on the identified genera, large proportion of identified ticks were male (72.8%) compared to female (27.2%) and male to female ratio was 2.68:1.

Seller/farmers’ perception and knowledge about ticks and CCHF:

Public awareness about zoonotic diseases is very important in prevention and control measures implementation in the country. From the total of sellers/farmers asked about CCHF, only 5% had heard about the disease. Meanwhile, sellers/farmers’ knowledge and awareness about transmission methods of CCHF to humans and the role of ticks in its transmission was 2.2% and 6.0% respectively, which are considered very low. Although just 2.5% of respondent stated that they had cases of CCHF in their family members, low awareness about the disease may underestimate the real situation in society. Due to the low awareness about the role of ticks in maintenance and transmission of many zoonotic diseases including CCHF to humans, more than one third of the farmers were removing the ticks from infested animals by their hands, which can expose them to CCHFV and other zoonotic diseases’ agents.

4. Discussion

This was the first comprehensive survey of tick infestation on domestic animals in Afghanistan, where the surveyed animals in Kabul city’s streets and live animal markets were originated from 85.3% of provinces of Afghanistan. Ticks are considered the crucial vectors of many infectious agents than any other arthropods which transmit many protozoan, bacterial and viral diseases to humans and animals (Ali et al., 2020; Khalil et al., 2018; Karim et al., 2017). In domestic animals, they cause irritation of skins, blood loss and anemia, reduction of weight gain, dysfunction of immune system and, as a consequence, decrease significantly the production of wool, hide, meat and milk and severely affect the quality of skin (Khalil et al., 2018; Karim et al., 2017). Carpet, hide and animal skin are considered the key export items of Afghanistan (Samadi et al., 2019), where ticks and tick-borne pathogens shortfall approximately 3 billion pieces of skin in cattle alone annually worldwide (Karim et al., 2017). In addition, ticks are the main reservoirs and vectors of many endemic infectious diseases of human and animal species in Afghanistan which cause severe socio-economic and public health loses continuously (Wallace et al., 2002; Mobini et al., 2008; Pages et al., 2010; Samadi et al., 2020; Samadi et al., 2021). The large movement of animals to Kabul city is accompanied by outbreaks of arthropod borne diseases such CCHF in Kabul, which could be attributed to tick bites or exposure to infected animal’s blood and tissues especially during Eid-al-Adha feast (Hatami et al., 2019, WHO, 2018). In addition, the peak of CCHF cases occurred between July and August, which coincides with the occurrence of Eid-al-Adha in recent years (2016 – 2019) (Samadi et al., 2020).

| Variables          | Positive (%) | Negative | Total* | χ² value | p-value |
|--------------------|--------------|----------|--------|----------|---------|
| Sex                |              |          |        |          |         |
| Male               | 356 (25.05)  | 1065     | 1421   | 0.295    | 0.587   |
| Female             | 38 (27.14)   | 102      | 140    |          |         |
| Age categories     |              |          |        |          |         |
| <1 year            | 10 (18.18)   | 45       | 55     | 13.46    | 0.001   |
| 1-2 year           | 287 (23.42)  | 938      | 1225   |          |         |
| >2 year            | 92 (33.45)   | 183      | 275    |          |         |
| Animal species*    |              |          |        |          |         |
| Sheep              | 304 (23.93)  | 966      | 1270   | 6.62     | 0.037   |
| Goat               | 32 (26.44)   | 89       | 121    |          |         |
| Cattle             | 54 (33.12)   | 109      | 163    |          |         |

*The differences in the total number of animals are due to missing values
* Due to very low numbers, buffalos and camels were omitted
In our study, the prevalence of tick infestation in cattle, sheep and goats was 25.2% which is considered not very high in domestic animals compared to Iran (73.6%) the neighboring country of Afghanistan (Soﬁzadeh et al. 2014). We found higher number of female animals (27.14%) infested with the ticks than males (25.05%) which was not statistically significant (p>0.05) and the same result was found by Mohammed et al. (2017). In addition, in our study the tick infestation by species was statistically significant (p<0.05) and high prevalence was detected in cattle, goat and sheep respectively. Meanwhile, it was revealed that, the older the animals the higher the infestation by the ticks. Almost the same results were reported by Alexander et al. (2020) where they found the heavy infestation in cattle (44.8%), sheep (33.6%) and goat (21.6%) respectively. The heavy infestation in older age group could be due to the facts that all of cattle speciﬁed for Eid sacriﬁce have to be ≥2 years old and sheep and goats have to be ≥1 years old (although in rare cases, sheep and goats can be 6 months too).

We found Hyalomma, Rhipicephalus, Amblyomma, Dermacentor; Boophilus, Ixodes, Argas tick genera in surveyed animals, and Hyalomma was the most prevalent genus identiﬁed. Other researchers (Amiri et al., 2021; Mustafa et al., 2011) also conﬁrm the presence of Hyalomma spp. in animals in Afghanistan. Meanwhile, Soﬁzadeh et al. (2014) and Loui Monfared et al. (2015) also found Rhipicephalus, Ixodes, Hyalomma, Boophilus, Haemaphysalis and Argas in domestic ruminants (sheep, goats and cattle) in Iran, and Rhipicephalus, Haemaphysalis, Hyalomma and Argas were detected in Pakistan (Karim et al., 2017), the two neighboring countries of Afghanistan. In addition, Soﬁzadeh et al. (2014) found Rhipicephalus as the most abundant tick in the study area in Iran, while Loui Monfared et al. (2015) found Hyalomma as the prevalent tick in domestic ruminants in the same country.

Because most of hard ticks including those identiﬁed in our survey are two to three – host ticks (Taylor et al., 2016) and many tick-borne diseases including CCHF have been reported from Afghanistan (Bulman et al., 1979; Wallace et al., 2002; Mobini et al., 2008; Pages et al., 2010; Khattak et al., 2017; Samadi et al., 2020; Samadi et al., 2021, https://reliefweb.int/report/afghanistan/infectious-diseases-afghanistan-report-global-disaster-information-network-gdin), severe infestation of domestic animals by these ticks pose great threats to human and animals’ health in Afghanistan.

5. Conclusion

With the endemic nature of many arthropod borne diseases including CCHF, low awareness about such diseases and their ecology among general population, and large movement of infested/infected animals from all over the country to Kabul city threaten the human health more than any place in the country. Coordinated One Health approach is needed among human health, animal health and environmental professionals, municipalities, sellers/farmers and the entire society to tackle the increasing threats of zoonotic diseases in Kabul city and throughout the country. Such well-coordinated efforts must be planned well in advance before Eid-al-Adha feast and must heavily focus on the public awareness about CCHF, ticks and their infestation, how to deal with Eid-al-Adha animals, and other issues.

Study limitations:

Data collection using smart phones by EpilInfo was the first experience in our team. Although it was successful during the survey, we faced with big challenges during transfer of data from smart phones to computers. In addition, some mobile phones were stolen during data collection on the streets and we lost the mobile and collected data in the same time. Although we examined 4,200 animals in four days of survey, only one-third of data (1,568) could be obtained from the mobile phones. Security issues are a big concern in Afghanistan. Deploying 145 staff on Kabul city streets and live animal markets was a risky action during survey. In the last day of survey, two big bomb explosions happened in Kabul city, where one of our team (Dasht –e-Barchi) just left the survey site only few seconds before the explosion in 6 district of Kabul city on August 09, 2019.

Acknowledgments: This survey was supported by Global Health Development | The Eastern Mediterranean Public Health Network (GHD|EMPHNET), and conducted by VSFKU staffs. VSFKU and EMPHNET are thankful from the efﬁcient coordination and cooperation of the authorities of Kabul city municipality and security and their 16 districts during the survey time. Meanwhile, we acknowledge the MAIL for the donation of some PPE and active participation of their team during the survey.

Compliance with Ethical Standards: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: The authors declare that they have no conﬂict of interests.

References

1. Abebe R, Fantahun T, Ahera M, et al. (2010). Survey of ticks (Acari: Ixodidae) infesting cattle in two districts of Somali Regional State, Ethiopia. Veterinary World 3(12):539-543.

2. Alam MM, Khurshid A, Sharif S, et al. (2013). Genetic analysis and epidemiology of Crimean Congo
hemorrhagic fever viruses in Baluchistan province of Pakistan. *BMC Infectious Diseases*, 13(1):201, https://doi.org/10.1186/1471-2334-13-201.

3. Alexander JW, Taiwo AA, Micah SP, et al. (2020). A Survey of Ticks Infestation on Some Domestic Animals in Mubi, Adamawa State, Nigeria. *European Journal of Biology and Biotechnology*, 1(3): http://dx.doi.org/10.24018/ejbio.2020.1.3.25

4. Ali S, Ijaz M, Ghaffar A, et al. (2020). Species distribution and seasonal dynamics of equine tick infestation in two subtropical climate niches in Punjab, *Pakistan. Pak Vet J.*, 40(1):25-30.

5. Amiri MS, Yaghoofi S & Razmi G, (2021). Molecular detection of *Theileria annulata* in dairy cattle and vector ticks in the Herat area, Afghanistan. *Archives of Kazi Institute* 76(1) Article in press.

6. Barker SC & Walker AR, (2014). Ticks of Australia. The species that infest domestic animals and humans. *Zootaxa*, 3816(1), https://doi.org/10.11646/zootaxa.3816.1.1.

7. Bulman GM, Arzo GM, & Nassimi, MN, (1979). An outbreak of tropical theileriosis in cattle in Afghanistan. *Trop Anim Health Prod*, 11(1):17-20, http://dx.doi.org/10.1007/BF02237759.

8. Chakraborty S, Kumar A, Tiwari T, et al. (2014). Advances in Diagnosis of Respiratory Diseases of Small Ruminants. *Veterinary Medicine International*, (2014): 1-16, https://doi.org/10.11155/2014/508304.

9. Chen Z, Liu Q, Liu JQ, et al. (2014). Tick-borne pathogens and associated co-infections in ticks collected from domestic animals in central China. *Parasites & Vectors*, 7(1):237, https://doi.org/10.1186/s12936-015-0604-8.

10. CSO (2018). *Statistical years book of Afghanistan* (2017-2018). Retrieved from: http://csos.gov.af/en/page/1500/4722/13%

11. Getiso T & Geinoro T, (2019). Prevalence of Ixodidae Ticks of Cattle in Sodozaria districts of Wolaytta zone, Ethiopia. *Int J Adv Res Biol Sci*, 6(3): 240-248.

12. Greay LT, Oslam LC, Golton WA, et al. (2016). A survey of ticks (Acari: Ixodidae) of companion animals in Australia. *Parasites & Vectors*, 9:207, https://doi.org/10.1186/s13071-016-1480-y.

13. Grava L, (2011). *Tick-borne fever in sheep - production loss and preventive measures*, Philosophiae Doctor (PhD) Thesis, Dept. of aquaculture and animal science, Norwegian University of Life Sciences, Thesis number 2011: 32, ISSN 1503-1667, ISBN 978-82-575-0995-8.

14. Hatami H, Qaderi S, Omid AM (2019). Investigation of Crimean-Congo hemorrhagic fever in patients admitted in Antani Hospital, Kabul, Afghanistan, 2017-2018. *International Journal of Preventive Medicine* 10. 117. https://doi.org/10.4103/ijpvm.IJPM-391-18.

15. Karim S, Budachetri K, Mukherjee N. et al. (2017). A study of ticks and tick-borne livestock pathogens in Pakistan. *PLoS Negl Trop Dis*, 11(6):e0005681.

16. Khalil MI, Lashari, MH, Akhtar MS & Tasawar Z, (2018). Prevalence of Ticks Infesting Buffaloes in and Around Jampur District Ranjanpur, *Pakistan. Pusat J Biol*, 8(2):27-33.

17. Khattak B, Khan MJ, Khan TA, et al. (2017). Study the incidence of babesiosis in cattle of Afghan refugees in Mohmand agency, Pakistan. *Journal of Entomology and Zoology Studies*, 5(3):1422-1424.

18. Loui-Monfared A, Mahmoodi M & Fattahi R, (2015). Prevalence of ixodid ticks on cattle, sheep and goats in Ilam County, Ilam Province, Iran. *J Parasit Dis*, 39(1): 37-40, https://doi.org/10.1016/j.jpisd.2015.06.018.

19. Mobini S, Brown C, Ami, DM, et al. (2008). *Illustrated manual of infectious diseases of livestock in Afghanistan*. Fort Valley State University, Boca Publishing Group, Inc., ISBN: 978-0-9659583-3-2.

20. Mohammed M, Demisse T & Wagari A, (2017). Study on Prevalence of Major Ixodid Ticks of Cattle, in Selected Sites of Harari Region, Eastern Ethiopia. *Ecology and Evolutionary Biology*, 2(6): 96-100, https://doi.org/10.11646/ejeb.2017.206.11.

21. Mustafa ML, Ayazi E, Mohareb E, et al. (2011). Crimean-Congo Hemorrhagic Fever, Afghanistan, 2009. *Emerging Infectious Diseases*, 17(10):1940 – 1941.

22. Nijhof AM, Bodan C, Postig M, et al. (2007). Ticks and Associated Pathogens Collected from Domestic Animals in the Netherlands. *Vector-Borne Zoonotic Dis*, 7(4):585-596, https://doi.org/10.1089/vbz.2007.0130.

23. Pages F, Faulde M, Orlandi-Pradines E & Parola P, (2010). The past and present threat of vector-borne diseases in deployed troops. *Clin Microbiol Infect*, 16(3): 209–224, https://doi.org/10.1111/j.1469-0691.2009.03132.x.

24. Rehman A, Nijhof AM, Sauter-Louis C, et al. (2017). 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. *Parasites and Vectors* 10(1):190, https://doi.org/10.1186/s13071-017-2138-0.

25. Salim-Abadi Y, Telmadarraiy Z, Vatandoost H, et al. (2010). Hard Ticks on Domestic Ruminants and their Seasonal Population Dynamics in Yazd Province, Iran. *Iran J Arthropod Borne Dis*, 4(1):66-71.

26. Samadi A, Ababneh MA and Amiri M, (2020). Crimean Congo Hemorrhagic fever and its history in Afghanistan. *CAB Reviews* 15(023), doi: 10.1079/PASNRR202015023

27. Samadi A, Esmati AB, Ababneh MMK, et al. (2021). Descriptive epidemiology of Crimean – Congo hemorrhagic fever cases admitted to Kabul main hospitals during 2015 to 2018. *Veterinary Medicine and Public Health Journal*, 2(1):1-7, https://doi.org/10.31559/vmhp2021.2.1.1.

28. Samadi A, Najib N, Ah, A et al. (2019). Prevalence and Pathological features of ovine lungworm infection in slaughtered animals in Nangarhar province of Afghanistan. *Comparative Clinical
29. Smith FD, Ballantyne R, Morgan ER & Wall R, (2011). Prevalence, distribution and risk associated with tick infestation of dogs in Great Britain. *Medical and Veterinary Entomology*, 25(4):377–384, https://doi.org/10.1111/j.1365-2915.2011.00954.x.

30. Sofizadeh A, Tehmadarraiy Z, Rahnama A, et al. (2014). Hard Tick Species of Livestock and their Bioecology in Golestan Province, North of Iran. *J Arthropod Borne Dis*, 8(1): 108–116.

31. Solomon A & Tanga BM, (2020). The First Investigation of Tick Vectors and Tick-Borne Diseases in Extensively Managed Cattle in Alle District, Southwestern Ethiopia, Hindawi, *Veterinary Medicine International*, Volume Article ID 8862299, 8 pages, https://doi.org/10.1155/2020/8862299.

32. Tavassoli M, Tabatabaei M, Mohammadi M, et al. (2013). PCR-based detection of Babesia spp. infection in collected ticks from cattle in West and North-West of Iran. *J Arthropod Borne Dis*, 7(2): 132–138.

33. Taylor MA, Coop RL and Wall RL, (2016). *Veterinary Parasitology*, fourth edition, WILEY Blackwell, New Delhi, India.

34. Walker AA, Bouatour A, Camicas JL, et al. (2003). Ticks of domestic animals in Africa: A guide to identification species, University of Edinburgh, Pp. 67-80.

35. Wallace RM, Hale RB, Utz, CG, et al. (2002). Endemic Infectious Diseases of Afghanistan. *Clinical Infectious Diseases*, 34(Suppl 5): 171–207, https://doi.org/10.1086/340704.

36. WHO (2018). *Upsurge of CCHF cases in Afghanistan*. Weekly Epidemiological Monitor 11 (26).