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Research

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Sero-epidemiological study of brucellosis in goats from Wadi Al Shati District in the Sahara region of Libya

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Abstract

Introduction: *Brucellosis is a worldwide infectious disease that primarily affects livestock, resulting in considerable illness and economic losses, especially in undeveloped areas. A cross-sectional epidemiological study examined the prevalence of Brucella infection in goats sourced from farm 6 towns within the Wadi Al Shati District in the Southern region of Libya.* ***Methods:*** *serum samples were analyzed using the Rose Bengal Plate Test (RBPT) and indirect Enzyme Linked Immunosorbent assay (iELISA). Further data analysis was conducted using the SPSS statistical software, with the Chi-square test employed to explore the associations between seropositivity and location, animal age (≤3 years vs. >3 years), grazing area (residential vs. farm), and farm size (≤5 acres vs. >5 acres).* ***Results:*** *a total of 472 samples were gathered from 26 different locations. The overall prevalence of Brucellosis was found to be 14.8% (70/472) with the highest rate detected in the town of Ashkadh at 84.28% (involving 59 samples across 14 farms), followed by Brak at 10% (seven samples from one farm) and Zalouaz at 5.7% (four samples from two farms). Further statistical analysis showed that there were no significant differences observed based on the variables used.* ***Conclusion:*** *this current research provides important epidemiological data on the incidence of Brucella infection within this significant Sahara region in Libya. Implementing a comprehensive prevention control strategy based on the "One Health" concept necessitates regional and international cooperation.*

Introduction

Brucellosis is primarily a zoonotic disease affects livestock worldwide resulting in substantial morbidity and economic losses, especially in the underdeveloped regions [1]. *Brucella* comprises a variety of species and biovars that displays a strong affinity for specific hosts [2]. The species *B. Melitensis*, *B. abortus*, *B. ovis* and *B. suis* are the most significant in causing zoonotic infections and substantial economic losses in livestock production especially in the underdeveloped regions [3].

Brucellosis is a major endemic disease affecting small ruminants in Africa [4]. In this region, research on Brucellosis in small ruminants is inadequate, yet data suggest a prevalence rate spanning between 0.1% to 7.5% [5-7]. The endemicity of Brucellosis in this region is mainly caused by *B. melitensis* affecting small ruminants followed by *B. abortus* originated from natural and non-specific hosts with variable incidences and epidemiological distribution [8-13]. In Eastern Africa, the prevalence of Brucellosis in small ruminants, among goats was found to range from 0% to 20.0% [14]. In the sub-Saharan region, approximately 16% of all livestock are believed to be infected with Brucellosis primarily caused by *B. abortus*, *B. melitensis* and *B. suis* with genetic lineages similar to those reported in the Mediterranean [3,9]. Research on brucellosis in the Saharan and sub-Saharan regions is remarkably limited, especially given the significant livestock and agricultural production in these areas.

A study conducted in Libya's western mountain region between 2006 and 2008 found brucellosis prevalence rates of 31% in goats, 42% in cattle and 40% in humans [15]. A further study, which aimed to determine the seroprevalence of human brucellosis in Libya's northwestern region, found an overall incidence of 0.2-22 cases per 100 000 inhabitants [16]. Backdated data offers valuable insights into the occurrences and geographical

spread of Brucellosis in livestock, necessitating updated information with regional and global significance. A recent study on the prevalence of brucellosis antibodies in the blood of sheep and goats in Libya's Al Jufrah district, which lies next to the Sahara region, reported that 2.7% of the examined small ruminants tested positive for brucellosis via the ELISA test from different locations [17]. This cross-sectional study was conducted to determine the seroprevalence of *Brucella* infection in goats and the correlation between particular factors and brucellosis in goats between July 2020 and October 2021 in Wadi Al Shati District of Libya's Sahara region.

Methods

Study design

A cross-sectional study was conducted to determine the seroprevalence of *Brucella* infection in goats and explore associations between seropositivity and the following variables: 1) geographic location (Ashkadh, Zalouaz, Brak, Hai Howede, Alafyaa, and Mahrouqa); 2) animal age (≤3 years vs. >3 years); 3) grazing area (residential vs. farm); 4) farm size (≤5 acres vs. >5 acres). The sample size was determined using an estimated expected prevalence of 15% (based on prior studies in similar regions), a 95% confidence level, and a desired precision of ±5%. P is the expected prevalence (0.15), and d is the margin of error (0.05). Sampling was performed using a stratified convenience sampling approach, where farms were selected from six towns within Wadi Al Shati District based on accessibility and livestock density. Within each farm, all apparently healthy goats meeting the inclusion criteria were sampled.

Study location

Wadi Al-Shati is situated in the central and Saharan part of Libya, bordering Nalut and Jabal Al Gharbi to the north, Jufra to the east, Ghat to the west, and Sebha, Wadi Al Hayaa and Ghat to the south. The district falls within the geo-historical region of Fezzen which is predominantly desert terrain covering 97,160 square kilometers, home to a population of approximately 166 thousand people, comprising roughly 76 thousand males and 90 thousand females. The region encompasses numerous cities and towns, with six towns chosen for this study due to their high population density and significant role in animal husbandry, specifically Ashkadh, Zalouaz, Brak, Hai Howede, Alafyaa and Mahrouqa. In this region, towns primarily rely on small ruminants, with goats being the main source, whereas camels and cows are the least common. Husbandry and breeding mainly centre around goats, whereas sheep, cattle and camels are the least prevalent (personal communications with local agriculture authorities).

Inclusion animals

The study involved all apparently healthy animals from the visited farms, assuming these farms had no signs of disease or illness other than a fever that had not occurred in them for at least six months prior to the study's start. Animals were selected based on availability and willingness of farm owners to participate in the study. To minimize selection bias, all goats within the age range of 1-4 years were included if they met the health criteria (e.g., absence of visible clinical signs such as abortion or diarrhea). Confidentiality assurances were provided to the owners and consent was obtained from them before the sampling process began.

Selected variables and data collection processes

A semi-structured questionnaire was administered to farm owners to collect data on geographic location (town of origin), animal age (recorded as ≤3 years or >3 years), grazing area (classified as residential areas or dedicated farm pastures) and farm size (measured in acres: ≤5 acres vs. >5 acres). Questions were pre-tested for clarity and conducted in Arabic by trained veterinarians.

Collection of blood samples

Five milliliters (5 ml) of fresh blood were collected via venipuncture from each animal and stored in an ethylenediaminetetraacetic acid (EDTA) tube in a cold icy sterile bag, positioned at an angle. The tube samples were then taken to the laboratory and subjected to centrifugal process at 5000 round per minute (RPM) for a 10-minute duration. The serum of each sample was pipetted into individual sterile tubes, which were labelled and kept at -20°C until additional testing could be conducted.

Serological testings

The initial step involved subjecting the sera samples to the Rose Bengal Plate Test (RBPT) for *Brucella* antibody detection, with the test performed according to the manufacturer's guidelines (ID.vet, Rose Bengal antigen for RSA test, ID vet 310, rue Louis Pasteur, Grabels, France). Serum samples were subsequently subjected to definitive diagnosis using the Indirect Enzyme Linked Immunosorbent assay (iELISA) to detect agglutination against the *Brucella* (IgG) antigen. The iELISA kit (BRUS-MS-5P model from ID vet France) was utilized to characterize multispecies antibodies directed against the smooth lipopolysaccharide (S-LPS) expressed by *Brucella*, encompassing *B. abortus*, *B. melitensis*, and *B. suis*. The test plates were read within 15 minutes using the ELISA reader at an optical density of 450 nanometers.

Data analysis

Prevalence at both individual and flock levels was calculated by calculating the proportion and percentage of seropositive samples using SPSS Statistics for Windows software, version 20 (SPSS-20, IBM Corp, Armonk, NY). Associations between seropositivity and predefined variables (location, age, grazing area, farm size) were assessed using the Chi-square test. Statistical significance was set at $p \leq 0.05$. Odds ratios (OR) with 95% confidence intervals (CI) were calculated to quantify the strength of associations.

Ethical approval

Ethical clearance was obtained from the Department of Medical Lab Technology Science, University of Wadi-Al-Shatii. Informed consent was obtained from all farm owners prior to sample collection.

Results

Demographic distribution of samples

A total of 472 samples were gathered from 26 different locations. The samples were allocated in the following proportions: 81.77% in Ashkadh (n= 386, 17 locations), 7.2% in Zalouaz (n= 34, 2 farms), 3.5% in Brak (n= 25, 2 farms), 2.11% in Hai Howede (n= 10, 1 farm), 1.9% in Alafyaa (n= 9, 2 farms) and 1.69% in Mahrouqa (n= 8, 1 farm). The individuals' ages span from 2 to 4 years, with a mean age of 3 years. The size of farms varied between 7 to 12 hectares, with the majority of farms exceeding 5 acres, accounting for 85.4% of the sample (n= 403), while those with 5 acres or less represented 14.6% (n= 69) as shown in Table 1.

Seroprevalence of Brucellosis

A total of 14.8% of samples, specifically 70 out of 472, from 17 farms tested positive for iELISA from 3 locations. The majority of seropositivity in the total frequency was found in Ashkadh, accounting for 84.28% of the total (based on 59 samples from 14 farms), with Brak and Zalouaz recording 10% (7 samples from 1 farm) and 5.7% (4 samples from 2 farms) respectively. The age group over three years showed the highest seropositivity rate of 54.3% (n= 38), with the age group of 1-3 years being second at 45.7% (n= 32). Furthermore, 85.71% (n= 60) of seropositive samples were sourced from farms, whereas 14.28% (n= 10) were from residential areas. According to the data, 84.28% of the seropositive samples (n= 59) came from farms larger than 5 acres, whereas 15.71% (11 samples total) originated from farms with an area of 5 acres or less (Table 1). Further

examination showed no notable disparities or correlation between the examined factors and the presence of antibodies (Table 2).

Discussion

The study's overall estimated prevalence, based on only three positive locations was 14.8%. Ashkadh had the greatest seropositivity rate, accounting for 84% of the total seropositive samples, followed by Brak at 10% and Zalouaz at 5.7%. Furthermore, no risk variables were that could affect the animals' brucellosis seropositivity were identified.

However, only 2.7% of the animals in a recent study on the seroprevalence of Brucellosis in sheep and goats from different sites were ELISA positive from the Al Jufrah District in Libya's Sahara region [17]. Only geographical location was found to be a significant risk factor for seropositive Brucellosis in this most recent investigation; no other important factors, such as the age groups under study, animal type, gender, or farm size, were found to be significant [17]. The Wadi Al Shati District's considerable animal output, together with other geographical and environmental factors, may be the cause of this diversity.

Further analysis explored the influence of specific variables on seropositivity. Goats older than 3 years demonstrated higher seropositivity compared to younger goats aged 1-3 years. Grazing location also appeared to play a role, as goats grazing on farms showed higher seropositivity than those in residential areas. Additionally, farm size was associated with seropositivity, with larger farms (>5 acres) exhibiting higher rates compared to smaller farms (≤5 acres).

To address the second objective of examining associations between specific characteristics and Brucellosis prevalence, statistical analysis using the Chi-square test revealed no significant associations between seropositivity and the variables analyzed (geographic location, age, grazing area, and farm size). While trends were observed -such as higher seropositivity in older goats, goats grazing on farms, and larger farms- these factors did not reach statistical significance. These findings suggest that other underlying factors, such as environmental conditions, livestock management practices, or genetic predisposition, may contribute to the epidemiology of brucellosis in this region. Further research incorporating advanced statistical models and broader sampling strategies is warranted to identify additional risk factors and inform targeted interventions.

The study of Brucellosis prevalence was lower than that of prior reports from Libya's North-west, which may have been caused by the district's unique position and environmental characteristics in the country's centre, which borders the Sahara and desert. These have a significant role in the introduction and spread of infectious diseases since they are the primary method by which animals intended for human food enter the local markets. The insecurity of the region and the possibility of illegal animal trade also make it difficult to completely monitor the movement of exported animals from adjacent sub-Saharan African nations, which typically cross or collect in this area on their way to other parts of Libya [17].

In North Africa, *Brucella* species of animal origins were reported revealing extinct evolved genetic properties attributed to the continuous evolution of Brucellosis and to the mixed breeding systems [18]. *Brucella* seropositivity was found in sheep ranging from 6.7 to 7.2% in a recent study conducted in Egypt, which identified *B. melitensis* biovar 3 as the most common serotype [19]. Unfortunately, the lack of appropriate laboratory and diagnostic infrastructures has prevented molecular investigation of Brucellosis from several North African regions, especially Libya.

In Libya, Brucellosis is a major public health concern, which is treated and diagnosed by

numerous medical facilities spread over few districts, mostly in the country's highly endemic northwest [20]. These facilities provide limited medical and diagnostic services to diagnose human Brucellosis. Additionally, animal diagnostic testing is insufficient, lacking proper laboratory facilities and skilled workers, and primarily relies on serological and clinical testing. To our knowledge, Libya does not currently have a national prevention program or system in place for brucellosis in animals, and attempts to stop its development and transmission have undoubtedly been hampered by the country's current unrest.

Prevention and control strategies against Brucellosis in small ruminants in North African countries are implemented to varying degrees, including mass vaccination and/or mandatory testing and by the slaughter of infected animals [10]. Efficient control of Brucellosis transmission was hindered primarily by local and cultural factors, including the consumption of unprocessed milk and milk products, as well as insufficient prevention measures [21]. International guidelines are suggested for countries dealing with animal Brucellosis, incorporating control and diagnostic methods such as serology, the culling of infected livestock, vaccination initiatives and rigorous hygiene protocols [22].

Conclusion

This research offers significant insights into the epidemiological situation of *Brucella* infections within the Sahara region of Libya. It is crucial to implement effective control and epidemiological management of Brucellosis in livestock. Implementing a unified approach to health adopting the "One Health" concept through national and local prevention control systems, and fostering international cooperation, are essential for managing brucellosis and other transboundary diseases within the studied region.

What is known about this topic

- *Brucellosis is an important global zoonotic diseases of major public health importance;*
- *Brucellosis is widespread across many African countries, particularly in regions south of the Sahara Desert;*
- *Brucellosis is endemic in many African countries with little knowledge from the Sahara and sub-Saharan region.*

What this study adds

- *This study identifies geographic variations in Brucella seropositivity among goats in the Wadi Al Shati District, with higher rates observed in specific towns compared to others;*
- *The findings reveal that older goats are more likely to test positive for Brucellainfection compared to younger animals, highlighting an age-related risk factor;*
- *The study demonstrates that grazing location and farm size influence Brucella seropositivity, with farms in rural areas and larger premises showing greater exposure risks.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Wesal Musa Abdesalam collected data, conducted the laboratory analyses and interpreted the data. Aisha Mohamed Shahlol designed the study, interpreted the data and supervised all aspects of laboratory work and laboratory analyses. Abdulgader Dhawi Dhawi designed data collections tools and interpreted the data. Murad Ali Hiblu and Ahmed Asaid Elkady designed data collections tools and interpreted the data. Mohamed Ali Daw and Yousef Mohamed Abouzeed made substantial contributions to the

design of the study and revised the manuscript. Mohamed Omar Ahmed supervised the study and wrote the article.

Tables

Table 1: seroprevalence of *Brucella* infection and distribution of selected risk factors among 472 goats in Wadi Al Shati District

Table 2: statistical analysis of associations between *Brucella* seropositivity and selected risk factors among 472 goats in Wadi Al Shati District

References

1. Delam H, Keshtkaran Z, Rezaei B, Soufi O, Bazrafshan MR. Changing Patterns in Epidemiology of Brucellosis in the South of Iran (2015-2020): Based on Cochrane-Armitage Trend Test. Ann Glob Health. 2022 Feb 10;88(1): 11. **PubMed**| **Google Scholar**
2. Qureshi KA, Parvez A, Fahmy NA, Abdel Hady BH, Kumar S, Ganguly A *et al*. Brucellosis: epidemiology, pathogenesis, diagnosis and treatment-a comprehensive review. Ann Med. 2023;55(2): 2295398. **PubMed**| **Google Scholar**
3. Ducrotoy M, Bertu WJ, Matope G, Cadmus S, Conde-Álvarez R, Gusi AM *et al*. Brucellosis in Sub-Saharan Africa: Current challenges for management, diagnosis and control. Acta Trop. 2017 Jan;165: 179-193. **PubMed**| **Google Scholar**
4. Ntirandekura JB, Matemba LE, Kimera SI, Muma JB, Karimuribo ED. Association of Brucellosis with Abortion Prevalence in Humans and Animals in Africa: A Review. Afr J Reprod Health. 2018 Sep;22(3): 120-136. **PubMed**| **Google Scholar**
5. Akakpo AJ, Têko-Agbo A, Koné P. L'impact de la brucellose sur l'économie et la santé publique en Afrique. InConf. OIE 2009 Feb; pp. 71-84).
6. Franc KA, Krecek RC, Häsler BN, Arenas-Gamboa AM. Brucellosis remains a neglected disease in the developing world: a call for interdisciplinary action. BMC Public Health. 2018 Jan 11;18(1): 125. **PubMed**| **Google Scholar**
7. Kakooza S, Watuwa J, Ipola PA, Munyiirwa DFN, Kayaga E, Nabatta E *et al*. Seromonitoring of brucellosis in goats and sheep slaughtered at an abattoir in Kampala, Uganda. J Vet Diagn Invest. 2022 Nov;34(6): 964-967. **PubMed**| **Google Scholar**
8. Brangsch H, Sandalakis V, Babetsa M, Boukouvala E, Ntoula A, Makridaki E *et al*. Genotype diversity of brucellosis agents isolated from humans and animals in Greece based on whole-genome sequencing. BMC Infect Dis. 2023 Aug 14;23(1): 529. **PubMed**| **Google Scholar**
9. Lounes N, Cherfa MA, Le Carrou G, Bouyoucef A, Jay M, Garin-Bastuji B *et al*. Human brucellosis in Maghreb: existence of a lineage related to socio-historical connections with Europe. PLoS One. 2014 Dec 17;9(12): e115319. **PubMed**| **Google Scholar**
10. Benkirane A. Ovine and caprine brucellosis: world distribution and control/eradication strategies in West Asia/North Africa region. Small ruminant research. 2006 Mar 1;62(1-2): 19-25. **Google Scholar**
11. Menshawy AM, Perez-Sancho M, Garcia-Seco T, Hosein HI, García N, Martinez I *et al*. Assessment of genetic diversity of zoonotic *Brucella spp.* recovered from livestock in Egypt using multiple locus VNTR analysis. Biomed Res Int. 2014;2014: 353876. **PubMed**| **Google Scholar**

12. Wareth G, Melzer F, El-Diasty M, Schmoock G, Elbauomy E, Abdel-Hamid N *et al*. Isolation of *Brucella* abortus from a Dog and a Cat Confirms their Biological Role in Re-emergence and Dissemination of Bovine Brucellosis on Dairy Farms. Transbound Emerg Dis. 2017 Oct;64(5): e27-e30. **PubMed**| **Google Scholar**
13. Bagheri Nejad R, Krecek RC, Khalaf OH, Hailat N, Arenas-Gamboa AM. Brucellosis in the Middle East: Current situation and a pathway forward. PLoS Negl Trop Dis. 2020 May 21;14(5): e0008071. **PubMed**| **Google Scholar**
14. Djangwani J, Ooko Abong' G, Gicuku Njue L, Kaindi DWM. Brucellosis: Prevalence with reference to East African community countries - A rapid review. Vet Med Sci. 2021 May;7(3): 851-867. **PubMed**| **Google Scholar**
15. Ahmed MO, Elmeshri SE, Abuzweda AR, Blauo M, Abouzeed YM, Ibrahim A *et al*. Seroprevalence of brucellosis in animals and human populations in the western mountains region in Libya, December 2006-January 2008. Euro Surveill. 2010 Jul 29;15(30): 19625. **PubMed**| **Google Scholar**
16. Ahmed MO, Abouzeed YM, Bennour EM, van Velkinburgh JC. Brucellosis update in Libya and regional prospective. Pathog Glob Health. 2015 Feb;109(1): 39-40. **PubMed**| **Google Scholar**
17. Alshekh KA, Shahlol AM, Mostafa KKB, Othman AA, Hiblu MA, Abouzeed YM *et al*. Seroprevalence of brucellosis in sheep and goats from Al Jufrah district in Libya. Pan Afr Med J. 2024 May 28;48: 23. **PubMed**| **Google Scholar**
18. El-Sayed A, Awad W. Brucellosis: Evolution and expected comeback. Int J Vet Sci Med. 2018 Mar 21;6(Suppl): S31-S35. **PubMed**| **Google Scholar**
19. El-Diasty M, El-Said R, Abdelkhalek A. Seroprevalence and molecular diagnosis of sheep brucellosis in Dakahlia governorate, Egypt. Ger J Vet Res. 2021;1(1): 34-9. **Google Scholar**
20. World Health Organization. Service Availability and Readiness Assessment of the public health facilities in Libya, 2017. WHO EMRO. 2017. Accessed September 01, 2024.
21. European Food Safety Authority. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2010. EFSA Journal 2018;16(12): 5500.
22. Food and Agriculture Organization of United Nations. *Brucella* melitensis in Eurasia and the Middle East. Animal Production and Health. May 2009. Accessed September 01, 2024.

Table 1: seroprevalence of Brucella infection and distribution of selected risk factors among 472 goats in Wadi Al Shati district		
Variable	**Total collected number**	**ELISA Seropositive animals N (%) (No. of farms)**
Area Location	**N (No. of farms)**	
Ashkadh	386 (17)	59 (84.28%) (14)
Zalouaz	34(2)	4 (5.7%) (2)
Brak	25(2)	7 (10%) (1)
Hai Howede	10(1)	0 (0%)
Alafyaa	9(2)	0 (0%)
Mahrouqa		0 (0%)
Age	8(1)	
Less than 1 year	0(0%)	0(0%)
1-3 years	252(53.38%)	32(45.7%)
Over 3 years		
Grazing place	220(46.6%)	38(54.3%)
Residential	53(11.22%)	10(14.28%)
Farm		
Farm□s size (acres)	419(88.77%)	60(85.71%)
≤ 5 acres	69(14.6%)	11(15.71%)
> 5 acres	403(85.4%)	59(84.28%)
Data include geographic location, age, grazing area, farm size, and ELISA seropositivity rates		

Table 2: statistical analysis of associations between Brucella seropositivity and selected risk factors among 472 goats in Wadi Al Shati district				
Variables	**Proportion & Number of samples**		**Chi-square test**	**Probability (P) value**
	Sero- (+) N(%)	**Sero- (-) N(%)**		
			8.450	0.133
Location				
Ashkadh	59(84.28%)	327(81.3%)		
Zalouaz	4(5.7%)	30(7.46%)		
Alafyaa	0(0%)	9(2.23%)		
Brak	7(10%)	18(4.47%)		
Mahrouqa	0(0%)	8(1.99%)		
Alhai Howede	0(0%)	10(2.48%)		
Age			1.946	0.163
< 1 year (n=0)	0(0%)	0(0%)		
1-3 years (n=252)	32(45.7%)	220(54.72)		
> 3 years (n=220)	38(54.3%)	182(45.27)		
Grazing area			0.770	0.380
Residential(n=53)	10(14.28%)	43(10.69%)		
Farm(n=419)	60(85.71%)	359(89.3%)		
Farm's size			0.079	0.779
≤ 5 acres (n=69)	11(15.71%)	58(14.42%)		
> 5 acres (n=403)	59(84.28%)	344(85.57%)		
Abbreviations: Sero- (+), Seropositive, Sero- (-), Seronegative				