



Determination of Seroprevalence of *Coxiella burnetii* Infection in Sheep from Central Anatolia, Türkiye

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ABSTRACT

Coxiella burnetii, the causative agent of Q fever, is a zoonotic pathogen that poses significant public health and veterinary concerns worldwide. This study aimed to determine the seroprevalence of *C. burnetii* infection in sheep raised in the Central Anatolia region of Türkiye. A total of 3,000 blood serum samples were collected from 100 sheep farms located in eight provinces (Afyonkarahisar, Aksaray, Antalya, Burdur, Isparta, Karaman, Konya, and Niğde). Samples were tested using a commercial ELISA kit (IDEXX Q fever Ab Test), and the results were interpreted according to the manufacturer's guidelines. Of the 3,000 serum samples analyzed, 279 tested positive, yielding an overall individual seroprevalence rate of 9.3%. Provincial seroprevalence varied widely, ranging from 1.5% in Antalya to 18.9% in Niğde. These differences may be associated with regional variations in animal husbandry practices, biosecurity levels, and climatic conditions. The use of ELISA, as recommended by the WOA, provided a reliable screening method for detecting *C. burnetii*-specific antibodies. This study highlights the presence and regional distribution of *C. burnetii* infection in sheep farms in Central Anatolia. Given the zoonotic potential and often subclinical nature of the disease, regular serological monitoring is essential for disease control and prevention strategies. The findings contribute valuable data for veterinary epidemiology and public health policy development in Türkiye.

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ÖZET

Coxiella burnetii, Q hummasının etkeni olan ve dünya genelinde önemli halk sağlığı ve veteriner hekimlik sorunlarına yol açan zoonotik bir patojendir. Bu çalışmanın amacı, Türkiye'nin İç Anadolu Bölgesi'nde yetiştirilen koyunlarda *C. burnetii* enfeksiyonunun seroprevalansını belirlemektir. Çalışma kapsamında sekiz ildeki (Afyonkarahisar, Aksaray, Antalya, Burdur, Isparta, Karaman, Konya ve Niğde) 100 koyun işletmesinden toplam 3.000 kan serumu örneği toplanmıştır. Örnekler, ticari bir ELISA kiti (IDEXX Q fever Ab Test) kullanılarak test edilmiş ve sonuçlar üretici firmanın talimatlarına göre değerlendirilmiştir. Analiz edilen 3.000 serum örneğinden 279'u pozitif bulunmuş olup, genel bireysel seroprevalans oranı %9.3 olarak belirlenmiştir. İl bazında seroprevalans oranları geniş bir aralıkta değişiklik göstermiş, en düşük oran %1.5 ile Antalya'da, en yüksek oran ise %18.9 ile Niğde'de saptanmıştır. Bu farklılıklar, bölgesel hayvancılık uygulamaları, biyogüvenlik seviyeleri ve iklim koşullarındaki değişikliklerle ilişkili olabilir. WOA tarafından önerilen ELISA testinin kullanımı, *C. burnetii*'ye özgü antikorların tespiti için güvenilir bir tarama yöntemi sağlamıştır. Bu çalışma, İç Anadolu'daki koyun sürülerinde *C. burnetii* enfeksiyonunun varlığını ve bölgesel dağılımını ortaya koymaktadır. Hastalığın zoonotik potansiyeli ve sıklıkla subklinik

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seyretmesi nedeniyle, düzenli serolojik izleme, hastalıkla mücadele ve önleme stratejileri açısından büyük önem taşımaktadır. Elde edilen bulgular, Türkiye’de veteriner epidemiyolojisi ve halk sağlığı politikalarının geliştirilmesine katkı sağlamaktadır.

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INTRODUCTION

Abortion in small ruminant farming is a significant issue in many countries, including Türkiye (Selim et al., 2018; Menzies, 2011; Özalp et al., 2018; Özsayın & Everest, 2019). Various factors causing abortion not only threaten animal health but also pose risks to human health (Benkirane et al., 2015; Bisias et al., 2009). One of these factors, *Coxiella burnetii*, has been reported to cause infections in birds, arthropods, and mammals. However, in mammals, it has been documented to cause abortions, pneumonia, and the birth of weak offspring (Maurin & Raoult, 1999; Arricau-Bouvery & Rodolakis, 2005).

Coxiella burnetii is a Gram-negative, pleomorphic coccobacillus and an obligate intracellular bacterium. This pathogen, which causes serious infections in humans, is transmitted via aerosols, with small ruminants such as sheep and goats serving as the primary reservoirs (Maurin & Raoult, 1999). Since the clinical signs and diagnosis of infections are challenging, serological methods play a crucial role in detection. The ELISA method is among the diagnostic techniques recommended by the World Organisation for Animal Health (WOAH) for detecting the disease (OIE, 2018).

Although several serological studies have investigated *Coxiella burnetii* infections in ruminants in Türkiye, data specifically addressing sheep populations in the Central Anatolia region remain scarce (Ceylan et al., 2009; Gazyagci et al., 2011; Kilic & Kalender, 2016). Therefore, this study aimed to determine the seroprevalence of *C. burnetii* in sheep from eight provinces across Central Anatolia and to provide region-specific epidemiological data that can support national Q fever prevention and control programs.

MATERIAL and METHODS

In this study, a total of 3,000 blood serum samples were obtained from 100 sheep farms located in Afyonkarahisar, Aksaray, Antalya, Burdur, Isparta, Karaman, Konya, and Niğde provinces. The samples were collected from farms in which abortion cases had been reported by the farm owners. Blood samples were taken from clinically healthy, adult, and unvaccinated sheep. During sampling, no clinical signs of disease were observed in the animals. According to the information provided by the farmers, none of the animals had been vaccinated against Q fever or other reproductive system infections.

The serum samples were transported under a cold chain to the Routine Diagnostic Laboratory of the Department of Microbiology at Aydın Adnan Menderes University Faculty of Veterinary Medicine and stored at $-20\text{ }^{\circ}\text{C}$ until testing. The IDEXX Q fever antibody ELISA test kit (IDEXX, USA) was applied according to the manufacturer’s instructions with the following steps: 3 μL of serum sample was pre-diluted in 1200 μL of dilution buffer, and 100 μL of the diluted serum was added to each antigen-coated well of the microplate and incubated at $37\text{ }^{\circ}\text{C}$ for 1 h. After incubation, each well was washed three times with 300 μL of wash solution, followed by the addition of 100 μL of conjugate solution and a further incubation at $37\text{ }^{\circ}\text{C}$ for 1 h. The washing step was repeated three times, then 100 μL of substrate solution was added to each well and incubated at room temperature for 15 min, after which 100 μL of stop solution was added. The optical density (OD) was measured at 450 nm using an ELISA reader, and the results were evaluated according to the ELISA kit guidelines as follows: $S/P \leq 30\%$ (negative), 30–40% (suspect), and $\geq 40\%$ (positive).

RESULTS

Blood serum samples collected from sheep farms were tested using the IDEXX Q fever antibody ELISA test kit. Among the 3,000 blood serum samples, 279 were found positive for *C. burnetii* antibodies. Based on the results, the individual seroprevalence was determined to be 9.3%. Seroprevalence rates by province are presented in Table 1.

The chi-square analysis ($\chi^2 = 90.34$, $df = 7$, $p < 0.001$) demonstrated a statistically significant difference in seropositivity rates among the provinces (McHugh, 2013). The conformity of seropositivity percentages to a normal

distribution was confirmed by both the Kolmogorov Smirnov test ($p = 0.722$) and the D'Agostino Pearson test ($p = 0.612$). These results indicate that the data are suitable for parametric analyses (D'Agostino & Pearson, 1973; Massey, 1951).

Table 1. Seroprevalence Rates by Province
Çizelge 1. İllere Göre Seroprevalans Oranları

Province	Number of Serum Samples	Positive	Negative	Seroprevalence (%)
Afyonkarahisar	390	16	374	4.1
Aksaray	360	28	332	7.7
Antalya	330	5	325	1.5
Burdur	390	54	336	13.8
Isparta	360	34	326	9.4
Karaman	390	34	356	8.7
Konya	390	34	356	8.7
Niğde	390	74	316	18.9
Total	3000	279	2721	9.3

DISCUSSION

Q fever, caused by *Coxiella burnetii*, is a globally significant zoonotic disease that affects both animal and human health (Berri et al., 2003). The bacterium has been detected and reported in numerous studies conducted not only in countries such as Germany, Spain, and France but also in Türkiye (Berri et al., 2002; Guatteo et al., 2006; Guatteo et al., 2007; Rousset et al., 2007). This pathogen can lead to severe health problems, particularly in people who have direct contact with livestock, including farmers, veterinarians, and abattoir workers. In the present study, *C. burnetii* antibodies were detected in 9.3% of sheep sera collected from eight provinces of the Central Anatolia region. This result demonstrates the circulation of the pathogen among sheep populations and emphasizes its endemic nature in the region. The use of the ELISA method, as recommended by the World Organisation for Animal Health (WOAH), ensured a reliable and sensitive screening approach for detecting *C. burnetii* antibodies (OIE, 2018). Although ELISA is widely recognized for its high diagnostic performance, confirmatory tests such as indirect immunofluorescence assay (IFA) or polymerase chain reaction (PCR) are suggested to further increase diagnostic accuracy (Guatteo et al., 2007; Kırkan et al., 2008; Blanda et al., 2024). In this study, all tested animals were unvaccinated, confirming that the observed seropositivity represents natural exposure rather than vaccine-induced immunity. However, as antibody presence does not necessarily indicate an active infection, future studies should include molecular confirmation to better assess pathogen circulation and identify potential sources of infection.

The findings revealed significant differences in seroprevalence between provinces, ranging from 1.5% in Antalya to 18.9% in Niğde. Such variation may reflect differences in ecological conditions, animal movement, herd management practices, hygiene standards, and the implementation level of biosecurity measures. The higher seroprevalence observed in Niğde could be related to more intensive animal movements and lower biosecurity awareness, while the low prevalence in Antalya may reflect more controlled herd structures and favorable climatic conditions that limit environmental persistence of the pathogen. These findings suggest that *C. burnetii* circulation in Türkiye is not uniform and that region-specific epidemiological factors should be considered when developing control strategies. Implementation of strict movement control, routine disinfection, proper manure management, and enhanced awareness programs for farmers and veterinarians would contribute to reducing transmission risk in high-prevalence areas.

The results of this study are largely consistent with previous findings from different regions of Türkiye and neighboring countries. Earlier studies have reported variable seroprevalence rates in sheep, ranging from 5.4% to 46% (Ceylan et al., 2009; Kennerman et al., 2010; Kılıç & Kalender, 2016; Bağatır et al., 2021). Kalender et al. (2001) found 38.59% seropositivity in aborted ewes and 11.01% in non-aborted ones, whereas Çetinkaya et al. (2000) reported a rate of 10.14%, similar to our findings. Some studies from the Marmara and Eastern Anatolia regions revealed higher seropositivity values (Karagül et al., 2019; Parin & Kaya, 2015), which may result from climatic and management differences or sample populations selected from herds with reproductive disorders. Conversely, lower rates such as those reported by Ceylan et al. (2009) may indicate regional variations in exposure or improved control measures in certain areas. Such heterogeneity emphasizes the complex epidemiology of *C. burnetii* infections in Türkiye and underlines the importance of sustained national surveillance to capture these spatial trends over time.

Beyond its veterinary relevance, *C. burnetii* remains a critical zoonotic pathogen with substantial public health implications. The European Food Safety Authority (EFSA, 2024) and World Health Organization (WHO, 2023) have both highlighted that Q fever continues to emerge across Europe, with Spain, France, and Germany reporting the highest human case numbers. Occupational exposure among farmers, abattoir personnel, and veterinarians remains a major risk factor, while immunocompromised individuals and pregnant women are particularly vulnerable (CDC, 2024). The persistence of the pathogen in the environment, facilitated by its resistance to heat, desiccation, and disinfectants, poses an ongoing challenge to disease eradication efforts. Recent advances in molecular diagnostics, including targeted next-generation sequencing (tNGS) and quantitative PCR, offer promising tools for rapid detection and strain differentiation. Integrating such methods into future research could enhance the understanding of regional strain diversity and transmission dynamics in Türkiye.

Overall, this study provides the first broad serological evaluation of *C. burnetii* exposure in sheep across the Central Anatolia region, revealing clear geographic disparities and confirming that Q fever remains an underrecognized but significant zoonosis in Turkish livestock. Regular serological monitoring, coupled with confirmatory molecular surveillance, would help identify high-risk zones and support early intervention. The findings also emphasize the necessity of adopting a “One Health” approach that unites veterinary, medical, and environmental health disciplines to prevent and control *C. burnetii* infections. Strengthening biosecurity measures, ensuring proper waste management during lambing, and conducting awareness campaigns among farmers and veterinarians are critical steps toward mitigating the risk of zoonotic transmission. In conclusion, while this study highlights the presence and variability of *C. burnetii* infections in sheep in Central Anatolia, it also underscores the urgent need for integrated control strategies that combine field-based surveillance, laboratory diagnostics, and intersectoral cooperation to protect both animal and human health.

CONCLUSION

In conclusion, this study confirms the endemic presence of *Coxiella burnetii* in sheep populations across the Central Anatolia region, with considerable regional variation in seroprevalence rates. These results underscore the need for region-specific control strategies, particularly in high-prevalence provinces such as Niğde. Regular serological monitoring, strict biosecurity measures, and awareness programs targeting farmers and veterinarians should be prioritized to prevent further spread of the infection. Moreover, integrating molecular diagnostics into future epidemiological studies would help characterize circulating strains and clarify the transmission dynamics of *C. burnetii* in Türkiye. Collectively, the findings highlight the importance of adopting a ‘One Health’ approach that links the veterinary and public health sectors for effective control of Q fever.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Statement of Contribution of The Authors

The authors declare that their contributions are equal.

Ethical Approval

Ethics Committee Approval: Ethics committee approval was obtained from Bornova Veterinary Control Institute (Date: 14.03.2025, Number: 2025/3)

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