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Communication

Seroprevalence of *Coxiella burnetii* in Goats from the Central and Western Thailand: Implications for Zoonotic Disease Surveillance and Control

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Simple Summary

Because Q fever vaccines have never been used in Thailand, the antibodies detected in goats indicate natural exposure to *Coxiella burnetii*. This study found higher individual seroprevalence than previously reported, with increased infection rates in the provinces surveyed earlier. This risk is likely due to expanding goat populations and the use of more sensitive diagnostic tests. Although infection levels within herds were lower than those observed during major outbreaks in other countries, true prevalence may be underestimated. Overall, *C. burnetii* infection appears to be widespread in the central and western Thailand, underscoring the need for stronger surveillance, targeted control measures, and increased awareness among at-risk individuals.

Abstract

Goats are important reservoirs of *Coxiella burnetii*, the causative agent of Q fever in humans. Therefore, monitoring infection in goats is essential for effective human disease control. However, epidemiological data on *C. burnetii* infection in Thai goats remain limited, particularly in the central and western regions, where goat farming has expanded. This study aimed to determine the seroprevalence of *C. burnetii* infection in goats raised in these two regions. A total of 947 serum samples from 101 herds were collected and tested using a commercial enzyme-linked immunosorbent assay (ELISA). Individual- and herd-level seroprevalence were calculated. Pearson's chi-square test was used to compare infection proportions between regions (central vs. western) and herd types (meat vs. dairy), with $p < 0.05$ considered statistically significant. Overall, individual- and herd-level seroprevalence were 22.39% and 58.42%, respectively. Individual seroprevalence in the central and western regions was 25.16% and 19.71%, while herd-level seroprevalence was 71.15% and 44.90%, respectively. The proportions of infection at both levels were significantly higher in the central region ($p = 0.044$ and $p = 0.007$). In contrast, no significant differences were observed between meat and dairy herds: individual-level seroprevalence was 22.81% and 25.25% ($p = 0.586$), and herd-level seroprevalence was 56.98% and 60.00% ($p = 0.855$), respectively. These findings highlighted the urgent need to strengthen control measures for *C. burnetii* infection in goats in central and western Thailand to protect human, animal, and environmental health.

Keywords: *Coxiella burnetii*; goats; seroprevalence

1. Introduction

Q fever is a multispecies disease caused by *Coxiella burnetii* (*C. burnetii*), a gram-negative intracellular bacterium [1]. It is a zoonotic infection in which ruminants serve as the primary source of human exposure [2]. Although clinical signs are uncommon in ruminants, the disease can cause substantial economic losses due to reproductive disorders, including late-term abortion, stillbirth, weak offspring, and infertility [3]. The impact of Q fever has been reported to be more severe in goats than in sheep [4]. Both clinically and subclinically infected goats shed large quantities of the pathogen during the periparturient period through birth products, vaginal discharges, feces, urine, and milk [4,5]. Owing to its high sensitivity and rapid turnaround time, the enzyme-linked immunosorbent assay (ELISA) is widely used as a screening tool for detecting *C. burnetii* infection in ruminants [6].

C. burnetii infection has been reported worldwide. In goats, individual seroprevalence ranges from 0.8% to 65.8%, and herd-level seroprevalence from 2.8% to 100% [7–14]. In Thailand, individual seroprevalence of goats ranges from 3.5% to 12.8% [15,16], while herd-level seroprevalence ranges from 33.3% to 62.0% [16,17]. The pathogen has also been detected in sheep, cattle, buffaloes, and individuals with occupational exposure [15,16,18,19], although prevalence in these groups is generally lower than in goats.

Goat farming has been increasingly promoted in the central and western regions of Thailand, which together accounted for one-third of the national goat population in 2023 [20]. Due to limited private grazing areas in these regions, some farmers allow their goats to forage on open-access lands. Such practices may facilitate disease transmission, as infected free-roaming goats pose a potential One Health risk to animals, humans, and the environment. Establishing the prevalence of infection in goats is therefore critical to guiding future control strategies. However, data from these regions remain scarce. This study aimed to determine the seroprevalence of *C. burnetii* infection in goats raised in the central and western Thailand.

2. Materials and Methods

An initial sample size of 1,000 goats was calculated to provide a reliable estimate of individual seroprevalence, based on an expected prevalence of 12.8% [16] and a 95% confidence level. This sample size was sufficient to achieve a margin of error of less than 3%. Sample sizes for each province in central and western Thailand were allocated proportionally according to the number of registered goat farms. Serum samples were first randomly selected from two laboratories under the Department of Livestock Development (DLD), Thailand, with a maximum of fourteen samples per farm. These samples had been collected between 2021 and 2023. Additional blood sampling was conducted in 2023 in the provinces where the number of available samples from DLD laboratories did not meet the target sample size.

A commercial ELISA kit (ID Screen® Q Fever Indirect Multi-species, IDvet™, Grabels, France) was used to detect *C. burnetii*-specific antibodies in serum samples. A herd was classified as positive if at least one sample tested positive.

Individual- and herd-level seroprevalence were calculated. Pearson's chi-square test was used to compare infection proportions between the central and western regions and between meat and dairy goats. A $p < 0.05$ was considered statistically significant.

3. Results

A total of 947 goat serum samples from 101 herds in nine central and six western provinces of Thailand were included in the study (Table 1). Most samples (760 from 83 herds) were obtained from two DLD laboratories, while the remaining 187 samples (18 herds) were collected through additional

field sampling. Although the total number of samples was slightly lower than the initially calculated sample size, it remained sufficient to produce estimates with a margin of error of less than 3%.

The overall individual- and herd-level seroprevalence rates of *C. burnetii* infection were 22.39% (95% CI: 19.84–25.16%) and 58.42% (95% CI: 48.43–67.75%), respectively. Twenty-five samples (2.64%) produced suspect results. Within-herd individual seroprevalence ranged from 0% to 100%, with a mean of 22.22%. At the provincial level, the highest individual seroprevalence (40%) was observed in Phra Nakhon Si Ayutthaya, while the highest herd-level seroprevalence (100%) occurred in both Phra Nakhon Si Ayutthaya and Nonthaburi. Pathum Thani, represented by five samples from a single herd, was the only province with no positive samples (Table 1 and Figure 1).

Pearson’s chi-square test showed that both individual- and herd-level seroprevalence rates were significantly higher in the central region compared with the western region ($p = 0.044$ and 0.007 , respectively). Although dairy goats exhibited slightly higher individual- and herd-level seroprevalence than meat goats (Table 2), these differences were not statistically significant ($p = 0.586$ and 0.855 , respectively).

Table 1. Seroprevalence rate of *C. burnetii* infection in goats at individual and herd levels by province.

Province	No. of samples	Individual seroprevalence	No. of herds	Herd seroprevalence
Central region	465	25.16	52	71.15
Bangkok	50	30.00	5	80.00
Chai Nat	80	17.50	10	70.00
Nonthaburi	20	20.00	2	100.00
Pathum Thani	5	0.00	1	0.00
Lopburi	160	31.88	16	75.00
Saraburi	60	20.00	7	85.71
Sing Buri	40	17.50	4	25.00
Phra Nakhon Si Ayutthaya	25	40.00	3	100.00
Ang Thong	25	16.00	4	50.00
Western region	482	19.71	49	44.90
Kanchanaburi	129	20.16	13	69.23
Nakhon Pathom	54	22.22	5	60.00
Prachuap Khiri Khan	20	25.00	2	50.00
Phetchaburi	126	6.35	13	7.69
Ratchaburi	80	31.25	9	44.44
Suphan Buri	73	26.23	7	57.14
Overall	947	22.39	101	58.42

Table 2. Seroprevalence rate of *C. burnetii* infection in goats at individual and herd levels by production type.

Type	No. of samples	Individual seroprevalence	No. of herds	Herd seroprevalence
Meat	798	22.81	86	56.98
Dairy	99	25.25	10	60.00
Unknown	50	10.00	5	80.00
Overall	947	22.39	101	58.42

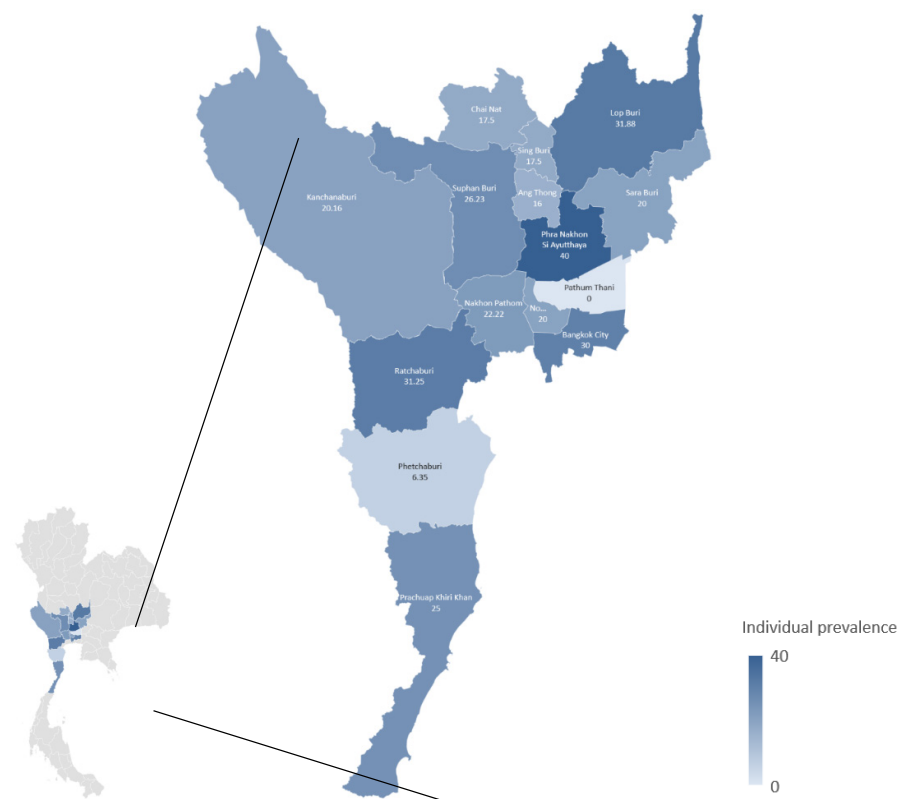


Figure 1. Geographic distribution of individual seroprevalence of *C. burnetii* infection by province.

4. Discussion

Since Q fever vaccines for ruminants have never been used in Thailand, the positive results in this study indicate natural exposure to *C. burnetii*. The individual seroprevalence of 22.39% observed here is notably higher than the previously reported range of 3.5–12.8% in Thai goats [15,16]. However, the herd-level seroprevalence of 58.42% is comparable to the 62.00% reported in a recent study [16]. Compared with data from 2013–2015, our study revealed higher individual and herd-level seroprevalence in the same locations—Kanchanaburi (20.61% and 69.23% vs. 15.66% and 63.16%) and Nakhon Pathom (22.22% and 60.00% vs. 12.10% and 54.54%) [16]. Goat farming promotion programs implemented by various organizations have contributed to a 2.6-fold increase in the goat population in these provinces between 2015 and 2023 [20], which may have facilitated pathogen transmission. Additionally, the ELISA technique used in this study is more sensitive than the immunofluorescent assay used previously [6], which may also account for higher detection rates.

The mean individual seroprevalence within infected herds (37.79%) was lower than the 46.6% reported in dairy goat herds in the Netherlands during the major Q fever outbreaks in humans and animals from 2007 to 2009 [8]. However, as noted by Rousset et al. [5], some goats infected with *C. burnetii* may not produce detectable antibodies, indicating the potential for underestimation. Incorporating antigen detection methods could help identify infected animals that test negative on serological assays and detect key transmitters within herds.

Differences in herd management practices between the central and western regions may explain the observed regional differences in seroprevalence. A previous study involving dairy cattle in two western provinces reported an individual seroprevalence of 7.33%, which was lower than in other regions, although the central region was not included in that study [21]. Most of the provinces with the highest individual prevalence—Lopburi, Ratchaburi, Bangkok, and Suphan Buri—had large dairy goat populations [20]. However, Pearson’s chi-square test revealed no significant differences between meat and dairy goats at either the individual or herd level. The influence of goat type on infection risk remains unclear. While some studies have reported higher prevalence in dairy

ruminants compared with meat-producing ruminants [16,22], Jesse et al. [14] found the opposite pattern, with higher seroprevalence in meat goats than in dairy goats.

Several risk factors for *C. burnetii* infection have been identified in previous studies, including increasing animal age, large herd size, contact with animals from other herds, co-rearing of sheep and goats, presence of ticks, and inadequate sanitation of feeding equipment [9,11,14,22–26]. Conversely, the use of kidding pens, replacement of bedding following abortions, and isolation of animals that have aborted have been reported as protective practices [26]. Prevalence has also been shown to vary by breed and geographic location [11,14,22,23,27]. However, limited background information from the samples obtained through DLD laboratories restricted the ability to assess risk or protective factors in this study. Further investigations are needed to identify such factors and support tailored disease-control strategies. Enhanced surveillance in other animal species and humans in affected areas is also recommended to better understand the epidemiological dynamics of Q fever.

5. Conclusions

This study identified a considerable prevalence of *C. burnetii* infection among goats in the central and western Thailand. These findings underscore the need for effective surveillance and control measures to limit pathogen transmission among animals. Additionally, increasing awareness among at-risk individuals regarding personal protective measures is critically important.

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Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. No publicly archived datasets were generated or analyzed during the current study.

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Conflicts of Interest: The authors declare no conflict of interest.

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