

Prevalence of Brucellosis in Saudi Arabia: A meta-analysis

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Abstract

Background: Brucellosis is a zoonotic bacterial infection caused by the *Brucella* species, prevalent in various regions of Saudi Arabia, posing public health challenges. Transmission occurs primarily through consumption of unpasteurized dairy products and direct contact with infected animals. Understanding regional prevalence of Brucellosis within Saudi Arabia is crucial for developing targeted interventions.

Objective: This meta-analysis assesses the prevalence of Brucellosis across different regions of Saudi Arabia, analyzing data from various epidemiological studies to determine disease distribution and burden.

Methods: A comprehensive search was conducted in PubMed and Google Scholar without restrictions on publication dates, focusing on English-language studies. Articles reporting the prevalence of Brucellosis in Saudi Arabia or its regions were included, provided they involved human participants. Data was extracted from eligible studies, and the prevalence rates were pooled using a random-effects model to account for variability across studies.

Results: The analysis revealed significant heterogeneity in Brucellosis prevalence across different regions of Saudi Arabia. Pooled prevalence was 4% (95% CI: 0.00–0.08), with higher rates observed in the Central Region and lower rates in Western and Southern regions. Studies included varied in design and sample size, contributing to the observed regional differences.

Conclusion: This meta-analysis highlights uneven distribution of Brucellosis prevalence in Saudi Arabia, with certain regions showing significantly higher rates. Findings suggest a need for region-specific public health strategies and further research to better understand the factors contributing to these disparities. A more intensive national study could provide a clearer picture of the disease's burden, guiding effective control measures.

Keywords: Brucellosis, *Brucella*, Prevalence, Saudi Arabia, Meta-analysis

Plain Language Summary

Brucellosis is a preventable bacterial illness that is common all over the world and a consistent problem in Saudi Arabia. Understanding the true prevalence of the disease in Saudi Arabia could provide information on how to tackle this health concern.

There have been many studies done regarding the general epidemiology and incidence in various regions of Saudi Arabia because it is understood that Brucellosis is a disease of concern in the country.

Our goal was to compare the prevalence rates of Brucellosis as shown in the included studies to get a sense of the overall prevalence rate in the country and to understand whether the region-specific studies provide data that is comparable.

Introduction

Overview of Brucellosis

Brucellosis, a bacterial infection caused by the *Brucella* genus, is a disease that can infect a variety of animals who then often transmit the disease to humans. Humans are typically infected due to the ingestion of contaminated food, particularly milk and cheese. People working in close contact with animals are more susceptible to the disease [1].

According to a study published in 2020, the prevalence of Brucellosis is estimated to range from 1.6% to 2.6% and affects all age groups in both genders. The brucellosis morbidity rate in the Saudi population is still on the rise, particularly in rural regions in different parts of the country [2]. The importance of livestock as a livelihood makes certain regions more susceptible, making human Brucellosis a significant concern in Saudi Arabia [3]. While Brucellosis is a disease found globally, it is of particular importance in Saudi Arabia due to the continuous influx of animals for the purpose of religious slaughter. There is also the common practice of consuming unpasteurized goat and camel milk which is a risk factor for contracting the disease [1].

Causing a range of symptoms including fever, fatigue, sweating, and muscular and joint pain, the diagnosis of Brucellosis is typically confirmed using blood tests [4].

Brucellosis is a health issue in many parts of the world including the Middle East and Asia, especially in areas where livestock farming is commonplace and dairy products may not always be pasteurized. The disease has been of significant concern in Saudi Arabia where the annual incidence from 2003 to 2018 was reported to be 15.34 per 100,000 population [5].

There have been many studies done on the broader aspect of Brucellosis as a disease but not many studies focus on the epidemiology or the prevalence in particular. An understanding of the true prevalence of Brucellosis in Saudi Arabia would provide a clearer indication of the impact the disease has on the local health care systems as well as give an excuse to take a deeper look at its

economic impacts. The livelihood of many people depends on livestock and the spread of this disease is a danger to both humans, animals, and the general output of the livestock infected [6].

Saudi Arabia, the largest country in the Middle East, is divided into 13 provinces: Asir, Al-Bahah, Al-Jawf, Al-Qassim, Eastern Province, Ha'il, Jazan, Mecca, Medina, Najran, Northern Borders, Riyadh, and Tabuk. These provinces can be further grouped into regions: Northern Region (Tabuk, Jouf, Hail), Western Region (Mecca, Medina, Jeddah), Eastern Region (Damam, Khafji, Alhasa), and Central Region (Riaydh, Qasim) [7].

The population and other demographic characteristics differ widely between each region. Epidemiological studies on Brucellosis have been previously conducted, but many of these studies are region specific. The purpose of this paper is to analyze the homogeneity or heterogeneity between the prevalence rate of Brucellosis among the regions of Saudi Arabia and determine whether there is a further need for region specific studies or nationwide studies.

Methodology

Aims and design

Compare studies highlighting the prevalence rate of Brucellosis in various regions of Saudi Arabia and gain an understanding of the current data on prevalence and whether other studies should be conducted to gain a clearer picture of whether cases of Brucellosis are growing or declining or are unchanged in number.

Clinical trial number

Not applicable.

Data sources and search strategy

Relevant studies were sourced from PubMed and Google Scholar. The following search terms/keywords were utilized: “Brucellosis”, “*Brucella*”, “Prevalence”, and “Saudi Arabia”. PubMed mesh terms were used to ensure thorough search results encompassing all aspects of the above-mentioned keywords. Five hundred seventy-six articles were procured from PubMed and forty-one articles from Google Scholar. This is detailed in the Prisma Diagram (Figure 1).

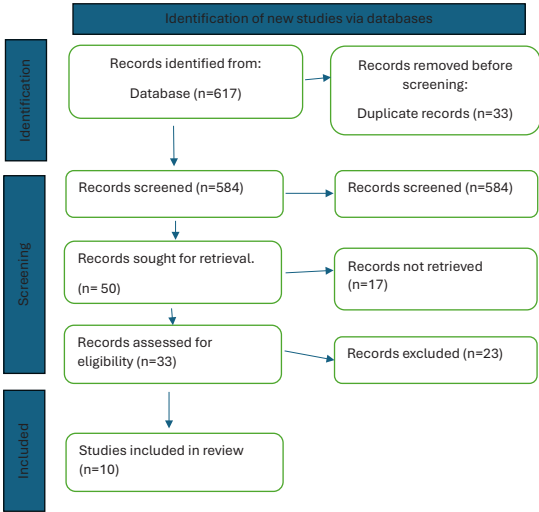


Figure 1. Prisma diagram

Study selection criteria

The inclusion criteria were outlined so that articles that focused on Brucellosis or the prevalence of Brucellosis were included. These articles must be of study groups that were the Saudi Arabian population. We only used articles published in English. Factors considered for the exclusion criteria allowed us to remove articles that were studying diseases other than Brucellosis, articles studying Brucellosis only in animals and not humans, study locations other than Saudi Arabia, articles with information on Brucellosis in Saudi Arabia but no data regarding the prevalence of the disease. Furthermore, 17 articles were not included in this study due to accessibility issues, full text versions were not accessible due to paywalls.

Data extraction

After extracting the initial 576 articles from PubMed and 41 articles from Google Scholar, the studies were exported and then imported in Rayyan AI. This was the primary data extraction tool utilized, and the articles were screened for duplicates. After full text review of the articles and applying the inclusion and exclusion criteria, 10 articles remained.

Results

Overview of included studies (Table 1)

The publication dates of the included studies ranged from 1996 to 2020. Three studies were conducted in the Central Region (Hail, Qassim, and Riyadh), Al Mofleh, Alsubaie, and Alaidarous. El Mofleh, 1996 revealed that out of the 5,597 people surveyed in the Central Region (Hail, Qassim, and Riyadh) of Saudi Arabia, 48% were seropositive. This study ensured that the sample size was representative of population size of the Central Region [8,9]. Another study of this region, Alsubaie *et al.*, suggested an increased focus on the screening of family members of patients diagnosed with Brucellosis. One hundred seventy-eight family members of twenty-five patients with acute Brucellosis were tested for 6 months. Nineteen percent of the family members were revealed to be seropositive for Brucella. This is the only cohort study included in this analysis [10]. A study conducted in the Riyadh province (located in the Central part of Saudi Arabia) in 2017, by Alaidarous, aimed to illustrate whether Brucellosis was still a disease of concern in the area. It showed a 38.3% positive rate when 489 out of 1,286 samples tested positive [11]. Al Qassim province, in the Central region, was

Table 1. Article summary.

Study	Study Title	Author Name	Year of Publication	Study Design	Study Site	Study Size
1	Brucellosis in Saudi Arabia: Epidemiology in the Central Region	Al Mofleh, <i>et al.</i>	1996	Cross-sectional	Central Region	5,597
2	Brucellosis in a Saudi community	El-Gilany, <i>et al.</i>	1999	Cross-sectional	North Region of Saudi Arabia	1,092
3	Epidemiology of Brucellosis in Al Medina Region, Saudi Arabia	Al-Sekait	1997	Cross-sectional	Al-Madina (Western) Region of Saudi Arabia	3,917
4	Acute brucellosis in Saudi families: Relationship between brucella serology and clinical symptoms	Alsubaie, <i>et al.</i>	2004	Cohort	Central Najed Region/ Riyadh	178
5	Prevalence of Brucellosis in Hawtat Sudair City, Riyadh Province, Saudi Arabia	Alaidarous	2017	Cross-sectional	Riyadh (Central)	1,286
6	Brucellosis in the Asir region of Saudi Arabia	Bilal, <i>et al.</i>	1990	Cross-sectional	Asir (Southern) Region in Saudi Arabia	1,331
7	Serological and molecular diagnosis of human brucellosis in Najran, Southwestern Saudi Arabia	Asaad, <i>et al.</i>	2012	Cross-sectional	Najran, Southwestern Saudi Arabia	340
8	Sero-prevalence and risk factors of brucellosis among suspected febrile patients attending a referral hospital in southern Saudi Arabia	Alkahtani, <i>et al.</i>	2020	Cross-sectional	South Saudi Arabia	7,567
9	Seroprevalence of 2 zoonotic diseases in Southwestern Saudi Arabia. Rift Valley fever and brucellosis	Elsheikh, <i>et al.</i>	2011	Cross-sectional	Najran (Southern) Region	1,440
10	Two-stage PCR assay for detection of human brucellosis in endemic areas	Kamal, <i>et al.</i>	2013	Cross-sectional	Western Region of Saudi Arabia	101

shown to have the highest region wise yearly average of Brucellosis cases in Saudi Arabia from 2009–2018 [12]. **Table 3** details the comparison of the prevalence results of the studies from the Central region.

Two of the studies focused on the Western region, Al-Sekait and Kamal, *et al.* The Al-Sekait 1997 study in the Al Medina area conducted a survey of 4,000 subjects. Of the 3,917 subjects that were ultimately clinically examined, there were 102 confirmed cases of Brucellosis indicating a prevalence rate of 2.6%. This prevalence rate is significantly lower than those from the studies in the Central region [13]. Kamal, *et al.*, collected 101 samples from febrile patients that were suspected of having Brucellosis. Forty-four tested positive, indicating a 43.6% prevalence. A comparison of these two studies may not be appropriate considering there may be a bias in Kamal *et al.* because their study population was already showing symptoms for the disease [14].

Only one study was conducted in the Northern Region of Saudi Arabia, El-Gilany. A random sample of 1,092 Saudi Arabians were surveyed and after examination, questioning and blood samples it was revealed that there was a 20.4% infection prevalence [9].

The majority of the studies included in this analysis had been conducted in the Southern/Southwestern region of Saudi Arabia. Bilal *et al.* 1991, a study conducted in the Asir province, analyzed blood samples of 1,331 subjects. The prevalence rate of Brucellosis was 27.4% [15]. A study in Najran, Asaad *et al.* 2012, analyzed 340 patients presumed to have Brucellosis. 15.9% of the provisionally diagnosed patients tested positive for Brucellosis [16]. Alkhatani *et al.* 2020, conducted in Southern Saudi Arabia, revealed a 12.8% prevalence rate of Brucellosis in 7,567 patients admitted with

suspected symptoms [17]. Another study in Southwestern Saudi Arabia/Najran region, Elsheikh *et al.*, tested both humans and animals for Brucellosis and revealed a prevalence rate of 7.3% in humans [18].

Quality and applicability of included studies

ROBINS-E is a bias assessment tool (full name ‘Risk of Bias in Non-randomized Studies of Exposures’) as utilized in this analysis to evaluate the potential for bias in the observational studies that were included, the results of which are included below. Areas of concern were in domains D1 and D3, showing a possibility for bias in these studies due to either confounding or in the selection of participants into the study (**Table 2**).

Discussion

Main findings

Our meta-analysis provides an overview of the prevalence of Brucellosis in a variety of regions in Saudi Arabia and our results indicate a significant difference in prevalence between regions as well as a need for further research in this area.

Ranging from as low as 2.6% in the Al Medina region (Al-Sekait 2000) to as high as 48% in the Central Region (Mofleh, Aska *et al.* 1996) (**Table 3**), the discrepancy in prevalence rate may be attributed to either regional differences or variation in the sampling methods of the studies [7,12]. Although nearly all of the studies included in this analysis are cross-sectional, our study did not account for similarities or differences in sampling methods. Some studies ensured randomization while others chose to focus on patients known to have clinical presentations that may point to Brucellosis.

Table 2. Risk of bias assessment: ROBINS-E tool.

Study	D1	D2	D3	D4	D5	D6	D7	Overall
Al Mofleh, <i>et al.</i> 1996	Low	Low	Some Concerns	Low	Some Concerns	Low	Low	Some Concerns
El-Gilany 1999	Some Concerns	Low	Some Concerns	Low	Some Concerns	Low	Low	Some Concerns
Al-Sekait, <i>et al.</i> 1997	Low	Low	Some Concerns	Low	Some Concerns	Low	Low	Some Concerns
Alsubaie, <i>et al.</i> 2004	High	Low	Some Concerns	Some Concerns	Some Concerns	Some Concerns	Low	High
Alaidarous 2017	High	Low	High	Low	High	Low	Low	High
Bilal, <i>et al.</i> 1990	Some Concerns	High	Low	Some Concerns	Some Concerns	Some Concerns	Some Concerns	High
Asaad, <i>et al.</i> 2012	High	Low	High	Low	High	Low	Low	High
Alkhatani, <i>et al.</i> 2020	Low	Some Concerns	Some Concerns	Low	High	High	Low	High
Elsheikh, <i>et al.</i> 2011	Low	Low	High	Low	Some Concerns	Low	Low	High
Kamal, <i>et al.</i> 2013	High	Low	Some Concerns	Low	Some Concerns	Low	Low	High

Domains: D1: Bias due to confounding, D2: Bias arising from measurement of the exposure, D3: Bias in selection of participants into the study (or into the analysis), D4: Bias due to post-exposure interventions, D5: Bias due to missing data, D6: Bias arising from measurement of the outcome, D7: Bias in selection of the reported result

Table 3. The prevalence results of brucellosis of each study.

Study	Author Name	Study Site	Study Size	Prevalence
1	Al Mofleh, <i>et al.</i>	Central Region	5,597	48.5% (2715/5597)
2	El-Gilany, <i>et al.</i>	North Region of Saudi Arabia	1,092	20.4% (223/1092)
3	Al-Sekait	Al-Madina (Western) Region of Saudi Arabia	3,917	2.6% (102/3917)
4	Alsubaie, <i>et al.</i>	Central Najed Region/Riyadh	178	19% (34/178)
5	Alaidarous	Riyadh (Central)	1,286	38.03% (489/1286)
6	Bilal, <i>et al.</i>	Asir (Southern) Region in Saudi Arabia	1,331	27.4% (365/1331)
7	Asaad, <i>et al.</i>	Najran, Southwestern Saudi Arabia	340	15.9% (54/340)
8	Alkahtani, <i>et al.</i>	South Saudi Arabia	7,567	12.8% (975/7567)
9	Elsheikh, <i>et al.</i>	Najran (Southern) Region	1,440	7.5% (108/1440)
10	Kamal, <i>et al.</i>	Western Region of Saudi Arabia	101	44% (44/101)

Interpretations

In the forest plot below (**Figure 2**) all of the studies in this analysis were included and it shows significant heterogeneity in the prevalence rates reported in different regions of Saudi Arabia.

The overall pooled prevalence according to the random-effects model is 0.04 or 4% with a 95% CI of [0.00, 0.08]. This wide confidence interval suggests there is significant heterogeneity among these studies.

Strength and limitations

Our analysis does cover a wide aspect of Saudi Arabia in terms of regions studied, however, it cannot provide a true overall prevalence rate because some studies had too small of a sample size which was not in correlation with the population of the area (Detailed in **Table 1**). One study that was included only checked the prevalence rate

of Brucellosis in the family members of patients who had already been diagnosed with Brucellosis. Although the information from this study may prove helpful in encouraging awareness among high-risk groups, it may not provide an accurate depiction of the overall disease burden on a region or national level. The significant variability in the sample size and selection criteria in these studies makes it difficult to conduct direct comparisons. Future studies aiming to research the prevalence of Brucellosis may benefit from accounting for these issues.

Most of the studies included in this meta-analysis were designated as ‘high risk of bias’ according to the ROBINS-E tool (as seen in **Table 2**). Some of the common causes of bias included potential confounding factors that were not controlled, selection bias due to non-random sampling methods, and information bias from self-reported data.

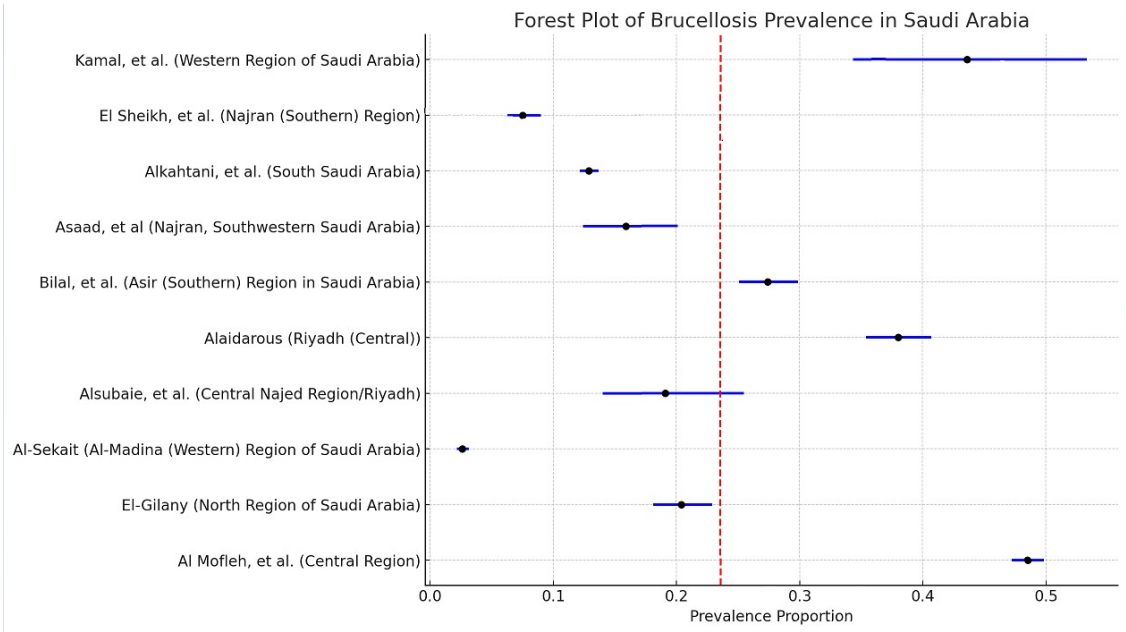


Figure 2. Forest plot of all studies.

Future directions

Studies that show a clearer regard for understanding the source of exposure may also provide crucial information on where preventative measures need to be targeted. This is necessary so that the local and nationwide healthcare systems can account for the disease burden of this disease as well as the measures that need to be taken to counter them.

Abbreviations

CI: Confidence Interval; ROBINS-E: Risk of Bias in Non-randomized Studies of Exposures; PCR: Polymerase Chain Reaction

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Ethics approval and consent to participate

Not applicable. As this study doesn't involve the direct participation of human subjects.

Consent for publication

Not applicable. The personal data of individuals was not included in this study.

Availability of data and materials

Data was accessed from free, full text studies.

Competing interests

The authors declare that there are no competing interests.

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