Review Article

Seroprevalence of Brucellosis Among Small Ruminants Around the World: A Systematic Review and Meta-analysis Protocol

Aboudou Habirou Kifouly[1,2,3]*, Géorcelin Alowanou[2], Pierre Challaton[2], Fréjus Tanguy Zinsou[3], Claude Houssoukpè[3], John Dossou[2], Gilles-Christ Akakpo[2] and Cyrille Kodoéito Boko[3]

[1]Pan African University Life and Earth Sciences Institute (Including Health and Agriculture), University of Ibadan, Nigeria

[2]Laboratoire d'Ethnopharmacologie et de Santé Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Bénin

[3]Unité de Recherche sur les Maladies Transmissibles, Ecole Polytechnique d'Abomey-Calavi, University d'Abomey-Calavi, Bénin

*Corresponding author: Aboudou Habirou Kifouly, Pan African University Life and Earth Sciences Institute (Including Health and Agriculture), University of Ibadan, Nigeria, **Tel:** (+229) 51928481

Abstract

Background: Brucellosis remains a significant zoonotic disease affecting livestock globally, especially small ruminants (goats and sheep). The global burden of brucellosis in these animals is underestimated in many regions.

Objective: To estimate the global pooled seroprevalence of brucellosis in small ruminants through a systematic review and meta-analysis.

Methods: Following PRISMA-P guidelines, we will search databases such as PubMed, Scopus, Web of Science, and regional databases from 2000 to 2025. We will include cross-sectional studies reporting seroprevalence in goats or sheep. Random-effects meta-analysis will be used to compute pooled prevalence estimates. Risk of bias will be assessed using a validated critical appraisal tool.

Expected Outcome: This study will provide updated global estimates of brucellosis prevalence in small ruminants and identify geographical and methodological heterogeneity.

Introduction

Brucellosis is a bacterial disease mostly of animals caused by gram negative, facultative intracellular coccobacilli belonging to the genus Brucella [1,2]. Though both animals and man are susceptible to the various species of Brucella, B. melitensis has been reported to be the most pathogenic of all the species to man [3]. The disease affects several species of domestic, wild and marine animals [4]. It is mostly characterized by inflammation of the genital organs and foetal membranes. Abortion, sterility, formation of localized lesions in joints and the lymphatic system are also important features of the disease [5,6].

Brucellosis is recognized as one of the neglected tropical zoonotic diseases with a global public health significance [7]. Although the disease been controlled/eradicated in many industrialized nations, it remains prevalent in parts of Asia [8], South America [9] and Africa [10-12]. Small ruminant production plays an important role in the economic improvement of "poor farmers" and contributes to poverty alleviation [13].

Numerous individual seroprevalence studies have been conducted across diverse geographic settings; however, no recent comprehensive synthesis of global data exists for small ruminants. A systematic review and meta-analysis are essential to evaluate the true burden of the disease, inform policy, and prioritize surveillance and control interventions globally.

Objectives

General Objective

To estimate the pooled global seroprevalence of brucellosis in small ruminants (sheep and goats) from published studies.

Specific Objectives

1. To assess the seroprevalence distribution by region, diagnostic method, species (sheep vs goats), and time period.

2. To identify risk factors reported in included studies.

3. To Identify geographic regions with higher prevalence.

4. To Explore methodological differences affecting prevalence estimates (test used, sample size, study setting).

5. To identify gaps in research and propose recommendations for control strategies.

Research Questions and Eligibility Criteria

Research Question (PICO Framework)

1. Population: Small ruminants (sheep and goats)

2. Intervention/Exposure: Natural exposure to Brucella spp.

3. Comparison: Not applicable

4. Outcome: Seroprevalence of brucellosis

Eligibility Criteria

Inclusion Criteria

1. Observational studies (cross-sectional, cohort) reporting seroprevalence of brucellosis in sheep/goats.

2. Peer-reviewed articles published in English or French between 2000 and 2025.

3. Diagnostic methods: Rose Bengal Test, ELISA, Complement Fixation Test, etc.

4. Studies reporting seroprevalence of brucellosis in small ruminants.

5. Cross-sectional or cohort study designs

Exclusion Criteria

1. Experimental studies, reviews, conference abstracts without full text.

2. Studies without clearly stated sample size or prevalence.

3. Studies on animals other than small ruminants or on humans

4. Case reports, reviews, or editorials.

5. Studies without seroprevalence data.

6. Duplicate datasets.

Methods

Protocol and Registration

This protocol follows the PRISMA-P guidelines and will be registered in PROSPERO (International Prospective Register of Systematic Reviews).

Information sources and Search Strategy

Data will be retrieved from electronics and strong Databases: PubMed, Scopus, Web of Science, CAB Abstracts, AJOL, Science Direct, and Google Scholar.

These keywords will be used for searching: "Brucellosis", "seroprevalence", "goats", "sheep", "small ruminants", "systematic review", "meta-analysis".

MeSH terms and Boolean operators:

("brucellosis" OR "Brucella melitensis") AND

("seroprevalence" OR "prevalence") AND ("small ruminants" OR "sheep" OR "goats") AND

("world" OR "global" OR "Africa" OR "Asia" OR "Europe" OR "America")

Grey literature from FAO, OIE, WHO reports will be considered. Search strategies will be adapted for each database.

Data Management and Selection Process

All citations will be imported into Mendeley/Zotero.

1. Two reviewers will independently screen titles and abstracts. Full texts of eligible studies will be assessed. Duplicate records will be removed. Discrepancies will be resolved by a third reviewer.

2. Selection process illustrated using a PRISMA flow diagram.

Data Extraction

A standardized data collection form will be used to extract:

Author(s), year, country; Animal species (sheep/goat); Sample size; Number of positives; Diagnostic method; Study design; Reported risk factors; Seroprevalence (%) or prevalence (%); Study setting (farm/abattoir/market).

Quality Assessment (Risk of Bias)

Quality will be assessed using a modified Joanna Briggs Institute (JBI) checklist for prevalence studies:

1. Sampling method, Sample size, Diagnostic test validity, Clear inclusion/exclusion criteria, Confounding factors addressed

2. A score >70% will be considered high quality. Each study will be evaluated by two reviewers independently.

Data Synthesis and Meta-Analysis

1. Meta-analysis will be conducted using R (meta and metafor packages).

2. Pooled seroprevalence calculated using a random-effects model (DerSimonian and Laird method).

3. Subgroup analyses by continent, species, diagnostic method, countries, and by year intervals (2000–2010, 2011–2020, 2021–2024)

4. Heterogeneity assessed using I^2 statistic and Cochran's Q test.

5. Publication bias assessed via funnel plot and Egger's test.

Ethical Considerations and Dissemination

As this study is based on published data, no ethical approval is required. Results will be published in a peer-reviewed journal and presented at relevant international conferences and shared with global health and livestock development agencies.

Timeline

Activity	Duration
Protocol registration (PROSPERO)	2 weeks
Literature search	3 weeks
Screening and selection	2 weeks
Data extraction and quality appraisal	3 weeks
Data analysis and interpretation	3 weeks
Manuscript writing and submission	3 weeks

Limitations

1. Potential publication bias.

2. Language restriction to English and French.

3. Variability in diagnostic methods and study quality.

Expected Outcomes

1. A pooled global estimate of brucellosis seroprevalence in small ruminants.

2. Regional and species-specific insights to inform One Health interventions (identification of high-risk regions)

3. Identification of research gaps for future studies.

Evidence-based insights for Brucella control programs

References

1. Young EJ (2000) Brucella species. In: Doughlas and Bennett's Principles and Practice of Infectious Diseases. Mandell GL, Bennett JE, Dolin R (eds) *Elsevier Churchill Livingstone, Philadelphia, USA.*

2. Alton GG, Forsyth JRL (2004) Brucella, General Concepts. Medical Microbiology, Fourth edition

3. OIE (2009) Bovine Brucellosis: Terrestrial Manual. *Office International des Epizooties.*

4. Agada CA, Ogugua AJ, Anzaku EJ (2018) Occurrence of brucellosis in small ruminants slaughtered at Lafia Central Abattoir, Nassarawa State, Nigeria. *Sokoto J Vet Sci* [crossref]

5. Franco MP, Mulder M, Gilman RH, Smits HL (2007) Human brucellosis. *Lancet Infect Dis* [crossref]

6. CDC (2005) Brucellosis. Centers for Disease Control and Prevention.

7. OIE (2018) Bovine Brucellosis. In: Terrestrial Manual, Chapter 2.4.3. *Office International des Epizooties*

8. Sofian M, Aghakhani A, Velayati AA, Banifazl M, Eslamifar A, Ramezani A (2008) Risk factors for human brucellosis in Iran: a case-control study. *Int J Infect Dis* [crossref]

9. Dias RA, Gonçalves VSP, Figueiredo VCF (2009) Epidemiological situation of bovine brucellosis in the State of São Paulo, Brazil. *Arq Bras Med Vet Zootec*

10. Bronsvoort BM, Koterwas B, Land F, Handel IG, Tucker J, Morgan KL, Tanya VN, Abdoel TH, Smits HL (2009) Comparison of a flow assay for brucellosis antibodies with the reference cELISA test in West African Bos indicus. *PLoS One* [crossref]

11. Ogugua AJ, Akinseye OV, Ayoola MC, Stack J, Cadmus SIB (2015) Risk factors associated with brucellosis among slaughtered cattle: Epidemiological insight from two metropolitan abattoirs in Southwestern Nigeria. *Asian Pac J Trop Dis* [crossref]

12. Mubanga M, Mfune RL, Kothowa J, Mohamud AS, Chanda C, Mcgiven J, Bumbangi FN, Hang'ombe BM, Godfroid J, Simuunza M, Muma JB (2021) Brucella seroprevalence and associated risk factors in occupationally exposed humans in selected districts of Southern Province, Zambia. *Front Public Health* [crossref]

13. Yakubu A, Salako AE, Imumorin IG (2011) Comparative multivariate analysis of biometric traits of West African dwarf and red Sokoto goats. *Trop Anim Health Prod* [crossref]