INPLASY

Zoonotic pathogens in rodents across Africa: systematic review and meta analysis of prevalence

Corresponding author:
Kokouvi Kassegne

kassegnek@sjtu.edu.cn

Author Affiliation:
Zhejiang University-University of Edinburgh International Institute, China.

Echoru, I; Jones, C; Sanogo, B; Sámano-Sánchez , H; Susan, CW; Kassegne, K.

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INTRODUCTION

Review question / Objective The objective of this systematic review and meta-analysis is to assess the prevalence and patterns of distribution of zoonotic pathogens in rodents across Africa. Using the PICOS framework, the population (P) includes rodents acting as reservoirs of zoonotic pathogens, while the intervention/exposure (I) involves identifying viral, bacterial, and parasitic pathogens reported through recommended tests that include molecular (PCR) and serological (ELISA, MAT) diagnostic methods. The comparison (C) will examined variations in pathogen prevalence across different rodent species, geographic regions, and environmental conditions. The outcomes (O) included pooled prevalence estimates, identification of high-risk rodent hosts, and an evaluation of heterogeneity in pathogen distribution. The study design (S) is a systematic review and meta-analysis of cross-sectional studies published between 2012 and 2023. This study will provide critical insights into the zoonotic spillover risks associated with rodent populations and highlight the need for enhanced surveillance and control strategies to lessen the transmission of rodent-borne infections across Africa.

Rationale Zoonotic diseases pose a significant global health challenge, with rodents playing an important function as reservoir hosts for multiple infectious pathogens. Rodent-borne zoonoses, including viral, bacterial, and parasitic infections, have been implicated in outbreaks of emerging and reemerging diseases. These infections often lead to severe morbidity and mortality, particularly in regions with deficient surveillance and healthcare infrastructure. Despite their public health significance, the prevalence and distribution of zoonotic pathogens in rodents across Africa remain poorly characterized.

Africa is home to a diverse rodent population, many of which live in close proximity to human settlements due to environmental and socioeconomic factors. Rapid urbanization, agricultural expansion, deforestation, and climate variability have increased human-rodent interactions, increasing the risk of zoonotic spillover. Poor sanitation, open waste disposal, and inadequate rodent control further facilitate the persistence and spread of infectious agents. Given these factors, there is an urgent need for assessment of rodent-borne pathogens to identify high-risk areas, key reservoir species, and potential transmission hotspots.

The lack of systematic and region-specific data has hindered the development of targeted surveillance and control strategies. Many studies on rodent-borne zoonoses in Africa are fragmented, focusing on specific pathogens or limited geographic areas, making it difficult to establish broader epidemiological patterns. Additionally, diagnostic capacity remains a major challenge, leading to underreporting and misdiagnosis of zoonotic infections. By synthesizing available data from multiple studies, this systematic review aims to bridge existing knowledge gaps and provide pooled prevalence estimates of rodent-borne zoonotic pathogens across the continent.

A meta-analysis of published studies will allow for an evidence-based evaluation of pathogen prevalence, transmission dynamics, and regional variations. These findings will inform public health policies, early warning systems, and targeted intervention programs, ultimately contributing to improved disease prevention and control efforts in Africa.

Condition being studied Zoonotic diseases represent a critical global health concern. Rodents, in particular, are well-established reservoirs for a variety of zoonotic pathogens, such as viruses, bacteria, and parasites, which can lead to severe health conditions in human populations. The ability of rodents to adapt to diverse environments, from dense urban settlements to rural and agricultural landscapes, increases their role in disease transmission. Their interactions with humans whether through direct contact, contamination of food and water sources, or via ectoparasites such as fleas and ticks facilitate the spillover of zoonotic pathogens, posing a significant public health challenge.

This systematic review focuses on rodent-borne zoonotic diseases in Africa, where the risk of transmission is increased by environmental, socioeconomic, and climatic factors. The health conditions associated with these pathogens can vary widely in severity and clinical manifestation, ranging from mild, self-limiting infections to life-threatening illnesses. Viral zoonoses, such as Lassa fever, hantavirus infections, and orthopoxvirus-related diseases, have been documented across the continent, with some leading to outbreaks characterized by high morbidity and mortality. These viruses are often transmitted through rodent urine, feces, or saliva, contaminating human environments and leading to direct or aerosol exposure.

Bacterial zoonoses such as leptospirosis, bartonellosis, and plague remain significant public health threats. Leptospira spp. infections forinstance can cause leptospirosis, a disease with a wide clinical spectrum, ranging from mild flu-like symptoms to severe complications involving renal failure, jaundice, and pulmonary hemorrhage. Bartonella spp., often transmitted through rodent-associated fleas, have been linked to febrile illnesses, endocarditis, and neurological disorders. The historical and ongoing threat of plague, caused by Yersinia pestis, highlights the enduring risk posed by rodent-associated bacterial pathogens in certain regions of Africa, particularly in areas with poor rodent control and limited healthcare access.

Parasitic infections associated with rodent reservoirs include Trypanosoma lewisi, Schistosoma mansoni, and Leishmania species, among others, all of which can cause devastating diseases in humans. Trypanosoma lewisi, once considered non-pathogenic to humans, has increasingly been reported in cases of febrile illness. Schistosomiasis, caused by Schistosoma mansoni, remains endemic in many African regions, with rodents playing a key role in maintaining its transmission cycle. Leishmania spp., transmitted through sandflies that feed on infected rodents, cause cutaneous and visceral leishmaniasis, diseases that can lead to disfiguring skin lesions and severe systemic infections affecting internal organs.

The geographic distribution and prevalence of these zoonotic pathogens vary across African regions, influenced by climate, land-use changes, human population density, and rodent species diversity. Rapid urbanization, deforestation, and agricultural expansion have increased human-rodent interactions, creating new opportunities for zoonotic spillover.

This review synthesizes current knowledge on the prevalence and distribution of rodent-transmitted pathogens across Africa, identifying high-risk areas, key rodent species, and pathogen hotspots. By providing a comprehensive assessment of rodent-borne pathogens, this study supports evidence-based policies aimed at reducing the

burden of zoonotic infections on African populations.

METHODS

Search strategy The study was carried out in accordance with the PRISMA 2020 checklist. A comprehensive search was conducted via multiple databases, including PubMed, Web of Science, ScienceDirect, Scopus, EMBASE, and Google Scholar, in September 2023. The key MeSH terms included "rodents," "zoonoses," "pathogens," and "Africa," with additional synonyms such as "rats," "mice," and "rodentia" for rodents and "viruses," "bacteria," and "parasites" for pathogens. Boolean operators (AND, OR) were used to combine terms, capturing a wide range of zoonotic infections in rodent populations.

PubMed
rodents: "rodent's"[All Fields] OR "rodentia"[MeSH Terms] OR "rodentia"[All Fields] OR "rodent"[All Fields] OR "rodents"[All Fields]
zoonoses: "zoonoses"[MeSH Terms] OR "zoonoses"[All Fields] OR "zoonose"[All Fields]
Africa: "africa"[MeSH Terms] OR "africa"[All Fields] OR "africa's"[All Fields] OR "africas"[All Fields]
Scopus
(ALL (rodents) AND ALL (zoonoses) AND TITLE-ABS-KEY (africa)) AND PUBYEAR > 2011 AND PUBYEAR < 2024AND (LIMIT-TO (LANGUAGE , "english")) AND (LIMIT-TO (EXACTKEYWORD , "animals") OR LIMIT-TO (EXACTKEYWORD , "animal") OR LIMIT-TO (EXACTKEYWORD , "article"))
EMBASE
Africa/ and zoonosis/ and rodent/ (2012-2023)
ScienceDirect
rodents, zoonosis, africa (2012-2023)
Web of Science
rodents (All Fields) AND zoonosis (All Fields) AND africa (All Fields) and 2016 or 2017 or 2018 or 2019 or 2020 or 2021 or 2022 or 2023 or 2015 or 2014 or 2013 or 2012 (Publication Years) and Article (Document Types)
Querry link: https://www.webofscience.com/wos/woscc/summary/73e90630-a94e-4141-8e7c-281dcc432949-edb3d727/relevance/1
Google scholar
((((ALL=(rodent)) AND ALL=(zoonotic)) OR ALL=(zoonoses)) OR ALL=(zoonosis)) AND ALL=(Africa).
To determine whether a study met the inclusion criteria, two independent reviewers (I.E. and B.S.) screened each record retrieved from the literature search. Initially, titles and abstracts were assessed for relevance based on predefined inclusion and exclusion criteria. Studies that met the preliminary screening criteria were then subjected to a full-text review. Reasons for the exclusion of some studies were missing data on sample sizes, studies carried out in multiple countries, reviews/theses, studies not in Africa, experimental studies, and non-rodent studies.

The review excludes:
• Studies that focus on non-rodent species (e.g., bats, primates).
• Experimental studies using laboratory rodents.
• Studies that lack prevalence data or diagnostic confirmation of zoonotic pathogens.
• Research was conducted outside of Africa.

Participant or population This systematic review focuses on wild rodent populations in Africa as the primary focus. Rodents are known reservoirs of zoonotic pathogens, and their role in disease transmission is crucial for understanding public health risks. The review includes studies that investigate:
Rodents species carrying viral, bacterial, and parasitic zoonotic pathogens are included, provided that the studies use molecular (PCR) or serological (ELISA, MAT) diagnostic methods to confirm pathogen presence.
The review includes studies conducted in all African regions (North, West, East, Central, and Southern Africa) to assess spatial distribution and prevalence patterns.

Intervention Not applicable.

Comparator Not applicable.

Study designs to be included A systematic review and meta-analysis were conducted in accordance with the PRISMA 2020 guidelines, ensuring methodological precision and transparency. The study design followed a structured approach to systematically identify, assess, and synthesize existing literature on the prevalence and distribution of zoonotic pathogens in rodents across Africa. The review focused on cross-sectional studies, as they provide direct prevalence estimates of zoonotic pathogens in rodents across different geographical regions. Cross-sectional studies offer a snapshot of disease burden at a given time.

Eligibility criteria Inclusion criteria:
• Cross-sectional studies published between January 2012 and July 2023.
• Studies reporting primary data on zoonotic pathogens in rodents.
• Studies using molecular (PCR) or serological (ELISA, MAT) diagnostic methods.
• Research conducted exclusively in Africa.

• Studies providing pathogen prevalence estimates with sufficient sample size.

Exclusion criteria:
• Review articles, theses, dissertations, conference proceedings.
• Experimental laboratory studies with captive or genetically modified rodents.
• Studies involving non-rodent hosts or lacking relevant zoonotic pathogen data.
• Research conducted outside Africa or studies combining data from multiple continents without regional specificity.

Information sources To ensure a wide and unbiased review, multiple information sources were utilized to identify relevant studies on zoonotic pathogens in rodents across Africa. The sources included electronic databases.

A systematic search was conducted across multiple high-impact scientific databases to retrieve peer-reviewed studies published between January 2012 and July 2023. The following databases were used:

PubMed, Web of Science; ScienceDirect; Scopus; EMBASE and Google Scholar.

Main outcome(s) We collected data on multiple outcomes to assess the prevalence and distribution of zoonotic pathogens in rodents across Africa. The outcomes were categorized into three main domains: pathogen prevalence, rodent species involvement, and geographical distribution.

For each outcome, a random effect model measure was used.

Additional outcome(s) None.

Data management Two independent reviewers extracted data using a structured data extraction form.

The extracted variables included:

Study characteristics (authors, year, location, sample size).

Rodent species involved.

Pathogen type (viral, bacterial, parasitic).

Diagnostic methods used.

Prevalence data (number of positive cases, total tested, pooled estimates).

Microsoft Excel (version 16.84) and R software (version 4.3.1) were used for data organization and analysis.

Quality assessment / Risk of bias analysis The eligibility of each full-text article was independently assessed by both reviewers using a modified Newcastle-Ottawa quality scale, which evaluated

study selection, comparability, and outcome assessment. Any disagreements between the two reviewers were resolved through formal discussion. If consensus could not be reached, a third reviewer was consulted to provide a final decision. No automation tools were used in the screening process; all assessments were manually conducted to ensure accuracy and adherence to inclusion criteria.

Strategy of data synthesis A random-effects meta-analysis model was applied to estimate pooled pathogen prevalence.

Pathogen prevalence was expressed as pooled prevalence with 95% confidence intervals (CI) using the inverse-variance method.

Forest plots were created to display individual study estimates and pooled prevalence with 95% CIs.

Heterogeneity analysis was assessed using the Cochran's Q statistic, the I^2 statistic, and the DerSimonian-Laird estimator for tau² (τ^2) using meta-regression analysis.

Publication Bias was evaluated using Egger's test and funnel plots for asymmetry.

Funnel plots were used to visualize publication bias, where asymmetry suggested potential reporting bias.

Subgroup comparisons were conducted based on geographical regions, rodent species, and pathogen type.

Sensitivity analysis was conducted to assess the robustness of the findings.

The level of certainty was determined using the grading system, which evaluated five key factors (risk of bias, inconsistency, indirectness, imprecision, and publication bias).

Subgroup analysis To explore variations in zoonotic pathogen prevalence among rodent populations across Africa, subgroup analyses were conducted based on geographical regions, rodent species, and pathogen type. These subgroup comparisons provided insights into regional differences, host-specific pathogen distributions, and transmission dynamics.

Sensitivity analysis Sensitivity analysis was conducted to assess the strenght and reliability of the meta-analysis results by systematically excluding individual studies and evaluating the impact on pooled prevalence estimates. This approach helped determine whether any single study disproportionately influenced the overall findings and assessed the stability of effect sizes across different pathogen groups (viruses, bacteria, and parasites).

Language restriction This systematic review included only English-language studies to ensure consistency, quality control, and accuracy in data extraction and interpretation.

Country(ies) involved The study is being carried out in China. Authors originate from Uganda, Togo, Mali, Mexico and United Kingdom.

Keywords zoonoses; pathogens; rodents; onehealth; viruses; bacteria; parasites; Africa.

Contributions of each author
Author 1 - Isaac Echoru - Conceptualized and designed the study; screened the electronic literature search results for relevant manuscripts and assessed their eligibility; extracted, analyzed, and interpreted the data; created figures and tables; and wrote the first draft of the manuscript.
Email: isaac.22@intl.zju.edu.cn
Author 2 - Caitlin Jones - Editing, verifying, and validating the data.
Email: jones.19@intl.zju.edu.cn
Author 3 - Benjamin Sanogo - Literature search and Eligibility check.
Email: benjamin.20@intl.zju.edu.cn
Author 4 - Hugo Sámano-Sánchez - Editing, verifying, and validating the data.
Email: samano@intl.zju.edu.cn
Author 5 - Susan Christina Welburn - Conceptualization, editing, funding acquisition, and supervision.
Email: sue.welburn@ed.ac.uk
Author 6 - Kokouvi Kassegne - Conceptualization, editing, funding acquisition, and supervision.
Email: kassegnek@sjtu.edu.cn