Jurnal Medik Veteriner
DOI: 10.20473/jmv.vol8.iss2.2025.489–503
October 2025, Vol.8 No.2, 489–503
online at https://e-journal.unair.ac.id/JMV

Quantifying Zoonotic Risk from Cats (*Felis catus*, Felidae: Carnivora): A Systematic Meta-Analysis of Pathogen Prevalence

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Abstract

Cats are known to be potential reservoirs for a variety of zoonotic pathogens. However, the overall prevalence of zoonotic pathogens in the cat population remains unclear amid growing concerns. This study aimed to measure the combined prevalence of zoonotic pathogens in cats through a systematic review and meta-analysis. Relevant literature reporting the prevalence of zoonotic pathogens in cats, published from 2015 to 2025, was collected from databases. A total of 49 studies met the inclusion criteria, encompassing a total sample size of 18,206 cats. A meta-analysis was performed using a random-effects model. *Toxoplasma gondii*, *Bartonella henselae*, and *Campylobacter spp.* were the most frequently reported pathogens, with pooled prevalence estimates presented with 95% confidence intervals (CIs). The I^2 statistic was used to assess heterogeneity. The combined prevalence of zoonotic pathogens in cats was estimated at 24% (95% CI: 17–32%). Considerable heterogeneity was observed among the studies (I^2 = 98.4%, $p < 0.001$), and this likely reflects differences in geographic region, diagnostic methods, and pathogen type. Individual study prevalences ranged from 0.02 to 0.97, with varying weights according to sample size and variance. This meta-analysis highlights the relatively high prevalence of zoonotic pathogens among cats. The relevance of applying a One Health perspective is emphasized by these findings for the development of evidence-based public health policies to reduce zoonotic risks at the community and global levels.

Keywords: cats, meta-analysis, pathogen prevalence, public health, zoonosis

Received: July 5, 2025 **Revised:** August 23, 2025 **Accepted:** September 23, 2025

INTRODUCTION

One of the most significant challenges in global health is zoonosis (Handoko, 2025). The cat (*Felis catus*), as a companion animal, is one of the most widespread domestic species worldwide (Handoko and Agusthusana, 2024). Because cats live in the same environment as humans, they are likely to be the main source of pathogens that infect people (Collela *et al*., 2020). Cats occupy a unique position in the ecology of zoonotic pathogens (Springer *et al*., 2020) due to their close contact with humans, free-roaming behavior, and frequent exposure to potentially infectious prey or environments. However, their role in zoonotic transmission remains under-recognized (Szentivanyi *et al*., 2024).

The shared environment between cats and humans across diverse regions and socioeconomic contexts means that cats play a significant role in the transmission of zoonoses, warranting consideration in public health strategies (Nguyen *et al*., 2021; Andityas *et al*., 2024). However, it is important to acknowledge that evidence on the prevalence of zoonotic pathogens in cats is limited and highly variable,

likely influenced by numerous factors such as geographic location, diagnostic methods, host characteristics, and local environmental conditions (Sharma *et al*., 2023; Neves *et al*., 2020). Raising awareness among animal health and public health professionals is essential to inform prevention and control measures informed by adequate epidemiological knowledge.

Despite the abundance of research on zoonotic pathogens in cats, the evidence base remains fragmented, often pathogen-specific, and limited by geographic boundaries. Consequently, the global prevalence of zoonotic pathogens in cats remains unclear, particularly across regions, pathogen types, and diagnostic techniques. Therefore, this study systematically reviewed the literature and conducted a meta-analysis to provide a global estimate of the prevalence of zoonotic pathogens in cats, while assessing heterogeneity related to pathogen types, diagnostic methods, and geographic settings.

MATERIALS AND METHODS

Ethical Approval

This study is a secondary analysis of previously published data; therefore, ethical approval was not required. No new data were collected from human or animal subjects. All studies selected and reviewed were assumed to have obtained appropriate ethical clearance at the time of initial data collection.

Study Period and Location

This study was conducted for four months, from January to April 2025. Data collection and extraction were conducted at the Pathology, Entomology and Microbiology Laboratory, Faculty of Agriculture and Animal Science, State Islamic University of Sultan Syarif Kasim Riau, and the Department of Veterinary Medicine, Faculty of Medicine, Universitas Riau, located in Pekanbaru, Indonesia.

Table 1. Search strategy and Boolean terms applied in database searches

Database	Search Terms/Keywords	Boolean Operators	Filters/Limits
PubMed	("zoonotic diseases"[MeSH] OR "zoonoses"[MeSH]) AND ("pets"[MeSH] OR "dogs"[MeSH] OR "cats"[MeSH] OR "companion animals"[MeSH]) AND ("prevalence"[MeSH] OR "epidemiology"[MeSH]) AND ("cross-sectional studies"[MeSH] OR "cohort studies"[MeSH] OR "case-control studies"[MeSH]) NOT ("review"[Publication Type] OR "systematic review"[Publication Type] OR "meta-analysis"[Publication Type])	AND / OR / NOT	MeSH terms; exclude publication types: review, systematic review, meta-analysis
Google Scholar	("zoonotic disease*" OR "zoonoses") AND ("companion animal*" OR "pet*" OR "dog*" OR "cat*") AND ("prevalence" OR "epidemiology" OR "seroprevalence") AND ("cross-sectional study" OR "cohort study" OR "case-control study") NOT ("review" OR "systematic review" OR "meta-analysis")	AND / OR / NOT	Search across all fields; exclude review, systematic review, and meta-analysis

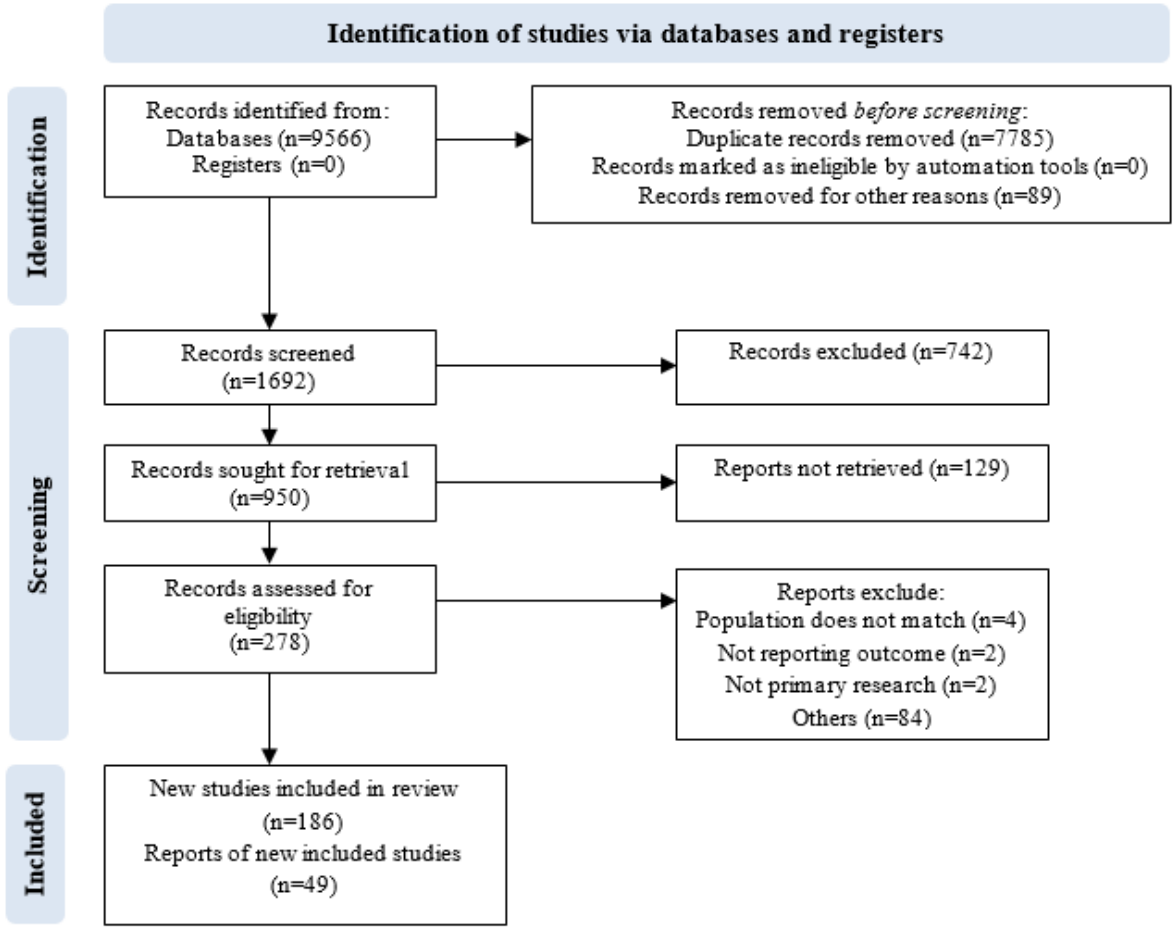

Figure 1. Number of articles selected regarding the global prevalence of zoonotic pathogen in cats (n = 49 studies).

Table 2. JBI critical appraisal checklist for analytical cross-sectional studies

Questions	Answers
Were the criteria for inclusion in the sample clearly defined?	Y, N, U, NA
Were the study subjects and the setting described in detail?	Y, N, U, NA
Was the exposure measured in a valid and reliable way?	Y, N, U, NA
Were objective, standard criteria used for measurement of the condition?	Y, N, U, NA
Were confounding factors identified?	Y, N, U, NA
Were strategies to deal with confounding factors stated?	Y, N, U, NA
Were the outcomes measured in a valid and reliable way?	Y, N, U, NA
Was appropriate statistical analysis used?	Y, N, U, NA

Y: yes, N: no, U: unclear, NA: not applicable.

Procedure

This systematic review and meta-analysis study was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page *et al*., 2021). A comprehensive search of scientific articles was conducted using electronic databases including PubMed which provides extensive coverage of biomedical and related studies, and Google Scholar which offers broad cross-disciplinary indexing. Technically, Boolean search terms were used in the search for these articles (Table 1). A manual search of the reference lists was also performed to identify additional eligible studies. Zoonotic risk in this review is operationally defined as the prevalence of zoonotic pathogens detected in cats, as reported in eligible studies. An indication of potential

transmission to humans is provided by using prevalence estimates as a proxy measure of risk.

The studies collected were considered eligible if they met the following criteria: (1) population: studies reporting zoonotic pathogens (bacteria, viruses, parasites, fungi, and so on) in cats, and must be original data; (2) outcome: studies providing quantitative data on prevalence or epidemiological measures of zoonotic pathogens; (3) study type: original research articles employing observational designs; (4) language: articles published in English; and (5) time frame: published between January 2015 and January 2025. The exclusion criteria are as follows: (1) study type: reviews, systematic reviews, meta-analyses, case reports, and experimental infection studies; (2) outcome: studies not reporting prevalence data, or without sufficient detail to extract relevant information; and (3) publication type: abstracts, editorials, conference proceedings, and non-peer-reviewed sources. Pathogen subgroup analysis was not performed due to insufficient and inconsistent data across the included studies.

Evaluation

Considering that these studies were based on previously published data, the evaluation phase involved detailed re-analysis and standardization of the reported findings of the reviewed studies. Critical evaluation of the studies involved was performed regarding the type of diagnostic methods used, laboratory procedures, and field assessments as described in the original article.

Data Collection

Three independent reviewers screened the titles and abstracts, followed by full-text evaluation. Discussion was conducted if any discrepancies were found. Extracted data included author names and year of publication, study location, sample size, number of positive cases, diagnostic methods and pathogen types.

Data Analysis

Proportional meta-analysis was performed with R Studio (R.4.4.3) with library (meta) (Viechtbauer, 2010). Meta-analysis of proportions was calculated by [Number of Event] / [Total Observed Sample]. Forest plots were utilized to visualize the results of meta-analysis in random-effects model (REM). A random-effects model was applied to quantify the expected heterogeneity across studies in terms of study population, geographic setting, pathogen type, and diagnostic technique. For clarity, a random-effects model was used throughout the analysis. We analyzed heterogeneity between studies using I^2. It is stated that there is heterogeneity between studies when the I^2 value is more than 65%. To assess the quality of the risk of bias of the included studies. We employed the Joanna Briggs Institute (JBI) checklist according to the study design. A standard checklist from the Joanna Briggs Institute (JBI) (Table 2) was adapted and used for quality assessment (Moola *et al*., 2020; Wada *et al*., 2021). Two reviewers independently assessed the risk of bias. Disagreements were resolved through discussion, and when consensus was not reached a third reviewer was consulted to make a final decision.

RESULTS AND DISCUSSION

A total of 49 studies met the inclusion criteria after a systematic screening and eligibility process (Figure 1). These studies were conducted in various countries and collectively represented data from 18,206 cats. All selected studies reported prevalence of at least one zoonotic pathogen in cats using laboratory-based or rapid diagnostic methods, as specified in the inclusion criteria. A comprehensive overview of the global prevalence of zoonotic pathogens in cats, based on studies published from 2015 to 2025, is presented in Table 3.

There are 37 types of zoonotic pathogens detected in 49 studies covering several groups such as protozoa, bacteria, viruses, worms and fungi. The percentage of the number of studies examining each pathogen is presented in Figure 2.

Methodological quality assessment using the JBI critical appraisal checklist for analytical cross-sectional studies revealed that the majority of studies had moderate and high methodological quality, 32 studies and 10 studies, respectively.

Table 3. Descriptive data on the global prevalence of zoonotic pathogens in cats

Authors	Country	Total Samples	Positive (%)	Technique
Cong *et al*. (2018)	China	180	39 (21.66)	Indirect hemagglutination test
Lecca *et al*. (2020)	Brazil	1411	118 (8.36)	Mycological culture
Mazotta *et al*. (2024)	Italy	257	114 (44.35)	Microagglutination test
Mazotta *et al*. (2024)	Italy	389	272 (69.92)	Microagglutination test
Souza *et al*. (2023)	Brazil	55	34 (61.81)	Sedimentation and flotation
Bojanić *et al*. (2016)	New Zealand	110	48 (43.63)	Multi-locus sequence typing
Kumar *et al*. (2017)	Malaysia	90	13 (14.44)	Enzyme-Linked Immunosorbent Assay (ELISA)
Scorza and Lapin (2017)	USA	32	14 (43.75)	Polymerase Chain Reaction (PCR)
Saru *et al*. (2022)	Nepal	36	17 (47.22)	Ectoparasite identification
Elmonir *et al*. (2023)	Egypt	1694	385 (22.72)	Copro-PCR
Turcotte *et al*. (2021)	Canada	59	3 (5.08)	ELISA, q-PCR
Villanueva-Saz *et al*. (2024)	Spain	183	4 (2.18)	ELISA
Teng *et al*. (2024)	China	54	5 (9.25)	Multi-locus sequence typing
Poulle *et al*. (2017)	France	147	61 (41.49)	q-PCR
Sawitri *et al*. (2024)	Indonesia	354	324 (91.52)	Sugar flotation technique
Gonzales *et al*. (2022)	Peru	303	52 (17.16)	Indirect hemagglutination
Villeneuve *et al*. (2015)	Canada	636	164 (25.78)	Sucrose solution double centrifugal flotation technique
Fayez *et al*. (2023)	Saudi Arabia	400	165 (41.25)	Antimicrobial Susceptibility test
Holzapfel *et al*. (2021)	French West Indies	92	34 (36.05)	Microagglutination test
Abdulwahab and Al-Thalib (2024)	Malaysia	75	24 (32.00)	Commercial Parasep tube floatation method
Etter *et al*. (2019)	South Africa	109	35 (32.11)	Latex agglutination test
Nugroho *et al*. (2024)	Timor-Leste	255	185 (72.54)	Kirby–Bauer disk diffusion
Li *et al*. (2024)	China	898	25 (2.78)	PCR
Sayed *et al*. (2022)	Egypt	75	6 (8.00)	PCR
Symeonidou *et al*. (2018)	Greece	278	98 (35.25)	Sedimentation and flotation
Rezaiemanesh *et al*. (2019)	Iran	236	82 (34.74)	ELISA
Mukutmoni *et al*. (2022)	Bangladesh	216	13 (1.38)	Double centrifugal flotation
Attipa *et al*. (2021)	Cyprus	155	50 (32.25)	ELISA

Lakhamsen *et al*. (2022)	Thailand	100	5 (5.00)	Rapid-Immunochromatographic Test (ICT)
Bourassi *et al*. (2021)	Canada	200	20 (10.00)	Microagglutination test
Fritz *et al*. (2025)	France	2036	189 (9.28)	Microsphere Immunoassay
Duijvestijn *et al*. (2023)	Netherland	407	11 (2.70)	ELISA
Mūrniece *et al*. (2024)	Latvia	273	10 (3.66)	Real-time PCR, ELISA
Köseoğlu *et al*. (2022)	Turkiye	1012	59 (5.83)	PCR
Hossein *et al*. (2022)	Iran	120	13 (10.83)	Sedimentation and Ziehl-Neelsen staining
Tangtrongsup *et al*. (2020)	Thailand	66	26 (39.39)	Centrifugal flotation and Immunofluorescence Assay (IFA)
Njuguna *et al*. (2017)	Kenya	103	53 (51.45)	Standard parasitological methods
Hegarty *et al*. (2015)	USA	715	60 (8.39)	Serological assay and PCR
Little *et al*. (2015)	USA	351	119 (33.90)	Flotation
Elnageh *et al*. (2021)	Libya	151	24 (15.89)	Bacterial cultures
Rocha *et al*. (2019)	Brazil	105	32 (30.47)	Indirect Fluorescent Antibody Test (IFAT)
Aurin *et al*. (2020)	Bangladesh	323	169 (52.32)	Concentration technique
Veyna-Salazar *et al*. (2023)	Mexico	200	50 (25.00)	Flotation technique
Alonte *et al*. (2024)	Philippines	33	31 (93.93)	Multiplex Real-time PCR
Sepúlveda-García *et al*. (2023)	Chile	324	66 (20.37)	Quantitative PCR
Brennan *et al*. (2020)	Australia	417	163 (39.08)	ELISA
Hassanien *et al*. (2021)	Egypt	600	8 (1.33)	Fungal cultures
Núñez *et al*. (2021)	Mexico	1591	906 (56.94)	Direct smear
Kakita *et al*. (2021)	Japan	241	40 (16.59)	PCR
Yurayart *et al*. (2024)	Thailand	59	27 (45.76)	PCR

Conversely, only a small number (7 studies) of studies did not meet the assessment standards (Figure 3).

The prevalence of zoonotic pathogens in cats collected from various studies has been calculated for heterogeneity. The forest plot in Figure 4 shows the results of the heterogeneity analysis. From a total of 18,206 cats, the pooled prevalence of the reviewed studies was estimated to be 24% (95% CI: 17–32%), using a random effects model.

This meta-analysis presents the first global synthesis of the prevalence of zoonotic pathogens in cats. The reported prevalence of zoonotic pathogens in cats varies widely, ranging from the lowest in Egypt (Hassanien *et al*., 2021) to the highest in the Philippines (Alonte *et al*., 2024). Three separate studies with different methodologies and results were from China reported by Cong *et al*. (2018), Li *et al*. (2024) and Teng *et al*. (2024). A wide range of prevalence across studies was seen in Brazil (Rocha *et al*., 2019; Lecca *et al*., 2020; Souza *et al*., 2023). To our knowledge, no previous study has measured the combined prevalence of multiple zoonotic pathogens in cats worldwide. Previous studies have generally focused on specific pathogens (e.g., *Toxoplasma gondii* or *Bartonella henselae*) or on specific geographic regions or diagnostic approaches.

Across all studies, there was a high variation in the diagnostic techniques used, which may have influenced detection rates. ELISA, PCR-based tests, flotation techniques, and microagglutination tests were all commonly used

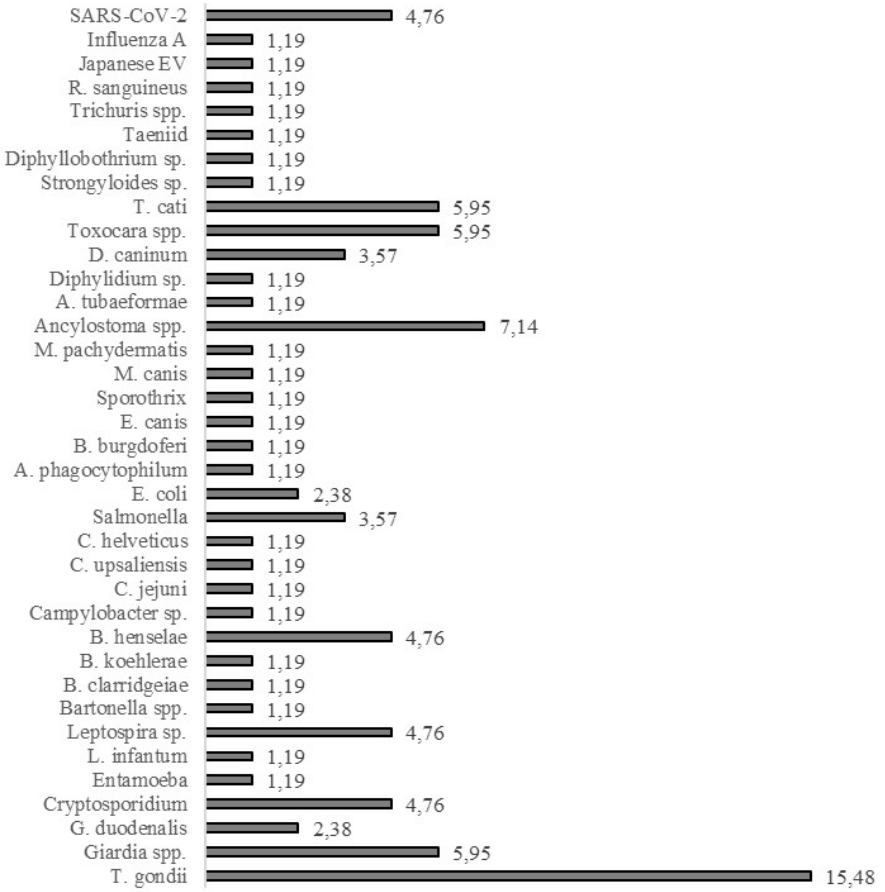

Figure 2. Percentage (%) of articles that reported the presence of each type of zoonotic pathogen in cats (n = 49 studies, 37 pathogens).

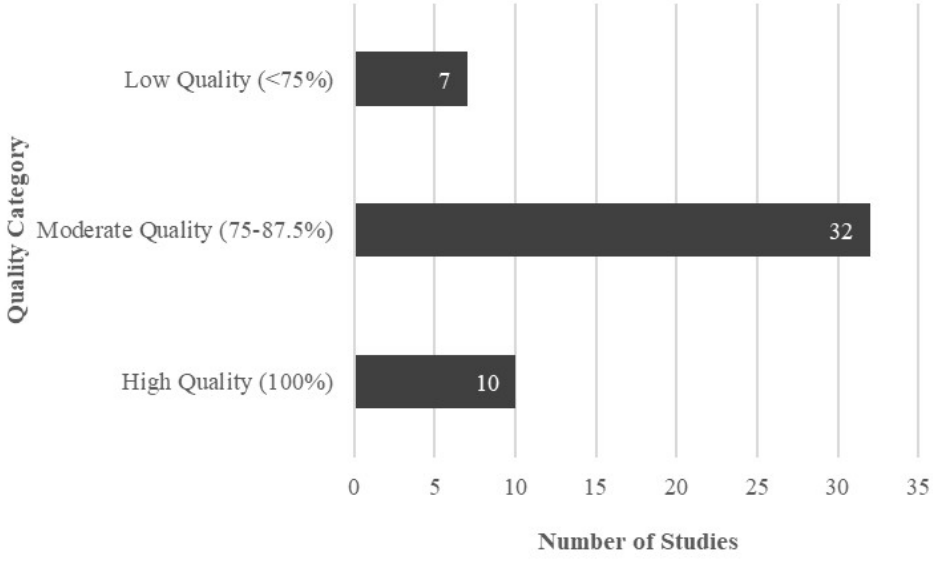

Figure 3. Average and percentage of each type of answer on the JBI critical appraisal checklist (n = 49 studies).

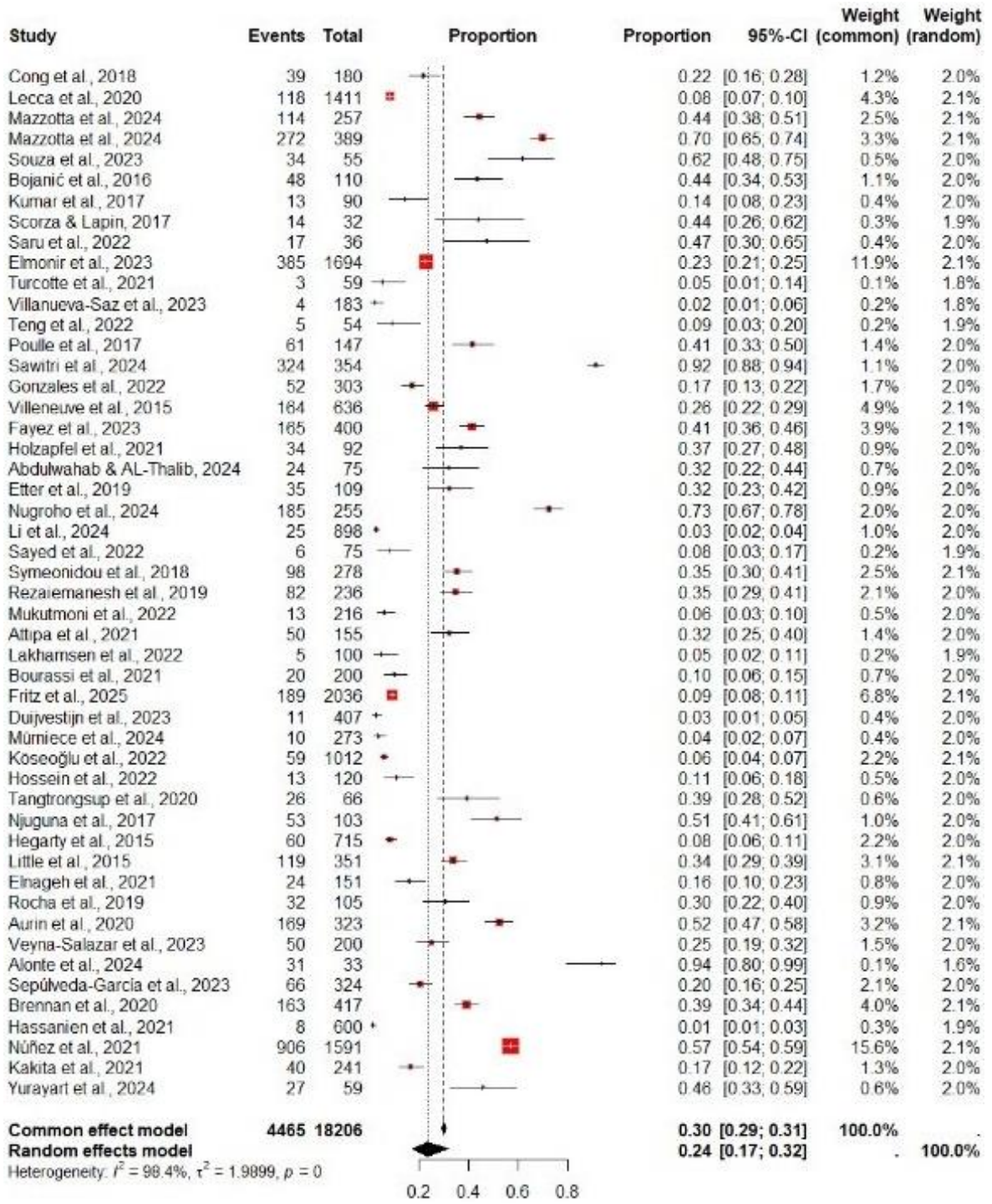

Figure 4. Forest plot of pooled prevalence estimates of zoonotic pathogens in cats (n = 49 studies). Error bars represent 95% confidence intervals.

by researchers. There was a trend toward higher prevalence in some regions when studies used sensitive molecular techniques, such as multiplex RT-PCR or qPCR (Alonte *et al*., 2024; Poulle *et al*., 2017; Scorza and Lapin, 2017; Yurayart *et al*., 2024). However, in some contexts, traditional methods such as flotation and direct swabs also yielded high detection rates. Local pathogen load or sampling strategies may also play a role. In general, and specifically for parasitic pathogens, flotation or direct smear examination showed the highest prevalence rates observed in studies such as those conducted in Indonesia (Sawitri *et al*., 2024), the Philippines (Alonte *et al*., 2024), and Mexico (Núñez *et al*., 2021). The flotation method with a loop wire carried out by Takano *et*

al. (2024) ensures that this method is simple, time-saving and can be applied to estimate the number of eggs or worm oocytes per gram of sample (feces).

Geographically, the main contributors to this prevalence data are Brazil, Mexico, and the US (Americas) and Indonesia, Bangladesh, and China (Asia). For the European region, prevalence rates often exceed 30%, such as in Italy (Mazotta *et al*., 2024), France (Poulle *et al*., 2017), and Greece (Symeonidou *et al*., 2018), thus providing significant data as well. African countries appear underrepresented, with moderate to high prevalence rates seen in South Africa (Etter *et al*., 2019) and Kenya (Njuguna *et al*., 2017). Overall, significant variability is seen in the prevalence data of zoonotic pathogens in cats across countries and diagnostic methods. This highlights the importance of methodological consistency and regional surveillance in understanding the true burden of zoonoses in cat populations.

Most of the included studies reported the presence of *T. gondii*. This indicates that this protozoan is the most frequently identified zoonotic pathogen in cats. This may be particularly important. For example, a review by Rabaan *et al*. (2023) of 95 studies found that 34.8% of *T. gondii* seropositive women had a history of physical contact with cats. The prevalence of *T. gondii* of more than 30% in cats was reported by Brennan *et al*. (2020) in Australia, Attipa *et al*. (2021) in Cyprus, and Abdulwahab and Al-Thalib (2024) in Malaysia. The seroprevalence of *T. gondii* in owned cats was reported to be lower than in adopted stray cats (Lakhamsen *et al*., 2022; Firdausy *et al*., 2025). Some other parasites including *Giardia* spp., *Toxocara* spp., *Ancylostoma* spp., and *Dipylidium caninum* were reported in lower prevalence. These findings reflect well-represented parasitic infections, reflecting the continued relevance of gastrointestinal parasites as a public health problem due to their fecal-oral transmission route. A review conducted by Barılı *et al*. (2023) summarized that the prevalence of *Toxoplasma* sp., *Giardia* spp., *D. caninum*, and *Toxocara* spp., in cats is higher compared to other parasites.

There are only two zoonotic fungal pathogens, *Microsporum canis* and *Sporothrix* whose prevalence has been reported. This is a very small proportion; however, dermatophytes such as *M. canis* are frequently found clinically in cats diagnosed with dermatophytosis (Moskaluk and VandeWoude, 2022; Gupta *et al*., 2025). Zoonotic fungi such as *Sporothrix* are also ubiquitous and present globally (Barrs *et al*., 2024). This supports the known zoonotic potential, especially in household and shelter environments.

Lower study frequencies were shown by bacterial pathogens, for example *B. henselae*, the causative agent of cat scratch disease, *Salmonella* spp. and *Campylobacter* spp. This possibly reflects under-reporting or diagnostic challenges. However, salmonellosis affects around 1.3 billion people each year and is associated with fecal contamination of pets, including cats, making it a global health problem (Dróżdż *et al*., 2021).

Zoonotic viral pathogens also appear to be poorly documented in studies. Prevalence data of SARS-CoV-2 in cats were reported low (Duijvestijn *et al*., 2023; Fritz *et al*., 2025; Mūrniece *et al*., 2024) in 4.76% of studies. This is interesting, perhaps due to limited surveillance of viral zoonoses in the cat host or due to very low prevalence in the sample population. The role of cats in the spread of SARS-CoV-2 appears to be limited, and to date there is no evidence of SARS-CoV-2 circulation among cats, but this remains a concern due to the unpredictable evolution of the virus (Doliff and Martens, 2022). Regarding the results of JBI critical appraisal, the findings emphasize that comprehensive and transparent reporting in primary studies is essential to improve the reliability of critical appraisal. Although the proportion of "Yes" answers is relatively high and encouraging, the presence of "Unclear" items calls for increased clarity and completeness in methodological descriptions.

Of the 37 types of zoonotic pathogens identified by all included studies, the parasite *T. gondii*, the bacteria *B. henselae*, and *Campylobacter* spp. are the three most frequently investigated zoonotic pathogens. To a lesser extent, several viral and fungal agents have also

been investigated. In addition to the overall burden, these findings also highlight the diversity of zoonotic pathogens carried by cats. These data certainly highlight the substantial zoonotic burden associated with the cat population. Peterson and Barnes (2020) found that zoonotic transmission between humans and cats has been, and continues to be, prevalent. The welfare of both species must be considered in addressing this public health threat, regardless of the education and intervention strategies implemented. The development of effective control strategies needs to be carried out with rapid monitoring and supervision by the government and accompanied by data dissemination (Abbas *et al*., 2022).

The highest prevalence was seen in the study by Sawitri *et al*. (2024), possibly reflecting a hyperendemic areas, with persistently high levels of pathogen transmission, setting or more sensitive and specific diagnostic techniques. In contrast, there was a relatively low prevalence reported by Villanueva-Saz *et al*. (2024), possibly due to low exposure to the pathogen or differences in sampling. Larger sample sizes, such as in the study conducted by Elmonir *et al*. (2023) with a total sample of 1,694, tend to show higher accuracy, which naturally contributes to overall heterogeneity. This emphasizes that pathogen circulation is greatly influenced by local epidemiological conditions. There are several possibilities that cause very high heterogeneity, including differences in sensitivity of the diagnostic techniques used, local epidemiological context, and study design. Serological techniques appear to provide higher prevalence estimates than molecular techniques, and this is one reason for the high variability. Similarly, cat husbandry practices, local epidemiological variations, and environmental conditions in which cats live can further exacerbate heterogeneity across studies. Subgroup or sensitivity analyses would be a solution to clarify the extent to which these factors influence prevalence estimates; however, such analyses were not feasible in this study due to limited and inconsistent data reporting. Identification of potential sources of heterogeneity was made difficult by the lack of detailed and standardized reporting, so pooled estimates should be interpreted with caution. For future studies, more comprehensive descriptions of study characteristics should be provided. This is important to facilitate more accurate analyses and improve comparability across research settings.

A limitation of this review is that the study search was limited to PubMed and Google Scholar. Limited access to other databases such as Scopus, Web of Science, or Embase may have overlooked studies indexed exclusively in these databases. Despite these limitations, the selected databases ensured extensive coverage of the biomedical and interdisciplinary literature. Potential bias was also minimized by a systematic search strategy.

It should be acknowledged that the possibility of publication bias cannot be completely ruled out, given that statistically significant study results are more likely to be published, which may lead to an overestimation of the true prevalence. Variations in the quality of included studies also potentially impact the pooled estimate. Furthermore, despite a comprehensive search strategy across multiple databases, it is possible that some relevant studies were missed, particularly those published in languages other than English. These factors should be considered when interpreting the findings.

It is confirmed that cats have an important role as reservoirs for various zoonotic pathogens globally. From a public health perspective, the high prevalence of zoonotic pathogens in cats underscores the need for greater integration of animal health, particularly for cats, into the One Health framework. Surveillance programs should incorporate standardized diagnostic techniques and ensure regional representation to reduce bias.

CONCLUSION

Substantial variability in prevalence across regions, pathogen types, and diagnostic methods has been revealed in the global picture of zoonotic pathogens in cats. This suggests a significant relevance between the role of cats as reservoirs of zoonotic infections and public health. Regional

surveillance systems that can capture local epidemiological patterns, as well as the implementation of standardized diagnostic protocols to ensure better comparability between studies, need to be strengthened to effectively address this risk. Furthermore, within the One Health framework, these measures should be implemented to enhance policymakers and public health authorities' ability to design evidence-based interventions. This is where efforts to prevent and control zoonotic diseases at the human-animal-environment interface become evident.

ACKNOWLEDGEMENTS

Our deepest gratitude goes to the researchers and authors of the primary studies included in this analysis, as their work is the basis of this research. We greatly respect and appreciate their contributions to the scientific community. We would also like to thank our colleagues and reviewers for their constructive comments and critical feedback to improve the quality and clarity of this manuscript. This research was financially supported by Dr J Veterinary Clinic, Pekanbaru, Indonesia, whose contribution is gratefully acknowledged.

AUTHORS' CONTRIBUTIONS

JH conceptualized the study, conducted the literature search, and drafted the manuscript. AMS conceptualized the study, extracted data, and performed statistical analysis. SS facilitated the initial project idea. TP and SI critically reviewed and revised the manuscript. YS, RM, and EA contributed to the literature search. All authors have read and approved the final version of the manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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