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Risk factors for Toxoplasma gondii infection in pregnant women living with or without HIV: A systematic review and meta-analysis

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Review Stage at time of this submission - The review has not yet started.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 September 2026 and was last updated on 16 September 2026.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aims to synthesize the available evidence on demographic, behavioral, environmental, and socioeconomic risk factors associated with Toxoplasma gondii infection among pregnant women living with and without HIV in Africa, quantify the strength of these associations, and identify potentially modifiable determinants that may inform targeted preventive interventions and antenatal care strategies.

Rationale Toxoplasma gondii infection during pregnancy is an important public health concern because maternal infection may result in congenital toxoplasmosis and adverse pregnancy outcomes. In Africa, the burden of T. gondii infection may be influenced by diverse demographic, behavioral, environmental, and socioeconomic factors, as well as by HIV infection and related immunological changes. However, the available evidence on risk factors for T. gondii infection among pregnant women in African settings is heterogeneous and remains fragmented across countries and populations. In particular, there is limited synthesis of the factors associated with infection among pregnant women living with and without HIV.

A systematic review and meta-analysis is therefore warranted to consolidate the available evidence, quantify the strength of associations between potential risk factors and T. gondii infection, and explore sources of heterogeneity across African settings. Identifying consistent and potentially modifiable determinants may contribute to the

development of targeted prevention strategies, improved antenatal care, and context-specific interventions for pregnant women, including those living with HIV.

Condition being studied Toxoplasma gondii infection (toxoplasmosis) during pregnancy, with a focus on demographic, behavioral, environmental, and socioeconomic risk factors associated with infection among pregnant women living with and without HIV in Africa.

METHODS

Search strategy We will search the following three electronic databases: PubMed, Web of Science, and Scopus. The search strategy will include terms related to Toxoplasma gondii and toxoplasmosis, pregnancy, HIV infection, risk factors, and countries in Africa. The search terms will include "Toxoplasma gondii", "Toxoplasmosis", "toxoplasma infection", "Pregnancy", "pregnant women", "gestation", "antenatal", "prenatal", "HIV infection", "HIV", "HIV-positive", "HIV infected", "HIV seropositive", "human immunodeficiency virus", "AIDS", "acquired immunodeficiency syndrome", "VIH", "Risk Factors", "risk factor*", "associated factor*", "determinant*", and "predictor*"**, combined with terms referring to Africa and individual African countries, including Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Côte d'Ivoire, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Eswatini, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe.
In PubMed, Medical Subject Headings (MeSH) terms and title/abstract terms were used, while Web of Science and Scopus searches were conducted using topic and title-abstract-keyword fields, respectively. The search was limited to studies published between January 1, 2000, and May 31, 2026. Only articles published in English were considered eligible. Articles published in Portuguese were also eligible, provided that an abstract in English was available.

Participant or population The population of interest comprises pregnant women living with HIV/AIDS in African countries. Eligible participants may include pregnant women diagnosed with HIV infection, regardless of gestational age, who were assessed for Toxoplasma gondii infection or toxoplasmosis. Studies involving pregnant women with confirmed HIV infection, HIV-positive status, or those receiving antenatal care in healthcare facilities or community-based settings will be considered eligible. The population may include participants from different African countries and geographical regions, provided that the study reports data on Toxoplasma gondii infection or toxoplasmosis and associated risk factors among pregnant women living with HIV.

Intervention No specific intervention is required for this review, as the studies of interest are primarily observational. The exposure of interest is HIV infection among pregnant women, with the main outcome being Toxoplasma gondii infection or toxoplasmosis. Studies evaluating potential risk factors, associated factors, determinants, or predictors of Toxoplasma gondii infection among pregnant women living with HIV will be considered eligible.

Comparator Not applicable. This review does not require a specific comparator or control group, as it synthesizes observational studies reporting bacterial prevalence, virulence, and antimicrobial resistance across different stages of the poultry production chain in African countries.

Study designs to be included We will include observational studies that investigate Toxoplasma gondii infection or toxoplasmosis among pregnant women living with HIV in African countries. Eligible study designs will include cross-sectional studies, cohort studies (prospective or retrospective), case-control studies, and other analytical observational studies that report relevant data on the prevalence, occurrence, risk factors, associated factors, determinants, or predictors of Toxoplasma gondii infection or toxoplasmosis in the target population. Studies using laboratory-confirmed diagnosis or serological evidence of Tox.

Eligibility criteria Studies will be eligible for inclusion if they meet all of the following criteria: (1) include pregnant women living with HIV/AIDS; (2) are conducted in one or more African countries; (3) investigate Toxoplasma gondii infection or toxoplasmosis; (4) report data on the prevalence, occurrence, risk factors, associated factors, determinants, or predictors of Toxoplasma gondii infection or toxoplasmosis; (5) use a valid laboratory, serological, molecular, or clinical method to assess Toxoplasma gondii infection; and (6) are observational studies, including cross-

sectional, cohort, case-control, or other analytical observational designs.

Studies will be excluded if they: (1) do not include pregnant women living with HIV/AIDS; (2) are not conducted in African countries; (3) do not assess Toxoplasma gondii infection or toxoplasmosis; (4) do not provide relevant data on risk factors or associated factors; (5) are case reports, case series, reviews, systematic reviews, meta-analyses, editorials, commentaries, letters, conference abstracts without sufficient information, or non-human studies; or (6) do not provide sufficient data to determine eligibility or extract the relevant outcomes. Only studies published between January 2000 and May 2026 will be considered. Articles published in English will be eligible, as well as articles published in Portuguese when an English-language abstract is available.

Information sources We will search the following three databases: Scopus, PubMed, and Web of Science.

Main outcome(s) The primary outcome will be the occurrence of Toxoplasma gondii infection or toxoplasmosis among pregnant women living with HIV in African countries. This will be assessed primarily through the reported prevalence or proportion of participants with evidence of Toxoplasma gondii infection, based on serological, molecular, or other validated diagnostic methods. Where available, the primary outcome will also include measures of association between potential risk factors and Toxoplasma gondii infection, such as odds ratios (OR), risk ratios (RR), prevalence ratios (PR), or adjusted measures of association with corresponding 95% confidence intervals.

Additional outcome(s) Additional outcomes will include the distribution of Toxoplasma gondii infection according to maternal and clinical characteristics, including maternal age, gestational age, parity, gravidity, and trimester of pregnancy. Other outcomes will include the seroprevalence of T. gondii IgG and IgM antibodies, evidence of recent or acute infection, and, where reported, molecular detection of T. gondii DNA.

Data management The full texts of the selected publications will be analyzed in Rayyan by two independent researchers. In case of disagreement, a third researcher will be consulted to reach a consensus. Data will be extracted using a standardized data extraction form. The extracted data will include study characteristics, such as year of publication, study period, country, geographical region, study design, study setting, sample size, participants' characteristics, and gestational age. Information related to Toxoplasma gondii infection will include diagnostic method, serological or molecular findings, prevalence or proportion of infected participants, and evidence of recent or acute infection. Data on HIV-related characteristics will include CD4 cell count, viral load, antiretroviral therapy status, and duration of HIV infection, when reported.

The extracted data will also include potential risk factors and associated factors for T. gondii infection, such as maternal age, parity, gravidity, dietary habits, consumption of raw or undercooked meat, exposure to cats or cat feces, contact with soil, source and treatment of drinking water, hygiene and sanitation practices, and other relevant behavioral or environmental factors. Measures of association, including odds ratios (OR), risk ratios (RR), prevalence ratios (PR), adjusted estimates, and corresponding 95% confidence intervals, will be recorded when available. Pregnancy and fetal outcomes, including miscarriage, stillbirth, preterm birth, low birth weight, and congenital toxoplasmosis, will also be extracted when reported.

The information obtained from the included studies will then be exported to Microsoft Excel (Microsoft 365 Apps for enterprise) and compiled according to the predefined eligibility criteria and study outcomes.

Quality assessment / Risk of bias analysis The risk of bias of the included studies will be independently assessed by two researchers using appropriate validated critical appraisal tools according to the study design. For non-randomized studies of exposures, the ROBINS-E (Risk Of Bias In Non-randomized Studies of Exposures) tool will be used. This instrument evaluates potential bias across multiple domains, including confounding, selection of participants into the study, classification and measurement of the exposure, departures from intended exposure, missing data, measurement of the outcome, and selection of the reported result. For studies for which ROBINS-E is not applicable, an appropriate validated tool corresponding to the study design will be used.

Each study will be assessed independently by two researchers, and disagreements will be resolved through discussion and consensus. If consensus cannot be reached, a third researcher will be consulted. The overall risk-of-bias assessment will

be considered when interpreting and synthesizing the findings of the review.

Strategy of data synthesis The data extracted from the included studies will be organized in Microsoft Excel and used for descriptive and, where appropriate, quantitative synthesis. Descriptive analyses will summarize the main characteristics of the included studies, including study design, country, sample size, participant characteristics, diagnostic methods, prevalence of Toxoplasma gondii infection, HIV-related characteristics, and reported risk factors or associated factors.

Where sufficient methodological and clinical homogeneity exists, a meta-analysis will be performed using R software (version 4.5.0) in RStudio. The metafor and meta packages will be used for the statistical analyses. A random-effects model using the restricted maximum likelihood (REML) estimator will be applied to calculate pooled estimates, with 95% confidence intervals (CIs). Pooled prevalence estimates of Toxoplasma gondii infection among pregnant women living with HIV will be calculated when data from sufficiently comparable studies are available.

Statistical heterogeneity between studies will be assessed using Cochran's Q test and quantified using the I^2 statistic. An I^2 value of 75% or higher will be considered indicative of substantial heterogeneity. Where appropriate, subgroup analyses or meta-regression will be performed to explore potential sources of heterogeneity, including geographical region, country, study design, diagnostic method, sample size, and study period.

For studies reporting associations between potential risk factors and Toxoplasma gondii infection, effect measures such as odds ratios (ORs), risk ratios (RRs), or prevalence ratios (PRs), together with their 95% CIs, will be extracted and, when sufficiently comparable, quantitatively synthesized using a random-effects model. Adjusted estimates will be prioritized over crude estimates when available.

Publication bias or small-study effects will be assessed when a sufficient number of studies are available for meta-analysis. Statistical significance will be considered at a p-value < 0.05. Where quantitative synthesis is not appropriate because of substantial clinical, methodological, or statistical heterogeneity, the findings will be synthesized narratively.

Subgroup analysis Where sufficient data are available, subgroup analyses will be conducted to explore potential sources of heterogeneity in the prevalence of Toxoplasma gondii infection and in the association between potential risk factors and infection among pregnant women living with HIV. Subgroups will be considered according to maternal age, pregnancy stage or trimester, number of pregnancies (gravidity), cat ownership or exposure to cats, contact with soil, educational level, occupation, consumption of raw or undercooked meat, place of residence (urban or rural), and source of drinking water.

Additional subgroup analyses may be performed according to geographical region or country, study design, diagnostic method, and other relevant characteristics reported consistently across the included studies. Subgroup analyses will only be performed when a sufficient number of studies and comparable data are available for each subgroup. Differences between subgroups will be assessed statistically where appropriate, and the results will be interpreted considering the potential for clinical and methodological heterogeneity.

Sensitivity analysis Sensitivity analyses will be conducted to assess the robustness of the findings and determine whether the overall results are influenced by specific methodological characteristics of the included studies. The analyses will include: excluding studies judged to have a high risk of bias; excluding studies with very small sample sizes; excluding studies with unclear or incomplete denominators; excluding studies using non-standard or poorly described diagnostic methods for Toxoplasma gondii infection; comparing pooled estimates obtained using different statistical approaches for prevalence data; comparing different estimators of between-study variance in random-effects models; conducting leave-one-out analyses; and assessing the influence of individual studies on the pooled estimates.

Where appropriate, sensitivity analyses will also be performed by excluding studies with substantial methodological heterogeneity, studies with extreme prevalence estimates, or studies with characteristics that may substantially affect the comparability of the results. The findings of the sensitivity analyses will be compared with the primary analysis to determine whether the pooled estimates and conclusions remain stable.

Language restriction Studies published in English will be considered eligible. However, studies

published in Portuguese or French were also eligible if they provided an abstract in English.

Country(ies) involved Portugal.

Keywords Toxoplasma gondii; toxoplasmosis; pregnancy; pregnant women; risk factors; Africa.

Dissemination plans The findings of this systematic review and meta-analysis will be disseminated through publication in a peer-reviewed scientific journal. The results may also be presented at relevant scientific conferences, workshops, and other academic or professional forums related to maternal and child health, infectious diseases, HIV, parasitic infections, and public health. The findings will be made available to researchers, healthcare professionals, maternal and child health practitioners, policymakers, and other stakeholders interested in Toxoplasma gondii infection, pregnancy, HIV, and the prevention of congenital toxoplasmosis in African settings.

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