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Understanding Socio-Demographic, Environmental, and Behavioral Factors Associated with Malaria Infection Among Children Under Five Years in Tanzania: A Rapid Review

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Abstract

Malaria is a global public health concern and remains one of the major causes of morbidity and mortality among children under five in sub-Saharan Africa, with Tanzania bearing a substantial share of the burden. Although multiple studies have examined risk factors, evidence on socio-demographic, environmental, and behavioral determinants remains fragmented. A comprehensive synthesis of this evidence is critical to guide context-specific interventions. This rapid review synthesised studies published between January 2021 and December 2025 to identify factors associated with malaria infection among children under five. Data on study characteristics and key findings were extracted systematically, verified, and synthesized narratively. The results were organised into socio-demographic, environmental, and behavioural determinant domains. Twenty-one studies met inclusion criteria. Cross-sectional designs predominated (n=8, 38%), followed by randomized trials (n=5, 24%). Most studies were community-based (n=19, 91%) and focused either exclusively on children under 5 (n=8, 38%) or on mixed-age groups (n=6, 29%). Malaria infection among children under five in Tanzania is consistently associated with child age, maternal education, and household socio-economic status. Environmental factors such as housing quality, sanitation, and proximity to mosquito breeding sites, along with behavioral factors including ITN use, care-seeking, and nighttime outdoor exposure, also influence risk. These determinants interact within ecological and socio-economic contexts, underscoring the need for integrated, context-specific interventions. Strengthening vector control, improving housing and environmental conditions, promoting protective behaviors, and addressing socio-economic inequities are key to reducing malaria. This review provides evidence to guide targeted interventions and future research for accelerating malaria control in Tanzania

Keywords: *Children, Factors, Malaria, Review, Tanzania, Under-fives.*

Introduction

Malaria remains a major global public health challenge, with an estimated 282 million cases and 610,000 deaths reported worldwide in 2024 [1]. The African Region of the World Health Organization (WHO) bears a disproportionate burden, accounting for 95% of malaria cases and 94% of deaths, with children under five years representing nearly three-quarters of malaria-related mortality [1]. Young children are particularly vulnerable due to their immature immune systems and limited prior exposure to malaria parasites [2]. Despite

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substantial investments in malaria control, transmission persists across sub-Saharan Africa, reflecting complex interactions between biological, environmental, and socio-structural determinants. Tanzania is among the countries most affected by malaria in the WHO African region [3]. The 2022 Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) reported an average malaria prevalence of 8% among children under five, with substantial regional variation [4]. The country has implemented multiple malaria control interventions, including insecticide-treated nets (ITNs), indoor residual spraying (IRS), prompt diagnosis with rapid diagnostic tests (RDTs), artemisinin-based combination therapy (ACT), intermittent preventive treatment in pregnancy (IPTp), and community-based health education programs [5]. Although these interventions have contributed to national declines in prevalence, residual transmission persists, particularly in rural and socioeconomically disadvantaged areas, highlighting the limitations of biomedical interventions alone. Despite overall declines in national malaria prevalence, transmission persists in rural and socioeconomically disadvantaged areas [5]. This disparity suggests that biomedical interventions alone are insufficient without addressing contextual determinants of infection risk [6, 7]. Accumulating evidence indicates that malaria infection among young children is shaped by interrelated socio-demographic, environmental, and behavioral factors. Socio-demographic determinants such as household wealth, maternal education, and child age influence exposure patterns and health access [8, 9]. Environmental conditions including proximity to mosquito breeding sites, sanitation, housing quality, and seasonal rainfall patterns modulate vector density and transmission intensity [10–13]. Behavioral factors, particularly consistent ITN utilization, IRS uptake, care-seeking practices, and nighttime outdoor exposure [14, 15], further mediate infection risk. However, evidence on malaria among children under five remains fragmented, varying across study designs and ecological settings. In addition, there is limited systematically synthesized information for the recent Tanzanian context. To address this gap, a rapid review of studies published between 2021 and 2025 was conducted to consolidate contemporary evidence on socio-demographic, environmental, and behavioral determinants of malaria infection among children under five in Tanzania. By synthesizing current evidence, the review aims to identify dominant risk patterns, clarify key determinants, highlight knowledge gaps, and inform context-responsive strategies for targeted malaria prevention and control.

Materials and Methods

Review Design

This study employed a rapid review design conducted in accordance with the Cochrane Rapid Reviews Interim Guidance [16] and reported findings in line with PRISMA 2020 recommendations where applicable [17]. A streamlined methodological approach was adopted to expedite evidence synthesis while maintaining transparency and methodological rigor. The review question, eligibility criteria, and analytical framework were defined a priori in a structured protocol developed by the research team. Due to the expedited timeline of the rapid review, we did not register the protocol in PROSPERO. This review focused on socio-demographic, environmental, and behavioral determinants associated with laboratory-confirmed malaria infection among children under five years in Tanzania. Key methodological stages included structured database searching, study selection, data extraction, and narrative synthesis.

Search Strategy and Data Sources

A structured literature search was conducted in PubMed, OpenAlex, and Google Scholar from November 2025 and January 2026. Database selection was guided by Cochrane

Rapid Review recommendations to balance comprehensiveness and feasibility. The number of databases was intentionally limited to enhance efficiency while ensuring adequate coverage of relevant literature. In addition, grey literature sources were also screened, including reports from the Tanzanian Ministry of Health, the National Malaria Control Program, and the World Health Organization (WHO), to contextualize findings and identify relevant primary studies. The search was restricted to studies published between 2021 and 2025 to reflect contemporary malaria epidemiological patterns, intervention coverage, and policy relevance in Tanzania. Only English-language publications were included. Search terms combined controlled vocabulary and free-text keywords related to malaria ("malaria," "Plasmodium falciparum"), population ("children under five," "under-five," "<5 years"), setting ("Tanzania," "United Republic of Tanzania"), and determinants ("risk factors," "determinants," "predictors," "socio-demographic," "environmental," "behavioral," "insecticide-treated nets," "ITN," "indoor residual spraying," "IRS"). Boolean operators were used to combine terms, and search syntax was adapted to each database.

Eligibility Criteria

Studies were considered eligible if they (1) included children under five years residing in Tanzania; (2) examined socio-demographic, environmental, or behavioral determinants of malaria infection; (3) reported laboratory-confirmed malaria diagnosed using microscopy, rapid diagnostic tests (RDTs), or polymerase chain reaction (PCR); and (4) employed observational (cross-sectional, cohort, or case–control) or interventional study designs. Studies were excluded if they were conducted outside Tanzania, did not report age-specific findings for children under five years, lacked primary data (e.g., editorials, commentaries, or opinion pieces), or did not assess associations between malaria infection and the specified determinant domains.

Study Selection

All identified records were imported into the Rayyan AI platform for de-duplication and screening. The search yielded 2,012 records, of which 930 duplicates were removed. We screened 1,082 titles and abstracts and assessed 198 full-text articles for eligibility, resulting in 21 included studies. Following Cochrane rapid review guidance, two reviewers independently screened at least ≥20% of titles and abstracts to ensure consistency in eligibility interpretation [16]. A single reviewer screened the remaining records. Full-text articles deemed potentially eligible were assessed for inclusion, and all exclusions at the full-text level were verified by a second reviewer. Discrepancies were resolved any disagreements through discussion and consensus.

Data Extraction

Data were extracted using a piloted and standardized extraction form in Microsoft Excel. To maintain feasibility within the rapid review framework, extraction focused on core descriptive and methodological characteristics, including author, year of publication, study design, population characteristics, setting, geographic location, and reported determinant categories. Effect size estimates and quantitative synthesis parameters were not systematically extracted, as the objective of the study was to map and categorize determinants rather than perform a quantitative meta-analysis.

Risk of Bias Assessment

Consistent with Cochrane Rapid Review guidance, a formal risk-of-bias assessment was not conducted due to time and resources constraints. Instead, study designs and notable methodological limitations were documented narratively to inform interpretation of findings.

Data Synthesis

Given the heterogeneity in study designs, exposure measurement, and outcome definitions, a meta-analysis was not appropriate. Findings were synthesized descriptively and organized thematically into three determinant domains: socio-demographic, environmental, and behavioral factors. Patterns of association were examined across studies to identify consistent risk factors and contextual influences.

Software and Reporting

Rayyan was used for the initial screening of titles and abstracts [18]. Microsoft Excel 365 was employed for systematic data extraction and organization. In addition, Zotero version 7.0.32 was used for citation management and reference organization. The study selection process is presented in a PRISMA flow diagram *(Figure 1)*.

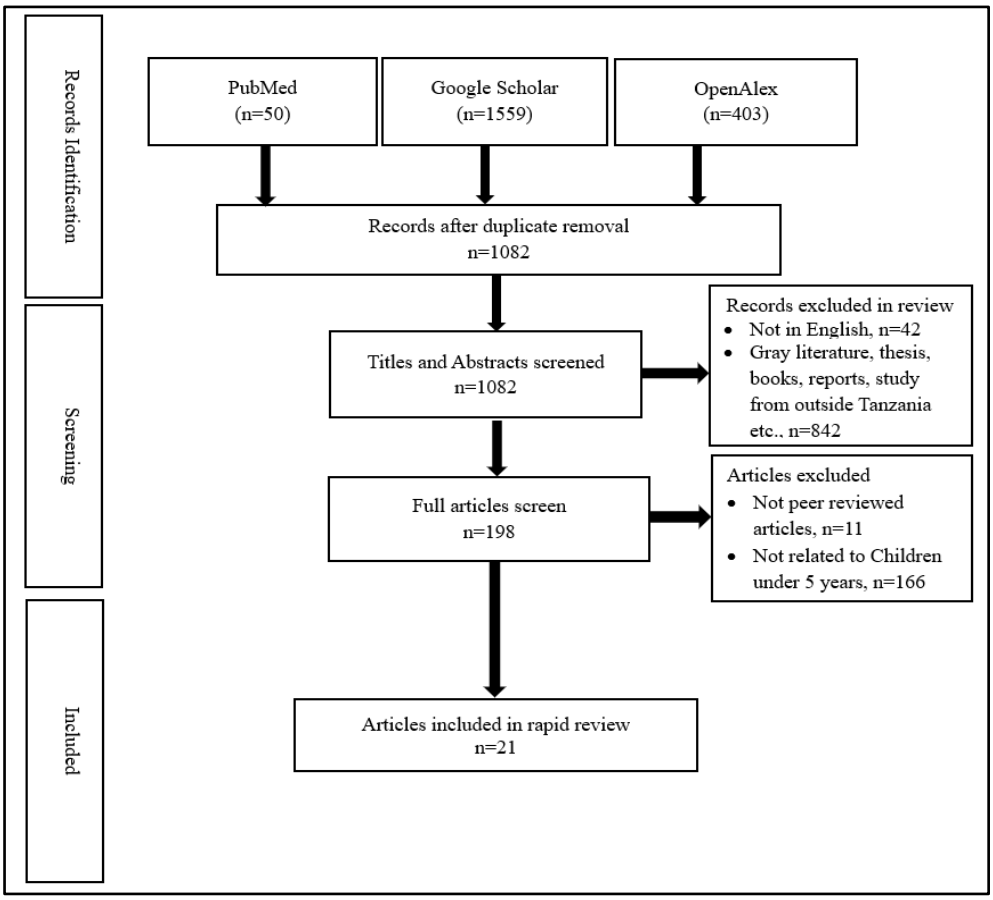

Figure 1. Prisma Flow Diagram for Identification, Screening, and Inclusion of Articles

Results

Characteristics of included studies

Twenty-one studies the eligibility criteria. All were published in English between January 2021 and March 2025. Nearly half of the selected studies were published in 2025 (n = 10; 47.6%), reflecting increased recent research attention. Cross-sectional designs predominated (n = 8; 38.0%), followed by randomized controlled trials (n = 5; 23.8%). Additional designs included qualitative studies (n = 2; 9.5%), mixed-methods studies (n = 2; 9.5%), record reviews (n = 2; 9.5%), one prospective cohort study (4.7%), and one entomological investigation (4.7%). With regard to populations, eight studies (38.0%) focused exclusively on children under five years, while six (28.6%) included both adults and children but reported age-disaggregated findings. One study (n=1; 4.7%) examined mosquito vectors to contextualize transmission

dynamics. Most studies were conducted in community settings (n=19; 90.5%), with broad geographic presentation across mnland Tanzania and Zanzibar, including high-transmission regions such as Mtwara, Kagera, geita, Kigoma, Ruvuma and Lake Zone regions *(Table 1)*. Overall, the evidence base was dominated by observational designs, with limited longitudinal data and few nationally representative studies.

Table 1. Characteristics of Studies Included in the Rapid Review

Authors	**Language**	**Study Design**	**Study Population**	**Setting**	**Location**
Animut et al., 2025	English	Cross-sectional	Children	Community	Tanzania
Mwaiswelo et al., 2021	English	Cross-sectional	Children	Community	Nanyumbu and Masasi Districts, Mtwara Region, Tanzania
Adam et al., 2025	English	Cross-sectional	Children	Community	Tanzania
Pauline et al., 2025	English	Cross-sectional	Children	Community	Tanzania
Mohammed et al., 2025	English	Cross-sectional	Children	Community	Tanzania
Chacky et al., 2025	English	Cross-sectional	Children	Community	Tanzania
Petro et al., 2024	English	Record review	Pregnant women and children	Health facility	Kagera Region, Tanzania
Mshamu et al., 2022	English	Randomized controlled trial	Children	Community	Mtwara Region, Tanzania
Mshamu et al., 2023	English	Randomized controlled trial	Children	Community	Mtwara Region, Tanzania
Challe et al., 2025	English	Cross-sectional	Children and adults	Community	Kigoma, Ruvuma, and Tanga Regions, Tanzania
Lutambi et al., 2025	English	Cross-sectional	Children and adults	Community	Tanzania
Mwalimu et al., 2023	English	Record review	Children and adults	Community	Lake Zone Regions, Tanzania
Lukole et al., 2025	English	Randomized controlled trial	Children and adults	Community	Misungwi District, Mwanza Region, Tanzania
Mmbando et al., 2025	English	Randomized controlled trial	Children and adults	Community	Mtwara Region, Tanzania
Odufuwa et al., 2025	English	Randomized controlled trial	Children and adults	Community	Chalinze District, Pwani Region, Tanzania
Matovelo et al., 2021	English	Qualitative	Women (caregivers)	Community	Misungwi District, Mwanza Region, Tanzania

Bofu et al., 2023	English	Mixed methods	Adults	Community	Mlimba, Malinyi, Ulanga, and Ifakara Districts, Morogoro Region, Tanzania
Kihwele et al., 2023	English	Qualitative	Adults	Community	Rufiji and Kibiti Districts, Pwani Region and Kilwa District, Lindi Region, Tanzania
Fink et al., 2022	English	Prospective cohort	Adults	Community	Kilombero and Ulanga Districts, Morogoro Region, Tanzania
Liheluka et al., 2023	English	Mixed methods	Adults	Community	Geita, Kigoma, Mtwara, and Ruvuma Regions, Tanzania
Khatib et al., 2025	English	Entomological (mosquito collection)	Mosquito vectors	Field	Zanzibar, Tanzania

Socio-Demographic Factors

Age emerged as the most consistently reported socio-demographic determinant. Children aged 12–59 months had higher malaria prevalence compared with infants under 12 months [19], with peak prevalence frequently observed among those aged 24–47 months [8, 9]. This pattern likely reflects a gradual decrease of maternal immunity combined with increased environmental exposure. No statistically significant association was observed between the sex of children under five and malaria infection [8, 20]. Maternal education was consistently associated with reduced malaria risk. It was shown that, higher educational attainment was linked to improved preventive practices, including appropriate ITN use and timely care-seeking [20, 21]. Household socio-economic status also demonstrated a strong gradient effect: children from lower-wealth households experienced disproportionately higher malaria prevalence compared with those from wealthier households [8, 20]. This association appeared mediated by differences in housing quality, access to vector control interventions, and healthcare utilization. On the other hand, rural residence was repeatedly identified as a structural risk factor, with higher infection prevalence observed in rural compared with urban or peri-urban settings. Several studies further reported ecological heterogeneity, with substantial variation across administrative regions and transmission zones [15, 22, 23].

Environmental Factors

Environmental exposures were significantly associated with increased malaria risk. Children living in households close to mosquito breeding sites, such as stagnant water bodies, agricultural irrigation schemes, and poorly drained areas, was linked to higher infection prevalence [24, 25]. Housing quality emerged as a consistent determinant. Children residing in houses with mud walls, thatched roofs, open eaves, or unscreened windows experienced higher malaria prevalence than those living in improved housing [10–13]. It was reported across nearly all studies that structural vulnerabilities likely facilitate mosquito entry and indoor-biting exposure. Likewise, climatic variability, including rainfall, temperature, and humidity, was reported to influence malaria transmission intensity [26, 27]. Seasonal peaks

in malaria incidence coincided with rainy periods, reflecting increased vector breeding and survival. Regional variation in transmission patterns further underscored the interaction between ecological conditions and household-level risk factors. The entomological study included in the review provided contextual evidence of vector persistence and outdoor biting behavior in certain settings, supporting epidemiological findings related to residual transmission [14].

Behavioral Factors

Insecticide-treated nets (ITNs) use was the most frequently examined behavioral factor. Consistent evidence indicated that malaria prevalence was lower among children who slept under an ITN compared to those who did not [9, 15, 28]. Importantly, several studies distinguished between ITN ownership and actual utilization, demonstrating that protective effects were strongest when consistent nightly use was reported [8, 27, 29]. Moreover, evidence shows that consistent implementation of IRS effectively reduces malaria prevalence, while lapses in IRS maintenance can lead to malaria resurgence [30], underscoring the critical need for sustained vector control coverage. Care-seeking practices also influenced infection outcomes. Delayed presentation to health facilities following onset of fever and other malaria symptoms and reliance on informal or traditional treatment were reported in several settings among malaria-positive children. Likewise, Caregivers' knowledge of malaria transmission and prevention was positively associated with adoption of protective behaviors and reduced infection prevalence [22, 29]. The evening and nighttime outdoor exposure emerged was also reported as a relevant behavioral risk factor. Children who remained outdoors after sunset, either playing or accompanying caregivers, had higher malaria prevalence, consistent with documented early-evening and outdoor-biting patterns in some regions [14, 15]. Moreover, lower malaria prevalence was reported among children from households demonstrating awareness of malaria transmission and preventive measures [29].

Evidence Gaps and Research Limitation

Despite the growing body of literature important gaps remain. Longitudinal studies are scarce, limiting understanding of temporal trends and sustained intervention effects. Few studies simultaneously examined socio-demographic, environmental, and behavioral determinants within integrated analytical frameworks, constraining causal inference and interaction assessment.

Additionally, limited research integrates household-level determinants with parasite resistance patterns, vector behavioral adaptation, or climate variability. Such integration is critical to understanding emerging transmission dynamics and informing adaptive malaria control strategies, especially to local contexts [31].

Discussion

This rapid review synthesizes recent evidence demonstrating that malaria infection among children under five in Tanzania is shaped by intersecting socio-demographic, environmental, and behavioral determinants. The findings indicate that malaria risk is not driven by single exposure but by the cumulative and reinforcing effects of structural vulnerability, ecological context, and household-level practices. Despite sustained scale-up of vector control interventions, persistent transmission of malaria in specific populations and regions underscores the importance of addressing contextual and structural drivers alongside biomedical tools.

Age was the most consistently reported individual-level determinant, with children aged 12-59 months, particularly those 24-47 months, experiencing higher infection prevalence than infants [8, 9]. This pattern is likely attributed to the waning of maternal

antibodies acquired during pregnancy, leaving older infants more susceptible to Plasmodium infection [2]. In contrast, sex differences were minimal across studies, suggesting that gender does not substantially modify malaria risk in early childhood in this context [8, 20]. Socioeconomic factors were also prominent, with lower household wealth and limited maternal education consistently associated with higher malaria prevalence [8, 20, 21]. These findings suggest that socioeconomic disadvantage constrains the consistent uptake and correct use of malaria prevention and treatment measures. These disparities reflect broader inequities in access to information, housing quality, and health services, particularly in rural and hard-to-reach areas [32]. The protective role of maternal education observed across studies aligns with evidence from other malaria-endemic settings in sub-Saharan Africa [33, 34], underscoring the importance of women's education as a long-term malaria control strategy. Environmental exposure remains a key challenge, particularly in rural and agricultural settings where vector breeding sites are difficult to eliminate [24, 25]. Furthermore, poor housing infrastructure increases indoor mosquito exposure and reduces the effectiveness of household-level interventions [10–13]. These findings support growing recognition that malaria control must extend beyond the health sector to include housing improvement, environmental management, and collaboration with sectors responsible for water, agriculture, and urban planning [34, 35]. Likewise, behavioral determinants act as critical modifiers of risk and intervention effectiveness. Inconsistent use of ITNs, delays in care-seeking, and variation in risk perception reduce the protective impact of existing malaria control tools [9, 15, 28]. These behaviors are shaped by contextual factors such as cultural norms, household decision-making dynamics, and perceived quality of health services [29]. Community-based health education and engagement strategies remain essential for sustaining preventive behaviors, particularly in high-transmission and seasonal settings [33, 34, 36]. The review also highlights some challenges in the current evidence base. Limited integration of social, environmental, and biological factors restricts understanding of how risks accumulate at household and community levels. Furthermore, insufficient consideration of evolving challenges such as insecticide resistance, changing vector ecology, and climate variability may limit the relevance of existing findings for future malaria control planning [37]. Addressing these gaps through integrated, longitudinal, and interdisciplinary research would strengthen the evidence needed to refine targeted interventions [38]. Overall, the findings reinforce the need for malaria control strategies in Tanzania that are equity-oriented, context-specific, and adaptive to local ecological and social conditions. Strengthening community health systems, improving living environments, and aligning prevention efforts with broader development initiatives are likely to enhance the impact of existing malaria interventions among children under five.

Conclusion

Malaria infection among children under five years in Tanzania is driven by interconnected socio-demographic, environmental, and behavioral determinants. Socioeconomic disadvantage, substandard housing, ecological exposure, inconsistent ITN use, and gaps in sustained vector control coverage collectively shape the risk of infection. Integrated strategies that combine strengthened community health systems, sustained vector control, environmental management, and targeted behavioral interventions are essential to accelerate progress toward malaria reduction. Future research should prioritize longitudinal and interdisciplinary approaches to better capture dynamic transmission patterns and inform adaptive, locally tailored interventions.

Limitations

This review has several limitations. The streamlined methodology, including restriction to three databases and English-language publications, may have resulted in omission of relevant studies. A formal risk-of-bias and certainty-of-evidence assessment was not conducted, consistent with rapid review guidance, which may limit confidence in the strength of conclusions. The predominance of cross-sectional designs constrains causal interpretation, and heterogeneity in study settings, diagnostic methods, and outcome definitions limits comparability across studies. Despite these limitations, the review provides an updated synthesis of key determinants influencing malaria infection among children under five in Tanzania and identifies priority areas for intervention and research.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

Ethical approval was not required for this study because it was based solely on a review and synthesis of previously published literature.

Authors' Contribution

HN conceptualised the study, designed the rapid review protocol, conducted the literature search, and drafted the manuscript. EM and AL-R supervised the study and revised the manuscript. HSA contributed to data interpretation, validation, and manuscript review. All authors read and approved the final manuscript.

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Data Availability

All data used in this rapid review were obtained from publicly available sources. The extracted dataset and supporting materials used for the analysis are available from the corresponding author upon reasonable request.

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