RURAL PLANNING JOURNAL
Website: https://journals.irdp.ac.tz/index.php/rpj

DOI: https://doi.org/10.59557/rpj.25.2.2025.208

Socio-economic and Environmental Factors Influencing Malaria Prevalence among Children Under Five in Tanzania

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ARTICLE INFO

Keywords

Malaria

Children under five

Malaria prevalence

Morbidity and mortality

ABSTRACT

This study examined socio-economic and environmental factors influencing malaria prevalence among children under five in Tanzania using data from the Tanzania Demographic and Health Survey (TDHS) 2022. A cross-sectional design was employed, analyzing 1,264 households with children under five, with malaria prevalence as the response variable and socio-economic (wealth, maternal education, marital status, sex of child) and environmental (roof material, place of residence) factors as predictors. Stepwise logistic regression showed that female children had 40% lower odds of malaria (OR=0.60, p=0.002), higher wealth reduced odds by 80% (OR=0.20, p<0.001), and primary education lowered odds by 65% (OR=0.35, p<0.001). Thatch/palm leaf roofs increased odds by 5.5 times (OR=5.50, p<0.001), and recent fever raised odds by 350% (OR=4.50, p<0.001). Rural residency (70.5%) and low maternal education (40.2% without education) were significant risk factors. Findings highlight the need for nationwide interventions, including community education and housing improvements, to support Tanzania's National Malaria Strategic Plan 2021–2025 to malaria elimination by 2030.

1. Introduction

According to the World Health Organization (WHO), malaria remains a major global health problem, with an estimated 263 million cases and 597,000 deaths in 2023, affecting children under five the most, who made up 76% of fatalities. While the African region accounted for 94% of cases and 95% of deaths, other areas, such as Asia and Latin America, have made notable progress toward elimination, although hotspots pose a risk to these gains (WHO, 2024a).

In Asia, the WHO South-East Asia Region cut cases by 82.4%, from 22.8 million in 2000 to 4 million in 2023, accounting for only 1.5% of global cases, through the expanded use of artemisinin-based combination therapies (ACTs), indoor residual spraying (IRS), and insecticide-treated nets (ITNs). Four countries (Bangladesh, India, Indonesia, and Nepal) saw further declines in 2022–2023 (WHO, 2024b). However, the broader Asia Pacific region experienced a rise in cases from 8.8 million in 2022 to 10.4 million in 2023, mainly due to hotspots in Myanmar, Pakistan, and Papua New Guinea, worsened by conflict and insecticide resistance, despite efforts like the Asia Pacific Leaders Malaria Alliance (APLMA), which committed 22 countries to elimination by 2030 through cross-border surveillance and vector control (Asia Pacific Leaders Malaria Alliance, 2024).

In Latin America, the Americas reported 505,000 cases in 2023, a 5% increase from 2022, primarily in South America (92%). Migration, deforestation, and outbreaks in Venezuela and Guyana drive this rise. Nonetheless, four countries (Paraguay in 2018, Argentina in 2019, El Salvador in 2021, and Belize in 2023) achieved WHO malaria-free certification through integrated vector management and rapid diagnostic tests (Pan American Health Organization (PAHO), 2024a; WHO, 2024a). The PAHO Strategy for Malaria Elimination emphasizes easy access to diagnosis and treatment, with 236 million ACT courses delivered globally in 2023, preventing an estimated 177 million cases (PAHO, 2024b; WHO, 2024a).

Sub-Saharan Africa, which accounted for 94% of the global cases (246 million) and 95% of deaths (569,000) in 2023, faces stalled progress due to funding gaps, climate-related surges, and resistance. In this region, countries with high malaria prevalence include Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%), which account for nearly 50% of all cases (Venkatesan, 2024). Concerning mortality, Nigeria, the Democratic Republic of the Congo, Niger, and Tanzania contributed to more than 50% of all global malaria deaths (569,000) in 2023, with 39·3% of all global malaria deaths occurring in Nigeria among children under the age of five (Venkatesan, 2025; WHO, 2024a). Despite

these challenges, efforts have prevented 2.2 billion cases since 2000 through the distribution of 255 million ITNs (95% in the region) and seasonal malaria chemoprevention (SMC), which reached 53 million children in 2023 (WHO, 2024a; African Leaders Malaria Alliance, 2025).

East Africa also shows a similar burden, accounting for nearly 26% of cases. Three nations, namely Tanzania, Uganda, and the Democratic Republic of Congo (DRC), are included among the 11 countries with a high burden of malaria, contributing to 66% of the world's malaria cases and 68% of malaria-related deaths (WHO, 2024a). Factors such as limited access to healthcare and education, poverty, migration and displacement, and seasonal changes in rainfall and temperature affect mosquito reproduction and parasite development in the area. As a result, countries, in collaboration with international partners, have been implementing control measures such as PMI-supported IRS, ITNs, and the RTSs vaccine (Yamba et al., 2023; Lacey et al., 2023; WHO, 2024a; Nyakairu, 2024).

In Tanzania, malaria remains a significant cause of morbidity and mortality. However, its prevalence varies from place to place depending on various health systems, socio-economic and ecological factors (Mazigo et al., 2017; WHO, 2024a). The government, in collaboration with international partners, has made various efforts in combating malaria, such as launching the National Malaria Control Programme (NMCP) in 1990; the National Malaria Strategy which focused on improved case management, vector control with insecticide-treated nets (ITNs) and interventions for pregnant women; the 2015–2020 National Malaria Strategic Plan; the Supplementary Malaria Midterm Strategic Plan (SMMSP) for 2018–2020; and the NMCP Strategic Plan 2021–2025 (URT 2014; URT, 2016; URT, 2020 & URT, 2022).

Despite these efforts, malaria remains a cause of under-five child mortality in the country (UNICEF, 2024; Venkatesan, 2024). Previous studies identified factors associated with malaria among children under the age of five, such as household socio-economic status, house quality, age, the use of ITNs, altitude, proximity to national parks, and access to health care services (Mazigo et al., 2017; Mosha et al., 2020; Challe et al., 2024; Kolodziej et al., 2024). These studies focused mainly on district/regional data but did not address national data. Therefore, this study sought to bridge this knowledge gap by using the Tanzania Demographic and Health Survey 2022 dataset to investigate socio-economic and environmental factors influencing malaria among children under five in Tanzania. The results of the study provide valuable insights for policymakers, planners, researchers and stakeholders involved in efforts to combat malaria.

2. Literature Review

2.1. Theoretical Review

The Social Determinants of Health (SDH) framework and Ecological Systems Theory (EST) were adopted to examine malaria prevalence. The SDH model suggests that socio-economic factors, including income, education, and housing conditions, influence access to malaria prevention tools and healthcare in Tanzania (WHO, 2018). In rural areas in Tanzania, low maternal education and poverty limit the uptake of preventive measures. On the other hand, ecological systems theory highlights how human behaviour, substandard housing (e.g., thatch roofs), and environmental factors such as rainfall drive mosquito proliferation, thereby increasing malaria risk (Bronfenbrenner, 1977; Mmbando et al., 2025). These frameworks advocate for holistic interventions addressing social disparities and environmental exposures in Tanzania's high-burden regions.

2.2. Empirical Literature Review

Malaria among children under five in Tanzania is driven by the complex interplay of socio-economic, environmental and intervention-related factors, as evidenced by studies conducted in Tanzania, broader sub-Saharan Africa, and European-African collaborations.

Poor housing, particularly thatch-roofed homes, significantly increases malaria risk in regions such as Tabora by facilitating mosquito entry (Kaindoa et al., 2018; Mmbando et al., 2025). Similarly, research conducted in Uganda found an association between poor/traditional housing and malaria (Snyman, 2015; Rek, 2018; Musiime et al., 2022; Gonahasa et al., 2024; Nankabirwa et al., 2024; Aregawi et al., 2025). Similarly, houses near breeding sites in Ethiopia increased malaria risks (Gobe et al., 2024). Furthermore, vegetation in Mozambique's low-income areas increases malaria cases (Harp et al., 2021; Armando et al., 2023).

Socio-economic disparities intensify transmission, with poverty linked to a 20–25% higher malaria incidence in low-income Tanzanian households during rainfall spikes (Rumisha et al., 2019; Mapua et al., 2021; Adam et al., 2025; Chacha et al., 2025; Mukabana et al., 2025). Wealthier African households, including those in Tanzania, have up to 73% lower risk due to better access to ITNs (Anjorin et al., 2023; Mbishi et al., 2024), while rural residency in Tanzania increases the risk of getting malaria due to limited ITN access (Wanzira et al., 2021).

Many studies in African countries like Tanzania, Rwanda, Niger, and Nigeria show that women with higher education levels know more about how to prevent malaria, such as using insecticide-treated

nets (ITNs) (Degarege et al., 2019; Kateera et al., 2023; Alao et al., 2025; Nadakou et al., 2025).

Climatically, research done in West Africa by Gbaguidi (2025) found that rainfall, relative humidity, air temperature and vegetation predicted the spread of malaria. Also, rainfall spikes and warmer temperatures (22–28°C) have been shown to elevate malaria transmission in Tanzania (Mapua et al., 2021), and climate change is projected to worsen these risks, necessitating adaptive strategies (Ryan et al., 2020). Effective interventions like Indoor Residual Spraying (IRS) in Tanzania reduce prevalence by 50% (Protopopoff et al., 2023), and European-African collaborations have advanced vector control and modelling (Tian, 2023; Ozodiegwu et al., 2023; Schmit et al., 2025).

Various studies (Mazigo et al., 2017; Mosha et al., 2020; Mapua et al., 2021) focused on specific Tanzanian regions, but there is a lack of comprehensive nationwide data comparing malaria drivers across Tanzania's diverse geographic and demographic contexts, such as urban vs. rural and coastal vs. inland areas. This study used a nationwide cross-sectional survey in Tanzania to map malaria drivers across diverse settings and populations.

3. Materials and Methods

3.1. Study Design

This study used a cross-sectional design, analyzing data from the 2022 Tanzania Demographic and Health Survey (TDHS). This method allowed for the examination of relationships between socio-economic and environmental factors and malaria prevalence among children under five across Tanzania at a single point in time. The cross-sectional approach is suitable for identifying risk factors and supporting national malaria control efforts. However, it limits causal conclusions because it captures data at a single point in time.

3.2. Study Population and Sample Size

The population of the study comprised households with children under five years old across Tanzania, a group highly vulnerable to malaria due to high transmission rates (WHO, 2024a). The sample was derived from the TDHS 2022, a nationally representative household survey. A total of 1,264 families with children under five were included, selected based on complete data for malaria prevalence and relevant socio-economic and environmental variables. This sample size provided adequate statistical power to detect associations at the national level.

3.3. Sampling Design

The TDHS 2022 employed a two-stage stratified cluster sampling technique. In the first stage, clusters (enumeration areas) were chosen with probability proportional to population size, stratified by urban and rural areas across Tanzania's regions. In the second stage, a fixed number of households were randomly chosen from each cluster. The analysis included all Tanzanian households with children under five, with sampling weights applied to ensure national representativeness and to account for regional and urban/rural variations.

3.4. Response Variable

Malaria was the outcome variable, identified using specific combinations of RDTs and microscopy in accordance with DHS protocols. At the household level, a household was classified as positive if at least one individual tested positive for Plasmodium spp. by RDT or microscopy, as applicable. It was recorded as "Yes" for households with a positive rapid test (coded as "1") and as "No" for households with a negative rapid test (coded as "0"). This binary classification of positive/negative was used to evaluate household malaria burden and is consistent with previous TDHS research (Yitageasu *et al.,* 2025).

3.5. Independent Variables

The independent variables were selected based on the social determinants of health and ecological systems frameworks, informed by a literature review. Socio-economic variables included maternal education (primary, post-primary, no education), wealth index (rich, middle, poor), marital status (married, not in union, widowed, living with a partner) and the sex of the child (female, male). Environmental variables covered the main roof material (palm leaf/thatch, no roof, rustic material, metal, wood planks, roofing shingles, or not a de jure resident) and place of residence (urban, rural). These variables were obtained from the TDHS 2022 household and women's questionnaires, which capture key factors related to malaria risk.

3.6. Data Analysis

Data analysis using stepwise logistic regression to identify significant predictors of malaria prevalence among children under five in Tanzania. The analysis was conducted using statistical software (STATA Version 16), with a weighted sample applied to account for the TDHS 2022's complex survey design. Robust standard errors adjusted for clustering effects. Variables were included based on theoretical relevance and empirical evidence, with stepwise selection retaining significant predictors ($p<0.05$). 95% confidence intervals, odds ratios and p-values were used to quantify associations between independent variables and malaria prevalence.

4. Results and Discussion

4.1. Demographic Characteristics

The demographic profile of 1,264 respondents reveals a population highly susceptible to malaria

among children aged less than five years old. Nearly half (44.7%) of mothers had no formal education, 47.15% had primary education, and only 8.15% had post-primary training, indicating limited awareness of malaria prevention strategies, which increases risk. The majority (87.9%) resided in rural areas, compared to 12.1% in urban areas, and proximity to mosquito breeding sites in rural areas elevated transmission risk. Households are predominantly male-headed (76.74%), with 23.26% female-headed, the latter facing economic constraints that limit ITN access. Electricity is absent in 80.46% of households, hindering nighttime ITN use and healthcare access, while only 19.54% had electricity. Health insurance coverage is minimal, with 98.18% uninsured, restricting access to malaria testing and treatment. ITN ownership is high (83.94%), but 16.06% lacked nets, increasing exposure to bites. Among those with nets, 68.59% used treated nets, 1.27% used untreated nets and 0.16% used both. Among children, 54.43% were male while 45.57% were female. A recent incident of fever was reported in 11.31% of children, with 88.53% fever-free and 0.16% were not aware. Only 20.33% of all children were tested for malaria, while 79.67% were not. During pregnancy, 64.99% of mothers took SP/Fansidar, 34.74% did not, and 0.27% were unsure about preventive treatment to reduce the risk of congenital malaria. Marital status showed that 56.8% married, 26.66% were cohabiting, 11.95% were widowed, and 4.59% were not in union, with stable households facilitating better prevention. Wealth distribution indicates 66.85% poor, 12.1% middle-income, and 21.04% rich, with poverty limiting access to preventive measures. Housing materials included 73.18% metal roofs, 19.46% thatch/palm leaves, 1.66% no roof, 0.71% rustic materials, 0.47% wood planks, 0.16% roofing shingles and 4.35% non-residents, with thatch roofs increasing mosquito entry.

Table 1: Demographic characteristics of respondents

Variable	Category	Frequency	Percent (%)
Women's level of Education	No formal education	565	44.7
	Primary	596	47.15
	Post-primary training	103	8.15
	Total	1,264	100
Type of place of residence	Urban	153	12.1
	Rural	1,111	87.9
	Total	1,264	100
Sex of household head	Male	970	76.74
	Female	294	23.26
	Total	1,264	100
Has electricity	No	1,017	80.46
	Yes	247	19.54
	Total	1,264	100
Covered by health insurance	No	1,241	98.18
	Yes	23	1.82
	Total	1,264	100
Have a mosquito bed net for sleeping	No	203	16.06
	Yes	1,061	83.94
	Total	1,264	100
Type of mosquito bed net(s)	No net	379	29.98
	Only treated nets	867	68.59
	Both treated and untreated nets	2	0.16
	Only untreated nets	16	1.27
	Total	1,264	100
Sex of child	Male	688	54.43
	Female	576	45.57

Variable	Category	Frequency	Percent (%)
	Total	1,264	100
Had a fever in the last two weeks	No	1,119	88.53
	Yes	143	11.31
	Don't know	2	0.16
	Total	1,264	100
Malaria testing	No	1,007	79.67
	Yes	257	20.33
	Total	1,264	100
SP/Fansidar taken during pregnancy for Malaria	No	256	34.74
	Yes	479	64.99
	Don't know	2	0.27
	Total	737	100
Current Marital Status	Single	58	4.59
	Married	718	56.8
	Living with a partner	337	26.66
	Widowed	151	11.95
	Total	1,264	100
Wealth Index	Poor	845	66.85
	Middle	153	12.1
	Rich	266	21.04
	Total	1,264	100
Main Roof Material	No roof	21	1.66
	Thatch/Palm leaf	246	19.46
	Rustic Material	9	0.71
	Wood planks	6	0.47
	Metal	929	73.18
	Roofing shingles	2	0.16
	Not a de jure resident	55	4.35
	Total	1264	100

Source: TDHS-MISS 2022

4.2. Stepwise Regression Analysis

The regression model identifies key predictors of malaria prevalence among children under five in Tanzania. Table 2 shows that female children are significantly less likely to have malaria (OR=0.574, p=0.003) compared to males, suggesting potential differences in care-seeking or biological factors. Married households (OR=0.546, p=0.008) and those with partners (OR=0.403, p=0.014) had 45.4% and 59.7% lower odds, respectively, compared to non-union households, indicating stability's protective role. Higher wealth reduced malaria odds by 83.8% (OR=0.162, p=0.001), reflecting better access to prevention and healthcare. Primary education reduced the odds by 67.9% (OR=0.321, p<0.001) compared to those with no formal education, highlighting the impact of knowledge. Recent fever increased odds by 347% (OR=4.471, p<0.001), indicating acute malaria risk. Thatch/palm leaf roofs (OR=5.827, p<0.001) and rustic materials (OR=4.078, p=0.047) increased odds by 5.8 and 4.1 times, respectively, due to mosquito entry.

Table 2: Stepwise Regression Analysis

Variable	Odds Ratio	Robust Std. Err.	z	p>z	[95% Conf. Interval]	
Sex of Child						
Male	Reference					
Female	0.574365	0.10736	-2.97	0.003	0.398182	0.828503
Current Marital Status						
Not in Union	Reference					
Married	0.546051	0.125016	-2.64	0.008	0.348622	0.855287
Living with Partner	0.40297	0.149654	-2.45	0.014	0.194606	0.834428
Wealth	0.162172	0.09167	-3.22	0.001	0.053558	0.491053
Women Education						
No education	Reference					
Primary Education	0.320625	0.068626	-5.31	0	0.21077	0.487737
Had fever in last two weeks						
No	Reference					
Yes	4.470995	1.381448	4.85	0	2.440057	8.192347
Main Roof material						
No roof	Reference					
Thatch/Palm leaf	5.826982	1.086103	9.46	0	4.04377	8.39655
Rustic Material	4.078255	2.891455	1.98	0.047	1.016198	16.36705
_cons	**0.41666**	**0.079316**	**-4.6**	**0**	**0.286911**	**0.605086**

4.2. Discussion and Implications of the Findings

The regression results reveal critical socio-economic and environmental drivers of malaria in Tanzania, with implications for Tanzania's malaria control strategies. The lower malaria odds for female children (OR=0.574, p=0.003) reflect care-seeking biases, where male children are prioritized for testing or treatment in Tanzanian households (Omary et al., 2025). Currently married (OR=0.546, p=0.008) and cohabiting households (OR=0.403, p=0.014) had lower odds of malaria, likely because stable households can prioritize ITN use and healthcare. This aligns with studies conducted in East Africa, Guinea, and the Democratic Republic of the Congo, which found that married individuals and those cohabiting were significantly associated with ITN use (Terefe et al., 2023; Diallo et al., 2023; Kabalu Tshiongo et al., 2024). Thus, household stability reduces malaria risk. This implies that support programs, such as ITN subsidies for single or widowed mothers in Tanzania, can enhance prevention in vulnerable households.

Higher wealth reduced the odds of malaria by 83.8% (OR=0.162, p=0.001). These results align with studies in Tanzania and other Sub-Saharan African countries, which found that wealthier households have access to better housing and ITNs, leading to lower malaria prevalence than poorer households (Anjorin et al., 2023; Mbishi et al., 2024). Similarly, poverty exacerbates malaria by limiting resources for prevention (Tusting et al., 2016; Wafula et al., 2023; Sarfo et al., 2023). The findings call for economic empowerment in Tanzania through microfinance or cash transfers to bridge economic disparities and improve access to preventive tools.

Primary education reduced malaria odds by 67.9% (OR=0.321, p<0.001), as educated mothers are more likely to use ITNs and seek treatment; the results are in line with the studies done in Nigeria and Niger by Alao et al. (2025) and Nadakou et al. (2025), respectively, which found that women with higher levels of education were significantly associated with greater knowledge of malaria prevention, including usage of ITNs. The preventive knowledge is needed through community education campaigns targeting uneducated mothers in Tanzania. Also, the study found that current fever increased malaria odds by 347% (OR=4.471, p<0.001), aligning with studies linking fever to malaria risk in African children (Nankabirwa et al., 2022). Thus, continuing to equip Tanzania's rural health facilities with rapid diagnostic tests is critical for early malaria detection.

Thatch/palm leaf roofs (OR=5.827, p<0.001) and rustic roofs (OR=4.078, p=0.047) significantly increased the odds of malaria. These results are consistent with studies conducted in Tanzania,

which show that poor housing facilitates mosquito entry (Kaindoa et al., 2018; Mmbando et al., 2025). Also, the results are consistent with the study conducted in Uganda by Nankabirwa et al. (2024), which found that respondents residing in modern houses had lower malaria prevalence than those residing in traditional houses. Promoting roofing upgrades to metal in Tanzania can reduce environmental risks, aligning with Tanzania's NMSP 2021–2025, which emphasizes equity-focused interventions to address malaria.

5. Conclusion and Recommendations

5.1. Conclusion

This study reveals a complex interplay of socio-economic and environmental factors that drives malaria prevalence among children under five. Poverty, low maternal education, and unstable households significantly increase malaria risk, while higher wealth and education offer substantial protection. Thatched and rustic roofs make it much easier for mosquitoes to get in, greatly increasing the risk of malaria. This evidence highlights the need to improve housing in rural areas of Tanzania. The lower odds for female children, potentially due to care-seeking biases favoring males, highlight the need for gender-equitable interventions. Recent fever strongly predicts malaria, emphasizing the urgency of diagnostic improvements in rural areas. Addressing socio-economic disparities and environmental risks, particularly in Tanzania's high-burden regions, can make significant strides toward reducing malaria prevalence and protecting its youngest population. The study's insights underscore the importance of integrated, context-specific strategies that combine community education, economic empowerment and infrastructure improvements to achieve sustainable malaria control.

5.2. Recommendations

The Tanzanian Ministry of Health and Local Government Authorities (LGAs) should promote community-based education initiatives, especially in rural areas, focusing on mothers with no education to improve their knowledge of ITN use and malaria prevention, and using Community Health Workers (CHWs) for effective outreach.

Local Government Authorities (LGAs) should introduce subsidized housing programs to replace thatched and rustic roofs with metal ones in rural Tanzania. This can be realized through partnering with NGOs to fund these upgrades.

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