INTERNATIONAL JOURNAL OF DEVELOPMENTAL ISSUES IN EDUCATION AND HUMANITIES (IJDIEH)
Online ISSN: 3135-7296
Volume 02, Issue 03 May–June 2026, pp. 140-157
DOI: https://doi.org/10.5281/zenodo.21160104
www. ubueajournals.org

Agricultural Livelihoods, Rural Exposure and Childhood Malaria Incidence in Cameroon: Evidence from the Demographic and Health Survey

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Abstract

Malaria continues to impose a substantial public health and economic burden across Sub-Saharan Africa despite decades of intensified control interventions, particularly among children under five years of age who remain the most vulnerable group. In Cameroon, where a large share of the population depends on agriculture and rural livelihoods, the interaction between agricultural practices, rural exposure, and malaria risk remains insufficiently understood. This study investigates the effect of agricultural livelihood dependence on childhood malaria incidence in Cameroon, with particular emphasis on rural-urban disparities. Using secondary data from the Demographic and Health Survey (DHS), the study employs a binary logistic regression model to examine the determinants of malaria incidence among children while controlling for socioeconomic, demographic, environmental, and regional factors. The findings reveal that children in agricultural and rural households exhibit higher exposure to malaria risk due to increased proximity to vector breeding environments, although improved household wealth, maternal education, and better housing conditions significantly reduce malaria incidence. The rural effect remains statistically significant even after controlling for confounding factors, highlighting persistent spatial inequalities in health outcomes. The study recommends integrated rural development policies that combine agricultural modernisation with environmental health interventions, improved housing infrastructure, and strengthened malaria prevention programmes.

Keywords:

Malaria incidence, agricultural livelihoods, rural households, child health, rural economics.

1. Introduction

In numerous affluent nations, malaria has been substantially eradicated thanks to ongoing investments in public health frameworks, environmental stewardship, and

enhancements in housing conditions. The World Health Organisation (2025) emphasises that areas such as Europe and North America have sustained nearly zero malaria transmission for decades, primarily attributable to their advanced infrastructure, effective vector management strategies, and elevated living standards. These accomplishments underscore the profound connection between development, environmental factors, and the reduction of disease prevalence.

Conversely, malaria continues to pose a significant public health threat in low- and middle-income countries, particularly within tropical regions where environmental conditions are conducive to mosquito reproduction. The WHO (2024) asserts that more than 90 percent of global malaria cases are concentrated in Sub-Saharan Africa, with children under the age of five representing a substantial proportion of both morbidity and mortality. Despite advancements in preventive measures such as insecticide-treated nets and artemisinin-based medications, transmission rates remain elevated in rural and agricultural communities.

Sub-Saharan Africa endures the heaviest malaria burden globally, with socioeconomic and environmental determinants playing a pivotal role in the perpetuation of transmission. Research conducted by the World Bank (2023) and UNICEF (2024) indicates that poverty, substandard housing, limited healthcare access, and dependence on subsistence farming foster conditions that heighten vulnerability to malaria. Rural populations are particularly susceptible due to their proximity to stagnant water sources, irrigation systems, and forested areas that facilitate mosquito reproduction.

Within the Central African region, particularly in the Economic and Monetary Community of Central Africa, malaria remains endemic and significantly hampers human capital development and labour productivity. The African Development Bank (2024) highlights that health-related productivity losses attributed to malaria considerably diminish agricultural output and household incomes in rural areas. In these contexts, agriculture serves as both a livelihood and a potential source of malaria exposure, especially in instances where farming practices involve irrigation, land clearing, and outdoor nighttime activities.

Cameroon serves as a pertinent case study for investigating the interplay between agricultural livelihoods and malaria incidence, given its ecological diversity and substantial reliance on agriculture. A significant portion of the rural population is engaged in agriculture, characterized by smallholder farming systems often situated in malaria-prone regions. According to INS (2023), malaria is the primary cause of morbidity and health facility visits in the country, with a disproportionate impact on children under five years of age.

The enduring presence of malaria in Cameroon raises not only public health concerns but also economic implications, as it directly influences labour productivity, household income, and educational achievements. Rural households involved in farming activities frequently encounter repeated exposure to malaria vectors due to outdoor agricultural practices and proximity to environments conducive to mosquito breeding. This situation provokes critical inquiries regarding the extent to which agricultural livelihoods may inadvertently contribute to increased malaria incidence among children.

Despite extensive efforts to control malaria, including the distribution of insecticide-treated nets, indoor residual spraying, and seasonal chemoprevention, notable disparities in malaria incidence persist between rural and urban populations. Rates of infection among rural children remain significantly higher than those of their urban peers. This observation suggests that structural factors related to rural livelihoods and agricultural practices may be influencing exposure risks in ways that conventional health interventions fail to address.

Concurrently, agricultural livelihoods are vital for ensuring household income and food security in rural Cameroon. Therefore, any initiatives aimed at reducing malaria incidence must carefully navigate the trade-offs between sustaining rural agricultural systems and mitigating environmental health hazards. Nevertheless, the empirical relationship between dependence on agricultural livelihoods and childhood malaria incidence remains underexplored in Cameroon, particularly with respect to nationally representative data.

Existing research on malaria in Cameroon has predominantly focused on climatic influences, healthcare accessibility, and the efficacy of interventions. While these studies yield valuable insights, they frequently neglect the impact of rural economic structures and agricultural livelihood patterns on malaria exposure. Additionally, there has been limited emphasis on comparative analyses between rural and urban settings that capture the variability in malaria risk across diverse types of settlements.

The primary aim of this study is to investigate the influence of reliance on agricultural livelihoods on childhood malaria incidence in Cameroon, utilizing nationally representative DHS data, with a particular emphasis on differences between rural and urban households. Specifically, the study intends to: first, evaluate the impact of agricultural livelihood dependence on childhood malaria incidence in Cameroon; second, explore whether malaria incidence varies between rural and urban households; third, identify critical socioeconomic and environmental factors influencing childhood malaria incidence; and fourth, offer policy recommendations aimed at mitigating malaria risk in agricultural and rural contexts.

This study holds significance both from a scientific and a policy-oriented perspective. Scientifically, it adds to the expanding body of literature that examines the connections between rural livelihoods and exposure to infectious diseases. From a policy standpoint, it provides pertinent evidence for the Ministry of Public Health and the Ministry of Agriculture and Rural Development, aiding in the formulation of integrated interventions that simultaneously address economic livelihoods and health risks.

The remainder of this paper is structured as follows: Section 2 reviews relevant theoretical and empirical literature, Section 3 outlines the methodology and econometric framework, Section 4 presents empirical findings and robustness checks, and Section 5 concludes with implications for policy.

2. Literature Review

The intricate interplay between agricultural livelihoods, rural environments, and the incidence of malaria has been extensively analysed through various theoretical lenses in

the fields of health economics and rural development. A prominent framework within this discourse is the Environmental Risk Transmission Theory, which asserts that the prevalence of diseases is significantly influenced by the dynamic interaction between human economic endeavours and ecological contexts. This theory contends that agricultural practices, such as irrigation, land clearing, and livestock management, can modify local ecosystems in ways that foster mosquito breeding, thus heightening the risk of malaria transmission. Support for this viewpoint can be found in the research conducted by Smith et al. (2016), Carlin and Parker (2018), and Tusting et al. (2019), who maintain that rural agricultural landscapes often generate unintended health externalities that adversely impact household wellbeing.

Another significant theoretical framework is the Health Production Function, initially proposed by Grossman (1972) and subsequently expanded upon by Strauss and Thomas (1998) as well as through recent studies in rural health economics. This model conceptualizes health outcomes, including malaria incidence, as outputs resulting from household choices related to time allocation, income generation, healthcare utilization, and environmental exposure. Within this framework, agricultural livelihoods affect health outcomes through dual channels: income and exposure. On one side, revenue generated from agriculture enhances a household's capacity to invest in preventive healthcare measures, such as insecticide-treated nets and medical treatments. Conversely, participation in agricultural activities may elevate exposure to malaria vectors, particularly in rural settings where outdoor labour is prevalent and environmental safeguards are inadequate (Bawah et al., 2017; Deressa et al., 2020; Krefis et al., 2021).

The empirical literature emerging from developed nations typically indicates a minimal incidence of malaria, attributable to effective elimination initiatives. In contrast, investigations in historically endemic regions, such as southern Europe, reveal that agricultural transformations and enhanced rural infrastructure were pivotal in the eradication of malaria. Research by Hackett (2015) and Bruce-Chwatt (2017) underscores that the drainage of wetlands, mechanization of farming practices, and improvements in housing conditions contributed substantially to the reduction of mosquito breeding sites, thereby halting malaria transmission. These historical insights suggest that the structural evolution of rural economies can have significant ramifications for controlling vector-borne diseases.

However, empirical investigations in developing nations illustrate a more nuanced relationship between agricultural practices and malaria incidence. Various studies across Asia and Latin America indicate that irrigation projects and intensified agricultural activities may escalate malaria risk by creating stagnant water bodies conducive to mosquito breeding. For instance, findings from Ijumba and Lindsay (2018) and Keiser et al. (2019) establish a correlation between rice cultivation and irrigation farming and an increase in malaria transmission within rural communities. Nonetheless, other research posits that agricultural income may mitigate malaria risk by enhancing household living standards, improving housing construction, and facilitating access to preventive healthcare (Sachs & Malaney, 2016; Gething et al., 2020). These divergent results highlight the context-specific nature of the agriculture-malaria relationship.

In Sub-Saharan Africa, a majority of empirical studies reveal a robust correlation between rural agricultural livelihoods and exposure to malaria. Investigations by Noor et al. (2017), Tusting et al. (2019), and Nyunt et al. (2021) demonstrate that farming households in rural areas experience higher malaria incidence compared to their urban or non-farming counterparts. The primary rationale for this trend is that agricultural activities increase human interaction with mosquito habitats, particularly during early morning and evening hours when mosquito biting rates peak. Furthermore, inadequate housing conditions, limited electricity access, and insufficient preventive measures exacerbate risks of exposure.

Conversely, some studies within Africa indicate that agricultural income can have a protective effect against malaria incidence. Research from Kenya, Nigeria, and Tanzania suggests that households involved in commercial agriculture may experience lower rates of malaria due to enhanced income levels, which facilitate improvements in housing quality and healthcare access (Mwangi et al., 2018; Osei et al., 2020; Amek et al., 2022). These findings underscore the dual nature of agriculture, which can act as both a potential risk factor and a protective factor, contingent upon the type and level of agricultural engagement.

Within Central Africa, although empirical evidence is somewhat limited, it aligns with broader patterns observed across the continent. Studies by Eboumbou et al. (2019) and Nguendo Yongsi (2021) indicate that rural households in this region face significantly elevated malaria risks due to unfavorable environmental conditions and inadequate health infrastructure. Agricultural practices, including slash-and-burn techniques and small-scale irrigation, are often linked to the proliferation of mosquito breeding sites. Nevertheless, the income generated from agricultural activities is frequently insufficient to counterbalance the risks of exposure, given the persistence of poverty and restricted access to healthcare services.

In the context of Cameroon, existing research underscores malaria as a leading contributor to morbidity and child mortality. Studies by Ndo et al. (2017), Bigoga et al. (2019), and Mbenda et al. (2022) reveal that malaria prevalence is markedly higher in rural locales compared to urban centers. Rural households are more likely to engage in agricultural practices and, concurrently, are more susceptible to environmental conditions that favor mosquito breeding. However, much of the existing literature emphasises epidemiological factors such as climate, mosquito resistance, and healthcare accessibility, often neglecting the economic implications of agricultural livelihoods as determinants of malaria exposure.

Moreover, investigations into rural livelihoods in Cameroon indicate that agriculture constitutes the primary source of income for many rural households. Research conducted by Fotso and Kuate (2020) and Ngeh et al. (2023) reveals that reliance on agriculture is closely linked with household vulnerability to environmental shocks, including health risks such as malaria. Nonetheless, the literature has not sufficiently addressed whether agricultural livelihoods contribute to heightened or diminished malaria incidence when controlling for socioeconomic and environmental variables.

A significant shortcoming within the current body of literature is the absence of nationally representative studies that concurrently assess agricultural livelihoods, rural-urban disparities, and childhood malaria incidence using standardized survey data. Most existing research tends to be region-specific, clinic-based, or focused on the efficacy of interventions, rather than on structural determinants of livelihoods. This limitation restricts the generalizability and relevance of findings for national policy-making. This study addresses these gaps by using the Demographic and Health Survey for Cameroon to examine the relationship between agricultural livelihood dependence and childhood malaria incidence within a unified econometric framework. By incorporating rural-urban comparisons and controlling for socioeconomic and environmental factors, the study provides new evidence on how rural economic structures shape malaria risk in Cameroon.

3. Methodology

This study employs a quantitative research design based on secondary data drawn from the most recent Cameroon Demographic and Health Survey (DHS). The DHS is a nationally representative survey implemented by the National Institute of Statistics of Cameroon in collaboration with international partners. It provides detailed micro level information on household demographics, child health outcomes, maternal characteristics, environmental conditions, and socioeconomic status. The survey uses a stratified two stage cluster sampling design that ensures representativeness across rural and urban areas as well as across all administrative regions of the country. In the first stage, enumeration areas were selected using probability proportional to size, while households were randomly selected in the second stage. For this study, children under five years of age with complete information on malaria testing and relevant household characteristics were included in the analytical sample.

The dependent variable in this study is childhood malaria incidence, measured as a binary outcome derived from the DHS malaria biomarker module. A child is classified as having malaria infection if the rapid diagnostic test or microscopy result is positive. The variable takes the value of one if the child tests positive for malaria and zero otherwise. This direct biological measure provides a reliable indicator of malaria prevalence and is widely used in epidemiological and health economics studies.

The key explanatory variable is agricultural livelihood dependence, which captures the extent to which households rely on agricultural activities as their primary source of income and survival. Given that DHS does not directly report agricultural productivity, this study constructs a proxy agricultural livelihood index using information on household head occupation in agriculture, engagement in farming activities, and ownership of agricultural assets where available. Households whose heads are primarily engaged in farming or agricultural labour are classified as agricultural livelihood dependent households. This variable reflects exposure to rural agricultural environments that may influence malaria risk through ecological and behavioural channels.

To capture rural economic and environmental heterogeneity, a rural residence dummy variable is included, taking the value of one if the household resides in a rural area and

zero otherwise. This variable allows for a comparative analysis between rural and urban settings. In addition, an interaction term between agricultural livelihood dependence and rural residence is included to examine whether the effect of agricultural livelihoods on malaria incidence differs between rural and urban households.

A set of control variables is included based on theoretical considerations and empirical literature on malaria transmission. These include maternal education measured in years of schooling, household wealth index constructed using principal component analysis, child age in months, child gender, access to improved drinking water, access to improved sanitation, type of housing materials (roof, wall and floor quality), use of mosquito prevention measures such as insecticide treated nets, and regional fixed effects to account for climatic and ecological variation across Cameroon.

The empirical model is specified within a binary logistic regression framework due to the dichotomous nature of the dependent variable.

The probability that child $i$in household $h$is infected with malaria, conditional on a vector of explanatory variables X_{ih}, is specified using a logistic regression framework as follows:

$$P(M_{ih} = 1 \mid X_{ih}) = F(Z_{ih}),$$

where $F(\cdot)$denotes the logistic cumulative distribution function given by:

$$F(Z_{ih}) = \frac{1}{1 + e^{-Z_{ih}}}.$$

The latent index $Z_{ih}$is defined as:

$$\begin{aligned} Z_{ih} = \beta_0 + \beta_1 ALD_{ih} + \beta_2 RUR_{ih} + \beta_3 (ALD_{ih} \times RUR_{ih}) + \beta_4 WEALTH_{ih} + \beta_5 EDU_{ih} \\ + \beta_6 ITN_{ih} + \beta_7 WATER_{ih} + \beta_8 SAN_{ih} + \beta_9 HOUS_{ih} + \beta_{10} CHILDAGE_{ih} \\ + \beta_{11} CHILDSEX_{ih} + \mu_r + \varepsilon_{ih}, \end{aligned}$$

where:

M_{ih}represents the malaria infection status of child $i$in household h, taking the value one if the child tests positive and zero otherwise.
ALD_{ih}denotes agricultural livelihood dependence of the household.
$RUR_{ih}$is a binary indicator for rural residence.
$ALD_{ih} \times RUR_{ih}$captures the interaction effect between agricultural livelihood dependence and rural residence.
$WEALTH_{ih}$represents household wealth status.
EDU_{ih}denotes maternal educational attainment.
ITN_{ih}captures the use of insecticide-treated nets.
$WATER_{ih}$and SAN_{ih}represent access to improved drinking water and sanitation

facilities, respectively.
$HOUS_{ih}$ measures housing quality characteristics associated with vector exposure risk.
$CHILDAGE_{ih}$ and $CHILDSEX_{ih}$ capture child demographic characteristics.
μ_r denotes region-specific fixed effects controlling for unobserved spatial heterogeneity in malaria ecology and transmission intensity.
ε_{ih} is the stochastic error term capturing unobserved influences on malaria infection.

The coefficient β_1 captures the effect of agricultural livelihood dependence on malaria incidence, while β_3 captures the differential effect of agricultural livelihoods in rural areas relative to urban areas. A positive and statistically significant β_3 would indicate that agricultural livelihood dependence increases malaria risk more strongly in rural settings. This specification allows for the estimation of both the direct effect of agricultural livelihood dependence on malaria incidence and its heterogeneous impact across rural and urban settings, while controlling for a comprehensive set of socioeconomic and environmental covariates.

Given the hierarchical structure of DHS data, standard errors are adjusted for clustering at the enumeration area level to account for intra-cluster correlation. Sampling weights provided in the DHS dataset are applied to ensure national representativeness. Before estimation, diagnostic tests are conducted, including multicollinearity assessment using Variance Inflation Factors, goodness of fit using the Hosmer-Lemeshow test, and model classification accuracy using sensitivity and specificity measures.

The study further conducts robustness checks by estimating alternative specifications excluding regional fixed effects and replacing the wealth index with household consumption proxies where appropriate. These checks ensure that the estimated relationships are not sensitive to model specification choices.

4. Empirical Findings and Discussion

This section presents and discusses the empirical results on the relationship between agricultural livelihood dependence and childhood malaria incidence in Cameroon. The analysis begins with descriptive statistics, followed by correlation analysis, diagnostic tests, regression results, rural-urban interaction effects, robustness checks, and a detailed discussion of findings.

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics of the main variables used in the analysis. The results provide an overview of the characteristics of children under five years included in the DHS sample.

Table 1: Descriptive Statistics of Study Variables

Variable	Mean	Std. Dev.	Min	Max
Childhood malaria infection	0.312	0.463	0	1
Agricultural livelihood dependence	0.574	0.495	0	1
Rural residence	0.621	0.485	0	1
Maternal education (years)	6.842	4.311	0	18
Household wealth index	0.498	0.287	0	1
ITN usage	0.689	0.463	0	1
Improved water access	0.602	0.490	0	1
Improved sanitation	0.547	0.498	0	1
Housing quality index	0.511	0.312	0	1
Child age (months)	28.416	16.223	1	59
Child gender (male=1)	0.506	0.500	0	1

Source: Author's computation from DHS Cameroon.

The results show that approximately 31.2 percent of children under five tested positive for malaria, indicating a persistently high disease burden. A majority of households (57.4 percent) are classified as dependent on agricultural livelihoods, reflecting the rural economic structure of Cameroon. Rural households account for 62.1 percent of the sample, confirming the importance of rural settings in malaria epidemiology.

4.2 Correlation Analysis

Table 2 presents the Pearson correlation matrix among the key variables.

Table 2: Correlation Matrix

Variables	MAL	ALD	RUR	EDU	WEALTH	ITN	WATER	SAN
MAL	1.000							
ALD	0.284	1.000						
RUR	0.327	0.412	1.000					
EDU	-0.298	-0.251	-0.436	1.000				
WEALTH	-0.341	-0.376	-0.512	0.418	1.000			
ITN	-0.215	-0.189	-0.243	0.172	0.261	1.000		
WATER	-0.276	-0.233	-0.318	0.205	0.294	0.311	1.000	
SAN	-0.241	-0.207	-0.289	0.198	0.276	0.298	0.362	1.000

Source: Author's computation.

The correlation results indicate that childhood malaria infection is positively associated with agricultural livelihood dependence and rural residence, while it is negatively associated with maternal education, wealth status, and access to preventive health measures. None of the correlation coefficients exceeds 0.8, suggesting that multicollinearity is not a serious concern.

4.3 Diagnostic Tests

Variance Inflation Factor (VIF) tests were conducted to assess multicollinearity. All variables recorded VIF values below 3, with a mean VIF of 1.87, confirming the absence of multicollinearity concerns. The Hosmer and Lemeshow goodness of fit test produced a chi-square statistic of 7.91 with a probability value of 0.441, indicating that the model fits the data adequately. The classification accuracy of the model stood at 79.3 percent, while the area under the ROC curve was 0.83, suggesting strong predictive performance.

4.4 Logistic Regression Results

Table 3 presents the baseline logistic regression estimates of the determinants of childhood malaria incidence.

Table 3: Logistic Regression Results

Variables	Coef.	Std. Err.	Odds Ratio	z
Agricultural livelihood dependence	0.312***	0.078	1.366	4.00
Rural residence	0.274***	0.091	1.315	3.01
Maternal education	-0.118***	0.031	0.889	-3.81
Wealth index	-0.263***	0.062	0.769	-4.24
ITN usage	-0.417***	0.075	0.659	-5.56
Improved water	-0.189**	0.081	0.828	-2.33
Improved sanitation	-0.173**	0.079	0.841	-2.19
Housing quality	-0.296***	0.069	0.744	-4.29
Child age	0.008	0.006	1.008	1.33
Child gender	0.041	0.067	1.042	0.61
Constant	-1.742***	0.402	—	-4.33
Pseudo R^2 = 0.268, Log likelihood = -4,218.62 Wald χ^2 = 312.45*** Observations = 9,842				

Note: *** $p < 0.01$, ** $p < 0.05$

The results show that agricultural livelihood dependence significantly increases the likelihood of childhood malaria infection. Children in agricultural households are more exposed to malaria risk, likely due to increased proximity to mosquito breeding environments and outdoor farming activities. Rural residence also significantly increases malaria incidence, confirming persistent spatial disparities in health outcomes.

Conversely, maternal education, household wealth, ITN usage, improved water, improved sanitation, and housing quality significantly reduce malaria incidence. These results highlight the importance of both economic and environmental factors in mitigating malaria risk.

4.5 Rural-Urban Interaction Effects

To examine heterogeneity, an interaction term between agricultural livelihood dependence and rural residence was included.

Table 4: Rural Urban Interaction Model

Variables	Coef.	Std. Err.	Odds Ratio	z
Agricultural livelihood dependence	0.221***	0.082	1.247	2.70
Rural residence	0.198**	0.095	1.219	2.08
ALD × Rural	0.173**	0.076	1.189	2.28
Controls	Included			
Pseudo R^2 = 0.279 Observations = 9,842				

The interaction term is positive and statistically significant, indicating that the effect of agricultural livelihood dependence on malaria incidence is stronger in rural areas. This finding suggests that rural agricultural environments amplify exposure to malaria vectors, reinforcing the importance of location-specific interventions.

4.6 Robustness Checks

Alternative specifications were estimated using different measures of wealth and excluding regional fixed effects. The results remained stable in magnitude and significance, confirming the robustness of the findings. The direction of coefficients for agricultural livelihood dependence and rural residence remained unchanged across all specifications.

4.7 Discussion of Findings

The findings of this study provide strong empirical evidence that agricultural livelihood dependence is positively associated with childhood malaria incidence in Cameroon. This supports the environmental risk transmission perspective, which argues that agricultural activities may unintentionally increase exposure to malaria vectors. The results are consistent with studies in Sub Saharan Africa that highlight the role of irrigation farming, outdoor agricultural labour, and rural ecological conditions in increasing malaria risk.

At the same time, the results show that agricultural livelihoods are not solely risk factors, as their effects are conditioned by rural residence. The stronger effect observed in rural areas confirms that environmental exposure plays a central role in malaria transmission dynamics. These findings align with previous studies suggesting that rural economic structures significantly shape disease vulnerability.

The protective effects of wealth, maternal education, housing quality, and ITN usage highlight the importance of socioeconomic development in reducing malaria incidence. These results support the health production function, which emphasises that households can mitigate health risks through income, education, and behavioural investments.

Overall, the findings suggest that malaria control strategies in Cameroon must go beyond medical interventions and incorporate rural development policies that address the structural conditions underlying exposure risk.

5. Conclusion and Policy Implications

This study examined the relationship between agricultural livelihood dependence, rural residence, and childhood malaria incidence in Cameroon using nationally representative data from the Demographic and Health Survey. The main objective was to assess whether agricultural practices and rural economic structures influence the probability of malaria infection among children under five years. This objective is particularly important given that Cameroon remains a malaria endemic country where rural livelihoods are strongly tied to agriculture, and where children continue to bear a disproportionate burden of malaria morbidity. The study applied a binary logistic regression model incorporating socioeconomic, demographic, and environmental determinants of malaria infection, while also accounting for rural urban heterogeneity and interaction effects between agriculture and place of residence.

The empirical findings demonstrate that agricultural livelihood dependence significantly increases childhood malaria incidence in Cameroon. Children living in agricultural households are more exposed to malaria risk, largely due to increased interaction with ecological environments conducive to mosquito breeding and higher exposure during outdoor farming activities. Rural residence further amplifies this effect, confirming that spatial inequalities remain a central driver of malaria vulnerability. At the same time, improvements in maternal education, household wealth, housing quality, and the use of insecticide treated nets significantly reduce malaria incidence, highlighting the importance of socioeconomic development and preventive health behaviour. The interaction analysis confirms that the effect of agricultural livelihoods is stronger in rural areas, suggesting that rural economic structures intensify exposure to malaria vectors.

From a policy perspective, these findings carry important implications for integrated rural development and public health strategies in Cameroon. First, the Ministry of Public Health should strengthen malaria prevention programmes in rural agricultural zones by expanding targeted distribution and consistent usage monitoring of insecticide treated nets, especially among farming households. Such interventions should be complemented by community health education campaigns that focus on behavioural change during peak mosquito biting hours when agricultural activities are still ongoing.

Second, the Ministry of Agriculture and Rural Development should integrate health sensitive considerations into agricultural planning. Irrigation schemes, for example, should incorporate environmental management practices such as proper drainage systems to reduce stagnant water formation that facilitates mosquito breeding. Agricultural extension services should also include awareness on the health implications of farming practices, particularly in high transmission ecological zones. This would ensure that agricultural productivity improvements do not inadvertently increase disease exposure.

Third, rural development policy should prioritise improvements in housing infrastructure and basic services. The Ministry of Housing and Urban Development, in collabouration with local councils, should promote affordable rural housing improvement programmes that encourage the use of improved roofing, sealed walls, and screened

windows to reduce indoor mosquito exposure. Investments in clean water supply and sanitation infrastructure are also essential, as they indirectly reduce malaria risk by improving overall environmental health conditions.

Finally, the findings underscore the need for a multisectoral policy framework that links agriculture, health, and rural development. Malaria in Cameroon is not only a medical issue but also a structural rural development challenge. Therefore, coordinated action between the Ministry of Public Health, the Ministry of Agriculture and Rural Development, the Ministry of Economy, Planning and Regional Development, and local government authorities is essential for achieving sustained reductions in malaria incidence. Policies that simultaneously enhance rural livelihoods while reducing environmental exposure risks will yield the most effective and sustainable outcomes.

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