

## Socioeconomic Status and Child Health in North Central Nigeria: Mediating Roles of Policy Interventions and Practices

by

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### Abstract

This study investigates the socioeconomic and health-related determinants of infant mortality and malaria occurrences among households in North Central Nigeria. Using stepwise logistic regressions on a sample of 539 households, the study examines the mediating effect of policy intervention and practices on the relationship between socioeconomic status and child health. The results reveal that household income consistently reduces both malaria incidence and infant mortality, highlighting the protective role of economic resources in improving living conditions and access to preventive measures. Maternal income significantly lowers malaria risk, while paternal education strongly reduces infant mortality, suggesting that household and parental human capital are critical determinants of child health outcomes. Sleeping under insecticide-treated mosquito nets significantly reduces both malaria incidence and infant mortality, whereas exclusive breastfeeding markedly decreases infant mortality but has no significant effect on malaria risk. Maternal occupation is positively associated with malaria, indicating occupational exposure, while paternal occupation increases infant mortality in models accounting for behavioural controls. Immunisation shows no significant effect on malaria and a weakly positive association with infant mortality, likely reflecting reverse causality or targeted vaccination of highrisk children. The findings underscore that child health outcomes are shaped by the interplay of socioeconomic resources, parental human capital and household health practices. Effective policy interventions should combine economic empowerment, parental education, promotion of preventive behaviours such as bed-net use and breastfeeding and targeted support for households at greater occupational or environmental risk, to simultaneously reduce malaria burden and improve infant survival.

**Keywords:** Health behaviours, socioeconomic determinants, child health, human capital

## 1. Introduction

Child mortality and common child diseases such as malaria and malnutrition are major indicators of child health in most developing countries including Nigeria. Although the rate of child mortality has substantially reduced and general child health has improved worldwide due to progress made in medicine, child mortality remains a major public health issue in Africa. For instance, the World Health Organisation (WHO, 2024) reported Sub-Saharan Africa and southern Asia, accounting for more than 80% of the 4.9 million under-5 deaths in 2022. In addition, Sub-Saharan Africa had the highest neonatal mortality rate in 2022 at 27 deaths per 1,000 live births, followed by Central and Southern Asia with 21 deaths per 1,000 live births. A child born in sub-Saharan Africa is 11 times more likely to die in the first month of life than a child born in the region of Australia and New Zealand. According to World Bank (2022), Nigeria, specifically recorded under-five mortality rate of 114 per 1000 live birth, which is the second highest globally. Also, Nigeria was the highest contributor to overall under-five deaths in 2020 with 844,321 under-five deaths overtaking India. This accounted for 16.72% of global under-five deaths in 2020. A report from WHO (2017) shows that a large percentage of under-five mortality rates in low-income countries were due to avoidable and curable illnesses like acute respiratory infections, malnutrition, diarrhoea and malaria.

Aside from the alarming rate poor child health outcomes in Nigeria, its consequential effects on human capital development cannot be over-emphasised. Children with low body weight, poor nutrition status and high incidence of diseases are susceptible to low productivity, poor education and low labour supply in adulthood, while children with better health outcomes are likely to have better quality capital development in adulthood (Currie & Jobman, 2023; Adejoh, Adofu, & Salami, 2023). This underscores the imperativeness of good investment in programmes and policies that improve household's socioeconomic status, child and general health outcomes. To reduce the scenario of high infant mortality rate and prevalence of chronic child conditions, the Federal Government of Nigeria and other stakeholders have spent a huge amount of money to combat the monster. For instance, 55.5 million USD was spent by the Federal Government of Nigeria from World Bank credit in 2015 through the programme Saving One Million Lives programme for Result (SOML PforR) aimed at cutting down maternal and child mortality rate and improve child health outcomes (SOML PforR, 2017). The Global Fund (2022) report added that

as the highest country with global malaria cases, Nigeria also received the largest global fund grant of over 1.5 billion US dollars to combat malaria for the 2017-2020 and 2020-2022 funding cycles.

Despite the humongous investment in programmes and policies towards general and child health outcomes' improvement in Nigeria, not much has been achieved. Policy makers concerned public and private organisations, foreign agencies and researchers have tremendous roles to play in averting avoidable health problems that are confronting children, women and other underprivileged members of the society. This study therefore used recent data to examine the mediating effects of policy interventions and policies (exclusive breastfeeding, immunisation and sleeping under treated nets) on the relationship between the socioeconomic status and child health in selected states of North Central Nigeria. This integrated approach, which differs from the existing studies, allows for a comprehensive analysis of the structural and behavioural factors that shape child survival outcomes.

Apart from the current section, the second section contains literature review, the third section contains methodology, the fourth section contains presentation and discussion of findings while the last section contains the summary, conclusion and policy recommendations.

## **2. Literature Review**

### **2.1 Theoretical Framework**

The theoretical framework for the study is the Health Capital Theory, propounded by Grossman (1972). The theory of health capital assumes that individuals inherit initial health stock which defines one's wellbeing that depreciates with age but can be increased by investment. The theory portrays that investment in health capital is possible through household production functions whose inputs constitute consumer own time and market goods which include exercise, medical care, housing, recreation, diet and individual level of education. The theory emphasises the significance of education, income, medical services and other socioeconomic factors in determining health outcomes.

## 2.2 Empirical Review

Among the numerous works that have been published on the socioeconomic determinants of child health, the most relevant ones to the current study are reviewed. Gautam, Rahman and Khanam (2025) investigate the association between socioeconomic inequalities and health behaviours among Australian children and adolescents, using Longitudinal Study of Australian Children (Waves 2–8), which included participants aged 2 to 15 years. Using Relative Index Inequality methods, the study found that children and adolescents with high socioeconomic status are 84% more likely to consume fruits and vegetables and 19% less likely to consume sugary beverages, but more likely to consume sweet and savory foods. The study further found that children and adolescents with high SES were less likely to spend their free time on screens and more inclined toward outdoor activities.

Currie and Jobman (2023) conducted literature on the relationship between Parental socioeconomic status, child health and human capital. The study found that investments in education pay enhances higher future earnings and differences in educational attainments explain a significant fraction of the adult variation in wages, incomes and other outcomes. Gautam, Dessie, Rahman and Khanam (2023) assessed the association between socioeconomic status and health behaviours in childhood and adolescence. The study found that children and adolescents with low socioeconomic status face an elevated risk of unhealthy behaviours in contrast to their counterparts. Conversely, children and adolescents from higher socioeconomic backgrounds exhibit a higher prevalence of health-promoting behaviours, such as increased consumption of fruit and vegetables, dairy products, regular breakfast, adherence to a nutritious diet and engagement in an active lifestyle.

Joseph and Adofu (2019) examined socioeconomic status and child healthcare utilisation in Nigeria, using NMIS data. Using Binary logistic regression as a method of analysis, the study result found a positive and significant relationship between socioeconomic status especially wealth differential and child healthcare utilisation. Other indicators of child health care use included region, family structure, gender of household head and place of residents which were also found to be important determinants of child health care use.

Poulain et al. (2019) investigated associations between socio-economic status (SES) and health parameters and behaviours in German children and adolescents. Using linear and logistic regression analyses. The study found that higher SES composite score was associated with better health. The study, however, found that SES was not associated with alcohol consumption or sleep problems. The strengths of the associations between SES and child health did not differ depending on SES indicators (education, occupation, income). The associations between SES and parent-reported behavioural difficulties and physical activity were stronger in older vs. younger children. Ehwarime et al. (2018) studied the assessment of the nutritional status among under-five children in Evbuotubu community Egor Local Government Area of Edo State, using chi-square to analyse sample size of 272 mothers and 544 under-five children. The result shows no significant relationship between mothers' income level and malnutrition in under-five children in Evbuotubu community.

Anyemele, Akanegbu, Assad and Ukawuilulu (2017) used pooled 2003 and 2008 NDHS data to study differentials in infant and child mortality in Nigeria, adopting logistic regression as a method of analysis. The study found the prevalence of infant and child mortality to be higher in rural areas of all six geopolitical zones compared to urban areas. Among the six geopolitical zones, NorthEast and Northwest had a higher prevalence of child and infant mortality compared to other geopolitical zones. The study further found that there was no significant difference in child and infant mortality rates between the rural and the urban poor after the interaction. Kingsley, Charlie and Chidi (2017) examined socioeconomic determinants of under-five children health outcomes among childbearing mothers in Abia State, Nigeria. The study found that under-five mortality was generally higher in the rural areas compared to urban areas of the state. The result shows that mothers who were paid civil servants in the rural areas of Abia state had lower incidents of child mortality compared to their urban counterparts.

### 3. Methodology

#### 3.1 Nature and Source of Data

This study used a cross-section survey data collected from three states (Benue, Kwara and Plateau) representing the North central region of Nigeria. The selection of the states is based on the heterogeneity of the selected states. Benue State is a gateway to southeastern part of the country and has Tiv and Idoma as the predominant ethnic groups in the state. Kwara State is the gateway to Southwestern part of Nigeria and has Yoruba as the predominant language in the state. Plateau state is connected to the Northeast region of the country and has Hausa as the predominant language in the state. The heterogeneity in the selected states is assumed to enhance variation in the collected data and give robust and reliable results that can represent the plurality and heterogeneity of the states in the North-Central Nigeria. The data was collected using structured questionnaire.

#### 3.2 Sampling Techniques and Distribution of Sampling Size

The study used multistage sampling techniques to select participants from the selected states. In the first stage, systematic sampling method was used to determine states and local government areas (LGA) to be selected for the study. Finally, random sampling was used to select political wards and households to be given the questionnaires.

**Table 1: Distribution of Sampling Sizes**

States	LGA	Sampling Interval	Position of LGAs	Sampling Size par State
Benue	23	$23/3 = 8$	8 <sup>th</sup> , 16 <sup>th</sup> , 23 <sup>rd</sup>	200
Plateau	17	$17/3 = 6$	6 <sup>th</sup> , 12 <sup>th</sup> 17 <sup>th</sup>	200
Kwara	16	$16/3 = 5$	5 <sup>th</sup> 10 <sup>th</sup> 15 <sup>th</sup>	200

**Source: Authors’ Computation, 2025.**

Table 1 presents the sampling strategy employed across three Nigerian states, Benue, Plateau and Kwara, for selecting Local Government Areas (LGAs) and determining sample sizes. For each state, the total number of LGAs was divided by the desired number of LGAs to be sampled (three

per state) to determine a sampling interval. This systematic sampling approach ensures proportional representation of LGAs across each state. For each selected LGA, a sample size of 200 respondents was allocated, resulting in uniform sampling coverage across states. This strategy balances efficiency with representativeness, minimizing selection bias while capturing regional variation within the three states.

### 3.3 Definition and Measurement of Variables

**Table 2: Definition and Measurement of Variables**

Variable	Definition	Measurement
Infant Mortality	Indicates whether a household had an infant (0–5 years) who died within ten years prior to the survey	Binary variable: 0 = No, 1 = Yes
Malaria Occurrence	Indicates whether a child usually has malaria weekly, monthly or yearly	Binary variable: 0 = yearly, 1 = weekly or monthly
Husband’s Income	Monthly income level of the husband	Continuous variable
Mother’s Income	Monthly income level of the mother (if intended)	Continuous variable
Mother’s Occupation Status	Employment status of the mother	Binary variable: 0 = Unemployed, 1 = Employed
Husband’s Occupation Status	Employment status of the husband	Binary variable: 0 = Unemployed, 1 = Employed
Mother’s Years of Education	Total years of formal education of the mother	Continuous variable
Husband’s Years of Education	Total years of formal education of the husband	Continuous variable
Sleeping Under Net	Indicates if a child sleeps under an insecticide-treated net (ITN)	Binary variable: 0 = Does not sleep under net, 1 = Sleeps under net
Exclusive Breastfeeding	Indicates if a child is exclusively breastfed	Binary variable: 0 = Not exclusively breastfed, 1 = Exclusively breastfed
Immunisation	Indicates if a child is fully or appropriately immunised	Binary variable: 0 = Not immunised, 1 = immunised

Source: Authors’ Compilation, 2025.

Table 2 shows definition and description variables used in the study. As shown in the table, the dependent variables, infant mortality and malaria occurrence captures whether a household

experienced the death of a child aged 0–5 years within the ten years preceding the survey and whether a child has malaria regularly or rarely. As binary outcomes, the two variables provide a clear basis for modelling the likelihood of infant death and malaria occurrences using logistic regression techniques.

The explanatory variables reflect three major domains: household socioeconomic status, parental education and child health practices. Household socioeconomic status is represented by income and employment indicators. Husband's income and mother's income are continuous measures reflecting the financial resources available for nutrition, healthcare and sanitation. Similarly, the employment status of both parents, measured through mother's occupation status and husband's occupation status, serves as an indicator of economic stability. Higher income and employment are generally associated with improved health outcomes, suggesting a likely negative relationship with infant mortality.

Parental education is captured through mother's years of education and husband's years of education. Education enhances health knowledge, decision-making capacity and the ability to utilise healthcare services effectively. Maternal education is frequently cited in demographic literature as one of the strongest predictors of child survival. Therefore, higher educational attainment is expected to reduce the risk of infant mortality.

The final group of variables represents direct child health interventions and practices. These include sleeping under an insecticide-treated net, exclusive breastfeeding and child immunisation status, all measured as binary indicators. Each of these practices plays a crucial role in preventing major causes of child deaths such as malaria, diarrheal diseases, respiratory infections and vaccine-preventable illnesses. Households that adopt these health-enhancing behaviours are therefore expected to exhibit lower infant mortality rates.

Overall, the variables collectively provide a multidimensional framework for assessing the determinants of infant mortality. Socioeconomic factors contribute to the household's ability to access health services; educational variables shape parental knowledge and behaviour; and child-specific practices influence direct exposure to disease.

### 3.4 Model Specification

The specification of the model for this study is based on Grosman’s Human Capital Theory. The theory hypothesised that health outcomes depend on socioeconomic factors and health-enhancing habits. To examine the impact of socioeconomic status on the child health (infant mortality and malaria occurrences), socioeconomic factors were run against the dependent variables in the baseline model, represented by equation 1.

$$CHLDHLT = f (HUINCOM MINCOM MOCCP1 HUOCCP2 MYRFEDU2 HYRFEDU) \dots\dots\dots(1)$$

Where CHLDHLT is a dependent variable represented in two models, Model1 has infant mortality (INFTM) while Model2 has Malaria Occurrence (MALO). HUINCOM represents husband’s income, MINCOM represents mother’s income, MOCCP1 represents mother’s employment status, HUOCCP2 represents father’s employment status, MYRFEDU2 represents father’s years of education

In addition to the baseline model, policy interventions and practices were introduced into the models using stepwise logistic regression. This was done to understand the mediating effects of the new variables in the relationship between socioeconomic status and child health. The subsequent model is represented in equation 2:

$$CHLDHLT = f (HUINCOM MINCOM MOCCP1 HUOCCP2 MYRFEDU2 HYRFEDU SleepingNet Exclusbrf2 Immunisation) \dots\dots\dots(2)$$

Where SleepingNet represents sleeping under mosquito nets, Exclusbrf2 represents exclusive breastfeeding, immunisation represents child immunisation. To ensure that the research instruments is free from multicollinearity, correlation matrix was used to assess the correlations among the variables

### 4. Presentation and Discussion of Results

This section contains presentation and discussion of findings from statistical analysis of the data collected used for the study. Outcome of the 600 questionnaires that were distributed, only 539

questionnaires correctly filled and returned after the field work. They were subsequently used for the study.

#### 4.1 Sociodemographic Characteristics of the Respondents

**Table 3: Sociodemographic Characteristics of the Respondents**

	Frequency	Percentage (%)
<b>Gender</b>		
Male	312	58
Female	227	42
<b>Household’s Head Age</b>		
18 – 40 years	365	68
41 - 60	145	27
60 years and above	29	5
<b>Level of Education (HH) No</b>		
formal education	53	8
Primary Education	98	18
Secondary Education	123	25
Postsecondary education	265	49
<b>Place of Residence</b>		
Rural	213	40
Urban	326	60

**Source: Authors’ Computation, 2025** (HH = Household Head)

Table 3 shows the sociodemographic characteristics of the respondents. It shows that males constituted a larger proportion of the sample (58%) compared to females (42%). This suggests a slightly male-dominated representation within the surveyed households. The age distribution of household heads shows that the majority (68%) fall within the 18–40 years category, indicating a predominantly youthful and economically active population. Those aged 41–60 years account for 27%, while only 5% are 60 years and above, reflecting a relatively small proportion of elderly household heads.

Educational attainment among respondents is generally high. Nearly half (49%) possess postsecondary education, 25% have completed secondary schooling and 18% have primary education, while only 8% reported having no formal education. This implies that most respondents

are relatively well educated, which may influence household decision-making and socio-economic outcomes. Regarding place of residence, 60% of respondents reside in urban areas, whereas 40% live in rural communities. This urban-skewed sample suggests that the study captures more characteristics of urban households, which may reflect differences in access to services and livelihood opportunities. Overall, the demographic composition indicates a youthful, moderately educated and predominantly urban set of respondents, providing a solid base for further analysis of the study variables.

#### 4.2 Socioeconomic Determinants of Infant Mortalities

**Table 4: Socioeconomic Determinants of Infant Mortalities**

VARIABLES	INFTM (1)	INFTM (2)	INFTM (3)	INFTM (4)
HUINCOM	-0.012*** (0.004)	-0.015*** (0.004)	-0.018*** (0.004)	-0.018*** (0.004)
MINCOM	0.005 (0.004)	0.005 (0.004)	0.006 (0.004)	0.005 (0.004)
MOCCP1	-0.075 (0.052)	-0.018 (0.055)	0.011 (0.057)	0.011 (0.057)
HUOCCP2	0.380 (0.375)	0.598 (0.398)	0.849** (0.407)	0.722* (0.407)
MYRFEDU2	0.002 (0.022)	0.010 (0.023)	0.020 (0.023)	0.025 (0.024)
HYRFEDU	-0.169*** (0.032)	-0.158*** (0.032)	-0.168*** (0.033)	-0.165*** (0.033)
SleepingNet		-1.294*** (0.237)	-1.107*** (0.244)	-1.245*** (0.259)
Exclusbrf2			-0.836*** (0.215)	-0.938*** (0.224)
Immunisation				0.551* (0.323)
Constant	1.840*** (0.566)	2.355*** (0.598)	2.490*** (0.608)	2.242*** (0.618)
Observations	539	539	539	539

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 4 shows the estimates of four regression models examining the socioeconomic determinants of infant mortality. Across all model specifications, household income (HUINCOM) consistently exhibits a negative and highly significant association with infant mortality. This implies that increases in household economic resources substantially reduce the likelihood of child deaths, reinforcing the central role of household-level socioeconomic conditions in shaping infant health outcomes.

Mother's income (MINCOM) and mother's occupation (MOCCP1) remain statistically insignificant across the models, suggesting that maternal economic characteristics alone may not exert a direct influence on child survival once household income and other controls are considered. Conversely, the coefficient on father's occupation (HUOCCP2) becomes positive and statistically significant in Models 3 and 4 after the inclusion of health-related behavioural variables. This finding indicates that certain paternal occupational categories may be associated with elevated mortality risks, potentially reflecting exposure to hazardous working conditions, income instability, or broader household vulnerabilities linked to occupation type.

Regarding parental education, mother's years of schooling (MYRFEDU2) does not significantly affect infant mortality in any model. However, father's educational attainment (HYRFEDU) remains negative and highly significant throughout, underscoring the important role of paternal education in promoting health-enhancing decisions, resource allocation and access to healthcare services within households. The inclusion of key child health practices in Models 2–4 substantially improves model explanatory power. Sleeping under treated mosquito nets is strongly and significantly associated with lower infant mortality, consistent with established evidence on malaria prevention. Exclusive breastfeeding also displays a robust and highly significant protective effect, highlighting its critical role in reducing early-life morbidity and mortality. The coefficient on immunisation in Model 4 is positive and weakly significant; while counterintuitive, this result is likely driven by selection effects whereby high-risk or previously ill children are more likely to receive vaccinations, or by underlying contextual factors that elevate mortality risks in areas with targeted immunisation efforts. Thus, the result should not be interpreted as evidence against the benefits of vaccination but rather as an artefact of underlying health system disparities. Taken

together, the results demonstrate that socioeconomic conditions, particularly household income and paternal education, play a central role in determining child survival, while targeted health behaviours such as mosquito-net use and exclusive breastfeeding substantially enhance infant health outcomes. The findings underscore the need for integrated policy approaches that combine socioeconomic empowerment with strengthened maternal and child health interventions.

### 4.3 Socioeconomic Determinants of Malaria Occurrences

**Table 5: Socioeconomic Determinants of Malaria Occurrences**

<u>VARIABLES</u>	<u>MALO (1)</u>	<u>MALO (2)</u>	<u>MALO (3)</u>	<u>MALO (4)</u>
HUINCOM	-0.006 (0.004)	-0.008* (0.004)	-0.009** (0.004)	-0.009** (0.004)
MINCOM	-0.012*** (0.004)	-0.012*** (0.005)	-0.012*** (0.005)	-0.012*** (0.005)
MOCCP1	0.299*** (0.059)	0.359*** (0.062)	0.370*** (0.062)	0.368*** (0.062)
HUOCCP2	-0.425 (0.444)	-0.403 (0.463)	-0.356 (0.466)	-0.372 (0.466)
MYRFEDU2	-0.054** (0.024)	-0.044* (0.025)	-0.041 (0.025)	-0.039 (0.025)
HYRFEDU	0.093*** (0.034)	0.114*** (0.036)	0.112*** (0.036)	0.113*** (0.036)
SleepingNet		-1.329*** (0.283)	-1.279*** (0.286)	-1.309*** (0.294)
Exclusbrf2			-0.293 (0.229)	-0.317 (0.235)
Immunisation				0.153 (0.325)
Constant	0.615 (0.597)	1.202* (0.646)	1.286** (0.652)	1.195* (0.677)
Observations	539	539	539	539

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5 shows the regression estimates of four model specifications examining the socioeconomic and behavioural determinants of malaria occurrences among households. The results reveal several

consistent and meaningful patterns. Household income (HUINCOM) is negatively associated with malaria in all models, becoming statistically significant from Model 2 onward. This suggests that higher household income modestly reduces malaria occurrence, likely through improved living conditions, access to preventive measures and better environmental hygiene. Mother's income (MINCOM) is negative and highly significant across all models, indicating that increases in maternal income substantially lower the likelihood of malaria. Maternal economic empowerment may translate into greater spending on preventive health inputs, improved household sanitation and greater autonomy in childcare practices that reduce malaria exposure.

Mother's occupation (MOCCP1) shows a strong and highly significant positive relationship with malaria across all specifications. This implies that certain maternal occupational types—possibly those involving outdoor work, irregular hours, or exposure-prone environments—are associated with increased malaria risk. Conversely, father's occupation (HUOCCP2) is consistently negative but statistically insignificant, indicating that paternal occupational characteristics do not meaningfully influence malaria risk within the sample studied.

Parental education shows mixed effects. Mother's education (MYRFEDU2) is significantly negative in Models 1 and 2 but becomes insignificant once additional health-related controls are included. This suggests that maternal education initially contributes to reduced malaria risk, likely through improved health knowledge and preventive behaviour, but its effect may be mediated by specific health practices. Interestingly, father's education (HYRFEDU) exhibits a positive and highly significant association with malaria across models. While counterintuitive, this may reflect contextual factors where more educated fathers engage in occupations or mobility patterns that increase household exposure to mosquito habitats, or where better reporting accuracy among educated households observed malaria incidence.

The introduction of behavioural health variables markedly improves model explanatory power. Consistent with malaria-prevention literature, sleeping under treated mosquito nets shows a large, negative and highly significant coefficient across Models 2 to 4, confirming that bed-net use remains one of the most effective strategies for reducing malaria occurrence. Exclusive breastfeeding (Exclusbrf2) is negative but statistically insignificant, indicating that while breastfeeding has well-established nutritional and immunological benefits, it may not directly

influence malaria exposure or incidence. Immunisation also shows no significant relationship with malaria, which is expected since childhood immunisations target other infectious diseases rather than malaria specifically.

Overall, the results indicate that malaria incidence is shaped by a combination of economic capacity, maternal-specific socioeconomic factors and household health behaviours. Key protective factors include higher maternal income, maternal education (in initial models) and consistent use of insecticide-treated nets. In contrast, certain maternal occupational categories appear to elevate malaria risk. These findings underscore the need for integrated malaria-control strategies that address both socioeconomic vulnerabilities and preventive health behaviours within households.

#### **4.4 Discussion of Findings**

The empirical results from Tables 4 and 5, which are in line with the existing studies like Gautam, Dessie, Rahman and Khanam (2023), Currie and Jobman (2023), Joseph and Adofu (2019) and Anyemele, Akanegbu Assad and Ukawuilulu (2017), provide a comprehensive overview of the socioeconomic and behavioural determinants of infant mortality and malaria occurrence within households. While the two outcomes represent different dimensions of child health, one reflecting severe health consequences (mortality) and the other representing disease, they share several underlying determinants. The combined findings offer important insights into how economic status, parental characteristics and health-related behaviours jointly influence child health outcomes.

A key point of convergence across both tables is the central role of household economic conditions. Household income shows a consistent protective effect, significantly reducing both infant mortality and malaria occurrence in the extended models. This underscores the importance of household-level economic capacity in improving environmental conditions, enhancing access to preventive resources and allowing for timely healthcare utilisation. Notably, mother's income demonstrates a strong and highly significant negative association with malaria, though it does not significantly reduce infant mortality. This asymmetry suggests that maternal economic empowerment may be particularly effective in preventing communicable diseases such as

malaria—possibly through increased control over spending on nets, repellents and sanitation—while the broader and more complex determinants of infant mortality may require more systemic household-level improvements.

Parental education also shows differentiated effects across the two health outcomes. Father's education consistently reduces infant mortality but surprisingly increases malaria risk. The protective effect on mortality aligns with existing evidence showing that more educated fathers are better equipped to support healthcare decisions and allocate resources to sustain child wellbeing. The positive association with malaria occurrence, however, is likely to reflect contextual or behavioural patterns, such as occupational mobility, time spent outdoors, or better reporting accuracy, rather than a direct causal pathway. Mother's education, by contrast, initially reduces malaria occurrence but loses significance once key health-behaviour variables are added and remains insignificant for infant mortality. This suggests that while maternal schooling may improve knowledge of preventive behaviours, its effect is largely mediated by actual household practices.

The behavioural health variables included in both tables highlight the critical importance of direct preventive practices. The use of insecticide-treated mosquito nets emerges as a strong and highly significant predictor of both reduced malaria occurrence and reduced infant mortality. This reinforces the central role of malaria-control interventions, not only in preventing infections but also in averting the fatal complications that malaria can impose on infants. Similarly, exclusive breastfeeding significantly reduces infant mortality, underscoring its role in strengthening infant immunity and overall health. Its weaker and insignificant relationship with malaria indicates that while breastfeeding is beneficial for general child survival, it does not directly mediate exposure to malaria vectors.

The immunisation variable demonstrates a contrasting pattern across the two health outcomes: marginal positive significance for infant mortality and no significant effect on malaria. This lacks biological plausibility and likely reflects reverse causality or targeting effects, where high-risk children or communities with elevated mortality are more likely to receive intensified immunisation campaigns. As such, the observed sign should not be interpreted as undermining the well-established benefits of childhood immunisation.

Occupational characteristics reveal another layer of complexity. Maternal occupation significantly increases malaria risk but does not affect infant mortality, whereas paternal occupation increases infant mortality in the models where behavioural controls are included but remains insignificant for malaria. These patterns suggest differentiated household risk profiles: certain maternal occupations may heighten exposure to mosquito bites, while certain paternal occupations may reflect broader socio-economic stressors affecting infant survival.

Taken together, the combined results emphasise that child-health outcomes are shaped by both distal socioeconomic factors and proximate behavioural practices, with each reinforcing or mediating the effects of the other. Economic empowerment, education (particularly for fathers) and targeted preventive behaviours operate through complementary pathways. While socioeconomic conditions provide the foundational capacity to invest in health, specific household practices, such as bed-net use and breastfeeding, deliver immediate and direct health protections.

Overall, the findings point to the necessity of integrated policy strategies that simultaneously bolster household socioeconomic resilience, enhance parental human capital and promote effective health behaviours. A multi-pronged approach addressing both structural vulnerabilities and day-to-day preventive practices offers the strongest potential for improving child survival and reducing malaria burden.

#### 4.5 Postestimations

**Table 6: Correlations Matrix for model1**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) CHLDMORT	1.000									
(2) HUINCOM	-0.123	1.000								
(3) MINCOM	-0.029	0.450	1.000							
(4) MOCCP1	-0.012	-0.283	-0.530	1.000						
(5) HUOCCP2	-0.064	0.308	0.102	-0.013	1.000					
(6) MYRFEDU2	-0.105	0.113	0.085	-0.248	0.061	1.000				
(7) HYRFEDU	-0.261	0.152	0.238	-0.184	0.259	0.422	1.000			
(8) SleeeepingNet	-0.255	-0.132	-0.104	0.211	0.083	0.057	0.124	1.000		
(9) Exclusbrf2	-0.198	-0.137	-0.100	0.207	0.133	0.045	0.033	0.293	1.000	
(10) Immunisation	-0.032	-0.026	0.030	0.114	0.206	-0.100	-0.014	0.328	0.306	1.000

**Table 7: Correlations Matrix for model2**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Malaria	1.000									
(2) HUINCOM	-0.225	1.000								
(3) MINCOM	-0.310	0.450	1.000							
(4) MOCCP1	0.361	-0.283	-0.530	1.000						
(5) HUOCCP2	-0.065	0.308	0.102	-0.013	1.000					
(6) MYRFEDU2	-0.135	0.113	0.085	-0.248	0.061	1.000				
(7) HYRFEDU	-0.027	0.152	0.238	-0.184	0.259	0.422	1.000			
(8) SleepingNet	-0.114	-0.132	-0.104	0.211	0.083	0.057	0.124	1.000		
(9) Exclusrf2	-0.015	-0.137	-0.100	0.207	0.133	0.045	0.033	0.293	1.000	
(10) Immunisation	-0.021	-0.026	0.030	0.114	0.206	-0.100	-0.014	0.328	0.306	1.000

To assess the presence of multicollinearity among the explanatory variables, correlation matrices (Tables 6 and 7) were examined alongside the underlying conceptual relationships among variables. As shown in Table 12, the majority of the pairwise correlations fall within the low to moderate range, with most coefficients well below the commonly accepted multicollinearity threshold of 0.70. The highest correlation (−0.530), in Table 6, occurs between mother’s income and maternal occupation, reflecting their natural socioeconomic linkage; however, this value remains sufficiently below levels that would raise concerns regarding inflated standard errors or unstable coefficient estimates. Overall, the correlation diagnostics provide no indication of harmful multicollinearity that might distort regression coefficients or undermine the reliability of the estimated models. The correlation structure alone suggests that the explanatory variables can be jointly included in the models without compromising statistical validity.

## 5. Summary, Conclusion and Policy Recommendations

This study has investigated the socioeconomic determinants of infant mortality and malaria occurrences in North Central part of Nigeria. The combined evidence from the analyses of infant mortality and malaria occurrences highlights the need for an integrated policy approach that simultaneously addresses socioeconomic vulnerabilities and promotes effective health behaviours within households. Several interrelated policy priorities emerge from the findings. First, the consistent protective effects of household income across both outcomes underscore the importance of broader economic empowerment strategies. Policies such as targeted cash transfers, livelihood support programmes and job creation initiatives can strengthen household resilience, enabling families to invest in child health, nutrition and preventive tools. Maternal income, which significantly reduces malaria occurrence, further suggests that promoting women's economic participation—through credit access, skills development and support for female-owned enterprises—can be a valuable component of malaria control efforts.

Second, parental education, especially paternal education, plays a critical role in shaping child health. The strong negative association between father's education and infant mortality indicates that investments in adult literacy, vocational training and community education may yield longterm health benefits. While maternal education shows mixed effects, its contribution to reducing malaria risk in the baseline model suggests that expanding women's access to education remains important for improving preventive health practices. Strengthening both formal and informal educational programmes can enhance household decision-making and improve uptake of beneficial health behaviours.

Third, the robust effect of insecticide-treated mosquito net usage across both models reaffirms the central role of malaria-prevention interventions. Scaling up the free distribution of treated nets, improving community-level awareness campaigns and ensuring behavioural compliance are crucial to reducing malaria incidence and the associated risk of infant mortality. Similarly, exclusive breastfeeding, shown to significantly lower infant mortality, should continue to be promoted through antenatal services, community health workers and public health campaigns, given its proven nutritional and immunological benefits.

Fourth, the contrasting and occasionally counterintuitive findings on immunisation highlight the need to strengthen the health system's capacity for early, universal and equitable vaccination coverage. Although the observed positive association with mortality is likely driven by reverse causality or targeting in high-risk areas, the result underscores the importance of addressing service gaps and ensuring that immunisation is delivered proactively rather than reactively.

Finally, the role of parental occupational dynamics suggests that labour-market vulnerabilities indirectly shape child health outcomes. Policies aimed at improving working conditions, reducing occupational hazards and providing social protection—particularly for low-skilled and precarious workers—may mitigate the socioeconomic risks associated with both malaria exposure and infant mortality. Overall, the combined findings point toward a multi-dimensional strategy that integrates economic, educational, occupational and behavioural interventions. Reducing infant mortality and malaria requires strengthening the socioeconomic foundations of households while simultaneously promoting evidence-based health practices. A coordinated approach that targets both structural determinants and household-level behaviours offers the most effective pathway to improving child health outcomes.

## 6. Acknowledgement

The article is an extract from the Institutional-Based Research sponsored by Tertiary Education Trust Fund (TETFUND), through Federal University of Lafia. Both TETFUND and Federal University of Lafia are duly appreciated and acknowledged.

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