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Original Article

Sociodemographic Factors Associated with Malaria Infection among Under-Five Children in Nigeria

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Abstract

Background: Malaria is a significant source of mortality and morbidity, particularly among children under the age of five. Meanwhile, the multi-causation theory in public health views disease and health development as underpinned by several variables, including social and demographic factors. Therefore, this study investigates the sociodemographic factors associated with malaria among under-five children in Nigeria.

Methodology: This study used secondary cross-sectional data collected from the 2018 Nigeria Demographic and Health Survey (NDHS). The sample for this study was 10,352 children. The response variable was malaria rapid diagnostic tests (RDTs) results, while the independent variables considered were children's age, residential area, zone, mosquito net ownership, gender, mother's level of education, and wealth status. Analysis was done using bivariate analysis and binomial logistic regression at a 0.05 significance level and 95% confidence interval.

Results: Children's age was statistically significant with malaria ($\chi2 = 166.200$, $p = 0.000$). Malaria had a statistically significant relationship with mother's level of education ($\chi2 = 762.530$, $p = 0.000$). The relationship between malaria and wealth index was statistically significant ($\chi2 = 1020.442$, $p = 0.000$). The result shows that children living in rural areas were more prone to have malaria infection than children living in urban areas (OR = 1.633, $p = 0.000$).

Conclusion: Children's age, wealth index, mother's level of education and place of residence are key predictors and factors associated with malaria infection among under-five children in Nigeria. Therefore, broad-based programmes and interventions should be increased to tackle malaria incidence and prevalence.

Keywords: Under-Five Children; Malaria; Nigeria; Sociodemographic Factors.

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Introduction

Malaria is a significant public health problem and a prominent source of morbidity and mortality in about 87 countries [1]. The 2024 World Malaria Report indicated around 229 million malaria cases and 409,000 malaria deaths globally in 2019, with two-thirds of deaths occurring among under-five children [2]. The Sub-Saharan Africa region has the highest burden of malaria deaths globally, with at least 94% of malaria cases and 70% of malaria mortality in Sub-Saharan Africa affecting under-five children [2]. Nigeria, the most populous nation in Sub-Saharan Africa, accounts for about 27% of the malaria burden globally [3]. Malaria is a major public health concern in Nigeria, especially among children, accounting for 30% of childhood mortality (children under-five), 25% of infant mortality (children less than one year) [2,4]. While the majority of the Nigerian populace suffer no less than one episode of malaria, children under the age of five experience about 2-4 episodes of malaria annually [4].

Malaria, being an infectious disease spread through the bites of female anopheles' mosquitoes (Anopheles gambiae) from one person to another, has symptoms including fever, weakness, vomiting, headache, vomiting, and prolonged sleeping [5]. The most common cause of human malaria in Sub-Saharan Africa is Plasmodium falciparum, which is responsible for 99.7% of malaria cases that are deadly among pregnant women and children under-five years [1]. Although preventable and curable, malaria, if not treated early, can progress and become more severe, causing developmental impairments and severe anaemia in children under five years, among whom a large percentage of malaria mortality occurs [2]. Furthermore, because developing immunity increases with age, children under the age of five are less likely to have developed sufficient immunity; thus, they are more vulnerable to malaria disease and death when compared with the general population [4]. Meanwhile, the persistence of malaria, particularly among children under the age of five, is influenced by an interplay of social, biological, and environmental risk factors, besides other health determinants [5].

Research conducted by Gup et al. [6] reported an 80.3% malaria rate in a rural area in Imo State, South-Eastern zone of Nigeria, while the study conducted in an urban community in Gboko City, Benue State, North-central zone of Nigeria by Houmsou et al. [7] reported a 14.5% estimate. This is considering that 97% of the Nigerian populace are susceptible to malaria infection, underpinned by several factors [5]. Meanwhile, the multi-causality theory in public health views disease and health development to be influenced by multiple variables [8]. In relation to malaria infection, such variables can be sociodemographic, such as the child's age, place of residence, zone, mosquito net ownership, gender, mother's level of education, and wealth status, which are identified as factors driving malaria prevalence, excluding the causative agent Plasmodium falciparum [9]. Therefore, robust nationwide data coverage is essential for accurate quantitative estimates of significant sociodemographic risk factors associated with malaria infection amongst under-five children in Nigeria.

The morbidity, mortality, and socioeconomic consequences of malaria are burdensome, which necessitates Sustainable Development Goal (SDG) 3 of the United Nations, which aimed to "ensure healthy lives and promote wellbeing for all at all ages" with a target to eradicate infectious diseases, including malaria by 2030 [10]. Hence, it is important to carry out a comprehensive analysis of the factors associated with malaria to efficiently tackle and address malaria in Nigeria. Therefore, this study analysed the data collected from the most recent Nigeria Demographic and Health Survey (NDHS) 2018 to examine the sociodemographic factors associated with malaria among under-five children in Nigeria.

Methods

Source of Data

This study used secondary data drawn from the 2018 Nigeria Demographic and Health Survey (NDHS) children's data. The 2018 NDHS, carried out from 14th August to 29th December 2018, is the most up-to-date demographic and health survey which covered households and clusters sampled across Nigeria to ascertain nationwide representation for the Nigerian population and was aimed to provide demographic and health indicators, including malaria rapid diagnostics tests (RDTs) results [11].

Variables

For this study, the malaria RDT results of children aged 6-59 months were used as the response variable. Those who tested positive are coded as 1, and those who tested negative are coded as 0. The independent variables were used as already numerically coded in the dataset, while the children's age was recoded into five categories. The independent variables which were the selected sociodemographic factors considered in this study were: age of the child in months (less than 12, 12-23, 24-35, 36-47, 48-59), residential area, zone, mosquito net ownership, gender, mother's level of education and wealth status. These factors were selected based on the findings presented by Nyarko & Cobblah [9] and Paul & Msengwa [12]. 11,197 children aged 6-59 months with properly recorded malaria RDT results were initially extracted from the household data file in the 2018 NDHS dataset. Then, 845 children with missing variables were excluded. Therefore, 10,352 under-five children comprised the final sample for this study.

Data Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 25in two steps. Firstly, bivariate analysis was conducted using the chi-square ($\chi 2$) test to investigate the relationship between malaria prevalence and each sociodemographic factor, while results were presented in proportions and frequencies. Secondly, binomial logistic regression analysis was used to examine the factors and predict the odds of malaria infection among the under-five children; thus, the binomial regression results were shown in odds ratios (OR). The binomial logistic regression is a predictive statistical model used for binary outcome data, which is effective in investigating disease aetiology by revealing the association between a dichotomous disease outcome and an exposure using the odds ratio [13]. The binomial logistic regression model used is appropriate because the malaria cases were asymmetrically distributed, and the outcome variable, which is the malaria RDT results, has a binary result as the children are either tested positive or negative. Data analysis and interpretation were conducted at a 0.05 level of significance and 95% confidence interval (CI).

Ethical Consideration

ICF International gave permission for the data used in this study. The authorization to access and download the 2018 NDHS dataset online from the DHS website (https://dhsprogram.com/data/dataset/Nigeria_Standard-DHS_2018.cfm?flag=1) for secondary data analysis was requested through online registration and application, and the approval was granted. Furthermore, the 2018 NDHS dataset has been collected through systematic and rigorous procedures, with confidentiality and anonymity already ensured during the survey. Also, all identifying details and particulars in the datasets have been removed, and the datasets are only available in numerical codes. Therefore, no further ethical approval was necessary.

Results

Table 1. Distribution of malaria prevalence by sociodemographic characteristics

	Frequency (%)		Chi-Square	
Variable	RDT-Negative Results	RDT-Positive Results	($\chi 2$)	P-Value (p)
Child's age (Months)			166.200	0.000*
< 12	913(14.12%)	317(8.16%)		
12-23	1628(25.17%)	779(20.06%)		
24-35	1386(21.43%)	841(21.65%)		
36-47	1288(19.91%)	964(24.82%)		
48-59	1253(19.37%)	983(25.31%)		
Child's gender			2.669	0.102
Male	3235(51.70%)	2007(50.10%)		
Female	3233(48.30%)	1877(49.90%)		
Mother's level of Education			762.530	0.000*
No Education	1939(30.00%)	2027(52.20%)		
Primary	1025(15.80%)	747(19.20%)		
Secondary	2698(41.70%)	1006(25.90%)		
Higher	806(12.50%)	104(2.70%)		
Place of residence			516.752	0.000*
Urban	3051(47.20%)	959(24.70%)		
Rural	3417(52.80%)	2925(75.30%)		
Geo-political zone			337.945	0.000*
North-central	1107(17.10%)	696(17.90%)		
Northeast	1189(18.40%)	689(17.70%)		
Northwest	1219(18.80%)	1279(32.90%)		
Southeast	1099(17.00%)	418(10.80%)		
South-south	854(13.20%)	308(8.00%)		
Southwest	1000(15.50%)	494(12.70%)		
Wealth index			1020.442	0.000*
Poorest	913(14.12%)	1164(29.97%)		
Poorer	1050(16.23%)	1027(26.44%)		
Middle	1410(21.80%)	886(22.81%)		
Richer	1560(24.12%)	612(15.76%)		
Richest	1535(23.73%)	195(5.02%)		
Mosquito net Ownership			45.656	0.000*

No	2180(33.70%)	1062(27.30%)
Yes	4288(66.30%)	2822(72.70%)

* P-value is significant at P ≤ 0.05.

Sociodemographic characteristics

Table 1 shows that malaria prevalence was least amongst children whose age is below 12 months (8.16%) and highest (25.31%) amongst those aged 48-59 months. A statistically significant relationship was found between children's age and malaria prevalence ($\chi 2$ = 166.200, p = 0.000). Nevertheless, no statistically significant relationship was found between gender and malaria ($\chi 2$ = 2.669, p = 0.102) as there were similar malaria cases for males at 50.10% and females at 49.90%. Furthermore, the mother's level of education had a statistically significant relationship with malaria ($\chi 2$ = 762.530, p = 0.000). The cases of malaria were highest amongst children whose mothers had no education (52.20%) and lowest amongst those whose mothers had a higher level of education (2.70%). Place of residence had a statistically meaningful relationship with malaria prevalence ($\chi 2$ = 516.752, p = 0.000) as children residing in rural areas have higher malaria cases (75.30%) than children in urban areas (24.70%). The results confirmed a significant relationship between geopolitical zones and malaria prevalence ($\chi 2$ = 337.945, p = 0.000). The North-West region of Nigeria had the highest malaria prevalence (32.90%) while the South-South had the lowest (8.00%). Furthermore, wealth index was statistically significantly related to malaria prevalence ($\chi 2$ = 1020.442, p = 0.000), and children in the poorest group had the highest malaria cases (29.97%), whereas the richest had the lowest (5.02%). Ownership of mosquito nets was statistically significant with malaria ($\chi 2$ = 45.656, p = 0.000). Surprisingly, Malaria prevalence was higher amongst those having a mosquito net (72.70%) compared to those who did not have a mosquito net (27.30%).

Table 2. Binomial logistic regression analysis on malaria infection and sociodemographic factors

Variable	Odds Ratio (OR)	Confidence Interval [95% CI]	P–value (*p*)
Child's age (Months)			
< 12	[Ref]	[Ref]	
12-23	1.549	[1.325 – 1.811]	0.000
24-35	1.982	[1.698 – 2.313]	0.000
36-47	2.419	[2.075 – 2.820]	0.000
48-59	2.545	[2.182 – 2.968]	0.000
Child gender			
Male	[Ref]	[Ref]	
Female	0.918	[0.842 – 1.001]	0.052
Mother's Level of Education			
No Education	[Ref]	[Ref]	
Primary	0.876	[0.757 – 1.001]	0.051
Secondary	0.639	[0.559 – 0.730]	0.000
Higher	0.363	[0.282 – 0.465]	0.000
Place of Residence			
Urban	[Ref]	[Ref]	

Rural	1.633	[1.466 – 1.820]	0.000
Geo-political Zone			
North-central	[Ref]	[Ref]	
Northeast	0.582	[0.502 – 0.675]	0.000
Northwest	1.125	[0.977 – 1.296	0.103
Southeast	1.059	[0.898 – 1.250]	0.495
South-south	0.824	[0.690 – 0.983]	0.032
Southwest	1.729	[1.464 – 2.041]	0.000
Wealth Index			
Poorest	[Ref]	[Ref]	
Poorer	0.797	[0.701 – 0.907]	0.001
Middle	0.596	[0.519 – 0.685]	0.000
Richer	0.430	[0.366 – 0.504]	0.000
Richest	0.163	[0.131 – 0.201]	0.000
Mosquito net Ownership			
No	[Ref]	[Ref]	
Yes	1.102	[0.998 – 1.216]	0.05

[Ref] = Reference Category

Table 2 makes evident that a children age is significantly associated with malaria amongst under-five children while the likelihoods of being infected with malaria were higher amongst children aged 12–23 months (OR = 1.549, p = 0.000), 24–35 months (OR = 1.982, p = 0.000), 36–47 months (OR = 2.419, p = 0.000), and 48–59 months (OR = 2.545, p = 0.000) in comparison with children under 12 months. While no significant association was observed between malaria and child's gender, the data suggest that male children were more likely to have malaria than female children (OR = 0.918, p = 0.052). Also, children whose mothers had primary education (OR = 0.876, p = 0.051), secondary education (OR = 0.639, p = 0.000) and higher education (OR = 0.363, p = 0.000) have lower odds of having malaria in comparison to children whose mothers had no education. Place of residence was revealed to be significantly associated with malaria prevalence as children living in rural areas were more prone to have malaria infection than children living in urban areas (OR = 1.633, p = 0.000). According to geopolitical zones, children from the Southwestern zone (OR = 1.729, p = 0.000), North-western zone (OR = 1.125, p = 0.103), South-Eastern zone (OR = 1.059, p= 0.495) had higher chances of contracting malaria infection in comparison with children from the North-central zone. Nevertheless, children from the South-South zone (OR = 0.824, p = 0.032) and Northeast zone (OR = 0.582, p=0.000) had a low likelihood of malaria infection in comparison to children from North-central zone. The results also revealed that wealth index is significantly associated with malaria prevalence. Children in the poorest category had higher chances of becoming infected with malaria infection to children in the poorer category (OR = 0.797, p = 0.001), middle (OR = 0.596, p = 0.000), richer (OR = 0.430, p = 0.000) and richest (OR = 0.163, p =0.000) households. Although mosquito net ownership had a significant association with malaria. Unexpectedly, the data suggests that children in households with mosquito nets were more likely to have malaria infection (OR = 1.102, p = 0.050) in comparison to those in households devoid of mosquito nets.

Discussion

This study examined the sociodemographic factors associated with malaria infection among under-five children in Nigeria using the countrywide representative data collected from the most recent Nigeria Demographic and Health Survey of 2018. The study revealed that malaria cases and likelihoods increased with age and were lowest for children aged below one year. This is consistent with a study conducted by Paul & Msengwa [12] in Tanzania, who found lower chances of malaria infection among children under 12 months, while children aged 12 – 59 months had a higher probability of contracting malaria infection. This could result from the higher levels of antibodies children acquired from their mothers during pregnancy, which provided immunity against malaria for the first few months before waning with increasing age [14]. Furthermore, the higher likelihoods of contracting malaria infection among children between age 12 to 59 months could be linked to the effects of nutritional deficiency resulting in reduced immunity, thereby making the children more vulnerable to malaria compared to children below 12 months who are most probably well-nourished via exclusive breastfeeding, thereby having stronger immunity against malaria infection [9]. There was no statistically significant relationship between a child's gender and malaria cases amongst male and female children was similar in frequency. Such findings were reported by Roberts & Matthews [15] in a study in Uganda, who found malaria distribution to be almost the same for males and females.

It was revealed that the highest malaria cases and odds were among children whose mothers did not have any education compared to children whose mothers had primary, secondary and higher educational levels. This substantiates the findings of Dahiru et al. [3] and Afoakwah et al. [16] in Nigeria and Ghana, respectively, which reported malaria to be the most prevalent among children whose mothers have no formal education malaria and least prevalent amongst children whose mothers had a formal education. it was revealed by Ma et al. [17] in a study in Congo that lower malaria cases amongst children were related to a higher level of mothers' education and thus established that higher maternal education is an essential defensive factor in malaria control. This may be because educated mothers are more receptive to health messages and have an improved knowledge, understanding, and attitude towards health issues, including malaria related to the symptoms, signs, treatment, and prevention [15]. Thus, childhood malaria morbidity is highly associated with maternal educational level. Furthermore, this study revealed that malaria prevalence and the chance of contracting malaria infection were significantly higher among children resident in rural communities compared to their urban counterparts, which agrees with several previous studies. Compared to urban areas, Paul & Msengwa [12] and Dahiru et al. [3] reported that malaria infection was significantly higher in rural communities, which led to the conclusion that rural locations are highly associated with childhood malaria morbidities. Adefemi et al. [5] explained that social and environmental factors influencing malaria breeding, including stagnant water pools, higher agricultural settings, illiteracy, and poor waste disposal, are very common in rural areas. Furthermore, several rural settings in developing countries, including Nigeria, have meagre house structures that allow mosquitoes entry, thus increasing the rate of malaria transmission [18]. Meanwhile, malaria has been recognized as a rural disease in Africa, and the low standards of living, exposure to vector breeding sites, and inadequate access to vector barrier methods like mosquito nets increase the risk of malaria infections in rural areas [2,5].

Furthermore, the malaria rate varies from one geopolitical zone to another, as childhood malaria was most prevalent amongst children in the North-Western zone and least amongst children from the South-Southern zone. Likewise, Dahiru et al. [3], who used the 2015 Nigeria Malaria Indicator Survey to examine childhood malaria morbidities, stated the North-western zone had the highest malaria cases while the South-eastern zone had the lowest. Although malaria infection is endemic amongst children in Nigeria [4], there were disparities as children in the Northern zone of Nigeria generally had more malaria cases than their Southern counterparts. Compared to the southern region of Nigeria, the Northern region has poorer performance on maternal and child health, maternal education, and media exposure [19],

which might have contributed to the perpetually increased rate of under-five childhood malaria among children in the Northern Zone of Nigeria.

Furthermore, malaria cases and odds, which were highest for the children in the poorest households, decrease with increasing wealth index. This agrees with the study of Paul & Msengwa [12] and Nyarko & Cobblah [9], who reported that children in poor families are more affected by malaria than children in rich families in Tanzania and Ghana, respectively. Poor households have low economic power to purchase and access anti-mosquito measures, poorly built housing structures that permit mosquito entry, and an unhealthy environment that encourages mosquito breeding sites, thus making them susceptible to mosquito bites [3,18,20]. Malaria has been considered a disease of poverty as the infection disproportionately affects the poorest in the world, both in developed and developing countries with extreme inequality [21]. The highest malaria mortality and morbidity rates are associated with nations having the highest levels of extreme poverty (proportion of the people living below US$1.25 a day), as well as with the poorest categories among these poor nations [20].

Surprisingly, the result of this study indicated that malaria cases were higher among under-five children in households with mosquito nets than in households that do not have mosquito nets. This finding was unanticipated and contrary to Nyarko & Cobblah's [9] results, which found fewer cases of malaria among children in households with mosquito nets in Ghana. Also, Paul & Msengwa's [12] study did not find any substantial association between mosquito net ownership and malaria. However, this finding needs to be interpreted cautiously because the use of mosquito nets is recommended by the World Health Organization (WHO) for malaria prevention and control [2]. Therefore, our finding may be due to several reasons; possibly there was already exposure to mosquito bites before the mosquito nets were used, or maybe there is inconsistent or inappropriate mosquito net usage [22]. Furthermore, having mosquito nets does not automatically translate to efficient use [23]. Also, as the NDHS data used was from a nationwide survey, hence, this result could also be due to recall bias or the participants telling the survey team what they wanted to hear. Nevertheless, Robert and Matthew [15] assert that having mosquito nets only might not effectively control malaria in malaria-endemic countries, including Nigeria. Therefore, apart from mosquito net usage, a multi-preventive approach including indoor residual spraying, reducing outdoor activities to prevent mosquito exposure as well as the practice of safe living habits in a clean and healthy environment, is essential for malaria prevention and control [2,15].

Limitations

The use of the NDHS data in this study, which was from a cross-sectional survey, has its limitations. A cross-sectional study will not effectively determine whether exposure resulted from the outcome or whether exposure was present before the outcome [24]. Hence, whether a child whose malaria RDT result was negative had been infected before the survey was not taken into consideration. Furthermore, the cross-sectional design could not establish the chronological sequence of association between sociodemographic factors and malaria infection. Nevertheless, the 2018 NDHS data used was representative and extensive enough to present an overall description of malaria infection and multiple sociodemographic variables among under-five children and is therefore very crucial in epidemiology and public health research.

Conclusion

This study concluded that children's age, geo-political zone, wealth index, mother's level of education and place of residence are key predictors and factors associated with malaria infection among under-five children in Nigeria. Therefore, the Nigeria Malaria Elimination Programme and the Nigeria Federal Ministry of Health should conduct additional malaria prevalence surveys to identify vulnerable geographical areas for intervention. Also, broad-based interventions and programmes should be increased to tackle malaria incidence and prevalence. Also, breastfeeding for infants and proper nutrition for older

children should be provided by mothers to enhance their immunity against malaria. Health Education on malaria control and prevention, including the proper use of mosquito nets, should be strengthened. Multi-preventive measures should be adopted for effective malaria prevention and control. Being associated with poverty, malaria prevention should be improved by adopting policies to improve the economic status of populations at risk in Nigeria.

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Competing interests: The authors declare that they have no competing interests.

Availability of Data: The datasets that support this study's findings are available to the public on request from ICF International through an online application on the Demographic and Health Survey (DHS) website (https://dhsprogram.com/data/dataset/Nigeria_Standard-DHS_2018.cfm?flag=1). Data is also available upon request from the corresponding author and with the permission of ICF International.

References

1. Ashley EA, Pyae Phyo A, Woodrow CJ. Malaria. *Lancet*. 2018 Apr;391(10130):1608–21. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673618303246
2. World Health Organization. World malaria report 2024: Addressing inequity in the global malaria response. Geneva: WHO; 2024. Available from: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024
3. Dahiru T, Alhaji A, Ahmadu L, Oyefabi M. Determinants of childhood malaria morbidities in Nigeria: Secondary analysis of 2015 malaria indicator survey. *Int J Trop Dis Health*. 2018 Jun 5;31(1):1–15.
4. Muhammad F, Abdulkareem JH, Chowdhury AA. Major public health problems in Nigeria: A review. *South East Asia J Public Health*. 2017 Dec 31;7(1):6–11.
5. Adefemi K, Awolaran O, Wuraola C. Social and environmental determinants of malaria in under five children in Nigeria: A review. *Int J Community Med Public Health*. 2015;2(4):345–50.
6. Gup I, Nnorom O, An A. Malaria morbidity among under-five Nigerian children: A study of its prevalence and health practices of primary care givers (mothers) in a resource-poor setting of a rural hospital in Eastern Nigeria. *Eur J Prev Med*. 2013;1(3):50.
7. Houmsou R, Amuta E, Wama B, Hile T, Bingbeng J. Occurrence of malaria in children under five years: Knowledge, attitudes and perceptions among mothers in a Nigerian semi-urban area. *J Sci Res Rep*. 2014 Jan 10;3(8):1127–34.
8. Guest G. Introduction to public health research methods. In: Guest G, editor. *Public health research methods*. 1st ed. London: SAGE; 2015.
9. Nyarko SH, Cobblah A. Sociodemographic determinants of malaria among under-five children in Ghana. *Malar Res Treat*. 2014;2014:1–6.

10. United Nations. Transforming our world: The 2030 agenda for sustainable development. 2015. Available from: https://sustainabledevelopment.un.org/post2015/transformingourworld
11. National Population Commission (Nigeria), ICF International. Nigeria demographic and health survey 2018. Abuja (Nigeria): NPC and ICF; 2019.
12. Paul E, Msengwa AS. Prevalence and sociodemographic factors associated with malaria infection among children under five years in Tanzania. *J Public Health Epidemiol*. 2018 Nov 30;10(11):387–94.
13. Kovalchik SA, Varadhan R, Fetterman B, Poitras NE, Wacholder S, Katki HA. A general binomial regression model to estimate standardized risk differences from binary response data. *Stat Med*. 2013 Feb 28;32(5):808–21.
14. Reynaldi A, Dent AE, Schlub TE, Ogolla S, Rochford R, Davenport MP. Interaction between maternally derived antibodies and heterogeneity in exposure combined to determine time-to-first *Plasmodium falciparum* infection in Kenyan infants. *Malar J*. 2019;18(1):19.
15. Roberts D, Matthews G. Risk factors of malaria in children under the age of five years old in Uganda. *Malar J*. 2016;15(1):246.
16. Afoakwah C, Deng X, Onur I. Malaria infection among children under-five: The use of large-scale interventions in Ghana. *BMC Public Health*. 2018;18(1):536.
17. Ma C, Claude KM, Kibendelwa ZT, Brooks H, Zheng X, Hawkes M. Is maternal education a social vaccine for childhood malaria infection? A cross-sectional study from war-torn Democratic Republic of Congo. *Pathog Glob Health*. 2017 Feb 17;111(2):98–106.
18. Musoke D, Miiro G, Ndejjo R, Karani G, Morris K, Kasasa S, et al. Malaria prevention practices and associated environmental risk factors in a rural community in Wakiso district, Uganda. *PLoS One*. 2018 Oct 9;13(10):e0205210.
19. Meh C, Thind A, Ryan B, Terry A. Levels and determinants of maternal mortality in northern and southern Nigeria. *BMC Pregnancy Childbirth*. 2019;19(1):417.
20. Tusting LS, Rek J, Arinaitwe E, Staedke SG, Kamya MR, Cano J, et al. Why is malaria associated with poverty? Findings from a cohort study in rural Uganda. *Infect Dis Poverty*. 2016;5(1):78.
21. Ensor C. Why the world ignores diseases of poverty [Internet]. 2018. Available from: https://www.huffpost.com/entry/why-the-world-ignores-diseases-of-poverty_n_5a57ae31e4b0a57f282c6568
22. Fokam EB, Kindzeka GF, Ngimuh L, Dzi KTJ, Wanji S. Determination of the predictive factors of long-lasting insecticide-treated net ownership and utilisation in the Bamenda Health District of Cameroon. *BMC Public Health*. 2017;17(1):263.
23. Yadav K, Dhiman S, Rabha B, Saikia P, Veer V. Socio-economic determinants for malaria transmission risk in an endemic primary health centre in Assam, India. *Infect Dis Poverty*. 2014;3(1):19.
24. Sedgwick P. Cross sectional studies: Advantages and disadvantages. *BMJ*. 2014 Mar 26;348:g2276.