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Socio-economic Determinants of Poverty in Malaria Endemic Areas of Kenya

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Authors' contributions

This work was carried out in collaboration between both authors. Author DGA acquired the data and performed the analysis. Authors DGA and MS designed the research problem and drafted the manuscript. Both authors discussed the results and implications and commented on the manuscript at all stages. Both authors contributed extensively to the work presented in this paper. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Poverty is a major issue in Kenya and even though there has been a remarkable economic growth, it has still not led to a significant poverty reduction in the country.
Objective: This study examined the factors associated with poverty in malaria endemic areas of Kenya. Using various well-being indicators, we calculated a composite index of household wealth to measure poverty/deprivation levels.
Methods: Data from the 2015 Kenya Malaria Indicator Survey (KMIS) was used. Generalized additive models for location, scale, and shape (GAMLSS) was used to estimate our model. Unlike the conventional estimation techniques, GAMLSS allow modelling not only of the mean (or location) but other parameters of the distribution of the response variable as linear and/or non-linear, parametric and/or additive nonparametric functions of explanatory variables and/or random effects.

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Results: Our results show that households with more educated and male household heads were wealthier than those headed by females and with less education. The study further indicated that urban residences were wealthier than rural residents in all provinces, however, household with a negative diagnosis for malaria are wealthier than those with positive outcomes in both urban and rural areas.

Conclusion: The positive relationship between malaria occurrence and poverty implies that poverty alleviation and malaria eradication should be simultaneously targeted in Kenya.

Keywords: GAMLSS; poverty; wealth; KMIS; non-parametric.

1. INTRODUCTION

As it is the case in many developing countries, poverty is a pressing issue in Kenya. Although Kenya has recorded impressive economic growth in recent years, this has not led to a significant poverty reduction. According to recent estimates, the percentage of the population who lives below the national poverty line has increased from about 46% in 2006 to 50% in 2012, while the actual number of poor people has increased from 17 million to 21 million [1].

Malaria is endemic in most African countries, where an estimated 90% of all malaria deaths occur. In the case of Kenya, close to 36% of the population in 2013 was at high risk of malaria (> 1 case per 1000 population) [2]. In addition, different studies have shown that poor economic and social conditions are significant risk factors for malaria contagion and other health risks [2-4]. Conversely, malaria might cause and perpetuate poverty due to various costs incurred both at the household and country levels [5,6]. Thus, winning the battle against malaria in poor countries requires understanding the factors that related to household level of poverty in malaria epidemic areas. This helps policy-makers in designing policies to reduce poverty, and further develop effective malaria control programs.

In sub-Saharan Africa (SSA), some studies have identified several risk factors associated with poverty [7]. At macro level, low level of human capital (education and skills), poor investment in infrastructure and service delivery, high level of inequality and poor economic growth, conflict/war, debt burden, high population growth, and the prevalence of HIV/AIDS are among the few factors that positively related with high incidence of poverty in SSA [8-10]. Several studies that examined the impacts of household/individual level factors on poverty have shown that household size and composition, gender, age, marital status, education level, saving behavior, access to financial services, and region of residence are important determinates of household poverty and wealth accumulation in SSA [11-13].

In general, although large family size is associated with high incidence of poverty, age and composition of household members matter critically to poverty reduction and wealth accumulation [13]. For instance, using data from 23 Sub-Saharan African countries, Zimmer and Das [13] found that wealth accumulation (measured using household asset holdings) is higher among households containing adults only (aged 15-59), while it is lower among households containing elders and children (under 15) or elders only. It is argued that given other things constant, having more number of adults in a household was associated with greater potential for income generation and household wealth accumulation [13,14]. These findings are also consistent with the life cycle hypothesis which suggests that while working age adults contribute to income generation and saving, elders and children are dissevers [15,16].

Similarly, marital status also affects housed poverty and wealth accumulation in SSA [13,17]. The study in Nigeria by Anyanwu [17] shows that monogamous marriage, being divorced/separated, and widowhood are associated with less likelihood of being poor. It is generally argued that compared to unmarried individuals married couples are more likely to save a higher portion of their income and accumulate more wealth. Furthermore, property inheritance during divorce or widowhood might help to improve asset holdings and reduce poverty [17,18].

There are also significant regional disparities in household wealth distributions or poverty levels in many Sub-Saharan African countries. In general, households/individuals located in rural and more remote areas are more likely to become poor compared to those located in urban centers [13,19]. Location of residence matters because access to employment opportunities, education, and other services are often related with location [11,20]. And better access to education and formal employment opportunity are associated with higher income and less probability of being poor [17,21,22]. Although previous studies suggest various risk factors for poverty, the direction, and significance of these factors on an individual or household level of poverty are context dependent. In addition, existing empirical studies mainly use traditional regression models that assume parametric relationship between outcome and covariates.

The aim of this study was to assess the effect of socio-economic, demographic and geographic factors on the wealth situation of households. In Kenya. In this study, we used the GAMLSS estimation approach, which allowed us to estimate both parametric and non-parametric relationship between the outcome variable and the explanatory variables.

2. METHODS AND MATERIALS

Kenya is in the Eastern Africa and shares borders with Ethiopia in the North, Somalia in the Northeast, South Sudan in the Northwest, Uganda in the West, and Tanzania in the South. The eastern part is bordering the Indian Ocean. The capital city of Kenya is Nairobi. Kenya is divided into four regions: the arid deserts of the North; the savannah lands of the South; the fertile lowlands along the coast; and the highlands in the West. All over the country, the hottest seasons are from December through March. But, the coastal areas are tropical and have high humidity especially in April and May. The lowland areas of Kenya are mostly hot but mainly dry and are more temperate with four seasons. Agriculture and tourism are the major economic sectors in Kenya. Based on the 2009 Population and Housing Census, Kenya's population size is 38.6 million with an annual population growth rate of nearly 3 percent each year [23-25].

In 2007, Kenya conducted the first Kenyan Malaria Indicator Survey (KMIS). As a continuous study, further KMISs were conducted in 2010 and 2015. These studies were designed to follow the Roll Back Malaria Monitoring and Evaluation Working Group guidelines, the Kenya National Malaria Strategy 2009-2018, and the Kenya Malaria Monitoring and Evaluation Plan 2009-2017. From July 6 to August 15, 2015, the 2015 KMIS was conducted nationally. The sample survey covers about 7,313 households. In that survey, testing for anaemia and malaria for children age 6 months to 14 years was included using a finger- or heel-prick blood sample. The results of anaemia and malaria rapid diagnostic testing were available immediately. The objective of that survey was to determine the progress of key malaria interventions as stated in the Kenya Malaria Strategy 2009-2018, to assess malaria parasite prevalence among children age 6 months to 14 years and anaemia prevalence among children age 6 months to 14 years [26,27].

The 2015 KMIS sample was considered in our survey to make available estimates for key indicators at country level and for the urban and rural area of Kenya and for each of the malaria epidemiologic zones: highland epidemic; Lake Endemic; coast endemic; semi-arid, seasonal; and low risk. For the sampling frame, the Fifth National Sample Survey and Evaluation Program (NASSEP V) master sampling frame was used. This survey contains lists of all enumeration areas (EAs) created for the 2009 census and covers the entire country. Two-stage stratified cluster sampling design was used for the survey. In the first stage, 131 for rural and 115 for urban areas totally 246 clusters were selected. In the second stage, a uniform sample of 30 households were selected using systematic sampling from each cluster [27].

The outcome of interest in our study is household wealth, which could be used as an indicator of long-term economic well-being. Although theoretically it is possible to measure wealth as a net asset worth, which is the total value of assets less total value of liabilities, in practice, for most household surveys, these measures are not available. Thus, household wealth can be considered as an underlying latent variable that is correlated with some observed indicator variables. The observable indicator variables are assumed to be correlated with a household's relative position in the underlying wealth distribution. The 2015 Kenya Malaria Indicator Survey consists several of these indicator variables. We followed a similar approach used by the Demographic and Health Survey (DHS) in selecting the indicator variables and estimating the wealth index.

The indicator variables used to construct the wealth index include ownership of selected assets (Radio, Television, Telephone (non-mobile), Computer, Refrigerator, Solar panel, Table, Chair, Sofa, Bed, Cupboard, Clock, Microwave oven, DVD player, CD player, Watch, Mobile phone, Bicycle, Motorcycle or Scooter, Animal-drawn cart, Car or Truck, Boat with a motor, Bank account, Owns land), Number of members per sleeping room, access to water, sanitation facilities, and electricity. Following these, Filmer and Pritchett (2001) principal component analysis (PCA) was used to generate weights to aggregate the various indicators into a single household wealth index [28]. Weights from the first principal component were used to represent the wealth index. The wealth index is then divided into quintiles to identify the poor from the non-poor. Based on the wealth index factor score, we classify the population into the poorest 40%, middle 40%, and richest 20% of the population.

The relationship between wealth status of a household and socio-economic factors has been an area of increasing interest [29-31]. Based on literature, we considered various risk factors that were expected to relate to poverty, these included geographic region, place of residence, age of respondents, relationship to the head, sex of household head, highest educational level of head of household, total children ever born, number of household members, number of children under 15 household, births in last five years, number of living children and result of malaria rapid diagnosis test result. The analysis for this study is at household level.

To estimate the relationship between the distribution of household wealth and the explanatory variables, we used the Generalized Additive Models for location, scale and shape (GAMLSS). These models are semi-parametric regression models. The model has both parametric which require a parametric distribution assumption for the response variable, and semi-parametric for the modelling of the parameters of the distribution, as functions of explanatory variables, may involve using non-parametric smoothing functions. First, GAMLSS were introduced by Rigby and Stasinopoulos (2001, 2005) and Akantziliotou, Rigby, and Stasinopoulos (2002) to address some of the limitations associated with the popular generalized linear models, and generalized additive models. The exponential family distribution assumption for GAMLSS is relaxed and replaced by a general distribution family. This contains highly skew and/or kurtotic continuous and discrete distributions. To allow modelling not only of the mean (or location) but other parameters of the distribution of the response variable as, linear and/or non-linear, parametric and/or additive non-parametric functions of explanatory variables and/or random effects, the systematic part of the model is extended. Therefore, GAMLSS is especially well-matched to modelling a response variable and does not follow an exponential family distribution [32-34].

2.1 GAMLSS Model Formulation

Let y_i for $i = 1, 2, \ldots, n$ independent observations with probability density function $f(y_i|\theta_i)$ conditional on $\theta_i = (\theta_{1i}, \theta_{2i}, \theta_{3i}, \theta_{4i}) = (\mu_i, \sigma_i, \nu_i, \tau_i)$ a vector of four distribution parameters. The parameters μ_i and σ_i are usually characterized as location and scale parameters and the remaining parameter(s), are characterized as shape parameters. Rigby and Stasinopoulos (2005) define the original formulation of a GAMLSS model as follows.

Let $y^T = (y_1, y_2, y_3, \ldots, y_n)$ be the n length vector of the response variable for $k = 1, 2, 3, 4$ and $g_k(.)$ be known monotonic link functions relating the distribution parameters to explanatory variables by

$$g_k(\theta_k) = \eta_k = \boldsymbol{X}_k\beta_k + \sum_{J=1}^{J_k} \boldsymbol{Z}_{jk}\boldsymbol{\gamma}_{jk}, \qquad (1)$$

i.e.,

$$g_1(\mu) = \eta_1 = \boldsymbol{X}_1\beta_1 + \sum_{J=1}^{J_1} \boldsymbol{Z}_{j1}\boldsymbol{\gamma}_{j1}$$

$$g_2(\sigma) = \eta_2 = \boldsymbol{X}_2\beta_2 + \sum_{J=1}^{J_2} \boldsymbol{Z}_{j2}\boldsymbol{\gamma}_{j2}$$

$$g_3(\nu) = \eta_3 = \boldsymbol{X}_3\beta_3 + \sum_{J=1}^{J_3} \boldsymbol{Z}_{j3}\boldsymbol{\gamma}_{j3}$$

$$g_4(\theta_4) = \eta_4 = \boldsymbol{X}_4\beta_4 + \sum_{J=1}^{J_4} \boldsymbol{Z}_{j4}\boldsymbol{\gamma}_{j4},$$

where μ, σ, ν and η_k are vectors of length n, $\beta_k^T = (\beta_{1k}, \beta_{2k}, \ldots, \beta_{J_k^{1}k})$, J_k^1, $\boldsymbol{X}_k$ is a fixed known design matrix of order $n \times J_k^1$, $\boldsymbol{Z}_{jk}$ known as

$n \times q_{jk}$ design matrix and $\boldsymbol{\gamma}_{jk}$ is a q_{jk} dimensional random variable and distributed as $\boldsymbol{\gamma}_{jk} \sim N_{qjk}(\mathbf{0}, \boldsymbol{G}_{jk}^{-1})$, where $\boldsymbol{G}_{jk}^{-1}$ is the inverse (generalized) of a $q_{jk} \times q_{jk}$ systematic matrix $G_{jk} = \boldsymbol{G}_{jk}(\boldsymbol{\lambda}_{jk})$ depend on a vector of hyperparameter $\boldsymbol{\lambda}_{jk}$, and where if $\boldsymbol{G}_{jk}$ is singular then $\boldsymbol{\gamma}_{jk}$ is understood to have an improper prior density function proportional to $\exp\left(-\frac{1}{2}\gamma_{jk}^{T}\boldsymbol{G}_{jk}\boldsymbol{\gamma}_{jk}\right)$ [32-34].

In model (1), each distribution parameter is expressed as a linear function of explanatory variable. Let $\boldsymbol{Z}_{jk} = \boldsymbol{I}_n$, where $\boldsymbol{I}_n$ is an $n \times n$ identity matrix, and $\gamma_{jk} = h_{jk} = h_{jk}(x_{jk})$ for all combinations of j and k in (1), then we have the semi-parametric additive formulation of GAMLSS given by

$$g_k(\boldsymbol{\theta}_k) = \boldsymbol{\eta}_k = \boldsymbol{X_k}\beta_k + \sum_{j=1}^{J_k} h_{jk}(\boldsymbol{X}_{jk}) \qquad (2)$$

Where, θ_k for k = 1, 2, 3, 4 to characterize the distribution parameter vectors μ$, \sigma, \nu$ and, and where x_{jk} for $j = 1, 2, \ldots, J_k$ are also vectors of length n. The function h_{jk} is an unknown function of the explanatory variable $\boldsymbol{X}_{jk}$ and $h_{jk} = h_{jk}(x_{jk})$ is the vector which evaluates the function h_{jk} at x_{jk}.

Further detailed explanation about the GAMLSS is well documented and be accessed from different books and articles [29,32-39].

3. ANALYSIS AND RESULTS

3.1 Descriptive Statistics

Before describing the model results, the distribution of wealth index in relation to the socio-economic, demographic, and geographic categorical variables were presented in Table 1. Table 1 indicates that among the province of Kenya, the poorest one is North Eastern province with 69% of the households being considered asset poor. This is followed by the Coast province and Eastern province with the figure being 62.5% and 54.8% respectively. In contrast, Nairobi is the richest province as all households being classified in the richest wealth quintile, followed by Central province with only 22.6% of the households being classified as poor. Comparing urban and rural residents the table showed that while about 65% of the households classified as poor in rural areas the figure is only 32.6% in urban areas (Table 1).

The distribution of household wealth also differed by age of household head, highest educational level, family size, and number of under 15 children. Looking at age of household head, households with young household head (<21) and those who were older above 50 are relative poorer compared to the other age groups. But, there is no big difference between male and female headed households. Unlike gender, poverty levels vary among the different educational level. Therefore, more than 85% of the households with no education were classified as poor (29.5%) for those with primary education (55.4%) and only 7.3% for those with higher education levels.

3.2 Estimation of Results and Discussion

Before discussing the determinants of household poverty using the chosen model, it is important to see the adequacy of the model. The model diagnosis was performed in the analysis and presented in Fig. 1. The figure displays the normalized quantile residuals. The upper two panel plots showed the quantile residuals against fitted value and against index, while two panels in the bottom provide a kernel density estimate and normal Q-Q plot. Therefore, the residuals appear random and the QQ plot shows normality.

Table 2 provides estimated results for the relationship between household wealth status and socio-economic, demographic and geographic factors using GAMLSS model. The results suggested that compared to the Western province, households living in provinces such as, the Coast, Eastern, and Nairobi are richer. Likewise, compared to households in urban areas households in rural area are less wealthy. Regarding education, households with no education are poorer than households with a secondary level of education. However, having a member more than a high school education level is positively related with more household wealth. The results also suggest that households with female heads are poorer than those with male heads.

In addition to the main effects, we found significate interaction effects. The first interaction effect is between result of malaria results and type of place of residence. Fig. 2 presented the interaction effect between result of malaria test and type of place of residence. Results from Table 2 showed that urban residences are wealthier than rural residents. However, coefficient estimates on the interaction effect indicated that households with negative malaria rapid diagnosis test were wealthier than those with positive results for both urban and rural residents. Likewise, Fig. 3 showed that residents with negative diagnosis for malaria are wealthier than those with positive outcomes for all provinces.

Table 1. Distribution between wealth of a household, and socio-economic, demographic, and geographic variables: Kenya 2015

Variables		**Wealth index**			
		Poor %	**Middle %**	**Rich %**	**P-value**
Region	Coast	62.5%	12.6%	24.9%	<0.0001
	North Eastern	69.0%	6.2%	24.8%	
	Eastern	54.8%	14.6%	30.6%	
	Central	22.6%	17.0%	60.4%	
	Rift Valley	53.5%	17.7%	28.8%	
	Western	50.4%	23.5%	26.1%	
	Nyanza	50.0%	24.8%	25.2%	
	Nairobi	0.0%	0.0%	100.0%	
Type of place of residence	Urban	32.6%	13.4%	53.9%	<0.0001
	Rural	65.6%	18.8%	15.6%	
Age of household head	< 21	71.2%	11.5%	17.3%	<0.0001
	21 – 30	52.5%	15.3%	32.2%	
	31 – 40	47.5%	18.2%	34.3%	
	41 – 50	53.1%	22.1%	24.8%	
	51 – 60	62.0%	9.5%	28.5%	
	> 60	60.4%	14.0%	25.6%	
Sex of household head	Male	51.2%	16.3%	32.5%	0.003
	Female	55.5%	17.6%	26.9%	
Highest educational level	No education	86.4%	5.9%	7.8%	<0.0001
	Primary	55.4%	21.3%	23.3%	
	Secondary	29.5%	19.2%	51.3%	
	Higher	7.3%	11.3%	81.4%	
Relationship to household head	Head	55.7%	17.0%	27.3%	<0.0001
	Wife	52.3%	16.2%	31.5%	
	Related member	51.2%	18.7%	30.1%	
	Unrelated member	20.9%	7.0%	72.1%	
Number of household members	1 – 5	45.9%	16.4%	37.7%	<0.0001
	6 – 10	60.5%	16.9%	22.6%	
	> 10	66.9%	19.1%	14.0%	
Under 15 number of members	0 – 4	48.4%	16.7%	34.8%	<0.0001
	5 – 8	71.2%	15.1%	13.7%	
	> 8	58.1%	37.2%	4.7%	
Total children ever born	1 – 5	47.9%	17.3%	34.7%	<0.0001
	6 – 10	73.4%	14.4%	12.2%	
	> 10	71.4%	2.9%	25.7%	
Births in last five years	1	40.7%	18.5%	40.9%	<0.0001
	2	63.6%	15.3%	21.2%	
	3	67.0%	13.6%	19.4%	
	4	50.0%	16.7%	33.3%	
	5	100.0%	0.0%	0.0%	
Number of living children	1	40.7%	17.8%	41.5%	<0.0001
	2	62.4%	15.9%	21.7%	
	3	69.5%	12.5%	18.0%	
	4	57.1%	16.7%	26.2%	
	5	100.0%	0.0%	0.0%	

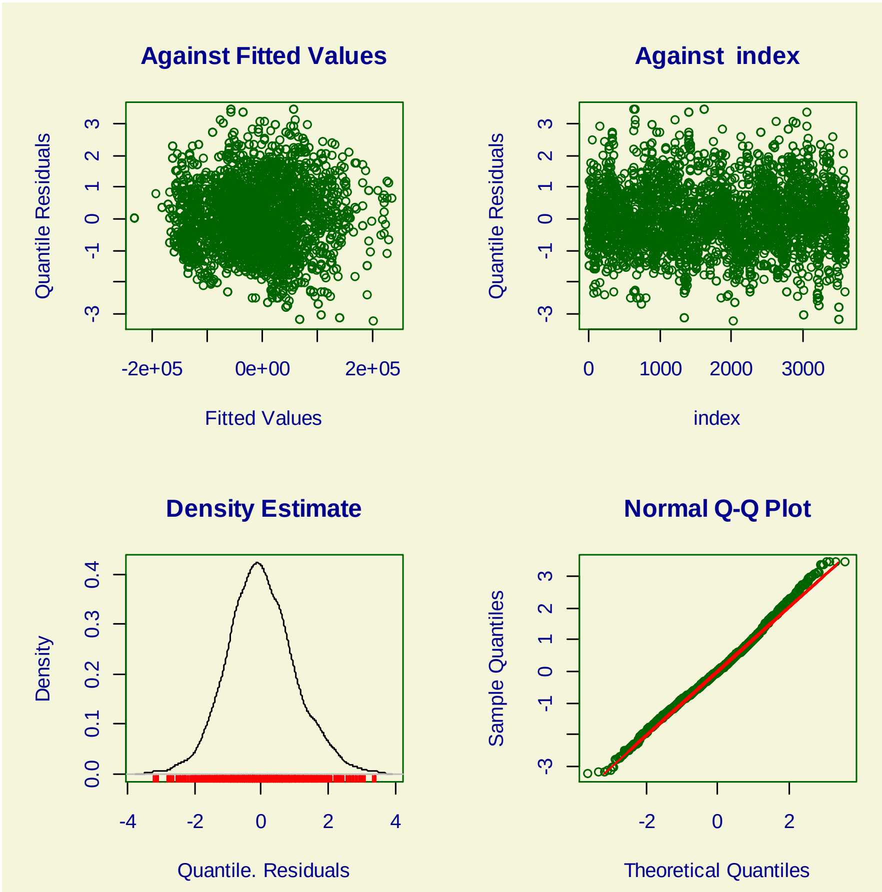


Fig. 1. Model diagnosis

Table 2. Estimate of the parameters from GAMLSS model: Kenya 2015

Parameter	Estimates	SE	t Value	Pr > |t|
Intercept	10.723	0.322	33.290	<.0001
Region (Ref. = Western)				
Central	0.259	0.278	0.930	0.351
Coast	0.473	0.289	2.640	0.015
Eastern	0.344	0.301	2.140	0.033
Nairobi	0.726	0.391	1.860	0.064
North Eastern	0.274	0.583	0.470	0.639
Nyanza	-0.043	0.289	-0.150	0.883
Rift Valley	0.078	0.264	0.290	0.768
Type of place of residence (Ref. Urban)				
Rural	-1.346	0.240	-5.620	<.0001
Sex of household head (Ref. = male)				
Female	-1.808	0.520	-3.470	0.001
Educational level (Ref. = Secondary)				
Higher	0.610	0.296	2.060	0.040
No education	-0.865	0.754	-1.150	0.252
Primary	-0.028	0.261	-0.110	0.915
Result of malaria rapid diagnosis test (Ref. = Positive)				
Negative	.192	.0165	134.941	<.0001

Table 3. Smoothing model analysis (Analysis of deviance): Kenya 2015

Source	DF	Sum of squares	Chi-square	Pr > ChiSq
Spline(Age of household head)	2	11.993	11.875	0.0026
Spline(Children ever born)	2	11.083	10.974	0.0041
Spline(Family size)	2	7.137	7.066	0.0292
Spline(Number of under 15 members)	2	5.728	6.672	0.0487
Spline(Births in the last five year)	1.96	8.885	8.797	0.0118
Spline(Number of living children)	2	1.068	8.058	0.0492

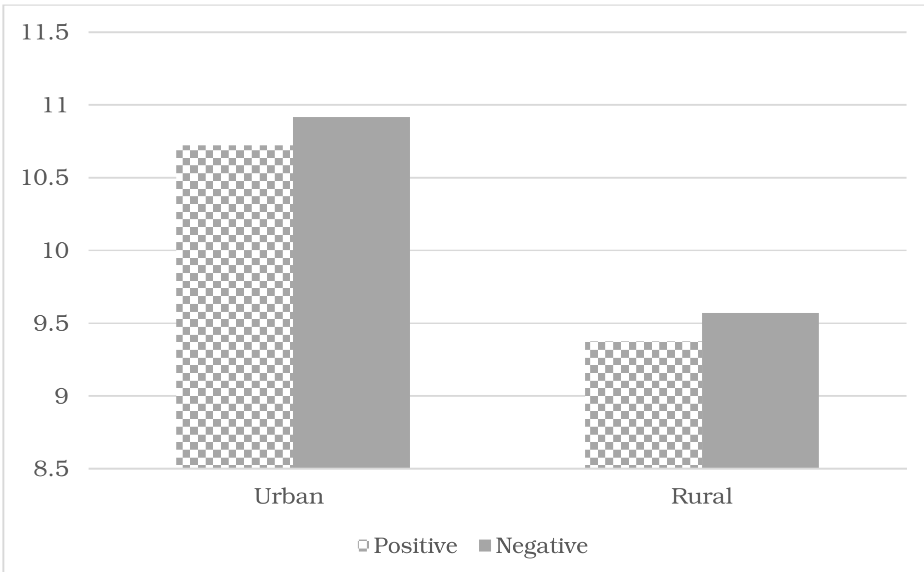


Fig. 2. Interaction effect between result of malaria test and type of place of residence: Kenya 2015

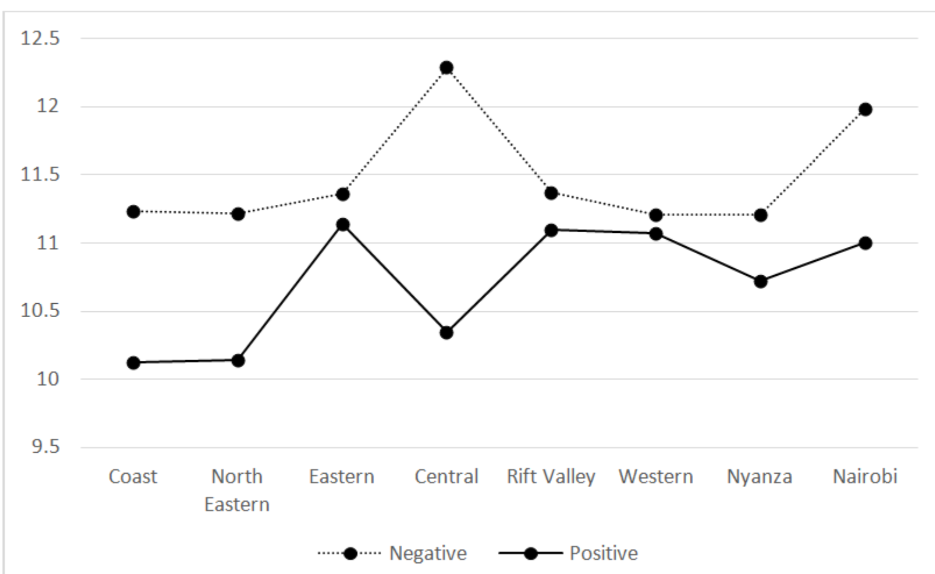


Fig. 3. Interaction effect between result of malaria test and region: Kenya 2015

The interaction effect between region and type of place of residence found to be significant. The result for the interaction has been presented in Fig. 4. As can be seen from the result, urban households are wealthier than rural households in all provinces. The other interaction effect which was found to be significant was between region and sex of head of households. Households who have male headed are wealthier than households with female heads for all regions (Fig. 5). Similarly, the interaction between educational background and type of place of residence found to be significant (Fig. 6). Households with higher educational level were found to be wealthier for both urban and rural households. But, residents who lives in urban area were found to be wealthier for all educational levels than rural residents.

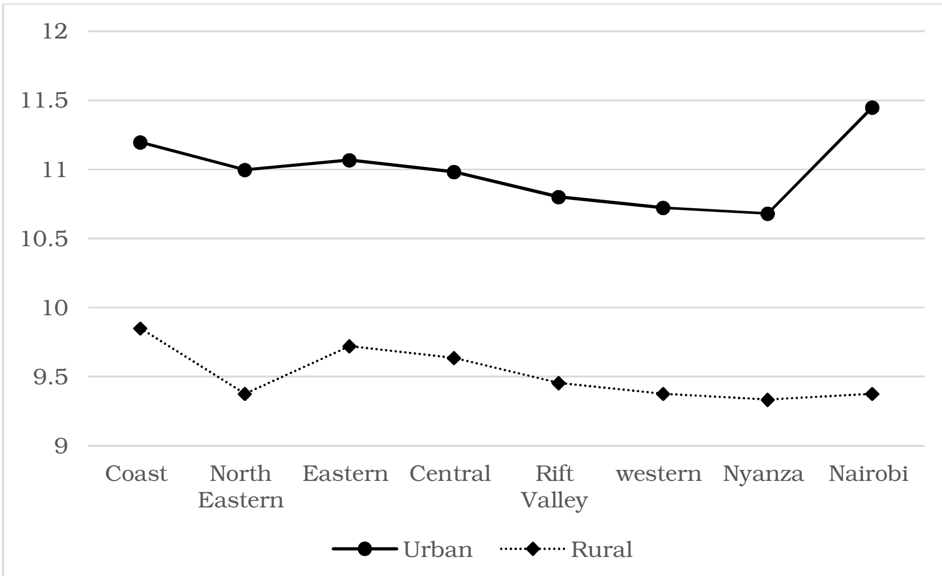


Fig. 4. Interaction effect between region and place of residence: Kenya 2015

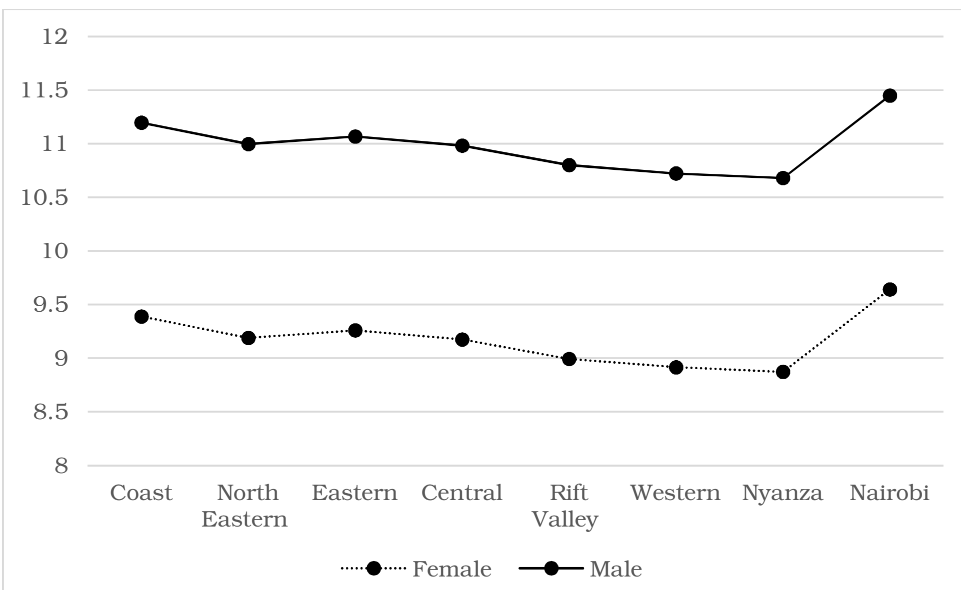


Fig. 5. Interaction effect between region and sex of household head: Kenya 2015

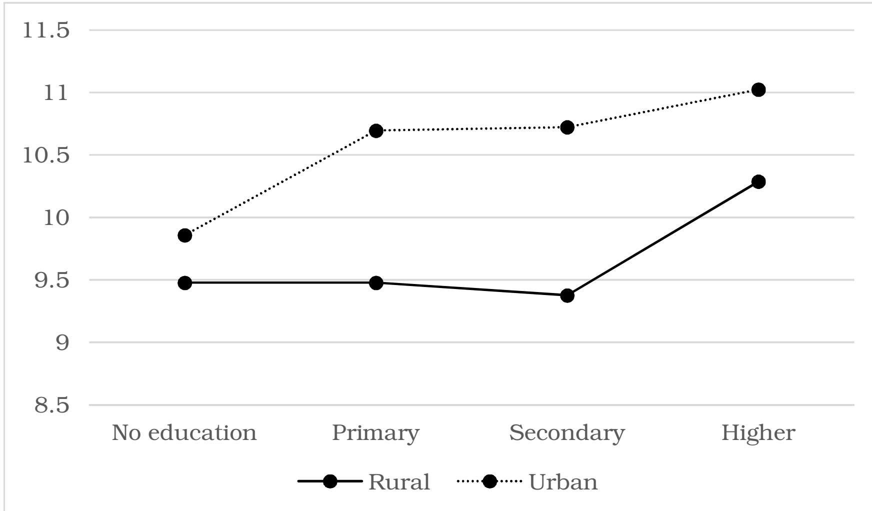
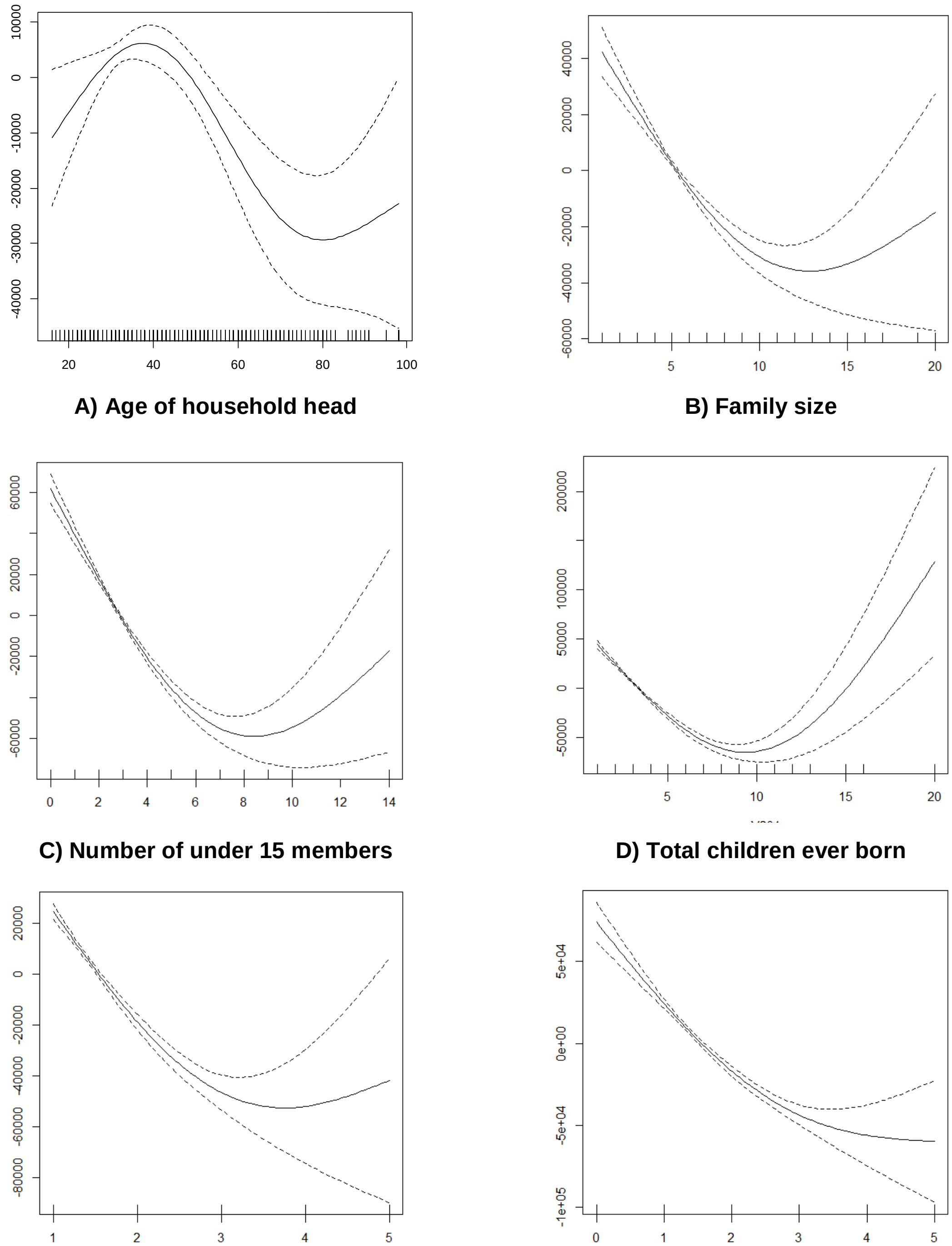


Fig. 6. Interaction effect between educational background and type of place of residence: Kenya 2015

In GAMLSS analysis, there were non-parametric parts in the model in addition to the parametric part. The basic statistical theory and associated mathematics for GAMLSSs are complex. The concept depends on the functional analysis [40]. Though, the key perceptions for GAMLSSs come from scatter plot smoothing idea. For Semi-parametric models, smoothing is the significant idea for non-parametric regression with the dependence of a variable *y* on group of predictors. Therefore, GAMLSSs are a special case of smoothing which gives some constraint to the predictors additively. Table 3 presented the non-parametric part of the model. Fig. 7 presented the estimated smoothing components for wealth of the household listed as A) age of household head, B) family size, C) number of fewer than 15 members, D) total children ever born. In each predictor's panel, the smooth line represents the estimated trend of a GAMLSS. Fig. 7A showed the estimated smooth function for age of household head with its 95% confidence interval. The figure suggested that household wealth status increases up to age 40 and starts to decrease up to age 80 and starts to increase again. The test statistic is 11.875, providing strong evidence (p-value =0.0026) against the assumption that age of household was linearly associated with wealth of the household (Table 3). Fig. 7B showed the estimated smooth function for family size of a household. Household wealth was higher for households with small number of family size and decreases up to 10 members and starts to increase again. The estimated smooth function for the size of fewer than 15 members was presented in Fig. 7C. The figure showed that household wealth decrease as the number of fewer than 15 family members increases and starts to increase after the number of members becomes four. Furthermore, the chi-square value is 8.797 with p-value = 0.0118, suggesting that births in the last five years is not linearly associated with wealth of the household. Similarly, number of living children was non-linearly related to the wealth of the household.

The analysis of our estimates suggests that although urban residences are wealthier than rural residents, residents with negative diagnosis for malaria were wealthier than those with positive outcomes in both urban and rural areas. Our findings suggest that there was a positive relationship between poverty and positive malaria outcome. This has important policy implication in fighting both malaria and poverty in poor countries. High prevalence of malaria among poor households may exacerbate their poverty as households incur high costs due to recurring malaria epidemic. Gender has a significant effect on household income and wealth accumulation. In the context of SSA, compared to men, women in general, accumulate less wealth [41-43]. Likewise, compared to male-headed households, households headed by female’s have less household wealth and are more likely to be poor [13,17,44]. The low wealth accumulation among women in SSA is partly attributed to social norms and legal systems that limit women’s ability to control assets or access to education [18,45], and other labor market discriminations against women [46]. Our study showed similar findings in comparison to previous studies. For instance, using data from three Africa countries (Ghana, Tanzania, and Kenya) a study found that of the total costs incurred per malaria period (direct and indirect costs) between 55% and 70% of it was incurred by household [6]. These findings suggest that poverty alleviation and malaria eradication should be simultaneously targeted.



A) Age of household head

B) Family size

C) Number of under 15 members

D) Total children ever born

E) Births in the last five years

F) Number of living children

Fig. 7. Smoothing components for wealth of the household: Kenya 2015

4. CONCLUSION

In this paper, we estimated the relations between poverty measured using household wealth index and various risk factors. We used, the GAMLSS, which provides a common clear basis for regression-type models. This model combines models that are often well-thought-out as different in the statistical literature. Therefore, this model is highly suited to solve non-parametric relationships because the model allows a wide family of distributions for the response variable. Therefore, unlike previous studies, this study attempted to estimate non-parametric relationships between wealth of household and socio-economic, demographic and geographic factors. In addition to this, the model allows all the parameters of the distribution of the dependent variable to be modelled. GAMLSS is a very flexible statistical modelling than other currently available methods. This flexibility gives more accurate assumptions for the data.

Our estimated results showed that households who reside in urban areas are wealthier than those how live in rural areas in all provinces of the country. We also found that education was an important determent of household wealth. In both rural and urban areas, household wealth increases with more education. In addition, the interaction effect between education and rural/urban regions showed that at all education level urban residents were wealthier than their rural counterparts.

ETHICAL CLEARANCE

The protocol for the 2015 KMIS was approved by the Kenyatta National Hospital/ University of Nairobi Scientific and Ethics Review Committee and ICF International's Institutional Review Board.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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