The economic impact of malaria on wage earnings in Kenya: a household level investigation

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Abstract

Background: Malaria remains one of the most severe diseases facing Sub-Saharan African. The global incidence of the disease is estimated at 350 to 500 million clinical cases annually, resulting in 1.5 to 2.7 million deaths each year in sub-Saharan Africa and parts of Asia. In Kenya, malaria is the leading cause of morbidity and accounts for 19 per cent of hospital admissions and between 30-50% of outpatient cases in public health institutions. In addition to its health effect, the disease imposes serious social and economic burden on individuals and households. It is also estimated that the total cost burden due to malaria in Africa increased from US dollars 1.8 billion in 1995 to US dollars 2 billion. While a great deal of research effort has been placed on the cost burden of malaria on households, comparatively little research, particularly in Kenya, has investigated the impact of malaria on wage earnings. Even rarer in previous work is the failure to address the endogeneity problem of malaria when estimating the effect of the disease on wage earnings. The objective of this study was to provide empirical evidence of the impact of malaria on wage earnings among households in Kenya.

Methods: The analysis was based on data drawn from Welfare Monitoring Surveys conducted by the Government of Kenya. The data provided information on individual and household socio-economic characteristics, sources of wage earnings community variables such as time taken to collect water and firewood during the wet and dry seasons. Two analytic samples were constructed, a full probability sample comprising households inflicted with malaria and other diseases and a sub-sample of healthy individuals and those having malaria.

Results: Based on the OLS results the coefficient on malaria exhibited the expected negative sign. The coefficient is significant at the 1% level, reflecting that an increase in malaria prevalence is associated with a decrease in wage earnings. Specifically, a 10% increase in the proportion of individuals affected by Malaria is associated with a reduction of 3.3% of wage earnings. The negative sign continues regardless of the method of estimation. The 2SLS results indicate that an increase in malaria prevalence reduces the log of wage earnings by 3.81. This implies that individuals afflicted by malaria have 44% lower wage earnings compared to healthy individuals. Also of interest is the coefficient on other diseases which has the expected negative sign and is statistically significant at the 5% level.

Conclusion: Individuals are likely to lose a significant proportion of their wage earnings if one suffers from malaria. However, investments in malaria control programmes have large economic returns because they make an immediate contribution to wage earnings by increasing the quantity and quality of labour, primarily through reductions in morbidity, debility, and absenteeism from work.

Keywords: Malaria, wage earnings, Mincer wage equation, economic burden

1. Background

Malaria remains one of the most severe diseases facing Sub-Saharan African. The global incidence of the disease is estimated at 350 to 500 million clinical cases annually, resulting in 1.5 to 2.7 million deaths each year in sub-Saharan Africa and parts of Asia (WHO, 1997, 1999; 2000). About 90% of these deaths occur in young children below the age of five years, who have not yet acquired clinical immunity, and pregnant women, whose immunity to malaria is temporarily impaired. In Sub-Saharan Africa (SSA) malaria is responsible for between 30 to 50% of outpatient visits and between 10 and 15% of hospital admissions (WHO, 1999). In addition, the disease exerts enormous pressure on scarce health resources in SSA countries. In general, it is estimated that the disease accounts for an average of 3% of the total global disease burden. More evidence points to significantly increasing malaria morbidity and mortality in SSA due to emergence of resistance by Plasmodium Falciparum to existing first line drugs (Arrow et al., 2004).

In addition to its health effect, the disease imposes serious social and economic burden on individuals and households. It is estimated that the total cost burden due to malaria in Sub-Saharan Africa increased from US dollars 1.8 billion in 1995 to US dollars 2 billion in 1997 (WHO, 1997). Recent estimates have placed the economic losses due to the disease in Sub-Saharan Africa to over US dollars 12 billion annually (WHO, 2010). The disease also imposes high and regressive cost burden on households that have a sick family member, with poor households spending a higher proportion of their income on health care than the better off households (Russel, 2004; Goodman et al., 2000). At the household level for instance, it affects productivity of the household members and their assets acquisition capacity.

In Kenya, malaria is the leading cause of morbidity and accounts for 19%of hospital admissions and between 30-50% of outpatient cases in public health institutions. It is also the leading cause of mortality in children under five years, a significant cause of adult mortality, and the leading cause of workdays lost due to illness (Republic of Kenya, 2001). Recent estimates show that 170 million working days are lost annually in Kenya due to malaria (Republic of Kenya, 2001).

While a great deal of research effort has been placed on the cost burden of malaria on households, comparatively little research, particularly in Kenya, has investigated the economic impact of malaria on wage earnings. Even rarer in previous work is the failure to address the endogeneity problem of malaria when estimating the effect of the disease on wage earnings. There are a number of reasons why endogeneity of malaria may lead to spurious results. First, since malaria illness in the welfare monitoring surveys is self reported, some households might tend to under-report malaria illness while others might over-report illness due to the disease. If this is the case, it will be difficult to separate the effect of malaria on wage earnings from the effect of the reporting error. Second, it is possible that we may encounter the problem of simultaneity which is due to the possibility of reverse causality between wage earnings and malaria. This relationship implies that an increase in malaria episode in a household might reduce worker productivity and hence wage earnings. On the other hand, an increase in wage earnings might improve the household income status, which in turn would improve the household's ability to seek prompt treatment or adopt control and preventive measures against malaria. It is therefore important to take into account these estimation issues in a discussion of malaria's impacts. The objective of this study was to provide empirical evidence of the economic impact of malaria on wage earnings.

2. Methodology

Data and variables

The data used in this study came from the Kenya Integrated Welfare Monitoring Surveys conducted by the Kenya Central Bureau of Statistics. The surveys were aimed at enabling the government to assess the welfare of the people. The 1994 data was administered from June to July in all the 47 counties in Kenya and covered 10,857 households consisting of 59,183 individuals. The 1997 covered 10,873 households, comprising 47,684 individuals drawn from 1,107 clusters of the National Sample Survey and Evaluation Programme (NASSEP III)2.

The welfare monitoring survey data contains information on individual and household socio-economic characteristics such as gender of household head, marital status, age, health, fertility rates, and household size, education level of household head, occupation of household members and job experience. It also contains information on incidence of malaria and other diseases (self-reported) by category of illness, two weeks prior to the surveys. This data was augmented with data on government expenditure on malaria prevention and treatment which was merged with the individual household survey data. Because information on expenditure on malaria treatment and control is not sufficient in explaining how much each household is entitled for, we assumed that each household within a county received an equal share of government allocation within a county.

The final sample consisted of members who were engaged either in part-time or full-time employment in the off-farm employment who provided valid responses to the variables used in the estimation model. Two analytical samples were constructed. A full sample comprising households inflicted with malaria and other

[2] It is imperative to note that although the data used in this study was collected in 1994 and 1997, the information is still relevant for our analysis and for policy direction because the structures that are under investigation remain almost the same.

diseases and a sub-sample of healthy individuals and those having malaria. The analytic samples were constructed by merging individual data sets with the corresponding data sets containing household socio-economic characteristics. Individual characteristics which had no corresponding household characteristics were dropped from the merged data.

Dependent variable

The variable names and definitions are summarised in Table 1. The WMS data does not have a direct measure of monthly wage. Average wage earnings were constructed as off-farm income from different sources. The wages were estimated from a sample of household members between 15 years and 65 years.

Explanatory variables

The wage function estimated in this study includes the typical explanatory variables involved in such analysis. However, the health variables, which have not previously been used in explaining monthly wage earnings, are of greatest interest in this study. There are four health indicator variables (proxied by malaria prevalence and prevalence of other diseases) used in the estimation of the wage functions. A continuous variable showing the proportion of household members who reported having contracted malaria two weeks preceding the survey, and a dummy variable for individuals reporting having contracted malaria two weeks before the survey, taking the value of 1 if a household member reported having contracted malaria two weeks prior to the survey. A dummy variable and a continuous variable for other diseases were also constructed similarly. The four malaria variables correspond to a self-assessed health question in the WMS data. It is hypothesised that malaria prevalence and the prevalence of other diseases has a negative relationship with wage earnings and as such we expect that coefficient on malaria and on the other diseases to be negative.

This study relies on individuals' self-reported ill health. The prevalence of malaria and that of other diseases was derived from direct responses to survey questions regarding the individual's sickness from malaria and other diseases two weeks prior to the survey. However, self-assessment of measure of having contracted malaria and other diseases is likely to be prone to 'rationalisation endogeneity' which occurs when an individual uses their self-assessed health as a rationalisation for their labour market status. Of particular relevance to this study is the use of valid instruments for malaria.

Table 1: Definitions of variables

Label	Definition	Apriori effect
Malaria-prevalence	Proportion of household members reporting having malaria two weeks prior to the study (a continuous variable) and a dummy variable =1 if a member reported having contracted malaria; 0 otherwise)	Negative
Prevalence of other_diseases	Proportion of household members having contracted other diseases two weeks prior to the survey (a continuous variable) and a dummy variable = 1 if a member reported having contracted other diseases; 0 otherwise	Negative
hh_age	Age of household head/respondent's age in years	Positive
hh_Agesq	Household head's/Respondent's age squared	Positive
hh_gender	Gender = 1 if respondent is male; 0 = female	Uncertain
hh_educ	Respondent's education in years of schooling (a continuous variable)	Positive
hh_pre-prim_educ	=1 if household head completed pre-primary school; 0 otherwise	Negative
hh_prim_edu	=1 if household head completed primary school; 0 otherwise	Uncertain
hhedu_secondary	=1 if household head completed form 4; 0 otherwise	Positive
hheduc_tertiary	= 1 if household head attained post secondary education; 0 otherwise	Positive
hheduc_university	= 1 if household head completed a degree programme; 0 otherwise	Positive
Marital_stat	Marital status =1 if married; 0 otherwise	Uncertain
marital_single	Never married (reference group)	Uncertain
Other_marital_stat	=1 if individual is divorced, separated, widowed, deserted; 0 otherwise	Uncertain
hh_size	Total number of adults in a household	Positive

urbrur	Rural or urban residence = 1 respondents lives in urban areas urban residence and 0 otherwise	Positive
work_hours	Total number of hours devoted to off-farm activities and in formal employment	uncertain
Province	Dummy variable = 1 if individual/household members resides in Nairobi province, 0 otherwise	Positive
	Dummy variable = 1 if individual/household members resides in Central province, 0 otherwise	
	Dummy variable = 1 if individual/household members resides in Coast province, 0 otherwise	
	Dummy variable = 1 if individual/household members resides in Eastern province, 0 otherwise	
	Dummy variable = 1 if individual/household members resides in Western province, 0 otherwise	
	Dummy variable = 1if individual/household members resides in North Eastern (Rift Valley province, 0 otherwise (baseline category)	
g_employ	1 = if head of the household is engaged in gainful employment; 0 otherwise	Positive
Adequate_rain	1 = if respondents reported experiencing adequate rainfall; 0 otherwise	Uncertain

Empirical model and estimation

The effects of human capital on wage earnings are commonly estimated using a human capital earnings function based on the model specified by Mincer (1974). In Mincer's model, the natural logarithm of wages is expressed as a linear function of years of schooling and a quadratic function of potential experience. The basic Mincerian wage function is written as follows:

$$\ln w_i = \alpha + \beta X_i + \varepsilon \quad (1)$$

Where $\ln w_i$ is the natural logarithm of the observed monthly wage for individual i, Xi is a vector of explanatory variables including, years of experience, age and its square, square of job experience and marital status among others; β is a vector of coefficients, and ε is the usual error term.

The human capital theory postulates positive relationship between one's earnings and education. When actual wage earnings deviate from the potential earnings, the difference is largely associated with lack of investment in human capital. In addition to investment in human capital, poor health is associated with a loss of wage earnings capacity due to reduction in labour supply or reduced labour productivity. Earlier works in this area include Bartel and Taubman (1979) who find that the presence of various diseases decreases labour supply and hence wage earnings. A similar study by Berkowitz et al., (1983) examined the impact of health on wages, labour supply and annual earnings. They found a negative correlation between poor health indicators and wages. Using single equation fixed effects and random effects instrumental variable estimators, Conntoyannis and Rice, (2001) found a significant impact of psychological well-being on the hourly wage for men and on self assessed health on women's wage.

By extending the standard Mincerian wage function to include variables related to personal characteristics (X), health indicator (M) and community characteristics (Z) the wage earnings function can be represented as follows:

$$\ln(w_i) = \alpha + \sum \beta_k X_{ik} + \delta M + \eta Z_i + \varepsilon \quad (2)$$

Where $\ln w_i$ is the log of monthly wage for individual i, X is a vector of personal characteristics such as education , age and its square, work experience, sex, and marital status; M represents malaria prevalence rate, Z is a vector of community variables such as residence location, access to local community infrastructures such as distance to the market and health facility. In addition to malaria, an additional health indicator variable, the prevalence of other diseases showing the number of household members afflicted by other diseases was also be included in the specification. The coefficients α, βk, δ, and ψ are the parameters to be estimated and ε, is the disturbance term. The observed concave profile for lifetime earnings is captured by the experience and quadratic experience variables, measured by years of work, or approximated by age, with positive and negative values of the coefficients, respectively. The parameter of interest is the coefficient on M, which shows the impact of malaria on wage earnings. Based on evidence from empirical literature, we expect a negative coefficient on M. The rest of the coefficients represent the effects of the explanatory variables on monthly wage earnings. The error term ε captures the combined effects of other factors that influence the individual's wage and is ~ NID $(0, \varepsilon)$ (i.e. the residuals are independently and normally distributed with mean zero and a common variance).

Estimation issues

In estimating wage earnings, certain econometric specifications need to be taken into account. Since malaria illness is self reported in the welfare monitoring survey data used in this study, some households might tend to under-report illness while others might over-report illness. If this is the case, then it will be hard to separate the effect of malaria illness on wage earnings from the effect of the reporting error. Second, it is possible that we may encounter the problem of simultaneity which is due to the possibility of reverse causality between wage earnings and malaria. This relationship implies that an increase in malaria episode in a household might reduce worker productivity and hence wage earnings. On the other hand, an increase in wage earnings might improve the household income status, which in turn would improve the household's ability to seek prompt treatment or adopt control and preventive measures against malaria. This is a common problem faced by researchers using health reported data.

To deal with the endogeneity of malaria, we used data from the 1994 and 1997 surveys which provide information on time taken to the river during the wet and dry seasons as well as time taken to reach the source of firewood to instrument malaria. Theoretically, time taken to the river and the time taken to collect firewood is expected to directly expose household members to the risk of contracting malaria, without affecting the outcome variable, namely, wages. That is, we expect the proportion of household members inflicted with malaria to increase with distance to the river or to the source of domestic energy. Hence, we estimated the regression equations (3) using our estimate of malaria to control for the endogeneity problem. For instance, equation (2) was estimated as follows:

$$\ln(w_i) = \alpha + \beta_k S_{ik} + \delta M^* + \psi Z_i + \varepsilon^* \quad (3)$$

where M^* is the predicted value of malaria and ε^* is an error term that is uncorrelated with M^* . To obtain M^* and ε^*, equation (3), which is the first stage regression, is estimated as follows.

$$M = \beta_0 + \beta_1 X + \beta_2 S + \beta_3 V + \mu \quad (4)$$

Where; X and S are as defined in equations (1) and (2) and V is a vector of identifying instruments for malaria. The term μ is assumed to be well behaved (i.e. independently and identically distributed, i.i.d.) with mean zero and constant variance. The malaria instruments V are valid if they are strongly correlated with malaria and uncorrelated with the error term in equation (4). That is, after controlling for malaria, the effect of the V vector of instruments on outcome variables should be close to zero.

The economic burden of malaria can be calculated using the following expression:

$$\Psi = [\exp(\hat{\theta}) - 1] \cdot 100 \quad (5)$$

In this equation, the economic burden of malaria is represented by ψ which is the percentage decline in wage earnings associated with malaria. The parameter "theta hat" in equation (5) is necessarily negative.

3. Results

Descriptive statistics

Table 2 presents the frequency and percentage distribution of the independent variables. The most noteworthy observation in this table is the significant variation in the monthly wage earnings in the two years, which was Log 10.4 and Log 7.07 in 1994 and 1997, with a standard deviation of Log 1.11 and Log 1.76 for 1994 and 1997, respectively. On average malaria prevalence among households who reported having a malaria episode two weeks prior to the survey was higher in 1994 (13.8%) than for the 1997 (8.8%). The prevalence of other diseases in 1994 and 1997 sub-sample, on average, stood at 12.1% and 8.84%, respectively. The average household size was about 5.6 for the 1994 sample and 6.9 persons per household in 1997. The increase in the mean of household size is in contrast to the evidence from the Kenya Demographic and Health Surveys (KDHS) of 1993 and 1998 which indicates that fertility in Kenya during this period continued to decline. The higher fertility rate for the 1997 could be due to the sample used rather than the national total fertility rate. The mean age in this sub-sample was 39 and 28 years in 1994 and 1997 respectively while the average number of years of schooling of a household head was 6.4 years and 6.1 years in 1994 and 1997 respectively.

Table 2: Frequencies and percentages for explanatory variables

	1994			1997		
Variables	**Observations**	**Mean**	**SD**	**Observations**	**Mean**	**SD**
Malaria prevalence	3115	0.138	0.22	4750	0.088	0.154
Prevalence of other diseases	3115	0.121	0.195	4750	0.088	0.162
Household Size	3115	5.580	2.74	4750	6.940	2.680
Log mean wage (in Kshs per year)	3115	10.4	1.11	4750	7.07	1.76
Age in Years	3115	39.6	10.6	4750	28	14
Sex (1= Male; 0 = Female)	3115	0.783	0.41	4750	0.490	0.499
Time taken to river during wet season (Minutes)	3102	23.20	31.3	4750	24.2	14.4
Time taken to river during dry season (Minutes)	3102	46.9	177	4750	34	20.0
Time aken o source of firewood (Minutes)	3102	49.8	69.3	4750	…	…
Education in years	3115	6.44	12.7	4750	5.09	4.35
Pre-primary Level	3115	0.004	0.066	4750	…	…
Primary Level (=1)	3115	0.429	0.495	4750	0.591	0.49
Secondary Level (=1)	3115	0.264	0.441	4750	0.110	0.313
Tertiary Level (=1)	3115	0.025	0.158	4750	0.003	0.059
University Level (=1)	3115	0.012	0.106	4750	0.003	0.061
No Education (=1)	3115	0.246	0.431	4750	0.298	0.457
Experience in years	3042	13.3	9.76		…	…
Residence (1=rural; 0 = Urban)	3115	0.823	0.381	4750	0.953	0.211

Regression analysis

The OLS and the 2SLS estimates are presented in Table 3. The OLS estimates are presented in column (1) and (2), while the IV estimates are presented in column (3) and 4). The first stage regression estimates are presented in Table 6 in the appendix. From the OLS results we see that the coefficient on malaria exhibit the expected negative sign. The coefficient is significant at the 1% level, reflecting an increase in malaria prevalence is associated with a decrease in wage earnings. Specifically, the results indicate that a 10% increase in the proportion of individuals affected by Malaria was associated with a reduction of 3.3% of wage earnings. The negative sign continues regardless of the method of estimation. The 2SLS results indicate that an increase in malaria prevalence reduces the log of wage earnings by 3.81. The coefficient of 3.81 implies that individuals afflicted by malaria have 44% lower wage earnings compared to healthy individuals. Also of interest is the coefficient on other diseases which has the expected negative sign and is statistically significant at the 5% level.

The estimated coefficient on age and age squared imply the expected significant concave and quadratic relationship with the logarithm of monthly wages. The results show that wage earnings increases with age, but declines at older ages. The low earnings associated with age squared suggest that as people advance in age, the quantity of time devoted to working is reduced. This can either be driven by a positive choice for more leisure at higher ages, or a negative effect on work-time through generally poorer health, or both (Contoyannis and Rice, 2001, Schultz and Tansel, 1997, Adebayo, 2004).

The impact of secondary, tertiary and university level of education also significantly increases wage earnings, as does the coefficient on gender, with the expected positive sign. Taking primary education as the reference group, completing secondary, tertiary and university education levels is associated with 1.9%, 3.9% and 4.4% increase in wage earnings. The earnings for all those individuals who received no formal education are lower by about 8.7%. A slightly different picture can be observed for individuals with primary and pre-primary education. Their mean wage earning is more or less the same and it seems there is no difference in wages as depicted by the positive coefficient on pre-primary level. .

The coefficient on gender (estimated by 2SLS) is positive and statistically significant at the 1% level of significance. The coefficient is 0.706 implying that females in the sample earned 7% lower wages than their male counterparts. Some possible explanation for this could be that fewer women are involved in off-farm activities and therefore their wage earning opportunities are fewer relative to those of men. The coefficient on household size is positive and statistically significant at the 5% level. However, the coefficient on residence variable is negative and statistically significant, implying that individuals living in urban areas earn higher wages relative to those based in the rural areas. Specifically, the results indicate that urban residents earn more than 70% higher wages relative to those working in rural areas.

Table 3: Effects of Malaria on Earnings (1994) (Dependent variable = log Wages) (Standard errors of estimated coefficients are shown in parentheses)

	OLS		2SLS	
Independent Variable	Coefficient	t-ratio	Coefficient	t-ratio
Constant	7.704 (0.818)	9.42***	8.99 (0.527)	17.05
Malaria prevalence	-0.336 (0.080)	-4.19***	-3.81 (1.99)	-1.92*
Prevalence of other diseases	-0.225 (0.085)	-2.63***	-0.800 (0.346)	-2.31**
Sex (1= Male; 0 = Female)	…	…	0.706 (0.208)	3.39***
Logarithm of age of household head	0.718 (0.263)	2.73***	0.051 (0.016)	3.20***
Log of age squared	-0.0005 (0.000)	-5.16***	-0.0005 (0.000)	-2.72***
Area of residence (urban =1; rural =0)	-0.735 (0.047)	-5.63***	-0.728 (0.059)	-12.25***
Logarithm of household size	0.073 (0.034)	2.17***	…	…
Primary level (=1)	0.277 (0.306)	0.91	0.344 (0.059)	5.80***
Secondary level (=1)	0.196 (0.063)	3.10***	0.614 (0.074)	8.30***
Tertiary level (=1)	0.397 (0.139)	2.85***	0.985 (0.127)	7.71***
University level (=1)	0.447 (0.244)	1.83*	…	…
No education (=1)	-0.867 (0.165)	-5.25***	…	...
Log working days	0.164 (0.022)	7.54***	0.163 (0.025)	6.49***
Log house hold size	0.073 (0.034)	2.17**	…	…
Log age*schooling	0.002 (0.001)	3.77***	…	…
Log years of schooling*sex	-0.024 (0.015)	-1.59	…	…
Log age*sex	0.010 (0.002)	4.46***	-0.011 (0.005)	-2.06**
Sample size = 3115 F(11, 3103) = 52.41 R-Squared = 0.235	…	…	…	…

Note: ***, ** and * significant at 1%, 5% and 10% level

Effect of malaria on wage earnings using a sample with malaria illness pooled with healthy individuals

W also estimated the model using malaria and other diseases pooled with healthy group. The results are presented in Table 4. The results show that the coefficient on malaria (malaria =1) in column (1) had the expected negative sign but not statistically significant. The coefficient continues to be negative when estimated using the 2SLS method and is statistically significant at the 10% level. The estimates show that a percentage increase in malaria morbidity reduces earnings by 0.042%. The 2SLS results in model (2) indicate that malaria reduces the log of earnings by 3.04 implying that individuals afflicted by malaria have 19.9% lower earnings relative to healthy individuals.

Table 4: Impact of malaria on earnings using a sample with malaria illness pooled with health individuals (1997). Dependent variable: monthly mean wage earnings (Standard errors of estimated coefficients are shown in parentheses).

Independent variable	**OLS**		**2SLS**	
	(1)		**(2)**	
	Coefficient	**t-ratio**	**Coefficient**	**t-ratio**
Constant	6.77 (1.021)	6.63	6.325 (1.790)	3.53***
Malaria = 1 if household member had malaria; 0 if other diseases	-0.042 (0.046)	-0.910	-3.046 (1.691)	-1.80*
Gender (=1 male; 0 otherwise)	0.304 (0.063)	4.83***	0.240 (0.120)	2.00**
Marital status (1 = married)	0.024 (0.026)	0.930	0.073 (0.057)	1.29
Log Age of household head	0.892 (0.329)	2.71**	1.728 (0.731)	2.36**
Log Age squared	-0.003 (0.000)	-3.19***	-0.000 (0.000)	-2.62**
Log Experience	0.000 (0.015)	0.001	-0.013 (0.028)	-0.47
Urban or rural area (Rural =1)	-0.776 (0.061)	-12.67***	-0.805 (0.112)	-7.15***
Logarithm of household size	0.154 (0.043)	3.57***	0.220 (0.089)	2.47**
Pre_primary (=1)	0.001 (0.314)	0.01	0.324 (0.613)	0.53
Secondary level (=1)	0.384 (0.052)	7.28***	0.257 (0.121)	2.12**
Tertiary level (=1)	0.690 (0.128)	5.39***	0.563 (0.269)	2.09**
University level (=1)	0.558 (0.237)	2.36**	1.026 (0.442)	2.32**
No education (=1)	-0.396 (0.062)	-6.34***	-0.467 (0.113)	-4.13***
Log working days	0.167 (0.032)	5.18***	0.089 (0.073)	1.23
Observations	2051			
F(14, 2036)	14.04			

Note: ***, ** and * significant at 1%, 5% and 10% level.

Table 5 compares the effect of malaria and other diseases on earnings relative to the healthy individuals. The coefficients on malaria dummy and on the other diseases show the extent to which earnings are lower among individuals afflicted by malaria or other diseases relative to earnings of healthy individuals. The coefficient on malaria dummy is negative and statistically significant at the 1% level regardless of the estimation method. The coefficient on other diseases is negative as well and is statistically significant at the 10% (OLS) and 1% (2SLS) respectively. The results shows that earnings of individuals afflicted with malaria are lower by 16% compared to earnings of healthy individuals, while the loss in earnings due to other diseases is lower by 0.6%% relative to that of healthy individuals.

Table 5: Impact of malaria and other diseases on wage earnings (1994), Dependent variable: monthly mean wage earnings (standard errors of estimated coefficients are shown in parentheses)

Independent Variable	OLS		2SLS	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	7.165 (0.795)	9.01	8.479 (1.379)	6.15
Malaria = 1 if household member had malaria and 0 if other diseases	-0.165(0.049)	-3.35***	-2.84 (1.331)	2.14**
Other diseases = 1 if malaria and 0 if other diseases	-0.089 (0.053)	-1.69*	-0.504 (0.246)	2.05**
Gender (1 = Male)	0.318 (0.044)	7.25***	…	…
Log of age of household head	0.833 (0.255)	3.27***	0.572 (0.416)	1.38
Log of years of age squared	-0.0003 (0.000)	-3.55***	-0.0002 (0.000)	1.81*
Urban or rural area (Rural =1)	-0.745 (0.047)	-15.95***	-0.454 (0.166)	-2.73***
Logarithm of household size	0.083 (0.033)	2.52**	…	…
Pre_primary (=1)	…	…	0.082 (0.415)	0.20
Secondary level (=1)	0.332 (0.041)	8.01***	0.170 (0.104)	1.63
Tertiary level (=1)	…	…	0.503 (0.260)	1.93*
Tertiary (=1)	0.704 (0.096)	7.29***	…	…
University level (=1)	…	…	-0.046 (0.461)	-0.10
None_pre_primary (=1)	-0.349 (0.052)	-6.72***	…	…
No education (=1)	…	…	-0.707 (0.242)	2.92***
Log working days	0.165 (0.022)	7.59***	0.151 (0.033)	4.51***
Log house hold size	**…**	**…**	-0.049 (0.116)	0.43
Age*education	…	…	0.001 (0.001)	1.41
Log age*sex	…	…	0.004 (0.002)	1.95*
Observations	2206	…	**…**	**…**

Discussion

The results have shown that malaria exerts a significant negative impact on wage earnings. This implies that households inflicted with malaria and other diseases earn less compared with healthy households. In particular, the estimates have shown that household wage earnings were lower for households who experienced an episode of malaria compared to the wages of healthy households. The loss in household wages is largely explained by loss of productive time by the sick relative and the time spent by household members taking care of the sick relatives and therefore has little time to engage in active income generating activities. Loss of labour time due to illness implies lower wages given that the majority of the respondents depends largely casual employment and the payment is based on one's productivity (Lucas, A.M. 2005, Laxminarayan, R., 2004, Wang'ombe, J.K., and Mwabu, G.M. 1993).

The results have also shown that education can mitigate the negative effect of malaria through increased awareness about the disease prevention and treatment. More knowledgeable individuals are better able to adopt preventive measures in ways that protect them from diseases compared to the less educated ones. This finding is consistent with similar studies which show that government expenditure in malaria control programmes significantly reduces the malaria intensity and, in turn raises labour productivity (Mitra and Tren, 2002, Laxminarayan, R. 2004).

Conclusion

The evidence arising from this study is that the impact of malaria on household wage earnings was higher among the inflicted households than among the healthy households. Increasing awareness on malaria prevention and education among households in malaria endemic areas can potentially mitigate the negative impact of malaria. Thus, households are likely to benefit significantly if malaria were to be eradicated. .

Policy implications of this study

In order to increase wage earnings in malaria endemic areas in the country, it will be necessary for the government and other stakeholders to put in place effective malaria control programmes. Malaria control can be economically beneficial because these measures make an immediate contribution to household welfare by increasing the quantity and quality of labour, primarily through reductions in morbidity and debility, and secondly through reductions in mortality. The benefit from malaria control should therefore be a motivating factor for the government and development partners to inject additional resources in malaria control.

In order to mitigate the negative impact of malaria on wage earnings there is need to enhance public awareness on how to prevent malaria. Incidence of malaria is higher for less educated households and in regions with poorer preventive health services. Hence, public health interventions which decrease the household's risk of contracting malaria will improve labour productivity and result in higher output levels. One would expect a negative effect for education on malaria, in the sense that more educated household members are expected to have a better understanding of the malaria -related issues and a better compliance with modern treatment as well as use of prevention measures. Ultimately, these measures are expected to reduce malaria transmission, improve labour productivity and wage earnings.

Improvement in health infrastructure will particularly reduce the susceptibility of low wage earners to malaria shocks. Thus, measures geared at: (i) improving public education on the importance of seeking prompt treatment and on prevention measures; (ii) increasing budget allocation for public health education campaigns; and (3) improving incomes of people living in malaria prone areas will empower people in high malaria transmission zones to embrace measures aimed at reducing malaria transmission and in doing so reduce the economic burden of malaria and reach a higher standard of living.

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Appendix

Table 6: Determinants of Probability of Contracting Malaria-First Stage Least Squares Estimation Results for Earnings, (1994)

Independent Variable	OLS Estimates	Std Errors	t-ratio
Log Age of household head	0.286	0.154	1.85
Log of age squared	-0.000	0.000	-1.45
Sex (1= Male; 0 = Female)	-0.024	0.031	-0.78
Marital status (=1 if married)	0.014	0.013	1.07
Log Household size	0.022	0.022	1.00
No education level (=1)	-0.031	0.029	-1.06
Pre-Primary level (=1)	0.102	0.161	0.63
Secondary level (=1)	-0.042	0.027	-1.55
Tertiary level (=1)	-0.045	0.071	-0.63
University level (=1)	0.174	0.098	1.76
Log experience	-0.004	0.007	-0.61
Urban or rural area (urban =1; rural =0)	-0.012	0.036	-0.33
Log working days	-0.025	0.016	-1.56
Time taken to collect water during wet seasons	0.017	0.012	1.42
Time taken to collect water during dry seasons	0.001	0.010	0.14
Time taken to collect firewood	-0.008	0.007	-1.12

Test for the strength of instruments
Test Log time taken to water source during the wet season
Test Log time taken to water source during the dry season
Test Log time taken to the dispensary

(1) Log time taken to water source during wet season = 0
(2) Log time taken to water source during dry season = 0
(3) Log time taken to the dispensary = 0
F (3, 2034) = 1.48

Prob > F = 0.2177