INFLUENCE OF SOCIOECONOMIC AND ENVIRONMENTAL CHARACTERISTICS ON MALARIA DISEASE RESURGENCE AMONG THE ADULT RESIDENTS OF ISIOLO SUB-COUNTY IN KENYA

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Abstract:

This study evaluated the determinants of malaria disease resurgence among the adult residents of Isiolo Sub-County in Kenya. The following specific objectives guided this research; to establish the influence of the level of awareness on malaria disease resurgence among the adult residents of Isiolo Sub-county in Kenya.to evaluate demographic characteristics influencing malaria disease resurgence among the adult residents of Isiolo Sub-county in Kenya, to investigate socio-economic characteristics influencing malaria disease resurgence among adult residents of Isiolo Sub-county in Kenya.to determine the influence of environmental characteristics on malaria disease resurgence among adult residents of Isiolo Sub-county in Kenya, to assess the influence of malaria disease resurgence interventions on malaria disease resurgence among the adult residents of Isiolo Sub-county in Kenya, This was a descriptive study, employing a cross-sectional study design. The researcher used mixed research methodology in this study which employed both qualitative and quantitative methods. Stratified sampling techniques were used for sampling the study respondents. The residents of Isiolo Sub-county, key informant interviewers and NGOs/CBO based focus group discussion constituted the target population. The study respondents were selected from five different wards of Isiolo Sub-county with a Sample size of 392 comprised of 385 respondents randomly selected for quantitative data and 7 key informants and focus group discussion for qualitative data. The study used interview guides to collect data from key informants. Quantitative data were collected using self-administered questionnaires. SPSS version 25.0 was used in quantitative data analysis while qualitative data was analyzed thematically. The study received 100% response rate almost balance by gender as approximately 55% of respondents were male and 45% were female. Education levels of respondents varied because there were respondents without formal

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education while others had attained a tertiary level of education. Respondents experienced malaria resurgence in the study as evidenced by knowledge of malaria disease symptoms, causative agents of malaria disease, mode of transmission, treatment and intervention strategies among others. This study established that all the characteristics considered in this research had some level of influence on the resurgence of malaria disease in the study site as deduced by regression analysis model whose, $R2 = 0.453$, F- $1.385 = 316.804$, $P = 0.000$ for socioeconomic, Beta- coefficient $= 0.410$, $p=0.000$ for an environmental factor, in all $p < 0.05$ at CI=95%. The study recommends that policymakers in Isiolo Sub-county should consider formulating policies that support education for the residents since a big percentage 58% had not attended any form of schooling. This study concluded that different malaria intervention strategies were implemented in the research site aimed at taming the resurgence of malaria disease but had mixed results. The researcher recommended that Policy makers and NGOs/CBOs sought to allocate additional resources in support of educating residents about malaria disease and how to control it since prevention is usually cheaper than treatment in their intervention programs to curb malaria resurgence in the study area. The researcher also recommended further research on the reasons behind a big percentage of residents of the Isiolo Sub-county not attending or enrolling in a formal school system.

Keywords: malaria, resurgence, socioeconomic, environmental characteristics, Isiolo Sub-county

1. Introduction

According to experts, malaria parasites in Africa have developed resistance to a major class of drugs used to treat the disease. Treatment resistance has long been observed in Africa; for example, Rwandan scientists discovered gene alterations associated with medication resistance in malaria parasites between 2012 and 2015. Because numerous medications make it harder for parasites to build resistance, the 'gold standard' treatments for malaria the pharmacological family that includes artemisinin and its derivatives are routinely used in what are known as artemisinin-combination therapy (ACTs). Resistance to artemisinin and its derivatives first appeared in Cambodia in the early 2000s. Malaria parasites in Southeast Asia began to resist some of the ACTs' partner medications within a few years, making some of the region's most powerful malaria drug combo's ineffective and sending public-health experts rushing to discover other combinations that still worked. The situation is more serious now that resistance has reached Africa. Most critically, widespread resistance to commonly prescribed antimalarial medications has resulted in much higher fatality rates in the world's most malaria-endemic regions. It is becoming increasingly difficult to find economic alternatives to chloroquine and Fansidar (SP) as a first-line antimalarial in many regions of the world since they are no longer effective. The newer "travelers" medications are still

effective against the malaria parasite but prohibitively expensive in the African environment because of their intrinsic cost.

As a result of this long-term lack of malaria treatment in research and development, the disease has become a global public health concern. Consequently, our arsenal of antimalarial medications is weakened as we enter the new millennium. First-line medications now accessible in endemic nations are rapidly losing their efficacy as drug resistance predictably rises as previously indicated. Once thought to be a miracle drug, chloroquine has been rendered virtually ineffective in the areas of the world most affected by the disease despite its excellent safety, efficacy and affordability. Only a few second-line antimalarials are available and all have serious safety issues or are prohibitively expensive in the poorest countries where they are needed. Only a few new medications and formulations recently approved for preventive use are easy to manufacture as generics due to the high intrinsic cost of the pharmaceutically active chemicals they include. Unfortunately, this is also true for artemisinin, a class of medications (or drug combinations) derived from *Artemesia Annua* plant extracts that are currently widely used. Though the cost of these treatments is expected to fall as they are more widely used, they will never be able to compete with fully synthetic drugs. Because of this, we are reminded that while innovation might be costly, its absence can be even more costly.

In a new analysis, funding cuts for malaria control are found to be the leading cause of the disease's return since 1930, with the bulk of global resurgences being traced to weakening malaria control programs. Open-access journal Malaria Research studied 75 documented cases where resurgences of malaria occurred in countries where the illness was nearing eradication and in countries where the disease was still prevalent but was being controlled. The UCSF Global Health Group along with the Clinton Health Access Ingenuity, and the Johns Hopkins Malaria Research Institute, found that 91 percent of those resurgences, or 68 out of 75, were triggered at least in quantity by weakened malaria regulator programs, with 39 of the 68 tied to funding limitations. There were other factors that could have backed the rise in malaria reappearance, including the movement of people and the changing weather patterns, as well as technical issues like medicine and pesticide resistance. Despite a global financial shortfall of $9.7 billion for malaria interventions over the succeeding three years, according to the international conglomerate Roll Back Malaria. Roll Back Malaria is a United Nations-affiliated global cooperation that is organizing a strategy to eradicate the illness globally among 500 organizations and member countries.

In most parts of Kenya, extreme temperatures are recorded in the months of February and March, while low temperatures are observed in July and August. The species that cause malaria are all found in Kenya, with *Plasmodium falciparum* being the most common and responsible for approximately 98% of the entire infections in the whole country. Typically, there are seasons of high temperatures reported in most parts of Kenya in February and March, while low temperatures are recorded in July and August. All the species involved in malaria infection are present in Kenya, with *Plasmodium*

falciparum being the leading one and approximately 98 percent of all infections in the entire world (Kenya Malaria Operation Plan, 2015).

Therefore, in light of this, a study is required to establish this fact and put Isiolo Sub-county on the global malaria map and if the study's result is known the necessary intervention actions are undertaken. Above all, from known information, no such kind of study has ever been conducted in Northern Kenya, leave alone Isiolo hence the desire for data regarding malaria study and more on the aspect of malaria resurgence.

An open-access journal published by BioMed Central has found that 75 verified cases of malaria reappearance worldwide have been connected to the decline of malaria control initiatives during the 1930s. This year Global Malaria Day (April 25, 2012) topic of "Save Lives, Sustain Gains: Invest in Malaria" indicated that financing disruptions were the most common cause of weakening malaria control programs. Scholars at the Center for Disease Policy, Dynamics, and Economics and UC San Francisco's Global Health Group did a literature analysis to find any instances of malaria recurrence that had been previously observed. The findings were compiled by the Clinton Health Access Initiative. Re-emergence of malaria refers to a return to a location that has been previously repressed by measures like the distribution of bed nets or insecticide spraying. All of the possible reasons for these resurgences were sorted into three categories: reduced malaria control efforts, increased potential for malaria transmission and technical difficulties such as medication resistance to the malaria parasite. On the other hand, the weakening of malaria control programs was blamed for sixty-eight out of seventy-five resurgences.

In addition to the treatments and reductions in malaria in Africa, the comeback of malaria infection has resulted in increased illness loads among adults and children as a result of a lengthy period of malaria control (Trape *et al.*, 2011). Despite the increased use of insecticide-treated nets and other treatments, malaria transmission patterns are shifting in some regions of Kenya (Olotu *et al.*, 2010). This incidence has been connected to insecticide resistance, a shift in vector population species, and global warming (Wanjala and Kweka, 2018). In Isiolo, for example, most of the county-side areas have no well-defined healthcare systems. This is due to the fact that there are few medical personnel and the accessibility of healthcare facilities is poor, coupled with the pastoralist lifestyle of the nomadic community in the study area. Another reason is that majority of those people living in these areas are poor, and majorly flooding in lowlands, humidity, rainfall etc. exacerbates a good breeding ground for the Mosquito vectors. This study, therefore, seeks to evaluate malaria disease resurgence determinants among the adult residents of Sub-county of Isiolo in Kenya.

The following specific objectives guided this study:
- To investigate socio-economic characteristics influencing malaria disease resurgence among residents of Isiolo Sub-county in Kenya.
- To determine the influence of environmental characteristics on malaria disease resurgence among residents of Isiolo Sub-county in Kenya.

2. Conceptual Framework

Figure 2: Conceptual Framework
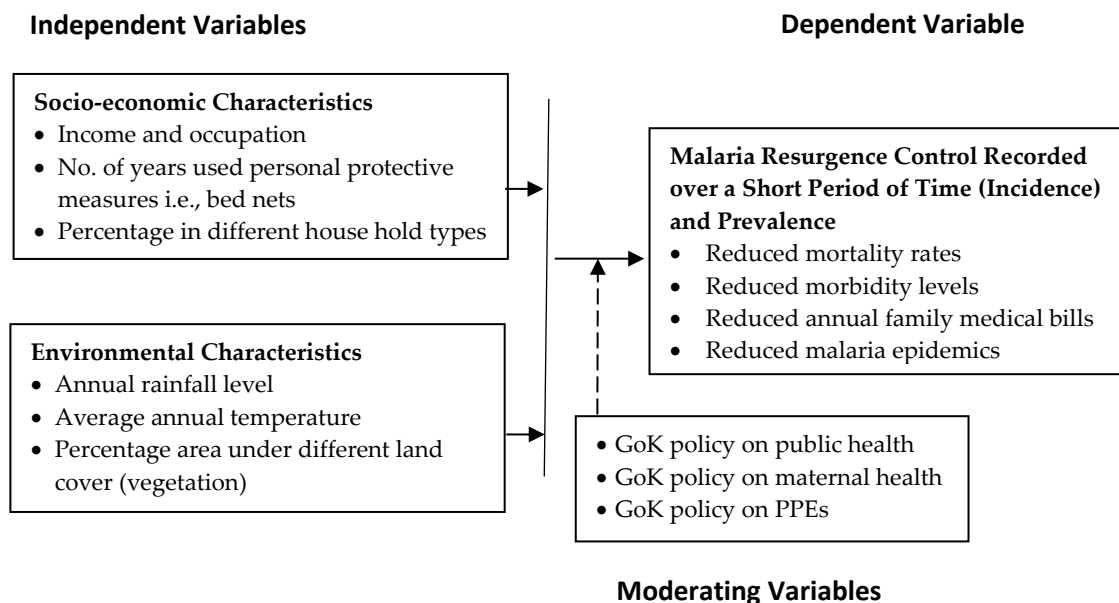
It was conceptualized that both socioeconomic and environmental characteristics influenced malaria disease resurgence and prevalence in Isiolo Sub-county.

3. Research Method

The study design defines the kind of research for instance as correlational, descriptive, semi-experimental, and experimental, meta-analytic, analysis, as well as sub-types for example descriptive-longitudinal case study. It also describes the problem of research, hypothesis, independent and dependent variables and where it applies, and the procedures for data gathering and analysis. The design of the study is thus a framework that is used to help answer the research questions. This study employed a cross-sectional design where both quantitative and qualitative data were used for collection and analysis.

Summarily the design used mixed approach methodology and also referred to as mixed method research designs that encompass data collection by use of surveys, interviews and focus group discussion and this is also referred to as the use of qualitative and quantitative research.

3.1 Settings, Population and Study Design

The research took place in Isiolo Subcounty, which is part of the greater Isiolo Sub-county. The sub-county covers an area of 3269 sq.km as well as five political administrative units that include Wabera, Bulla Pesa, Burat, Ngaremara and Oldonyiro.

The populace targeted was residents of Isiolo Sub-county which were composed of local residents, Key Informants {health managers and CEC/CCO and NGOs/CBO in support of health programs. The study respondents were selected from five different wards in Isiolo Sub-county.

3.2 Inclusion Criteria
1) All the adults with sound mind randomly selected formed the basis of study respondents;
2) Only the relevant heads of the county health department were selected as key informant interviewers;
3) The study respondents must be above 18 years old;
4) Only sane respondents were considered to participate in the study.

3.3 Exclusion Criteria
1) Insane respondents randomly selected were not allowed to participate in this study;
2) Visitors to the sub-county who will not have stayed in the region for more than one year were excluded from the study;
3) Minors were not allowed to participate in this study.

3.4 Sample Size
This study focused on a population of fewer than 10000 people and hence targets 385 respondents in addition to 7 key informants' interviewers hence totaling 392 respondents and two sessions of focus group discussion of 10 people which are mainly health professionals working in the disease surveillance in the 5 mentioned wards, Local influential leaders, business community and religious leaders.

The study respondents were selected from five different wards and which are done by simple random sampling after stratification, therefore it is clear that the study's total target population was N=385. Therefore, the sample size will be calculated with the help of Yamane formula of 1968 as shown below from a population of less than 10000 statistically.

Below is the mathematical illustration for the Taro Yamane method:

Where:
n signifies the sample size;
N signifies the population under study;
e signifies the margin error.
n = 385
$1+10.0 \times (0.005)(0.005)^2$
n = 385 Sample Size

The sample size was then proportionately shared with the population of the wards as per the latest literature review on the census by the researcher. The sample size of 385 and 7 key informant interviews totaling to 392 as total respondents in this research. The table below shows the sample sizes for study respondents as per wards summing up to 385 total sizes of the sample determinations.

Table 1: Population sample size proportionate as per wards

Wards	Population	% of the Total	Sample Size
Burat	20,795	24%	92
Bulla Pesa	25,167	28%	108
Ngare Mara	6,114	7%	27
Oldonyiro	17,044	19%	73
Wabera	19,307	22%	85
Total	**88,427**	**100%**	**385**

Source: 2019 Kenya Population and House Hold Census.

The sample size was then proportionately shared with the population of the wards as per the latest literature review on the census by the researcher. The sample size of 385 and 7 key informant interviews totaling 392 as total respondents in this research.

3.5 Data Analysis

The reliability of the study instruments will be checked through the test-re-test method. This method involves administering the instruments to the respondents and after some period of time re-administering the same instruments to see the consistency with which the questions are answered. The researcher administered the Questionnaires to 20 members of the public at the neighboring Meru County and after a two-week period, the Researcher administered the same instruments once more to the actual respondents. The reliability of the instruments was based on the consistency of the responses given. Computation of the alpha reliability coefficient between the scores of the two sets of questionnaires was carried out using Pearson's Product Moment Correlation Formula. If a value of r > 0.70 is obtained, then this will indicate high internal reliability (Kothari, 2009), for our case 15 respondents gave a similar reading that corresponds at 75% of that total measure hence this index of the coefficient was greater than 0.75 which indicated that our tool was valid.

In this study, the researcher used both SPSS and Info Software. The SPSS is for quantitative data analysis and hence deals with numbers only while Info Software is like SPSS but doesn't deal with numbers but deals with attitudes, and beliefs and therefore mainly for themes and subthemes also called thematic analysis and it's purely for qualitative data. Lastly, the study findings were presented in form of tables, figures and pie charts etc.

The study used multiple regression models to find the link between the dependent variable and independent variables (2 or more). This analysis technique is vital since it allows and promotes theory building and explanation as well as prediction of certain characters. One dependent variable (criterion), as well as 2 or more independent variables

(predictor variables), are crucial for the effective utilization of the multiple regression models. For this research, malaria resurgence and its outcomes are represented as the response (criterion) variable (Y), while the independent (predictor) variables are the determinants of malaria resurgence, (X1) socioeconomic characteristics and (X2) Environmental factors. The following model was used in this research:

$$Y = \beta_1 X_1 + \beta_2 X_2 + \Sigma$$

Where:
Y is the dependent variable (malaria disease resurgence and its outcomes);
X represents the set of 5 independent variables;
X1 – Socioeconomic characteristics;
X2 – Environmental factors.

3.6 Ethical Considerations

Bryman and Bell (2007) sum up the following points to give the most crucial principles concerning ethical considerations in studies:

1) No harm should be subjected to the respondents and the community in general.
2) The research should prioritize the dignity of participants.
3) The participants should sign the full consent before the study starts.
4) The research participant's privacy should be protected.
5) The research should ensure adequate confidentiality levels of the research data.
6) The individuals and organizations engaged in the research should remain anonymous.

4. Findings

The respondents were interested in the research and willing to provide research information attested by a 100% response rate. Respondents to research questions were of different gender including males and females. None of the respondents was transgender or neither male or female. A total of 213 (55.3%) males and 172 (44.7%) females responded to research questions as shown in Table 1.

Table 1: Distribution of Respondents by Gender

Gender of Respondents	Frequency	Percentage (%)
Males	213	55.3
Females	172	44.7
Total	**385**	**100.0**

Source: Researcher (2022).

4.1 Distribution of Respondents by Age
Data on the age of research respondents were analyzed and presented in Table 2.

Table 2: Distribution of Respondents by Age

Age of respondents in years	Frequency	Percentage (%)
18-20	194	50.4
21-29	30	7.8
30-39	102	26.5
40-49	30	7.8
50-59	20	5.2
60 years or older	9	2.3
Total	**385**	**100.0**

Source: Researcher (2022).

Data indicated that the majority of respondents 52.1% were aged between 18 to 20 years of age followed by respondents aged between 30 and 39 years at 25.3%. The lowest percentage of respondents (2.5%) were aged 60 years and above. The data shows that majority of respondents were aged 39 years and below at 84.8%.

4.2 Distribution of Respondent by Education
The respondents were of different levels of education as shown in Table 3.

Table 3: Distribution of Respondents by Education

Education level of respondents	Frequency	Percentage (%)
No education	223	57.9
Primary level	42	10.9
Secondary level	69	17.9
Tertiary level	51	13.2
Total	**385**	**100.0**

Source: Researcher (2022).

Data indicated that respondents who had no formal education were the majority (57.9%) while those who had attained primary school level were a minority at 10.9%. Respondents who had attained at least a secondary school level of education were 31.1%. It was noted that at least 42% of respondents had some level of formal education.

4.3 Analysis of Malaria Resurgence in Isiolo Sub-county
Malaria resurgence was the dependent variable in this study. The researcher set out to investigate the level of awareness and understanding of the respondents in identifying malaria resurgence in the research area. To achieve the goal of determining the level of awareness amongst the respondent, the researcher posed specific questions which elicited the respondent's reactions including knowledge of cardinal symptoms of malaria, tests for malaria, and causative agents for malaria and transmission mode. Additionally, the researcher determined respondents understanding in terms of treatment for malaria disease, management of malaria during febrile illness, prevention and knowledge or identification of health workers.

To understand the respondents' cardinal awareness of indicators of malaria in the research area, the researcher asked respondents to identify malaria symptoms and responses shown in Table 4.

Table 4: Distribution of Respondents Based on Identification of Malaria Disease Symptoms

Symptoms of malaria	Frequency	Valid Percentage (%)
Fever	180	46.8
Rigors	54	14.0
Fever + rigors	33	8.6
Fever + rigors + headache	19	4.9
Fever + rigors + headache + confusion	99	25.7
Total	**385**	**100.0**

Source: Researcher (2022).

Data indicated that the highest percentage of respondents (46.8%) identified fever only as a symptom of malaria and 14% only identified rigors as a symptom. A total of 60% of the respondents could only identify one symptom of malaria. However, at least 39% of respondents could identify multiple signs of malaria. Despite the fact that respondents identified different signs of malaria it was possible that they failed to express themselves adequately that malaria had more than one symptom because of the low formal education levels.

To determine the respondents' understanding of the causative agents of malaria the researcher requested them to identify the one responsible for causing malaria from a list of different insects, bacteria and viruses. The results were presented in Table 5.

Table 5: Distribution of Respondents by Identification of Malaria Causative Agent

Causative agents	Frequency	Percentage (%)
Mosquito	189	49.1
Bacteria	46	11.9
Virus	17	4.4
Mosquito + Bacteria	18	4.7
Plasmodium	115	29.9
Total	385	100.0

Source: Researcher (2022).

Data shows the highest percentage of respondents (49.1%) identified mosquito as the insect related to malaria resurgence in the research site. However, only 29.9% of respondents correctly identified *plasmodium* as the causative agent for malaria. *Plasmodium* is transmitted by mosquito hence the association of mosquito to malaria by many respondents. The data indicate that malaria resurgence in the research site is a real problem evidenced by respondents' ability to associate it with mosquito (the vector) and *Plasmodium* (the causative agent).

To gauge respondents' understanding of malaria treatment, the researcher asked about its treatment by providing respondents with a list of different drugs to select from and responses presented in Table 6.

Table 6: Distribution of Respondents by Identification of Treatment for Malaria Disease

Treatment drug	Frequency	Percentage (%)
Coartem alone	169	43.9
Other antimalarials	60	15.6
Paracetamol	29	7.5
Coartem + others (ACT)	17	4.4
Antibiotics	110	28.6
Total	**385**	**100.0**

Source: Researcher (2022).

Respondents correctly identified Coartem as a drug for the treatment of malaria as shown by 44% of the respondents which implies that malaria resurgence in the research site happens to force respondents to learn and know what drugs to use when such resurgence occurs. There was an indication that other anti-malaria treatments were available in the research sites that are used to treat the disease as indicated by 28.6% of respondents. The availability of several options for the treatment of malaria disease in the research area attests to the fact that malaria resurgence is a common problem in Isiolo Sub-county.

To understand different prevention strategies for malaria disease, the researcher enquired how it was done in the research area and the responses presented in Table 7.

Table 7: Distribution of Respondents by Understanding of Prevention Strategies for Malaria

Strategy used	Frequency	Percentage (%)
Doing nothing	157	40.8
Drain stagnant water	66	17.1
Use of nets	23	6.0
Burn vegetation outdoors	25	6.5
Put screens on windows	112	29.1
Drain stagnant water + coils	2	.5
Total	385	100.0

Source: Researcher, (2022).

Data shows that residents of Isiolo Sub-county understood different strategies for preventing malaria resurgence as shown by 60% of respondents who listed different strategies that are appropriate. However, there was 40.8% of respondents indicated that they do nothing which implies that there is a need for awareness creation amongst that group of respondents to forestall the resurgence of malaria. The huge knowledge base (60% of respondents) on the prevention of malaria strategies points to the fact that malaria disease resurgence in the research area is a problem that continually affects the population of the region.

4.4 Influence of Socio-Economic Characteristics on Malaria Resurgence among Residents of Isiolo Sub-county

The first objective of this research was to determine the influence of socio-economic characteristics on the resurgence of malaria in Isiolo Sub-county, Kenya. The researcher set out to answer the question "How does socio-economic characteristics influence

malaria resurgence among residents of Isiolo Sub-county in Kenya. In analysing the research question, the researcher considered different aspects of socio-economic characteristics and assessed them accordingly.

Respondents were asked to indicate how they rated socio-economic characteristics to contribute to malaria resurgence and their responses are shown in Table 8.

Table 2: Distribution of Respondents Based on the Influence of Socio-economic
Characteristics on Malaria Resurgence in Isiolo Sub-county

Type of responses	Frequency	Percentage (%)
Strongly agree	180	46.8
Agree	54	14.0
Neutral	33	8.6
Disagree	19	4.9
Strongly disagree	99	25.7
Total	385	100.0

Source: Researcher (2022).

The findings indicated the highest frequency 180 (47%) of respondents strongly agreed that socio-economic characteristics influence malaria resurgence in Isiolo Sub-county while a total of 99(26%) strongly disagreed. A total of 33 (8.6%) respondents were neutral implying they did not have a positive or negative answer to the research question. The results show that at least a total of 234 (61%) of respondents agreed that socio-economic characteristics influenced malaria resurgence in Isiolo Sub-county. On the other hand, a total of 118 (30%) respondents at least disagreed that socio-economic characteristics influenced malaria resurgence in Isiolo Sub-county.

Regression analysis was conducted to understand the influence of socio-economic characteristics on malaria resurgence in Isiolo Sub-county. The results of linear regression were presented in Table 9 (Model summary), Table 10 (Statistical significance) and Table 11 (estimated regression coefficients).

Table 3: Regression Model Summary of the Influence of Socio-economic
Characteristics on Malaria Resurgence in Isiolo Sub-county

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.673a	.453	.451	6.12948
Predictors: (Constant), Socio-economic characteristics				
Dependent: Malaria resurgence				

Source: Researcher (2022).

The R-value of +0.673 obtained in this regression model summary shows that there is a strong positive linear correlation between the level of socio-economic characteristics and the resurgence of malaria disease. The coefficient of determination R^2 value of +0.453 was interpreted to mean that demographic factors accounted for at least 45.3% of variations in the regression model. This implied that apart from socio-economic characteristics identified in the research there were other factors that accounted for at least 54.7% of malaria resurgence in the research area.

Table 10 presents the appropriateness of the regression model in the analysis of the data on the influence of socio-economic characteristics on malaria resurgence in the Isiolo Sub-county.

Table 10: Statistical Significance of the Influence of Socio-economic
Characteristics on Malaria Resurgence in Isiolo Sub-county

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11902.490	1	11902.490	316.804	.000b
	Residual	14389.525	383	37.571		
	Total	26292.016	384			
a. Dependent Variable: Malaria resurgence						
b. Predictors: (Constant), Socio-Economic Factors						

Source: Researcher (2022).

The output indicates the F-ratio values of $F_{(1, 385)} = 316.804$; $p < 0.05$. The P-value obtained was 0.000 which is less that the alpha value of 0.05. This suggests that the result obtained in this regression model was appropriate and that the result could not possibly be obtained through other methods such as the comparison of means. The regression model indicates that socio-economic factors could be used to predict malaria resurgence in Isiolo Sub-county.

The coefficients of the regression model were studied and fitted into the regression model/equation

$Y = a + \beta3X3 + e$.

The regression coefficients obtained were presented in Table 11 below.

Table 11: Regression Model Summary of the influence of Socio-economic
characteristics on malaria resurgence in Isiolo Sub-County

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.673a	.453	.451	6.12948
Predictors: (Constant), Socio-Economic characteristics				
Dependent: Malaria resurgence				

Sources: Researcher (2022).

The findings indicated that socio-economic factors could be used to predict malaria resurgence in Isiolo Sub-county. The findings are in line with the findings of scholars such as Yadav *et al.* (2018) whose study was on the influence of socio-economic variables on malaria occurrence in India. The study had demographic and socio-economic variables including age, gender, education level and bed-net usage behaviours. They found statistically significant relationships with income, distance from health centres and knowledge and awareness of malaria. Ajayi (2013) argued that poor households have a relatively higher chance of getting malaria compared with households with higher

incomes. This was attributed to the fact that poor families may not have sufficient finances to acquire protective gear as well as appropriate medications to treat those already infected. Poor households also tend to live in environments that bear ample breeding sites for malaria. Other studies found that the quality of housing significantly influences the level of human-mosquito contact hence affecting the overall infection rates. A survey conducted in Zambia also supports the fact that the poor are more at risk of malaria infection than the rich (Roll Back Malaria, 2011).

Normally, it is expected that every community has some differences in terms of livelihoods which manifests in social status. The research area also was observed to possess differences in terms of economical endowment which has a bearing on the ability to afford treatment and prevention requirements for malaria. Literature showed that some communities have a larger percentage of un-educated members which contributes to the spread of malaria at the same time prevents control mechanisms of malaria due to a high level of ignorance (Collins *et al.,* 2012 & Yadav *et al.,* 2014). The research area despite being metropolitan is surrounded by poor communities mainly composed of pastoralists whose livelihoods get seriously affected by the vagaries of weather. At one time livestock may be decimated by drought leaving nothing for the community to eke a living from. This implies the inability to even afford basic malaria resurgence prevention requirements. The urban center in Isiolo has administrators and people in business apart from the non-governmental workers who can afford malaria resurgence prevention requirements including advanced treatment regimes. A teacher from Kiwanjani Primary school said,

> *"In this area, you get a mix of all types of people. Some are able to travel in helicopters while other cannot even afford a pair of shoes".*

The Imam from the nearby Al Naim Mosque which is not only a religious place for the Muslim community but also an important knowledge-sharing center noted that,

> *"This area is badly hit by drought and people suffer due to poverty. The few who are able to afford to share their wealth with the poor as guided by Muslim teachings which make life bearable for the poor people around."*

4.5 Influence of Environmental Characteristics on Malaria Resurgence among Residents of Isiolo Sub-county

The second objective of this research was to determine the influence of environmental characteristics on the resurgence of malaria in Isiolo Sub-county, Kenya. The researcher set out to answer the question "How do environmental characteristics influence malaria resurgence among residents of Isiolo Sub-county in Kenya". In analyzing the research question, the researcher considered different aspects of environmental characteristics and assessed them accordingly.

Respondents were asked to indicate how they assessed environmental characteristics to contribute to malaria resurgence and their responses are shown in Table 12.

Table 4: Distribution of Respondents Based on the Influence of
Environmental Characteristics on Malaria Resurgence in Isiolo Sub-county

Type of response	Frequency	Percentage (%)
Strongly agree	216	51.4
Agree	62	14.8
Neutral	33	7.8
Disagree	19	4.5
Strongly disagree	91	21.5
Total	385	100.0

Source: Researcher (2022).

The results indicated that a high percentage of respondents 216 (51.4%) strongly agreed that environmental characteristics influence malaria resurgence in Isiolo Sub-county. A total of 62 (14.8%) of respondents agreed while 33 (7.8%) respondents were neutral. 91 (21.5%) of respondents strongly disagreed that environmental factors had anything to do with malaria resurgence in Isiolo Sub-county. Overall, at least 278 (66.2%) of respondents at least agreed that environmental factors influenced malaria resurgence in Isiolo Sub-county. Only 110 (26%) of respondents at least disagreed that environmental factors influenced malaria resurgence in Isiolo Sub-county.

Regression analysis was done to understand the influence of environmental characteristics on malaria resurgence in Isiolo Sub-county. The results of linear regression were presented in Table 13 (Model summary), Table 14 (Statistical significance) and Table 15 (estimated regression coefficients).

Table 5: Regression Model Summary on the Influence of
Environmental Factors on Malaria Resurgence in Isiolo Sub-county

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.410a	.168	.166	7.55725
a. Predictors: (Constant), Environmental Factors				

Source: Researcher (2022).

The R-value of +0.410 obtained in this regression model summary shows that there is a moderate positive linear correlation between the level of demographic factors and the resurgence of malaria disease. The coefficient of determination R^2 value of +0.168 was interpreted to mean that demographic factors accounted for at least 16.8% of variations in the regression model. This implied that apart from socio-economic characteristics identified in the research there were other factors that accounted for at least 83.2% of malaria resurgence in the research area.

Table 14 presents the appropriateness of the regression model in the analysis of the data on the influence of socio-economic characteristics on malaria resurgence in the Isiolo Sub-county.

Table 14: Statistical Significance of the Influence of
Environmental Characteristics on Malaria Resurgence in Isiolo Sub-County

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4418.092	1	4418.092	77.358	.000b
	Residual	21873.924	383	57.112		
	Total	26292.016	384			
a. Dependent variable: Malaria resurgence						
b. Predictors: (Constant), Environmental factors						

Source: Researcher, 2022.

The output indicates the F-ratio values of $F_{(1,385)} = 77.358$; $p < 0.05$. The P-value obtained was 0.000 which is less that the alpha value of 0.05. This suggests that the result obtained in this regression model was appropriate and that the result could not possibly be obtained through other methods such as the comparison of means. The regression model indicates that environmental factors could be used to predict malaria resurgence in Isiolo Sub-county.

The coefficients of the regression model were studied and fitted into the regression model/equation:

$$Y = a + \beta_4 X_4 + e$$

Where:
y = malaria resurgence;
a = 14.329;
β = 2.243;
e = error term.

The regression coefficients obtained were presented in Table 15.

Table 6: Estimated Regression Coefficients of the Influence of
Environmental Factors on Malaria Resurgence in Isiolo Sub-county

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	14.329	.826		17.338	.000
	Environmental Factors	2.243	.255	.410	8.795	.000
a. Dependent Variable: Malaria Resurgence						

Source: Researcher (2022).

The researcher observed that standardised B coefficients obtained of +0.410 for environmental factors with a statistical significance of 0.000 indicated that environmental factors were statistically significantly different from zero (0).

The output showed that environmental factors can be used to predict the outcome of malaria resurgence using the regression line:

$$(y) = 14.329 + 2.243X4 + e.$$

The findings indicated that environmental factors could be used to predict malaria resurgence in Isiolo Sub-county. The findings are in line with the findings of scholars who observed that the high presence of malaria in Africa is significantly associated with the environment. Environmental factors like climate, temperature, rainfall, topography, land use, and forest cover have been found to strongly influence the incidence and resurgence of malaria. The presence of favorable environmental and climatic conditions that are conducive to vector survival as well as the presence of an insecticide-resistant strain of mosquitoes (*Anopheles gambiae complex*) account for the high malaria transmission in SSA (Alonso *et al.,* (2013); De Silva *et. al.* (2012) and Mfueni *et al.* (2017). It shows that the malaria-carrying vector (mosquito) thrives in specific environmental conditions which are found in the research area including high temperatures and long rainy seasons that provide good breeding grounds. Focused group discussion indicated that malaria disease is usually more prevalent and serious amongst residents of the areas during rainy seasons. One elder noted that,

> *"During rain periods the disease becomes more serious and affects more people than during dry periods when grass for our animals is scarce".*

According to Ukaegbu *et al.* (2014), malaria's prevalence is attributed to warm temperatures, rainfall, and stagnant waters that facilitate ideal conditions for the growth of mosquito larvae. Additionally, other factors that determine environmental conditions include vegetation composition and distribution, type and abundance, and humidity. Evidently, environmental components account for more incidences that trigger high malaria prevalence rates.

5. Conclusion

The third objective of this research determined the influence of socio-economic characteristics on the resurgence of malaria in Isiolo Sub county, Kenya. The researcher set out to answer the question "How do socio-economic characteristics influence malaria resurgence among residents of Isiolo Sub county in Kenya". Descriptive analysis results showed that at least a total of 234 (61%) of respondents agreed that socio-economic characteristics influenced malaria resurgence in Isiolo Sub-county. On the other hand, a total of 118(30%) respondents at least disagreed that socio-economic characteristics

influenced malaria resurgence in Isiolo Sub-county. The R-value of +0.673 obtained in the regression model summary shows that there is a strong positive linear correlation between the level of socio-economic characteristics and the resurgence of malaria disease. The coefficient of determination R^2 value of +0.453 was interpreted to mean that demographic factors accounted for at least 45.3% of variations in the regression model.

The second objective of this research was to determine the influence of environmental characteristics on the resurgence of malaria in Isiolo Sub-county, Kenya. The researcher set out to answer the question "How do environmental characteristics influence malaria resurgence among residents of Isiolo Sub-county in Kenya". Descriptive analysis of data showed that at least 278 (66.2%) of respondents agreed that environmental characteristics influenced malaria resurgence in Isiolo Sub-county. Only 110(26%) of respondents at least disagreed that environmental characteristics influenced malaria resurgence in Isiolo Sub-county. The R-value of +0.410 obtained in the regression model summary shows that there is a moderate positive linear correlation between the level of demographic factors and the resurgence of malaria disease. The coefficient of determination R^2 value of +0.168 was interpreted to mean that demographic factors accounted for at least 16.8% of variations in the regression model.

5.1 Recommendations for Residents

1) Residents should put more effort in understanding the mode of transmission of malaria disease as currently, the understanding is relatively low as indicated 61.5% of residents did not understand how malaria disease is transmitted.
2) Policymakers in Isiolo Sub-county should consider formulating policies that support education for the residents since a big percentage 58% had not attended any form of schooling.
3) Constant supplies of pharmaceuticals, laboratory equipment and reagents to Isiolo Sub-county Teaching and Referral Hospital located within the sub-county in Isiolo County.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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