Linking insecticide mosquito nets to malaria: the roles of malaria Knowledge and household-income

Mohammed Aliye¹, Tao Hong^{1*}

Affiliation¹ email: aliyemohammed@yahoo.com

¹School of Management, Harbin Institute of Technology, Harbin P.R China, 150001

correspondence: hongtao@hit.edu.cn

Abstract:

Background: Drawing on the theory of the health belief model, this study examined the interplay of insecticide mosquito nets, malaria-knowledge, household income, and malaria. The study premised on the notion that insecticide mosquito nets proposed to be positively related to malaria, and knowledge was proposed to mediate the relationship between insecticide mosquito nets and malaria. Furthermore, household-income was anticipated to have a moderating effect on the direct and indirect relationships (through malaria knowledge) between insecticide mosquito nets and malaria.

Methods: The hypothesized relationships were examined using the panel data collected from 10 regions of Ethiopia during 2011 – 2015. Structural equation modeling and random effect model used to test the articulated hypothesis. Statistical analyses were performed using Stata version 13.0.

Results: The results were consistent with our proposed hypotheses, showing a significant and positive relationship between the research variables. Accordingly, our estimate suggests that malaria knowledge contributed to improving insecticide mosquito nets and malaria disease relationships. The result revealed a significant and positive effect ($\beta = 0.47$, $p = 0.003$) of the indirect effect where the direct effect coefficient is also positive ($\beta = 0.28$, $p = 0.001$). The study also reported a positive impact of household-income in strengthening the relationship between insecticide mosquito nets and malaria via knowledge with considerable value ($\beta = 0.13$, $p = 0.000$).

Conclusion: The findings are potentially useful for the health sector to assure the success regarding infectious disease prevention and control, particularly malaria, explaining how such factors contribute to the relationship.

Keywords: Malaria, Insecticide mosquito net, malaria knowledge, Household-income, Structural equation modeling

Background

While everyone has the right to live healthy throughout their lifetime, providing adequate health care is a significant challenge (1). An estimated 216 million malaria cases occurred globally in 2016, where 90% is in the African region (2). Besides, 214 million cases of global malaria reported, of which 88% happened in the African Region, and resulting in about death toll of 438, 000 people (3). Every year many international travelers fall ill with malaria while visiting regions where malaria disease is endemic. And more than 10,000 visitors confirmed to become sick with malaria after returning home; underreporting, however, means that the real figure of illness is much higher (4). Recent estimates show, 212 million cases of malaria worldwide and 429, 000 deaths in 2015 alone (5), and many deaths reported to have occurred in the African region of WHO (92%), followed by South-East Asia Region of WHO (6%) and the Eastern Mediterranean Region of WHO (2%). Malaria generally reflects a significant burden on health systems and the broader economy, particularly in Africa, which represents a significant economic burden for households to pay for prevention and treatment (6).

African heads of governments set a target of 60% coverage of bed nets for use by pregnant women and children U5 by 2005 following the Abuja summit in 2000 (7). Ethiopia set an objective to have had a community with appropriate knowledge and health-seeking behaviors regarding malaria prevention and control by 2020 (8). Also, ownership and utilization, net care and repair via demand creation and familiarity is the critical point to implement. The universal coverage of mosquito net is one of Ethiopia's primary vector control and prevention initiatives for ensuring unlimited access to an insecticide mosquito net, and spraying households with indoor residual spray in targeted areas (4,9). The cumulative number of ITNs exceeded 65 million, and about 6 million households in malaria-prone areas are sprayed yearly with indoor residual sprays in 2015 (10). However,

61 malaria continued as a significant public health challenge in Ethiopia (11). Insecticide mosquito
62 net identified as the most effective malaria prevention approach (12). Insecticide mosquito net
63 decreases malaria incidence in a variety of settings by 50% and malaria mortality rates by 55% in
64 children under 5 in Sub-Saharan Africa (2). Since the introduction of the intervention strategy,
65 significant success attained in the malaria program, and from 2000 and in the year 2015, malaria
66 decreased by 48% worldwide (3). Yet, malaria disease remains the leading cause of maternal and
67 child morbidity and mortality in low-resource countries. And Ethiopia accounts for 6% of malaria
68 cases worldwide, and about 12% of global affairs and deaths from *Plasmodium vivax* (13). In
69 Ethiopia, more than 50 million people are at risk, representing nearly two-thirds of the population
70 living in malaria area, and 75% of the land is malaria (14,15). The ministry of health Ethiopia, in
71 line with Millennium Development Goals and Roll-Back Malaria, aiming to cut malaria morbidity
72 and mortality by 50% by 2010 and to end it by 2015. While good progress made in fighting against
73 malaria during the program era, the goal has not been achieved (16). PETER indicated, general
74 improvements in malaria prevention and control, but the level of knowledge and use of malaria
75 intervention tools remained low (17). The study also shows weak public awareness and practice
76 towards malaria prevention and control alternatives, and misunderstandings about malaria persist,
77 and malaria control practice is unsatisfactory (18). Many studies investigated knowledge, attitude,
78 and practice about malaria prevention options such as insecticide mosquito nets (12,18–21) —
79 most of these studies relying on the assessment of knowledge about malaria with specific study
80 populations. Studies indicate that, despite acrimonious facts, communities are not well aware of
81 the multi-dimensional challenges of this disease in Ethiopia. Lack of awareness, misuse of ITN,
82 and unsatisfactory malaria control methods reported (22–26). So, it is pertinent to consider the
83 impact of knowledge on strategic interventions to protect the disease.

To the best of our knowledge, none of the previous work takes into account the role of malaria knowledge to the relationship between insecticide mosquito net and malaria. Besides, none of the previous research tests the moderating role of household-income in strengthening the relationship between strategic interventions and malaria through malaria-knowledge. This study, therefore, measures the influence of malaria knowledge and household-income in the relation aimed to investigate the effect of insecticide mosquito nets on malaria as knowledge and income of the household as a mediating and moderating role, respectively.

Apart from this fundamental contribution, we contribute to the existing literature in numerous ways. First, we observed the changes in the outcome with the direct relationship between ITN and malaria, besides with moderation-mediation effect. Second, we considered a national-level aggregate panel data with a considerable number of observations. Third, this is the first study in Ethiopia to evaluate the ITN–malaria relationship in the context of malaria knowledge and income of the household as a mediation-moderation effect. Finally, we conducted our analyses using structural equation modeling in line with a random effect model of panel data estimation technique. The rest of the paper organized as follows. Section 2 explains the theoretical background. Section 3 discusses the hypothesis development. Section 4 presents the analysis and results. Section 5 discussion and implications

Theoretical Background

The Health Belief Model

The theory of the HBM first introduced by a group of U.S public health service social psychologists in the 1950s to understand and explain why most people fail to participate in preventive and detective health measures (27). The doctrine remains the most widely employed theories of health behavior (28). Also, the most commonly recognized approach in the health field

(29). The health belief model hypothesizes that health-related action depends upon the simultaneous occurrence of three classes of factors: (1) The existence of sufficient motivation (or health concern) to make health issues salient or relevant. (2) The belief that one is susceptible (vulnerable) to a severe health problem or to the sequelae of that illness or condition, which often termed as a perceived threat. (3) The belief that following a particular health recommendation would be beneficial in reducing the perceived threat, at a subjectively-acceptable cost. Furthermore, the theory based on the understanding that a person will take a health-related action if that person believes s/he is susceptible to the condition (perceived susceptibility), the condition has serious consequences (perceived severity), believes taking action would reduce their vulnerability to the condition or its severity (perceived benefits), and these benefits outweigh the cost of taking action (perceived barriers) (30). Action is taken more easily if the person exposed to factors that prompt action (cues to action) and is confident in her/his ability to successfully perform an action (self-efficacy) (31). The current study employed the doctrine of the health belief model, holding that independent variable (insecticide mosquito nets). Mediating variables (malaria knowledge). And moderating variables (income of the household) should influence the dependent variable (malaria). Since, if a person has a good level of knowledge, has positive attitudes towards malaria prevention strategies if intervention tools access to a vulnerable group and at risk, then he/she is more likely to practice preventive measures and can thus reduce his/her risk of getting malaria, and of treating patients with malaria effectively. The HBM is a tool to explore the perceptions and beliefs about malaria and the use of strategic interventions such as ITN(32). This theory guides the research in establishing the relationship between the explanatory variables and outcome variable in line with mediating and moderating variables.

Figure 1. Theoretical framework

Hypothesis Development

Insecticide mosquito nets and malaria

Net distribution is an integral part of a selective vector control strategy for malaria protection. As a result, an insecticide mosquito net identified as having a significant impact on malaria (3,13,26). Regular use of ITN can reduce the overall risk of death for young children by 20% and the number of clinical malaria episodes in that age group by 50% (34). ITNs provide proper personal protection and also have a community preventive effect due to the benefits of malaria prevention to individuals beyond those using them (35). The impressive decline in child mortality reported being due to the implementation of vector control methods use and distribution, such as ITN and IRS (36). For malaria control, ITN and IRS recommended by world health organization as the cornerstone of the strategy (3,37). To fight against malaria, Ethiopia implemented selective vector control, such as insecticide mosquito nets, indoor residual spraying, and environmental management (38). Accordingly, malaria morbidity and mortality declined due to the introduction of the vector control intervention method (39). However, malaria disease remains a major health

problem in the country(40). Besides, the government works to eradicate malaria providing technical and material support for its protection, but malaria is still prevalent in every season of heavy rain relatively in lowland areas of Ethiopia (41). Inadequate knowledge about malaria and insecticide mosquito nets identified in some areas (42) that challenged the program success towards prevention and its control. Regular use of insecticide mosquito nets reported preventing malaria (43), also believed ITN prevents mosquito bites if used regularly. Therefore, we hypothesized that:

Hypothesis 1: Insecticide mosquito nets are positively related to malaria.

Insecticide mosquito nets and malaria knowledge

Effective preventive action is the outcome of public health programs, which resulted in the implementation of community-based health education. Awareness creation about the programs towards prevention and control measures plays a critical role (44), which occurred through iterative actions to strengthen the awareness of the population for malaria prevention. Lack of knowledge about the malaria disease reported not practicing any measures of personal protection (45). According to the health belief model of health and illness, it is not only the subjects' belief that matters but also their knowledge and attitude (46). Difference in malaria knowledge have shown to cause discrepancies in tackling malaria disease(47) due to differences in strategic utilization. Similarly, respondents who were knowledgeable about strategic interventions to prevent malaria such as IRS compared to respondents who were not knowledgeable were less likely to take up the spray, but gaps in knowledge and fears in health effects identified as a challenge (48). The other study reports the influence of knowledge gaps and wrong perception on the use of insecticide-treated nets to protect malaria (49). Likewise, the study reported better ownership and use of ITN by the communities with good knowledge than those who are not (50).

Knowledge about malaria transmission and prevention methods identified as a significant factor in combatting the disease (33). Another study revealed a high level of malaria knowledge about mosquito vectors and the ability to kill among study participants. However, the access and use disconnected with the practice for protection (26). The association between age, educational status, and household income reported affecting the relationship (51). The other study reported respondents' familiarity with malaria where 99% heard of malaria and disease control methods, with 97% of participants owning bed nets. But only 58.2% of insecticide mosquito net owned households used bed nets the night before (12). This is maybe due to the improper delivery of health education with specific communities. Health motivation is the central focus of the HBM to evoke health concerns, e.g., malaria's area and the possibility of contracting with the disease (31,52). Likewise, the study found good mothers' awareness and attitude towards malaria and insecticide mosquito net with a favorable attitude of 74.3 % and 51.1%. But only 15.6 % associated mosquitoes with malaria and most of them (65.6 %) replied the disease transmitted due to poor personal hygiene and environmental sanitation (19). The other study reported gaps in community understanding of malaria transmission and lack of malaria vector knowledge and malaria transmission patterns (53,54). Thus, we hypothesized:

Hypothesis 2: Insecticide-treated net positively associated with knowledge of malaria.

Knowledge and malaria

Malaria Knowledge is the most critical factor that contributed to several malaria deaths in various community' populations (55). Therefore, there is a need for practical health education to improve understandings about health programs among the public to control infectious diseases such as malaria. Due to differences regarding malaria prevention and control practices, the adopted strategy should tailored according to the environment (25). The study revealed the achievements

of malaria intervention planning if relied on local knowledge of malaria transmission (56). Also, the study reported communities who gained advanced information about malaria and its burden interested in prevention and practice of personnel decisions on how to protect the disease (57). Apart from the evidence from various channels, witnessing the death and the sufferings of others to a particular health problem contribute to positive health behavior (46,58). To design and implement effective interventions, local knowledge on the prevalence, distribution, and influencing factors reported as paramount importance (59). Besides, similar use of malaria intervention tools stated in communities with reasonable knowledge about malaria and its consequences (60). Low willingness in the uptake of the IRS reported due to the community's awareness about the severity and seriousness of the disease while infected (48). The individual's belief about the severity of the problem, mostly based on medical information and knowledge, which may motivate the decision to action towards its protection (61). Barriers to the use of the intervention method are not about the cost and access; instead, it linked with fear of the interventions and limited knowledge about malaria (62). Malaria prevention and control program need to take into account local misconceptions and wrong perceptions to achieve optimal health-seeking behaviors in endemic settings (63). An insecticide mosquito net is an effective method of malaria control, but school-age children have reported less frequently to its use (64). This is linked with a lack of proper knowledge and in-appropriate education lined with health programs. Therefore, we designed our hypothesis:

Hypothesis 3: Knowledge is positively related to malaria, and

Hypothesis 4: knowledge links Insecticide-treated nets to malaria.

Moderating effect of household-income

Malaria remains the leading cause of morbidity and mortality in low and middle-income countries (65,66). The burden of chronic diseases is increasing in low and middle-income countries, where it constitutes multiple burdens along with infectious diseases, other health problems (10). The study reported the positive association of household income on the use of ITN to protect malaria (67). The study also revealed that quality of life and health status basically linked to economic, income, and educational attainment of residents (68). The report also shows malaria elimination from high-income countries though it is a challenge for low and middle-income countries (62). Likewise, the study revealed the association between income and practice of malaria preventive actions, where higher income groups are more likely to practice two times higher than low-income groups (69). Besides, the report shows access to intervention influenced by household income (7). Similarly, the study reported that, though ITN suggested as a means of malaria reducing approach, the communities with large families and low-incomes more affected by malaria disease (70). The other study also showed the significant predictor variables for knowledge on malaria using IRS as a control tool were age, educational level, occupation, and income levels (71). Therefore, we hypothesized that:

Hypothesis 5: Income of the house-hold moderates the mediated relationship between Insecticide mosquito nets and malaria through knowledge. In such a way that the mediated relationship will be stronger for those societies who are better in owning income.

Hypothesis 6: Income of the household moderates the strength of the direct relationship between Insecticide-treated nets and malaria. Such that the relationship will be stronger for an advanced community than for those who are lower-income level.

METHODS

Data source

We investigate the moderated mediation role of malaria knowledge and household income to the relationship between ITN and malaria in Ethiopia. The study used data from national malaria indicator survey (EMIS) and health-related indicators, that obtained from the Federal Ministry of Health, Ethiopia fielded from 2011 to 2015. The data are collected by Ethiopian Public Health Institute/Ministry of Health collaboratively with Central Statistics Agency (CSA), US President's Malaria Initiative (PMI), United Nations Children's Fund (UNICEF), Malaria Control and Elimination Partnership in Africa (MACEPA/PATH), Malaria Consortium (MC)-Ethiopia, World Health Organization (WHO), and ICAP. The data contains extensive details about malaria and related indicators on an annual basis. All malaria epidemic regions of the country included in the study and the data are secondary panel data containing 50 observations for final review after condensing as suitable. All relevant variables for the current study identified. Accordingly, malaria (outcome variable), insecticide mosquito nets (independent variable), income of the household (moderating variable), and knowledge (mediating variable) were selected for the current study.

Measures

Malaria

We measured malaria by the sum of malaria prevalence according to rapid diagnostic tests (RDT) and microscopy test in all age groups(40,72).

Insecticide mosquito nets

Items measuring insecticide mosquito net is the percentage of households with at least one insecticide bed nets of any type (10,40)

Malaria knowledge

Malaria knowledge was measured by the percentage of respondents who have heard of malaria, who have recognized fever as a symptom of malaria, who report mosquito bites as a cause of malaria, who have reported mosquito nets (treated or untreated) as a prevention method (40,72). Then we condensed these indicators via principal component analysis to obtain the general knowledge.

Household income

We measured household income using four indicators. The lowest income category, the second, the middle, the fourth and the highest, and then condensed through principal component analysis to get the total household income for the current study (73).

Analysis

All analyses were performed using Stata software version 13.0. The insecticide mosquito net was used as an intervention strategy for malaria protection such that malaria knowledge mediates the relationship, and household income played a moderating role, we evaluate malaria as an outcome effect. We followed a two-step approach to conduct the analysis and deduce results — the principal component analysis used to condense variables given by multiple indicators. The theoretical framework proved in two steps — first, the linear relationship of the study variables estimated using random-effect model. Second, we used structural equation modeling to test all of the conditional direct and indirect hypothesized relationships.

Significance of the study and corresponding (95% CI) determined using Wilson's test. We used a z-test to check the statistical significance of the study variables for outcome variables, and the mediating and moderating effect of malaria knowledge and household income on the relationship. The coefficients used to see insecticide mosquito net and malaria mediated by malaria knowledge

and moderated by income via malaria knowledge. All variables and correlations found to be significant if $P < 0.05$.

Empirical models

We designed equations to find the overall impact of insecticide mosquito net on malaria. Also, the mediating effect of knowledge on insecticide mosquito net and malaria relationship. Besides, the equation designed to investigate the moderating role of household income to the relationship between ITN and malaria through knowledge. The model uses a log of dependent and independent variables to reduce data variances and to capture with mediating and moderating factors of malaria knowledge and household income given by multiple indicators through principal component analysis. The current study employed the following nine equation models to test the result of the research hypotheses.

$$MP_{it} = \beta_0 + \beta_1(ITN) + \varepsilon_{it} \quad (1)$$

$$Know_{it} = \beta_0 + \beta_1 ITN + \varepsilon_{it} \quad (2)$$

$$MP_{it} = \beta_0 + \beta_1 Knm + \varepsilon_{it} \quad (3)$$

$$MP_{it} = \beta_0 + \beta_1 ITN + \beta_2 Knm + \varepsilon_{it} \quad (4)$$

$$MP_{it} = \beta_0 + \beta_1(Income) + \varepsilon_{it} \quad (5)$$

$$Know_{it} = \beta_0 + \beta_1(Income) + \varepsilon_{it} \quad (6)$$

$$MP_{it} = \beta_0 + \beta_1(ITN * Income) + \varepsilon_{it} \quad (7)$$

$$Know_{it} = \beta_0 + \beta_1(ITN * Income) + \varepsilon_{it} \quad (8)$$

$$MP_{it} = \beta_0 + \beta_1(know * Income) + \varepsilon_{it} \quad (9)$$

Where, MP is a dependent variable, measured by the sum of confirmed malaria cases for both Plasmodium species through RDT kit and microscopy test (14,40,72). ITN is an independent variable measured for all regions; malaria knowledge is mediating variable with different

indicators but condensed via principal component analysis. Household income is the moderating variable with various indicators and summarized using principal component analysis. While β is an estimate of the effect; and ε_{it} error term of equation (74).

We used structural equation modeling and random effect model to solve endogeneity and serial correlation and has the advantage of higher efficiency relative to FEM leading to smaller standard errors of coefficients and higher statistical power to detect effects (75,76). The moderation and mediation assessed by disintegrating paths into direct and indirect impact to get the immediate effect of the variables under the structural equation model (77).

Results

Descriptive statistics

The means (M), standard deviations (SD), minimum, maximum, and number of observations of the study variables provided in **Table 1**.

Table 1. Descriptive statistics of research variables

Variables		Mean	Std. Dev.	Min	Max	Observation		
Malaria	overall	9.328151	2.553441	2.3979	13.7181	N	=	50
	between		2.04277	5.566182	11.48004	n	=	10
	within		1.639451	6.159869	12.62001	T	=	5
ITN	overall	11.39936	3.790337	0	15.3455	N	=	50
	between		2.938286	5.91212	14.39478	n	=	10
	within		2.537303	5.122061	16.25176	T	=	5
knowledge	overall	3	1	.739625	4.29885	N	=	50
	between		.954039	1.441853	4.098688	n	=	10
	within		.4051063	1.533178	3.689393	T	=	5
Income	overall	2	1.000002	.227062	3.351187	N	=	50
	between		1.005721	.565118	3.086802	n	=	10
	within		.2666422	1.475116	2.48946	T	=	5
ITN*Inc	overall	24.96946	15.17194	0	49.36902	N	=	50
	between		15.26644	3.361229	43.80043	n	=	10
	within		4.018591	17.97984	35.93472	T	=	5

334

335 **Direct relationship**

336 The direct relationship between the study variables tested simultaneously. The results presented in
337 **Table 2.** The results showed that the positive relationship between Insecticide mosquito nets (ITN)
338 and malaria reported ($\beta = 0.28$, $p < 0.01$). Besides, a positive coefficient (β) has had reported in
339 our analysis for all study variables, suggesting a positive relationship between insecticide mosquito
340 nets, knowledge, the income of the household, and malaria. The findings are consistent with the
341 research (42,54,78), which shows the benefit of insecticide mosquito net for malaria protection.

342

343

Table 2. Results of structural equation model path analysis

	(1)	(2)	(3)	(4)	(5)
	malaria	knowledge	malaria	knowledge	malaria
ITN	0.278** (0.0866)	0.0523* (0.0288)			
knowledge			0.651 (0.417)		
Income				0.628*** (0.132)	1.655*** (0.340)
_cons	6.165*** (1.083)	2.403*** (0.372)	7.374*** (1.335)	1.744*** (0.301)	6.018*** (0.762)
<i>N</i>	50	50	50	50	50

344 Standard errors in parentheses

345 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

346

347 **Testing the direct and indirect relationship (hypothesis 1-6)**

348 The proposed direct and indirect relationships for all hypotheses simultaneously tested under
349 structural equation modeling. The results depicted in **Table 3**. Accordingly, the results showed a
350 positive and direct relationship between insecticide mosquito nets and malaria ($\beta = 0.28$, $p =$
351 0.001), providing support for hypothesis 1. Additionally, insecticide mosquito net is positively
352 related to malaria knowledge ($\beta = 0.053$, $p = 0.049$), and malaria knowledge positively related to
353 malaria ($\beta = 65$, $p = 0.118$), confirming hypothesis 2 and 3. Our result also supports the partial
354 mediation of Judd & Kenny (79). The findings corroborated by the study report, which showed
355 insecticide mosquito nets as the most preferred strategy for malaria prevention (12). Other studies
356 also indicate the use of insecticide mosquito nets to protect against malaria among the study

communities (20). Likewise, (7) reported a proper use of insecticide mosquito nets could cut transmission of malaria disease at least by 60% and child mortality by 20%. To further confirm mediation we used Judd & Kenny Difference of Coefficients Approach which involves subtractions of the partial regression coefficient obtained (79). The result showed the indirect effect of insecticide mosquito nets on malaria through knowledge of malaria ($\beta = 0.47$, $p = 0.003$) was significantly different from zero, with 95%CI. Thus, hypothesis 4 regarding the mediation effect of malaria knowledge was supported.

As seen in **Table 3**, the effect of the interaction between insecticide mosquito nets and household income on malaria was positive and significant ($\beta = 0.13$, $P = .000$), indicating a moderating effect. Thus, the results supported our proposed hypothesis 5. Regarding the moderated mediation effect, we checked for conditions suggested under Preacher et al. (2007) that needed to be met for the existence of moderation mediation effect (80). To establish mediation moderated, 1) the relationship between the independent variable and the outcome variable should be significant; 2) the interaction of moderator variable and mediator variable on the outcome variable should be significant; 3) the interaction effect of the moderator variable and the independent variable on the outcome variable should be significant, and 4) the mediator variable should be positively related to the outcome variable. The analysis showed that the insecticide mosquito net was significantly related to malaria ($\beta = 0.28$, $P < .001$), satisfying condition 1. The interaction between malaria knowledge and household income had significant effect on malaria ($\beta = 0.35$, $p = .000$), meeting condition 2. The interaction between insecticide mosquito nets and household income had a significant effect on malaria ($\beta = 0.13$, $P = .000$), fulfilling requirement 3. Malaria knowledge was positively related to malaria ($\beta = 0.65$, $P = 0.118$), meeting condition 4, as shown in Table 3 for results. These results were consistent with our proposed hypothesis 6. Our study also shows a

positive association between the interaction of ITN and the income of the household on malaria knowledge ($\beta = 0.04, p = 0.000$).

Figure 2. Paths of a structural model

401

Table 3. Results of structural equation model path analysis

Paths			Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
ITN	→	Malaria	0.28	0.086	3.21	0.001	.1078217	.4472075
ITN	→	Knowledge	0.05	0.029	1.82	0.049	-.0041617	.1088234
Knowledge→ Malaria			0.65	0.416	1.56	0.118	-.1651322	1.467698
Income	→	Malaria	1.65	0.339	4.87	0.000	.9894127	2.320555
Income	→	Knowledge	0.63	0.301	4.76	0.000	.3695931	.8868861
ITN*Inco → Know			0.04	0.009	4.41	0.000	.0216277	.0562295
ITN*Inco → Malaria			0.13	0.023	5.53	0.000	.0819049	.1717884
Know*Inco→ Malaria			0.35	0.082	4.33	0.000	.1940172	.5145745
ITN → know → Malaria			0.47	0.096	2.94	0.003	.0935075	.4694023

402

403 **Discussion**

404 The goal of the present study was to examine the interplay of insecticide mosquito nets, malaria
405 knowledge, household income, and malaria in the context of public health. Programs must consider
406 local values, emphasize the role of vectors in the transmitting disease to assure malaria protection
407 (22,23,81). Our results proved a positive and direct relationship between insecticide mosquito nets
408 and malaria. The findings imply that insecticide mosquito net is action-based mechanism activated
409 in response to protect malaria. This result is consistent with previous findings, which reported ITN
410 as a malaria prevention method (19). Besides, this finding promotes a contextualized
411 understanding of the possible causes of malaria by providing a set of antecedents rooted in public

health, which may inspire cerebral rationalizations. We also found that insecticide mosquito net was positively related to malaria knowledge, and knowledge was positively related to malaria. Moreover, malaria knowledge mediated the positive relationship between insecticide mosquito nets and malaria. Findings regarding malaria knowledge are consistent with its previous conceptualization as perceived severity, benefit and self-efficacy reflecting a reaction to practice (32). The present findings also suggest a positive and significant result in the relationship between ITN and malaria when the outcome variable linked with explanatory factors as malaria knowledge as a mediating role. The role of malaria knowledge in the current study is consistent with (42) people's behavior about how they react to threat influenced based on their current perception and conceptualization of the diseases.

Furthermore, the direct as well as the indirect relationship (via malaria knowledge) between insecticide mosquito nets and malaria was stronger with the existence of household income as a moderating factor. This finding is consistent with the previous study reported a low-income earning community might not have access to effective preventive strategy such as ITN (82). Likewise, household income reported among the factor tend to influence awareness regarding malaria and possible malaria prevention access such as vaccine (83). Moreover, this study will help to develop a detailed understanding of malaria knowledge and household income to the relationship between strategic interventions and malaria to achieve the malaria elimination program. This study has empirically proved its role in the evaluation of situational factors as moderation and mediation role in the relations when umpiring the ethicality of an action. Generally, our study concludes a positive relationship between insecticide mosquito nets and malaria as knowledge of malaria and household income as a moderation mediation role.

Implications

Malaria imposes a heavy burden in Ethiopia in particular. Nevertheless, many studies on malaria prevention and control do not find the estimate of malaria knowledge and household income to the relationship between strategic interventions and malaria. As reported in different studies, access to interventions cannot solve the challenges regarding its utilization for infectious disease prevention and control, particularly malaria. Therefore, the provision of proper health education program has to given due focus to improve awareness about malaria and its prevention. Also, various studies reported associations of access to and use of intervention methods with household income (50). Our finding supports the active moderation mediation role of malaria knowledge and the income of the household in the relationship.

This research offers concrete and practical information to policymakers and health planners, the invaluable advantage of malaria knowledge and income of the household to assure the program's optimum performance. Malaria threatens mostly pregnant women and children, and achieving malaria elimination goals only possible through awareness creation backed by proper education for vulnerable groups. So, the study recommends policymakers to strengthen the provision of health education. Besides, the findings demonstrate the incorporation of health-related subjects in education curricula from primary school level, in line with community-based health literacy for adults, has to be given due attention to strengthening the usage culture to prevention interventions.

Abbreviations

ITN: insecticide mosquito nets, WHO: world health organization, RDT: rapid diagnostic test, HHI: health and health-related indicators, EMIS: Ethiopian malaria indicator survey, HBM: health belief model

Acknowledgments

Not applicable

Funding

This study supported by the National Natural Science Foundation of China (grant number 71473059).

Availability of data

The datasets used and/or analyzed during the current study are available from the corresponding author on a reasonable request.

Authors' contributions

This work was collaboratively carried out. Author M.A is the first author in this study right from conception, execution, data analysis, and work review. Authors T.H supported the supervision, manuscript writing and revision, and reading and confirmation of the final manuscript. Each author involved in the manuscript preparation and approval of the final version submitted.

Ethical Approval: “Not applicable,” the research is exempt from ethical approval because of the utilization of secondary data.

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

Consent for publication: Not applicable

References

1. Dalglish T, Williams JMG., Golden A-MJ, Perkins N, Barrett LF, Barnard PJ, et al. Sustainable Development Goals. J Exp Psychol Gen. 2007;136(1):23–42.
2. World Health Organization. World malaria report: Geneva. 2017.
3. World Health Organization. WORLD MALARIA REPORT WHO GLOBAL MALARIA PROGRAMME 2015. WHO. 2015;
4. World Health Organization. Chapter 7 Malaria. WHO Tech Rep Ser No 936. 2010;
5. Africa S. Country trends in selected indicators Annex 4 - Data tables. 2016;

- 482 6. DFID. Malaria Burden and Interventions Evidence Overview. 2010;(December).
 483 Available from: [https://www.gov.uk/government/publications/malaria-burden-and-](https://www.gov.uk/government/publications/malaria-burden-and-interventions-evidence-overview)
 484 [interventions-evidence-overview](https://www.gov.uk/government/publications/malaria-burden-and-interventions-evidence-overview)
- 485 7. Odoko JO, Nwose EU, Igumbor EO. Utilization of insecticide treated nets against malaria
 486 among pregnant women in Southern Nigeria. *Int J Res Med Sci.* 2017;5(11).
- 487 8. Prevention D, Directorate C, Control NM, Program E, Ababa A. NATIONAL MALARIA
 488 STRATEGIC PLAN : National Malaria Strategic Plan. 2020;(April 2017):2017–20.
- 489 9. Turgeman. global malaria programme. 2011;
- 490 10. Federal Minstry of Health. Health Sector transformation plan. 2015;
- 491 11. Watiro1 AH, Awoke2 W. Insecticide-treated net ownership and utilization and factors that
 492 influence their use in Itang , Gambella region , Ethiopia : cross-sectional study. *Risk*
 493 *Manag Healthc Policy.* 2016;101–12.
- 494 12. Animut A, Negash Y, Kebede N. Distribution and utilization of vector control strategies in
 495 a malarious village of Jabi Tehnan District, north-western Ethiopia. *Malar J.* 2014;
- 496 13. Alzate NG. Effectiveness of Pyriproxyfen and Olyset Duo in Controlling Insecticide
 497 Resistant Mosquito Populations in Burkina Faso. 2016;(November).
- 498 14. Ababa A. Disease Prevention and Control Directorate , Malaria Control Programme. Guid
 499 lineline. 2014;
- 500 15. World health organisation. global malaria programme; world malaria report. 2013;b.
- 501 16. President’s Malaria Initiative. Ethiopia: Malaria Operational Plan. 2016; Available from:
 502 [https://www.pmi.gov/where-we-work/ethiopia%0Ahttps://www.pmi.gov/docs/default-](https://www.pmi.gov/where-we-work/ethiopia%0Ahttps://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy16/fy-2016-ethiopia-malaria-operational-plan.pdf?sfvrsn=5)
 503 [source/default-document-library/malaria-operational-plans/fy16/fy-2016-ethiopia-malaria-](https://www.pmi.gov/where-we-work/ethiopia%0Ahttps://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy16/fy-2016-ethiopia-malaria-operational-plan.pdf?sfvrsn=5)
 504 [operational-plan.pdf?sfvrsn=5](https://www.pmi.gov/where-we-work/ethiopia%0Ahttps://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy16/fy-2016-ethiopia-malaria-operational-plan.pdf?sfvrsn=5)

- 505 17. OSSAI PO. AWARENESS , ACCESSIBILITY AND USE OF MALARIA CONTROL
506 INTERVENTIONS AMONG AT-RISK GROUPS IN LAGOS METROPOLIS ,
507 NIGERIA. 2014;
- 508 18. Molla Gedefaw ZA. Knowledge, Attitude and Practice of the Community towards Malaria
509 Prevention and Control Options in Anti-Malaria Association Intervention Zones of
510 Amahara National Regional State, Ethiopia. J Trop Dis [Internet]. 2013;01(03). Available
511 from: [http://www.esciencecentral.org/journals/knowledge-attitude-and-practice-of-the-](http://www.esciencecentral.org/journals/knowledge-attitude-and-practice-of-the-community-towards-malaria-prevention-and-control-options-2329-891X.1000118.php?aid=18663)
512 [community-towards-malaria-prevention-and-control-options-2329-](http://www.esciencecentral.org/journals/knowledge-attitude-and-practice-of-the-community-towards-malaria-prevention-and-control-options-2329-891X.1000118.php?aid=18663)
513 [891X.1000118.php?aid=18663](http://www.esciencecentral.org/journals/knowledge-attitude-and-practice-of-the-community-towards-malaria-prevention-and-control-options-2329-891X.1000118.php?aid=18663)
- 514 19. Fuge TG, Ayanto SY, Gurmamo FL. Assessment of knowledge, attitude and practice
515 about malaria and ITNs utilization among pregnant women in Shashogo District, Southern
516 Ethiopia. Malar J [Internet]. 2015;14(1):1–9. Available from:
517 <http://dx.doi.org/10.1186/s12936-015-0755-7>
- 518 20. Forero DA, Chaparro PE, Vallejo AF, Benavides Y, Gutiérrez JB, Arévalo-Herrera M, et
519 al. Knowledge, attitudes and practices of malaria in Colombia. Malar J. 2014;13(1):1–10.
- 520 21. Inah S, Eko J, Uwadiogwu Z, Inah J. Knowledge of Malaria among Adult Residents in
521 Abi Local Government Area, Cross River State, Nigeria. Asian J Res Med Pharm Sci
522 [Internet]. 2017;1(1):1–9. Available from: <http://www.sciencedomain.org/abstract/20321>
- 523 22. Amaechi E, Ukpai O. Knowledge , attitude and practices about malaria among mothers
524 and care- givers in Aba South Local Government Area , Abia state , Nigeria. Anim Res Int
525 10(3) 1786 – 1791. 2013;(January).
- 526 23. Ruberto I, Camara S, Banek K, Loua MK. Knowledge, attitudes and practices of malaria
527 control among communities from the health district of Forécariah in the Republic of

- 528 Guinea, West Africa. *J Vector Borne Dis.* 2014;51(2):119–27.
- 529 24. Taffese HS, Hemming-schroeder E, Koepfli C, Tesfaye G, Lee M, Kazura J, et al. Malaria
530 epidemiology and interventions in Ethiopia from 2001 to 2016. *BMC Infect Dis.* 2018;
- 531 25. Seth RK, Agarwal A. Awareness About Malaria And its Prevention Amongst Rural
532 Population of western Uttar Pradesh. *IOSR J Dent Med Sci.* 2017;16(8):28–31.
- 533 26. Shimaponda-Mataa NM, Tembo-Mwase E, Gebreslasie M, Mukaratirwa S. Knowledge,
534 attitudes and practices in the control and prevention of malaria in four endemic provinces
535 of Zambia. *South African J Infect Dis [Internet].* 2017;32(1):29–39. Available from:
536 <https://www.tandfonline.com/doi/full/10.1080/23120053.2016.1205330>
- 537 27. Orji R, Vassileva J, Mandryk R. Towards an Effective Health Interventions Design : An
538 Extension of the Health Belief Model. 2012;4(3).
- 539 28. Hounton SH, Carabin H, Henderson NJ. Towards an understanding of barriers to condom
540 use in rural Benin using the Health Belief Model : A cross sectional survey. *BioMed Cent.*
541 2005;8:1–8.
- 542 29. Zyl-schalekamp C Van. Perceived Threat of Malaria and the Use of Insecticide Treated
543 Bed Nets in Nigeria. *African Sociological Rev.* 2013;17:25–44.
- 544 30. Michielsen K, Chersich M, Michielsen K, Chersich M, Temmerman M, Dooms T, et al.
545 Nothing as Practical as a Good Theory ? The Theoretical Basis of HIV Prevention
546 Interventions for Young People in ... Nothing as Practical as a Good Theory ? The
547 Theoretical Basis of HIV Prevention Interventions for Young People in Sub-Saharan
548 Africa : A Systematic Review. 2016;(August 2012).
- 549 31. Gl ance Theor y at a.
- 550 32. Watanabe N, Kaneko A, Yamar S, Leodoro H, Taleo G, Tanihata T, et al. Determinants of

the use of insecticide-Treated bed nets on islands of pre-and post-malaria elimination: An application of the health belief model in Vanuatu. *Malar J.* 2014;13(1):1–12.

33. Kumar M, Raghavendra K, Kleinschmidt I, Bhatt RM, Kumar D, Bellamy T, et al. *International Journal of Infectious Diseases* Impact of long-lasting insecticidal nets on prevalence of subclinical malaria among children in the presence of pyrethroid resistance in *Anopheles culicifacies* in Central India \$. *Int J Infect Dis* [Internet]. 2017;(2016). Available from: <http://dx.doi.org/10.1016/j.ijid.2017.02.001>
34. World health organisation. Strategic orientation paper on prevention and control of malaria. *Strateg Orientat Pap Prev Control Malar.* 2005;First Edit.
35. Deressa W, Ali A, Enqusellassie F. Self-treatment of malaria in rural communities, Butajira, southern Ethiopia. *Bull World Health Organ.* 2003;81(4):261–8.
36. Eckert E, Florey LS, Tongren JE, Ren S, Rukundo A, Habimana JP, et al. Impact Evaluation of Malaria Control Interventions on Morbidity and All-Cause Child Mortality in Rwanda , 2000 – 2010. *Am, J, TropMedHyg.* 2017;97(Suppl 3):99–110.
37. World health organisation. Indoor Residual Spraying, policy and strategy. 2015;
38. PMI. President ' S Malaria Initiative Technical. *Cdc.* 2016;9–11.
39. Alemu A, Muluye D, Mihret M, Adugna M, Gebeyaw M. Ten year trend analysis of malaria prevalence in Kola Diba, North Gondar, Northwest Ethiopia. *Parasites and Vectors.* 2012;5(1):1–6.
40. EHNRI/EPHI. Ethiopia National Malaria Indicator Survey. 2015.
41. Alealign A. Current Status of Malaria in Ethiopia : Evaluation of the Burden , Factors for Transmission and Prevention Methods. *Acta Parasitol Glob.* 2016;7(1):1–6.
42. State T, Vol J, Page I. Awareness about Mosquito Borne Diseases and Practice about

- Preventive Methods Against Mosquito Bite in Rural Field Practice Area of a Tertiary. J Med Sci Clin Res. 2018;06(02):512–8.
43. Laar¹ AS, Laar² AK, Dalinjong³ PA. Community perception of malaria and its influence on health-seeking behaviour in rural Ghana: a descriptive study. MalariaWorld J. 2013;4(1):1–6.
44. Diouf G, Kpanyen PN. Evaluation of the Effectiveness of Intervention for Malaria Control in Rural Areas in China. 2010;2(2):41–50.
45. Associate NJ, Assistant MN, Kotian SM, Omar M, Aswin RS, Donkena S, et al. Awareness, practices and expenditure towards mosquito bite prevention methods in urban and semi-urban areas of South India. Int J Mosq Res IJMR. 2015;53(21):53–9.
46. Constructs T, Concept T. Health Belief Model. HBM. 2003;
47. Tokponnon FT, Ogouyémi AH, Sissinto Y, Sovi A, Gnanguenon V, Cornélie S, et al. Impact of long-lasting, insecticidal nets on anaemia and prevalence of Plasmodium falciparum among children under five years in areas with highly resistant malaria vectors. Malar J. 2014;13(1):1–11.
48. Wadunde I, Mpimbaza A, Musoke D, Ssempebwa JC, Ediau M, Tuhebwe D, et al. Factors associated with willingness to take up indoor residual spraying to prevent malaria in Tororo district, Uganda: a cross-sectional study. Malar J [Internet]. 2018;17. Available from: <https://malariajournal.biomedcentral.com/articles/10.1186/s12936-017-2163-7>
49. Doda Z, Solomon T, Loha E, Gari T, Lindtjørn B. A qualitative study of use of long - lasting insecticidal nets (LLINs) for intended and unintended purposes in Adami Tullu , East Shewa Zone , Ethiopia. Malar J [Internet]. 2018;1–14. Available from: <https://doi.org/10.1186/s12936-018-2209-5>

- 597 50. Tassew A, Hopkins R, Deressa W. Factors influencing the ownership and utilization of
598 long - lasting insecticidal nets for malaria prevention in Ethiopia. *Malar J.* 2017;1–9.
- 599 51. Adebayo AM, Akinyemi OO, Cadmus EO. Knowledge of malaria prevention among
600 pregnant women and female caregivers of under-five children in rural southwest Nigeria.
601 *PeerJ [Internet]*. 2015;3:e792. Available from: <https://peerj.com/articles/792>
- 602 52. HEALTH COMMUNICATION FROM THEORY TO PRACTICE Second Edition. 2014.
- 603 53. Birhanu Z, Yihdego YY ebiyo, Yewhalaw D. Caretakers' understanding of malaria, use of
604 insecticide treated net and care seeking-behavior for febrile illness of their children in
605 Ethiopia. *BMC Infect Dis.* 2017;17(1):1–16.
- 606 54. Getachew D. Ecology and Distribution Pattern of Anopheles Mosquitoes and Malaria
607 Transmission in Ghibe River Basin , southwestern Ethiopia. thesis-PhD. 2017;
- 608 55. Karunamoorthi K, Bekele M. Changes in Malaria Indices in an Ethiopian Health Centre :
609 A Five Year Retrospective Analysis. *Heal Scope.* 2012;1:118–26.
- 610 56. Pinchoff J, Larsen DA, Renn S, Pollard D, Fornadel C, Maire M, et al. Targeting indoor
611 residual spraying for malaria using epidemiological data : a case study of the Zambia
612 experience. *Malar J.* 2016;1–6.
- 613 57. Asingizwe D, Poortvliet PM, Koenraadt CJM, Vliet AJH Van, Murindahabi MM, Ingabire
614 C, et al. *NJAS - Wageningen Journal of Life Sciences* Applying citizen science for
615 malaria prevention in Rwanda : An integrated conceptual framework. *NJAS - Wageningen*
616 *J Life Sci [Internet]*. 2018;86–87(August 2017):111–22. Available from:
617 <https://doi.org/10.1016/j.njas.2018.06.002>
- 618 58. Sylvester G. Technologies for agricultural information sharing - Part II. 2013;51–105.
619 Available from: <http://www.fao.org/docrep/019/i3557e/i3557e01.pdf>

59. Alemu A, Tsegaye W, Golassa L, Abebe G. Urban malaria and associated risk factors in Jimma town, south-west Ethiopia. *Malar J*. 2011;10:1–10.
60. Nkoka O, Chuang TW, Chuang KY, Chen YH. Factors associated with insecticide - treated net usage among women of childbearing age in Malawi : a multilevel analysis. *Malar J* [Internet]. 2018;1–16. Available from: <https://doi.org/10.1186/s12936-018-2522-z>
61. Sharma M, Bernard AL, Rojas-guyler L. Using the Health Belief Model to Determine Safer Sexual Behavior among African Immigrants 8VLQJ WKH + HDOWK % HOLHI ORGHO WR ' HWHUPLQH 6DIHU 6H [XDO % HKDYLRU DPRQJ \$ IULFDQ , PPLJUDQWV. *J Health Care Poor Underserved*. 2013;(February).
62. Salam RA, Das JK, Lassi ZS, Bhutta ZA. Impact of community-based interventions for the prevention and control of malaria on intervention coverage and health outcomes for the prevention and control of malaria. *Infect Dis Poverty*. 2014;3(1):1–15.
63. Birhanu Z, Abebe L, Sudhakar M, Dissanayake G. Malaria Related Perceptions , Care Seeking after Onset of Fever and Anti-Malarial Drug Use in Malaria Endemic Settings of Southwest Ethiopia. *PLoS One*. 2016;7:1–20.
64. Nankabirwa J, Brooker SJ, Clarke SE, Fernando D, Gitonga CW, Schellenberg D, et al. Malaria in school-age children in Africa: An increasingly important challenge. *Trop Med Int Heal*. 2014;19(11):1294–309.
65. Rugnao S, Gonahasa S, Sebuguzi CM, Opigo J, Yeka A, Katureebe A, et al. LLIN Evaluation in Uganda Project (LLINEUP): factors associated with childhood parasitaemia and anaemia 3 years after a national long - lasting insecticidal net distribution campaign : a cross - sectional survey. *Malar J* [Internet]. 2019;1–12. Available from: <https://doi.org/10.1186/s12936-019-2838-3>

- 643 66. Wangroongsarb P, Hwang J, Thwing J, Karuchit S, Kumpetch S, Rand A, et al. Using
644 respondent driven sampling to identify malaria risks and occupational networks among
645 migrant workers in Ranong, Thailand. PLoS One. 2016;11(12):0–1.
- 646 67. Balami AD, Said S, Afiah N, Zulkefli M, Norsa B, Audu B. Knowledge , motivation , self
647 - efficacy , and their association with insecticidal net use among pregnant women in a
648 secondary health centre in Maiduguri , Nigeria. Malar J [Internet]. 2018;1–17. Available
649 from: <https://doi.org/10.1186/s12936-018-2518-8>
- 650 68. Hall G. Health Equity Guide for Public Health Practitioners and Partners. Delaware Heal
651 Soc Serv Div Public Heal Community Heal June 2015. 2015;(June).
- 652 69. T. M. Masaad T. Knowledge, Attitude and Practices Among Mothers Towards
653 Insecticide-Treated Nets in Abuharira Village -Um Remta Locality- The White Nile State
654 -2015. Sci J Clin Med [Internet]. 2017;6(2):24. Available from:
655 [http://www.sciencepublishinggroup.com/journal/paperinfo?journalid=159&doi=10.11648/](http://www.sciencepublishinggroup.com/journal/paperinfo?journalid=159&doi=10.11648/j.sjcm.20170602.11)
656 [j.sjcm.20170602.11](http://www.sciencepublishinggroup.com/journal/paperinfo?journalid=159&doi=10.11648/j.sjcm.20170602.11)
- 657 70. Ayele DG, Zewotir TT, Mwambi HG. International Journal of Medicine The risk factor
658 indicators of malaria in Ethiopia. Int J Med Med Sci. 2013;5(July):335–47.
- 659 71. Munga S, Kimwetich Z, Atieli F, Vulule J, Kweka EJ. Knowledge and perceptions about
660 indoor residual spray for malaria prevention in mumbar division, Nandi county in
661 central province of Kenya. Tanzan J Health Res. 2017;19(4):1–9.
- 662 72. EHNRI/EPHI. Ethiopian National Malaria Indicator Survey. 2011;
- 663 73. EHNRI/EPHA. Ethiopian National Malaria Indicators Survey. 2015;
- 664 74. Bell A. Explaining Fixed Effects: Random Effects Modeling of Time-Series Cross-
665 Sectional and Panel Data*. Eur Polit Sci Assoc. 2015;3(1):133–53.

75. Schmidheiny K. Short Guides to Microeconometrics. Panel Data: Fixed and Random Effects. Vol. 2, Universität Basel. 2018.
76. Brand JE. EFFECTS : A STRUCTURAL EQUATIONS APPROACH. NIH Public Access. 2011;89(1):1–34.
77. Breen R, Karlson KB, Holm A. Total, Direct, and Indirect Effects in Logit and Probit Models. Sociol Methods Res. 2013;42(2):164–91.
78. Sovi A, Azondékon R, Aïkpon RY, Govoétchan R, Tokponnon F, Agossa F, et al. Impact of operational effectiveness of long-lasting insecticidal nets (LLINs) on malaria transmission in pyrethroid-resistant areas. Parasites and Vectors. 2013;6(1):1–13.
79. Mackinnon DP, Fairchild AJ, Fritz MS. Mediation Analysis. 2007;
80. Preacher KJ, Rucker DD, Hayes AF, Preacher KJ, Rucker DD, Hayes AF, et al. Addressing Moderated Mediation Hypotheses : Theory , Methods , and Prescriptions Addressing Moderated Mediation Hypotheses : Theory , Methods , and Prescriptions. 2017;3171(October).
81. Ukpai OM, Irole-Eze OP, Amaechi EC, Ejike BU, Ejike EN, Okorocha NA. A Study of Knowledge, Attitude, and Practices Regarding Malaria Among Inhabitants of Ezinihite Local Government Area, Imo State, Eastern Nigeria. Manila J Sci [Internet]. 2017;10(10):65–74. Available from: <http://www.manilajournalofscience.com.ph/download/Manila-Journal-of-Science-10-2017-pp.-65-74.pdf>
82. Attu H, Adjei JK. Local knowledge and practices towards malaria in an irrigated farming community in Ghana. Malar J [Internet]. 2018;1–8. Available from: <https://doi.org/10.1186/s12936-018-2291-8>

689 83. Chukwuocha UM, Okorie PC, Iwuoha GN, Ibe SN, Dozie IN, Nwoke BE. Awareness ,
690 perceptions and intent to comply with the prospective malaria vaccine in parts of South
691 Eastern Nigeria. Malar J [Internet]. 2018;1–7. Available from:
692 <https://doi.org/10.1186/s12936-018-2335-0>
693
694