Walden University

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Abstract

Associations Between the Use of Bed Nets and Malaria Infection on the School Performance of Juveniles in Ghana

by

Ans Bumbokuri

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy and Administration

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Abstract

Millions of malaria cases are reported yearly in sub-Saharan Africa, events which adversely influence children's school performance. The purpose of this quantitative, cross-sectional study was to investigate the effectiveness of major malaria control policies in reducing malaria cases as a means of improving academic performance among school children in the greater Accra region of Ghana. A secondary data set was obtained from the 2014-2016 data from the Ghana Malaria Indicator Survey (GMIS). Findings indicated that bed net use and malarial episodes in children of participant recorded a *p*-value of 0.43 which is a significant association between the variables. The likelihood of child getting malaria when children slept under the mosquito net was low as $p = 0.637$. The type of ITNs bed nets children slept under was not predictive of malaria episodes, evident by an odd ratio of 0.878. The impact of malarial infection on academic performance was positively associated as a *p*-value near 0.000 was obtained. Findings showed that age and gender of child did not relate to the prevention of malaria; however, use of bed nets prevented malaria and reduced or eliminated the risk of cerebral malaria and aided enhance academic performance in children. The social change implications may include fewer infections and improved academic performance. Malaria prevention education of ITNs use should be planned to reach people of all demographic backgrounds and encourage adherence with recommended malaria preventive practices.

[Keywords: *Malaria, Bed nets, Social influence, Interpersonal influence, Ghana, Prevention, Performance, Juvenile, Students*]

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Dedication

To children living in malaria prone areas of the world.

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Chapter 1: Introduction to the Study

Introduction

Mosquito bed nets (Mbn), treated and untreated, are used to curb the spread of malaria (Amusan et al., 2017). The effectiveness of the introduction of mosquito nets in reducing malaria cases may be linked to the academic performance of school children in Ghana. The Mosquito bed nets policy had been one of the major policies the government of Ghana had implemented to help solve the increasing cases of malaria. Several studies have been conducted to evaluate the performance of this policy as far as malaria control strategies are concerned (Amusan et al., 2017). This study focuses on the relationship between malaria infections and the use of insecticide-treated and non-treated mosquito bed nets among schoolchildren in Ghana's Greater Accra Region. The Integrated Malaria Vector Management Policy (IMVMP) were explored by evaluating the effectiveness of insecticide treated materials (ITMs), specifically, the mosquito net use policy/adherence among the participants. Among the subjects, malaria infection frequency was also explored. The ITN assessment among the participants was evaluated based on the subjects' net use in the hyperendemic communities. School absenteeism contributes to poor school performance (Morrissey, Hutchison & Winsler, 2014). Hence, malaria-driven school absenteeism may lead to substantial school performance barriers among school children.

Malaria cases are public health crises in any endemic areas because it poses adverse health effects on the physical, mental, and social well-being of the people as well as on the economic development of the nation (Lozoff & Georgieff, 2006). Malaria infections among pregnant women and during infancy could lead to anemic conditions and impede utero

nutrition, which adversely impacts cognitive development (Lozoff & Georgieff, 2006). The disease conditions could delay the development of the central nervous system (Beard, 2008). It could reduce a child's ability to respond to environmental cues (Burhans, Dailey & Wiesinger et al., 2006). Malaria exposure during childhood also worsens neurocognitive performance, including attention, memory, vision-special skills, and language function, making advancement through school more difficult (Kihara et al., 2006). Symptomatic, uncomplicated malaria attacks in school-aged children have been linked to decreased cognitive function, including lower scores in math and language tests in Sri Lanka and Brazil (Fernando et al., 2003; Vitor-Silva et al., 2009). While in Mali, lower education achievements and cognitive performances were linked to malaria infections (Thuilliez et al., 2010). In Yemen, lower performance in cognitive tests was reported (Al Serouri et al., 2000). Researchers in Uganda and Zambia showed an association between episodes of clinical malaria or malaria-related anemia and reduced cognitive skills among children between the age of 3 to 6 years old (Bangirana et al, 2014; Fink et al., 2013).

The strongest evidence on the benefits of treatment of both symptomatic and asymptomatic malaria was shown using a randomized control trial of malaria chemoprevention to assess educational outcomes and the impact of cognitive performance (Chen et al., 2016). In Sri Lanka, using a randomized trial approach, researchers showed that IX (9) months of chloroquine prophylaxis administered among selected subjects, improved educational attainment, and decreased absenteeism (Fernando et al., 2006). These findings are consistent with studies in school children in Western Kenya and Mali, where Intermittent presumptive treatment was associated with increased sustained

attention scores (Clarke et al., 2008, 2013). In the Gambia, long-term benefits to education and cognitive development were demonstrated (Jukes et al., 2006). In the study, the group that received malaria chemoprophylaxis in early childhood showed higher levels of cognitive function and lower rates of school drop-out compared to the control group (Jukes et al., 2006).

Although indirect, educational outcomes have improved over time in countries where malaria cases have been eliminated or substantially controlled including Sri Lanka, Brazil, Colombia, Ethiopia, Italy, Mali, Mexico, Paraguay, and Uganda (Chen et al., 2016). This exemplary outcome improvement should encourage policymakers, educational and health systems, and other stakeholders in the endemic regions of Ghana to implementing robust, easy, and accessible malaria preventive control, and treatment measures to advance academic performance among the target or vulnerable population. Such efforts could largely be achieved with support from empirical findings on the effects of malaria infections among school children. In this study, the researcher attempted to provide evidence-based findings by examining the association between insecticide-treated nets and nontreated mosquito net use among school children in Ghana. The outcome of this study may help policymakers advance informed policies on this public health concern. In this chapter I present the background of the study, the problem statement, the purpose of the study, research questions, research hypotheses, study approach, the theoretical framework of the study, nature of the study, assumptions, scope and delimitation, limitations, and the significance of the study.

Background

Based on the World Health Organization (WHO, year) estimate, half of the world's population is still exposed to malaria despite massive international efforts. Malaria remained the most human disease transmitted by mosquitoes in the tropical and subtropical regions, especially in the developing countries of the world where it accounts for around 220 million cases and at least, 0.6 million deaths per year (WHO, 2012). Many of the cases and deaths occurred in sub-Saharan Africa (WHO, 2012). Globally, 3.2 billion people in 95 countries and territories are at risk of being infected with malaria and developing a disease, and 1.2 billion are at high risk (>1 in 1000 chance of malaria infection per year; Attanasio et al., 2017).

Malaria is a major public health problem in sub-Saharan Africa (WHO, 2015). According to the World Malaria Report (2015), there were 214 million cases of malaria in 2015 and 438,000 malaria deaths. The 2015 report showed a substantial decrease in malaria cases and deaths since 2000 by 37% and 60% respectively. However, malaria health burdens are relatively high in the African regions (WHO, 2015). About 90% of all malaria deaths occurred within the African regions (WHO, 2015). Children under 5 years of age accounted for more than two-thirds of all deaths (WHO, 2015).

The WHO (2015) reported supported and confirmed the findings advanced by Pellissier (2012). Pellissier explored the prevalence and incidence of malaria globally. In the study, the author concluded that approximately 225 million cases of malaria were reported worldwide. Out of these cases, 90% occurred in the sub-Saharan region, where 3,000 people die each day from the disease (Pellissier, 2012).

Even when considerable progress has been made in the fight against malaria, the public health burden of the disease is still very high, especially in sub-Saharan Africa (WHO, 2015). These regions accounted for 80% of the global malaria cases in 2015 (WHO, 2015). The economic impact of the disease in sub-Saharan Africa is estimated at roughly $12 billion per year. Malaria is a preventable and amendable disease, therefore, there is an urgent need in furthering or advancing efforts to at least reduce the disease or its occurrence substantially to the minimum, if the option of complete elimination is not feasible or possible (WHO, 2015).

In Ghana, malaria is still endemic in all the 10 regions of the country (Ghana Health Service, 2016). The country recorded 4,940,270 suspected cases of malaria in the first half of 2016 (Ghana Health Service, 2016). On average, approximately 26,922 suspected cases of malaria were recorded daily in the country's health facilities during the period (Ghana Health Service, 2016). Progressively, based on the WHO report, there is a substantial reduction of daily cases of malaria from 685 to 385 between 2015 and 2016, however, the disease is still a major public health problem in Ghana (WHO, 2016). In Ghana, the malaria case fatality rate for children under 5 years old was 0.35 in 2016 (Ghana Health Service, 2016). The financial burden of the disease is very high in Ghana and the malaria-driven financial constraint could threaten the advancement of the malaria prevention programs. The funding trend from both the public sector and other donors is discouraging (Solomon, 2015). An estimated annual funding gap of approximately 2.6 billion dollars for malaria prevention has been projected to incur from 2011 to 2020 (Solomon, 2015). Malaria infections in Ghana and other endemic countries have been linked to anemia, cerebral

malaria, and severe malaria (Solomon, 2015). These malaria-driven health burdens may continue to rise if the use of currently available tools for malaria interventions such as rapid diagnosis and appropriate treatment, use of ITNs, and indoor residual spraying strategies are not heavily funded as the core intervention measures to control malaria prevalence and incidence (Snowden, 2014).

Malaria affects the health of people of all ages (WHO, 2015). The infection is very serious among children because they are prone to malaria episodes due to a lower immune system (Sena et al., 2015). Malaria is particularly virulent among children and has become one of the principal causes of child morbidity and mortality in sub-Saharan Africa (WHO, 2010). Each year, approximately more than 500 million people are infected, particularly children, and they are more susceptible to the severe stage manifestations of the disease (Carter & Mendis, 2002). Exposure to the malaria parasite not only leads to bouts of high fevers but also increases the risk of malnutrition and anemia among children under 5 years of age (Ehrhardt et al, 2006). Further, malaria infection among school children is a major cause of absenteeism in endemic countries (Ehrhardt et al, 2006). It is estimated that about 2% of children who recover from cerebral malaria suffer brain damage including epilepsy (WHO & UNICEF, 2003). Among young children, frequent episodes of severe malaria have adverse impacts on the learning abilities and educational attainment among the exposed population (Bangirana et al., 2016). This health situation is a possible threat to human capital accumulations, which constitutes a key factor in the economic development processes (Requejo et al., 2015). The high rate of infectious disease exposure, including malaria, is shown to correlate with low national intelligent quotients (IQs; $r = 0.82$, $p <$

0.0001; Hassall & Sherratt, 2011). According to Hassall and Sherratt (2011), infectious and parasitic disease burden are negatively associated with IQ score, $r = 0.854$, $p < 0.001$. Pellissier (2012) indicated that average sub-Saharan Africa's IQ is between 30-40 points lower than that of the East Asian and Western nations. Add summary/synthesis to balance out the use of information from the literature and connect back to your study.

Several researchers suggested that the spectrum of malaria infection, from asymptomatic to severe disease, affects cognitive functions (Al Serouri et al., 2000; Fernando et al., 2003; Nankabirwa et al., 2013; Olney, 2007; Thuilliez et al., 2010). Spinal muscular atrophy affects as many as 5 million children annually and could affect cognitive functions, which may significantly hinder children's full cognitive development potentials (Murphy & Breman, 2001). Malaria exposure during childhood could also adversely affects neurocognitive performance including attentiveness, memory, vision-spatial skills, and language function, and thus, making advancement through school more difficult (Kihara et al., 2006). The impacts of malaria exposures or episodes on a child, particularly on the mental and cognitive function abilities within the life course perspective could have serious adverse health effects on the academic performance of the child.

A review of the literature showed the association between malaria infections ITN and nontreated mosquito net use could affect children's school performance in the parasitic hyperendemic areas that remain unexplored (Vorasan et al., 2015). On the other hand, the literature revealed mixed findings on the association between malaria infection and ITN and nontreated mosquito net use of school-age children (Vorasan et al., 2015). In this study, therefore, I addressed the gaps by examining the effects of malaria infections, insecticide-

treated nets and nontreated mosquito net use in the parasitic hyperendemic areas in Ghana. A study which will contribute substantially to the body of knowledge on the impacts of malaria effects on ITN and nontreated mosquito nets and an investigation that could help policymakers in Ghana make informed decisions on the malaria infection driven public health problems.

Problem Statement

Malaria is hyper-endemic in all parts of Ghana with the entire population at risk and transmission occurs all year round (Ghana Health Service, 2013). The current IMVMP was implemented in Ghana with the intent to increase demand and appropriate use of ITMs within and around the mosquito-infested endemic area (Ghana Health Service, 2017). The application of the ITM is an all-year-round mosquito prevention approach to reduce or eliminated mosquito habitat and malaria among all vulnerable groups including children under 5 years and pregnant women (Ghana Health Service, 2017). The practical application of IMVMP includes the integration of malaria vector management regulation and implementation strategies requiring adulticiding (control or killing of adult mosquitoes through indoor residual spraying [IRS]), larviciding (control of larval stages of the mosquito at their sites) and environmental management (chemical or biological means-manipulating living organisms to suppress vector populations) as the common approaches in eradicating or controlling mosquito or mosquito-borne illnesses or outcomes (Ghana Health Service, 2017). However, the IMVMP-driven approaches have had its inherent shortfalls. One of the demerits of the IMVMP includes the lack of or insufficient evaluation

indicators to measure the effectiveness of the policy for either mosquito-borne illnesses or events (Saaka & Glover, 2017).

On the other hand, the association between malaria infections and ITN and nontreated mosquito net use among children in Ghana, as a means of providing anecdotal evidence regarding the effectiveness of the ITMs or mosquito net use policy, a core part of the IMVMP, is unknown, although several studies show association between malaria infections among students, social aspects, and *Plasmodium* infection risk factors (Fink et al., 2013; Omolade et al., 2011; Vito-Silva et al., 2009; Vorasan et al., 2015). In my study, I investigated the association between malaria infections and ITN and non-treated mosquito net use among children in the Greater Accra Region of Ghana, as an evaluation indicator to measure the effectiveness of the ITMs or mosquito net use policy.

Purpose of the Study

The purpose of this study was to investigate the effectiveness of major malaria control policies in reducing malaria cases as a means of improving academic performance among school children in the greater Accra region as a core part of the IMVMP. Between malaria infections and ITN and nontreated mosquito net use among children in the Greater Accra Region of Ghana as a means of providing anecdotal evidence regarding the effectiveness of the ITMs or mosquito net use policy, a core part of the IMVMP.

Research Questions and Hypotheses

RQ1: What is the relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana?

$H_0$1: There is no relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

H_a1: There is a relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

RQ2: What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net?

$H_0$2: There is no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net.

H_a2: There is a significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net.

Theoretical Foundation

The social-ecological model (SEM) is an integrated model useful for understanding a variety of complexities of multifaceted and interactive effects of societal, community,

relationship, and individual behaviors or events (citation). The multilevel ecological model SEM authored by Bronfenbrenner (1977) is a theoretical framework widely applied in public health and policy. The SEM could be used to investigate parameters that strongly correlates with disease transmission leading to undesired health outcomes or events or behaviors (Berk, 2000; Henderson, 1995). The social-ecological theory is based on understanding environmental conditions that support the occurrence and transmission of pathogens and the prevention of disease as a major public health policy (CDC, 2015). A SEM is a framework tool that could help investigators explain how factors impact behaviors or events or outcomes at various levels including institutional, community, and policy settings (Bronfenbrenner, 1977, 1990).

The overlapping layers in the model illustrated how factors at one level influence other factors in another level (Bronfenbrenner, 1977, 1990). The model demonstrates the complex interplay between individual, relationship, community, and societal factors that underpin the association between diseases or events and the environment (CDC, 2015). Researchers have used the SEM to explore the links between disease and the environment and how the interactions spurred new interest in research on the impact of the environment or extrinsic factors or vectors on health outcomes (Mcleroy et al., 1988; Reis et al., 2015). Caprara et al. (2015) indicated that environmental conditions support the frequency of disease infections and disease-linked behaviors. Many public health professionals have advocated for an integral approach to infectious disease prevention. Thus, SEM is ideal for investigating the association between malaria infection and school performance. It is also appropriate to use this theory in the assessment of the burden of malaria infection in Ghana

because it elucidated factors such as disease or event or behavioral outcomes, environmental interactions, individual/subject of interests, and the rate of event outcomes. The findings from this study could be used by health policymakers to engage vulnerable populations with a greater need for intervention. For instance, the social-ecological theory was crucial in my exploring the in-depth understanding of the phenomenon and could spur future research to re-direct research and policy focus on some of the pertinent health issues in the hyperendemic areas.

Nature of the Study

The nature of this study was based on quantitative methods. Quantitative methods employ objective measurements, statistical, and mathematical or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing data using computational techniques (Creswell, 2014). The focus of the study is on gathering numerical data and the use of the data to explain a phenomenon/observation (Creswell, 2014). Regoniel (2015) also defined quantitative methods as those research methods that use numbers as its basis for generalizing about a phenomenon. Thus, the use of quantitative methods could help explore the association between the predictor variable and the outcome variable, in this case, malaria infections.

Malaria infections quantified as a ratio level of measurement (zero, one, two, three, four, and five or more malaria infection per year) were categorized into two groups (≤ 1 ≥ 2 and malaria infection per year) for this study. Individuals with zero or at most one case of malaria infection per year were Group I (control group) while those with at least 2 or more cases of malaria infections per year were Group II (exposed group). Similarly,

mosquito net use status, malaria infection status, and socioeconomic characteristics of the participants were grouped into two categories. The net users were categorized into individuals that use a bed net and those that do not use a bed net. The outcome variable malaria infections were categorized into a group with low malaria infections and those with high malaria infection. The socioeconomic status was categorized into the low socioeconomic status and high socioeconomic status.

Stratification and simple random sampling techniques were used to select participants from the secondary data set for the study. The gathered data was analyzed using both descriptive and inferential statistical approaches. Descriptive analysis of the data gathered covered expression of data trends in frequency and percentage counts. This was applied to the demographic data as well as the variables considered independently. Identifying these trends allowed for a more detailed analysis using the inferential analysis such as the chi-sqaure, Cramers V and regression analysis. To test for the significance in relationship between two or more variables chi-sqaure test were used, however, the extent to which variables are related was not indicated by this test. To ocvercome this inadequacy, the Cramers V value was computed and compared to the set designations. With regards the inferential analysis of the data, regression analysis was completed. Both binary and multinomial regression analysis were employed for a two variable analysis and multivariable analysis. Two variable analysis is where a dependent and an independent variable are analyzed to determine the significance in relationship, the odd ratio of the independent predicting the dependent variable (citation). The multinomial regression considers running a regression analysis where categories are present for a particular

variable run against another variable, such as malaria infections against the educational backgrounds of parents. The G*Power software were used for the sample size estimation. The G*power estimation parameters depended on several factors including but were not limited to statistical methods, type of analysis, which in this study were chi-square, Cramers V, and regression analysis, predetermined alpha level which is 0.05 and at a significant interval of 95%, statistical power, and the effect size estimates which in this study are the changes that occur in dependent variables as affected in positive tests by the independent variables. The estimations are based on the need to produce statistics that are a true picture of the situation on the ground as considered under statistical terms.

Definitions

Adulticiding: An approach used in controlling mosquito pathogens using chemical treatment applications on the ground or aerial spray of the targeted areas (Ghana Health Service, 2013).

Endemic: The level of the disease or event intensity and prevalence in a geographic region. In such locations, the high number of individuals living in the area is exposed and perhaps affected by the event or disease-causing agents at any given point in time (Gordis, 2009).

Frequency of episodes/diagnosis: Frequency of the episode/diagnosis is the duration since the last malaria attack (Vorasan et al, 2015).

Health outcome: Refers to either infectious or communicable disease or chronic health conditions. The health outcome intended to address in this study is malaria (WHO, 2016).

Hyperendemic areas: Areas where the parasitemia levels for a given disease or condition are persistently present at a high incidence and/or prevalence rate and affect all groups equally (Ghana Health Service, 2013).

Incidence: The new cases for a given event or disease or health outcome during a specific timeline or period in a target population (WHO, 2016).

Larviciding: A treatment approach used in the termination of immature mosquitoes' larva through the use of biological agents to control pupae at the source within water habitats (Ghana Health Service, 2013). *Malaria infection*: A *plasmodium* infection by mosquitoes and confirmation of malaria parasitemia in a blood sample. The infection is associated with variable signs and symptoms of fever, headache, myalgia, nausea, back pain, chills, sweats, vomiting, cough, and diarrhea (Vorasan et al, 2015).

Morbidity: The rate of disease within a population or the condition of being diseased (Szklo & Nieto, 2014).

Mortality: Death fatalities of persons resulting from diseases, injury, events, virus infection, and natural causes in a targeted area or population (Gordis, 2009).

Prevalence: The overall or cumulative cases of an event or a disease or health outcome within a specified population (WHO, 2016).

Unit of Analysis: The entity observed in a study (Gordis, 2009; Szklo & Nieto, 2014).

Vector: A medium or host such as an insect or mosquito species in which plasmodium undergoes its sexual cycle of the disease-causing sporozoite agents (completion stages of the extrinsic development) (Szklo & Nieto, 2014).

Assumptions

The school children living in the hyperendemic areas in the Greater Accra Region have the same level of exposure to the plasmodium falciparum, which is associated with severe morbidity and mortality, particularly in children (citation). It was assumed that in the hyperendemic areas of Ghana the Plasmodium falciparum mosquito, one of the vectors that transmit malaria, is constantly present at a higher level and affects all groups equally. Another inherent assumption in this study was that the application of the inclusion criteria and sample size, assures that the participants have experienced the saggggme phenomenon or outcome. Also, I assumed that all the individuals who participated in the study had an interest in enrolling in the study and thus did not have any other motives or incentives, for instance, hoping to get a monetary benefit for just for participating in the study. Besides, the participants in this study have no intention of distorting the information misclassifying their exposure status in an attempt at demonstrating that Plasmodium falciparum may not influence their mosquito net use.

Scope and Delimitations

The findings from this study may not extend beyond the selected participants or individuals with basic education levels who are living in other endemic or hyperendemic areas where the Plasmodium falciparum may flourish. The scope of the study involves descriptive and inferential assessments of relevant variables and indicators. The focus on school-aged children is relevant because it allows pertinent measurement of net use for the selected target area. Since malaria's prevalence and incidence are high in the African continent, it is a serious health problem that must be addressed continuously to provide,

update, and support evidence-based intervention approaches (Pellissier, 2012). The inclusion/exclusion criteria required for this study analysis were established using evidence-based practices. The inclusion age of the unit of analysis or participants is between 0 - 6 years old who are living in endemic or hyperendemic areas of Ghana, or the locations identified by the Ghana Multiple Indicator Cluster Survey, 2011. One of the major delimitations is that the data source for this study is secondary data-based, which may or may not cover the full scope of the research questions posed or may not provide an in-depth information needed to address the identified gap in the literature as would have been possible if primary data source was implemented for the study assessment.

The study included both gender groups (male and female). However, individuals living in nonendemic or nonhyperendemic areas of Ghana were excluded from the study. Individuals with sickle cell anemia, including sickle cell or sickle cell carriers, and people with mental health challenges and other medical issues that affect mental be excluded health were also be eliminated from the study. Individuals with known resistance to malaria other than sickle cell anemia cases were also be excluded from the study.

Limitations

Also, by using a secondary data set the baseline data of the participant's cases of malaria for each exposure group may not be available for pairwise comparison. The factors or variables implicated in this study were not controlled and thus, the findings from this study may not be used to infer causal relationship but rather, the inferential assessment between the predictor and health outcome variables is limited to correlational evaluations. The level of variations in the educational integrity of the school systems in Ghana could

influence the quality of education advanced or the school performance for the attending students as schools with high-quality or high academic integrity may have better school curriculums that provide quality education regardless of the influence malaria infection may have on the students. For instance, the private-school systems in Ghana could have qualified and better-trained teachers than the public-school systems. If the public-school systems in Ghana inherently have a higher proportion of poorly trained and less qualified teachers with low teaching skill set, then such disproportionality could skew the findings in this study substantially. The data used did not take into consideration the level of qualification and quality of education that the child received, as such this possible variation could not be countered. Also, the data used might have not undergone any form of peer review and may not stand a good test of rigor under peer review exposure. Finally, the data used might not suit the exact purpose of this study in totality. This is because the data was not collected with the intention of this particular study but for another purpose though related. To reduce the specified biases, the samples will be randomly selected from the secondary data sets.

Significance of the Study

The focus of the study is to uniquely address the need to understand the effects of malaria infections and ITN and nontreated mosquito net use among the vulnerable population living in hyperendemic areas. Its design setting helped in exploring the relationship between the frequency of the disease transmission and malaria infection among the school-aged individuals in the Greater Accra Region of Ghana. The integrated malaria vector management policy and antimalaria drug policy are two of many policies

currently in place for reduction, treatment, and control of malaria and mosquito-related health issues in Ghana (citation). The IMVMP intervention approach is based on three key strategies, which included the application of insecticide-treated materials, larviciding, and environmental management to manage malaria vector populations to reduce or interrupt disease transmission (Ghana Health Service, 2016). The antimalaria drug policy (AMDP) was initiated to provide prompt, safe, effective and appropriate antimalaria treatment to the entire population. Specifically, the use of standard treatment gGuidelines (STGs), essential medicines list (EML), and national health insurance were incorporated in this policy (Ghana Ministry of Health, 2016).

In addition to providing evidence-based support to new and future policies, the findings from this study could advance vital information to promote and encourage the expansion of effective policies and its application reach. It could also help health practitioners address the persistent infections, net use/challenges, and social factors facilitating malaria transmissions and Plasmodium infection. The study findings could be useful in stimulating evidence-based and meaningful long-term health promotion measures by providing information that may be implemented exclusively and extensively in disrupting the malaria infection path and frequency at the community level. As such, health promotion measures could be tailored based on the information generated from the identified risk factors and suspected outcomes to substantially reduce the exposure/risk and outcomes.

The information generated from this study could be further explored by other researchers in advancing extensive early mosquito screening approaches among the

vulnerable target population and communities. For instance, if in this study, an association between malaria infection and ITN and nontreated mosquito net is demonstrated, then the assessment of the overall level of malaria infections within the vulnerable target population in Ghana moving forward could be used as a quantifiable measure to evaluate the effectiveness of the application of the specified policies. The effectiveness of unique malaria policies established in Ghana or at any other malaria-endemic geolocation could be quantified. The integration of the finding in this study is measuring the effectiveness of an existing policy that would help in the elimination or improvement processes of policies that are not necessarily effective. Such stringent steps could help policymakers implement a tailored policy to address the existing malaria problems.

Also, the findings from this research inquiry may support the need for a functional change in the community setting in Ghana by promoting a tailored malaria prevention awareness within the nested geolocation so that school-age children and parents, as well as educators, could have fresh insight on this issue. Similarly, vulnerable students would have a fair opportunity to attain success in schools. Perhaps, there may be a need for the school board in Ghana to monitor students from hyperendemic regions and to develop special education programs and after-school programs specific to vulnerable kids in such areas. Such positive social change school programs, when supported by the GHS, could inform public health and the educational system in Ghana on better approaches/practices to address malaria-driven adverse health or behavioral issues. Also, such programs would be of immense social benefit to students by creating the opportunity for a new perspective on health promotion strategies on malaria impacts. If the relationship between the malaria

infection and ITN and nontreated mosquito net challenges exist, the study could be used as an objective evidence-based platform to support malaria preventative policy measures on this important public health issue in Ghana.

Summary

The main purpose of the study is to investigate the association between malaria infections and ITN and nontreated mosquito net use among children in the Greater Accra Region of Ghana. The key variables and factors in this study are malaria infections/exposures, ITN, and nontreated mosquito net use. One outcome variable is malaria infection risk for RQ2, which was addressed based on the levels of risk for malaria infection. The other is ITN and nontreated mosquito net use. However, cases of malaria infection in RQ1, which examined the relationship between insecticide mosquito net use policy and nontreated mosquito bed net for sleeping, is the outcome under investigation. The SEM was employed in investigating the phenomenon of the association between repeated-malaria infection and school performance. The SEM is an important tool in exploring the interactive nature of health outcome or event against the intrinsic and extrinsic factors; known components which have enormous impacts on individual and social outcomes. The study is quantitative method-driven research, which employs both descriptive and inferential analysis to examine associations between the dependent (MI) and the independent variables (insecticide-treated net and nontreated mosquito net). An in-depth overview of the literature reviewed in this study will be discussed in Chapter 2.

Chapter 2: Literature Review

Introduction

Malaria is a major public health concern, especially among children, and it is an entrenched health problem in Africa and perhaps globally (WHO, 2011). The disease is endemic in over a hundred countries in the world (WHO, 2011). According to the WHO (2011) estimates, about half of the world's population are still exposed to malaria despite massive international efforts. Acute malaria is estimated to cause 225 million cases of ill health annually, resulting in over 1 million deaths each year, most of which occur in sub-Saharan Africa (WHO, 2010). In 2015, there were roughly 212 million malaria cases in 91 endemic countries and territories worldwide (or ranged from 148–304 million), and approximately 429,000 malaria deaths (WHO, 2015). Increased prevention and control measures have led to only a 29% reduction in malaria mortality rates globally since 2010 (WHO, 2015).

Sub-Saharan Africa continues to carry a disproportionately high share of the global malaria burden (WHO, 2015). In 2015, the region reported about 90% of malaria cases and 92% of malaria deaths (WHO, 2015). In contrast, Asia, Latin America, the Middle East, and parts of Europe are affected to a lesser extent (WHO, 2016). The South-East Asia region accounted for about 7%, and the Eastern Mediterranean region reported approximately 2% cases (WHO, 2016).

According to the report, fewer than half of the 91 malaria-affected countries and territories are on track to achieve the 2020 milestone of a 40% reduction in case incidence and mortality (WHO, 2016). Children under the age of 5 years old were particularly

susceptible to malaria illnesses, infections, and deaths (WHO, 2016). In 2015, malaria killed about 303,000 children under the age of 5 years old globally (WHO, 2015). Out of which 292,000 deaths were in the African region (WHO, 2015). Between 2010 and 2015, the malaria mortality rate among children under the age of 5 years old decreased by 35% (WHO, 2015). Nevertheless, malaria remains a major killer among children under the age of 5 years old, claiming the life of one child every 2 minutes (WHO, 2016). This chapter contains a review of current literature related to malaria prevalence and the educational attainment of school children. The major sections of this chapter include the literature search strategy, a thorough discussion of malaria prevalence and educational attainment of school children, the theoretical framework of the study, and the empirical studies related to this research inquiry.

Several researchers investigated the association between malaria infection and school performance, however, not on insecticide-treated nets and nontreated mosquito nets and malaria infection (see Fink et al., 2013; Vito-Silva et al., 2009; Vorasan et al., 2015). Vitor-Silva et al. (2009) examined the relationship between malaria infections and school performance in children living in an endemic area where Plasmodium vivax is the species responsible for most of the cases. The study was conducted in the Municipality of Carreiro, Amazonas, and Brazil, which included children between the age of 5 to14 years old attending eight-grade public schools (Vitor-Silva et al., 2009). The authors concluded that nonsevere malaria compromises the school performance of children even during a 9-month follow-up, potentially, contributed to the underdevelopment in countries endemic to malaria infections (Vitor-Silva et al., 2009). Ncogo et al. (2015) employed a cross-sectional

survey design and introduced a multistage, stratified, cluster-selected geolocation techniques to assess the malaria prevalence in Bata District (urban and rural zones) of Equatorial Guinea. In the study, the authors concluded that in both zones, the age group affected the most with the malaria cases were children between the ages of 13 months to 14 years old (Ncogo et al., 2015).

Fernando et al. (2006) conducted a double-blind, placebo-controlled trial for 9 months duration to investigate the impact of malaria on the educational attainment of school children in a malaria-endemic area in southern Sri Lanka where both Plasmodium falciparum and Plasmodium vivax infections are prevalent. They suggested that educational attainment was significantly better among children whose compliance with chloroquine prophylaxis was higher (Fernando et al., 2006). Also, the authors showed that malarial attacks have adverse health impacts on the educational attainment of the school child and prevention of these attacks significantly improved the educational attainment of children living in malaria-endemic areas (Fernando et al., 2006). In contrast, Vorasan et al., (2015) concluded that malaria infection is not associated with school performance. They also suggested that the effects of uncomplicated malaria episodes on school performance may not be prolonged.

Mosquito Net Use Policy: IMVMP

Benelli and Beier (2017) evaluated the IMVMP challenges within the African continent. They suggested that the current methods of IRS have done little in the fight against malaria transmission and recommended the use of modern scientific technologies as part of the strategy in malaria vector control (Benelli & Beier, 2017). According to

Benelli and Beier , IRS and LLNs have impacted malaria incidence but have done very little on the prevalence of malaria. In 2015, malaria transmission has been ongoing in 91 countries and thirteen countries in sub-Saharan Africa (Benelli & Beier, 2017). The sub-Saharan Africa region accounts for 76% of malaria-infected cases and 75% deaths globally (Benelli & Beier, 2017). Add summary and synthesis throughout the paragraph to balance out the use of information from the literature with your own analysis.

Chanda et al. (2016) explored the effectiveness of IMVMP activities. They demonstrated that in high transmission areas, the application of a single approach has very little impact on malaria vector control (Chanda et al., 2016). An estimated 214 million malaria cases were registered, and 438,000 deaths occurred globally in 2015 (Chanda et al., 2016). sub-Saharan Africa has the highest malaria episodes with over 88% cases and 90% related deaths (Chanda et al., 2016). Add summary and synthesis throughout the paragraph to balance out the use of information from the literature with your own analysis

In another study conducted by Nartey et al. (2013), the effectiveness, contribution, and application of integrated vector control in terms of the *Bacillus thuringiensis (Bti)* prevention efficacy were explored. The approach focused on larvae at breeding sites in the Kumasi metropolitan area of Ghana (Nartey et al., 2013). In the study, *Bti* at a low dosage of 0.2 kg/ha was sufficient and effective against *Anopheles larvae*. Also, *Bti* could be used for the management of mosquitoes at the breeding sites (Nartey et al., 2013).

Integrated Malaria Vector Management Policy Analysis

Malaria remains the most important vector-borne disease in public health and the current intensification of malaria control efforts includes the delivery of a package of vector

control interventions aimed at controlling transmission (USAID, 2017). In Ghana, after extensive review and lessons learned from the successful scale-up of ITNs, and the introduction of IRS with limited larviciding, the National Malaria Control Programme adopted the IMVM with the principal objective to reduce malaria morbidity and mortality through the reduction of transmission levels (USAID, 2017). This policy seeks to outline the key intervention measures to guide and regulate the selection and implementation of appropriate strategies for malaria vector control (Ghana Health Service, 2017). The key intervention approaches outlined in the policy include the following;

- Insecticide treated Materials
- Adulticiding and larviciding
- Environmental management

To ensure the implementation of the policy is monitored and evaluated appropriately to meet the desired objectives and to inform future reviews of this policy, the Ministry of Health, in collaboration with accredited research institutions in the country, are expected to carry out the following purview measures:

- Entomological surveys across the various epidemiological strata of the country to evaluate the susceptibility, resistance development, changes in vector behavior, mutations, and other factors.
- Environmental impact assessment of all the interventions. In other words, the Ministry of Health ensures that impact studies are conducted to determine whether there is increasing use of the various interventions in an integrated manner for malaria vector control.

- ITMs, insecticides, etc., supplied, distributed, and used are safe and effective and are being disposed of properly after use.
- There is an increase in knowledge about integrated malaria vector management.

The IMVMP survey results are meant to be disseminated to the public.

According to Saaka and Glover (2017), one of the demerits of the IMVMP is the lack of or insufficient evaluation indicators to measure the effectiveness of the policy for either mosquito-borne illnesses or events. Other shortfalls include inappropriate use of insecticides, inadequate data on the malaria vector, inadequate resources, and shortage of trained personnel (Saaka & Glover, 2017). The analysis focus of the policy in this current study is presented in Table 1.

Table 1*: Integrated Malaria Vector Management Policy Analysis*

Policy	Objective	Key Elements
ITMs	The overall objective of the ITM policy is to increase the use of ITMs as a key strategy in malaria control	1. Increase demand and ensure the appropriate use of ITMs 2. Ensure standards and regulations 3. Ensure a supply of ITMs

Note: Table 1 shows the policies, objectives and key elements in the Integrated Malaria Vector Management Policy Analysis.

Integrated Malaria Vector Management (IMVMP) Approach

Africa accounted for most global cases of malaria (88%), followed by South-East Asia (10%) and Eastern Mediterranean (2%; Cibulskis et al., 2016). Most of these deaths occurred in Africa (90%), followed by South-East Asia (7%) and the Eastern Mediterranean (2%;Cibulskis et al., 2016). Children under five are particularly susceptible to malaria illness, infection, and death (Sultana et al., 2017). In 2015, 306,000 deaths among children under the age of 5 years occurred globally (Sultana et al., 2017). Add summary and synthesis.

IMVMP Approaches: Adulticiding and Larviciding Policy

The objective of the Adulticiding and Larviciding Policy of the IMVMP is to reduce the mosquito population density to decrease the rate of malaria transmission (citation). The key elements under this policy include LLNs (insecticide-treated net use), adulticiding (IRS and space spraying), larviciding, repellants (coils, personal sprays, creams, etc.), and biological control (fish, fungi, sterile insect technique). Adulticiding (IRS and space spraying) components of the policy strategy involve the IRS (McFee et al., 2018). A continuous annual spray cycle based on the climatic conditions of the specific area (. It also involves the implementation system that adheres to the internationally accepted standards and the national guidelines. Insecticides are specific groups of chemicals such as organochlorines, organophosphates, carbamates, and pyrethroids. Training and registration of spray operators by the standard criteria of Ministry of Health/Ministry of Food and Agriculture MOH/MOFA and the registration of commercial pest control companies implementing the IRS with the GHS/Disease Control Unit/National Malaria Control

Programme should be properly assessed (McFee et al., 2018). Add summary and synthesis throughout the paragraph.

Larviciding constitutes an integral part of an Integrated Malaria Vector Control Programme. Larviciding strategy of the policy is aimed at killing the mosquito larvae before they emerge as adults (Nartey et al., 2013). According to the IMVMP criteria, all the larvicides that are chosen should be World Health Organization Pesticides Evaluation Scheme (WHOPES) approved and registered by the Ghana Environmental Protection Agency (GEPA) for use as mosquito larvicides (Nartey et al., 2013). The use of *Bacillus thuringiensis (B.t.), B. sphaericus (B. s.)* and fish, such as guppies, as biological control agents should be used. Other forms of biological larvicide could be used as and when dictated by circumstance and type of water body (Sarwar, 2016). The application of larvicide should be controlled by adherence to manufactures instructions and national guidelines (Sarwar, 2016). Larviciding should only be used when breeding is found, not as a general measure (Sarwar, 2016). Repellants (coils, personal sprays, creams, etc.) are useful tools in the IMVMP application as well (Ghana Health Service, 2017). As stipulated by the policy, the types of coils and other repellants should be approved and registered with the Food and Drug Board FDB and EPA (Ghana Health Service, 2017). Public awareness of the benefits of using repellants should be intensified through education, information, and communication using all media forms and health personnel (Ghana Health Service, 2017). Add summary and synthesis throughout the paragraph to balance out the use of information from the literature with your own analysis.

Environmental Management Policy

Environmental management involves the planning, organization, implementation, and monitoring of activities for the modification and/or manipulation of environmental factors, or its interaction with humans to prevent or minimize vector propagation and reduce human-vector pathogen contact (Ghana Health Service, 2017). The main objective of the Environmental Management Policy of the IMVMP is to ensure and advocate for practices to reduce factors in the environment that contribute to the breeding of mosquitoes and malaria transmission (Ghana Health Service, 2017). The Environmental Management Policy are grouped into three main categories: (a) environmental modification, (b) environmental manipulation, and (c) modification of human habitations and behaviors (Ghana Health Service, 2017).

The environmental modification involves the physical change of the environment (often long term) to potential breeding areas designed to prevent, eliminate, or reduce vector habitat (Ghana Health Service, 2017). The main activities under this policy are to carry on advocacy for environmental management, advocate for the provision of well sloped secondary and tertiary drains, construct soak-away pits where applicable, enforce environmental by-laws on reclamation of degraded lands such as galamsey (illegal gold mining term in Ghana) and sand winning lands (Ghana Health Service, 2017). The approach also promotes the following: (a) line sides and bottom of drains with concrete material, (b) drain marshes through pumping, (c) creation of channels to improve water flow, and (d) design water holding structures such as in minidams and small-scale irrigation projects appropriately to prevent mosquito breeding (Ghana Health Service, 2017). Other

medication options include (a) planting shade trees near potential *Anopheles gambiae* and *Anopheles funestus* larval breeding habitats, (b) reclaiming sand winning and mining degraded lands, (c) filling pits from roads and housing construction sites, (d) using larvivorous fishes in fishponds (e.g. tilapia, goldfish, etc.), and (e) planing new settlements well before development are recommended (Ghana Health Service, 2017). Add summary and synthesis to connect back to your study.

Environmental manipulation refers to activities that reduce larval breeding sites of the vector mosquito through temporary changes to the aquatic environment in which the larvae develop (Ghana Health Service, 2017). The main activities under this policy includes the filling potholes, excavations and dug-out pits, empty water in bathroom catch-pits daily, clear irrigation channels, drain empty tins, car tires, abandoned fridges, vehicles, televisions, etc. to prevent breeding of other mosquitoes such as *Aedes aegypti* (Ghana Health Service, 2017). Add summary and synthesis throughout the paragraph to balance out the use of information from the literature with your own analysis.

Modification of human habitations and behaviors of the Environmental Management Policy of the Integrated Malaria Vector Control Programme refers to the changes in placement and structures of human habitation as well as changes in behavior to reduce human-vector contact (Ghana Health Service, 2017). The main activities under this policy are to properly equip the environmental health officers to deliver their services including mosquito control responsibilities, enforce building regulations (e.g. institute certificate of habitation for new buildings; Ghana Health Service, 2017). Involved informing local mosquito control committees in urban and rural communities to work in

collaboration with the environmental health units (Ghana Health Service, 2017). It also involves the improvement of housing design and construction (e.g. screen doors, windows and eaves with mosquito-proof materials), repair cracks and holes of houses through which mosquitoes enter, build new houses away from swampy and water-logged areas (Ghana Health Service, 2017). Preferred housing sites should also be on well-drained, high ground, cover water storage containers to prevent the breeding of other mosquito species (Ghana Health Service, 2017). Arrange to clothe in thatched houses properly, i.e. fold clothes instead of hanging them to deprive mosquitoes of harborages, intensify industrial engineering consultants (IEC) on the impact of human behavior on mosquito breeding and malaria transmission, and sensitize key politicians on mosquito breeding and malaria transmission (Ghana Health Service, 2017). Add summary and synthesis throughout the paragraph to balance out the use of information from the literature with your own analysis. Develop a strong conclusion for the section.

The Relevance of the Problem

Malaria is a major threat to public health in Ghana and the burden of the disease affects the quality of life and life expectancy of children. It is also the leading cause of morbidity and mortality among children under five years in the country (Nonvignon et al, 2016). Besides, it has been identified as the leading cause of absenteeism among school-age children in Ghana (Baafi & Kodzitse, 2010). In Ghana, malaria accounted for outpatient visits (38%), admissions in health facilities (27.3%), and deaths among children under the age of 5 years old in 2015 (48.5%) . It is also one of the leading causes of

morbidity and mortality (Ghana Health Service, 2014). Ghana and nine other countries in SSA accounted for more than 60% of malaria related-deaths in 2012 (WHO, 2014).

Several studies conducted among children with severe *Plasmodium falciparum* malaria focusing on neurological sequelae showed some impairment in developing cognitive abilities after the acute episode, both in the short-term and long-term exposures or observations (Boivin et al., 2007; Carter, et al., 2005). According to Kihara et al. (2006), deficits in all categories of cognition (attention, memory, visual-spatial skills, language, and executive functions) may occur after severe *Plasmodium falciparum* infection, but also appear to occur after less severe infections. It appears that the effects of repetitive episodes of *Plasmodium falciparum* infections on the cognitive development of children needed more and serious attention by all stakeholders involved– parents, government, and other well-meaning organizations.

This study, therefore, serves to provide empirical evidence and reason for the need to further explore the effect of malaria infections on children's cognitive development by investigating the association between malaria infections and insecticide-treated net and non-treated mosquito net use among children in the Greater Accra Region of Ghana. The association between mosquito net use policy and malaria infections among children in the Greater Accra Region of Ghana will also be explored. Two important sources, including (a) research findings that confirm the prevalence of malaria and (b) current literature on the effect of malaria infection on the cognitive development and net use among children in families that have ITN and non-treated mosquito bed net, will demonstrate the relevance of the stated research problems.

According to the WHO (2017), in 2016, an estimated 216 million cases of malaria occurred worldwide (with a 95% confidence level and raged between 196–263 million cases), compared to 237 million cases in 2010 (95% CI: 218–278 million) and 211 million cases in 2015 (95% CI: 192–257 million). Out of the 91 countries reporting indigenous malaria cases in 2016, about 15 countries – all in sub-Saharan Africa, except India – carried 80% of the global malaria burden or deaths (WHO, 2017). The incidence rate of malaria was estimated to have decreased by 18% globally, from 76 to 63 cases per 1000 population at risk, between 2010 and 2016 (WHO, 2017). The WHO South-East Asia region recorded the largest decline (48%) followed by the WHO Region of the Americas (22%), and the WHO African region (20%) (WHO, 2017). Despite these reductions, between 2014 and 2016, substantial increases in case incidence occurred in the WHO Region of the Americas, and marginally in the WHO South-East Asia, Western Pacific, and African regions (WHO, 2017).

According to the WHO (2017) malaria report, in 2016, there were 445,000 deaths from malaria globally, compared to 446,000 estimated deaths in 2015. The WHO African regions accounted for 91% of all malaria deaths in 2016, followed by the WHO South-East Asia Region (6%), estimations that are similar to the 2015 risk evaluation (WHO, 2017). All regions recorded reductions in mortality in 2016 when compared with 2010, except for the WHO Eastern Mediterranean region, where mortality rates remained virtually unchanged in that period. The largest decline occurred in the WHO regions of South-East Asia (44%), Africa (37%) and the Americas (27%) . However, between 2015 and 2016,

mortality rates stalled in the WHO regions of South-East Asia, Western Pacific, and Africa, but increased in the Eastern Mediterranean and the Americas (WHO, 2017).

Perhaps, malaria epidemic is an urgent health issue and should be addressed as a public health and epidemiologic priority. Malaria and the costs of treatment are an economic and health burden to families, especially those in poor developing countries or regions (Ghana Health Service, 2016; Modern Ghana, 2014). Currently, 3.2 billion (almost half of the world population) are at risk (UNICEF, 2017). Since 2000, the cost associated with malaria within sub-Saharan Africa is approximately $300 million (US dollars) each year for case management alone, and it is estimated to cost up to 1.3% of the African GDP (UNICEF, 2017). Some of the challenges discussed that prevents countries' abilities to stay on track and advance towards the elimination of malaria include lack of sustainable and predictable international and domestic funding; risks posed by conflict in malaria-endemic zones; anomalous climate patterns; the emergence of parasite resistance to antimalarial medicines, and mosquito resistance to insecticides (Akpalu & Codjoe, 2013; WHO, 2017).

Malaria infection has a tremendous effect on children. According to UNICEF (2016), malaria is the number one killer of children (UNICEF, 2017). Malaria kills one child every 30 seconds, and about 3000 children every day (UNICEF, 2017). Over one million people die from malaria each year, mostly children under five years of age (UNICEF, 2017). According to UNICEF, in 2016, there were 216 million malaria cases that led to 440,000 deaths, an estimate similar to the WHO report (UNICEF, 2016). Out of the reported cases in 2016, about 70% were children under the age of 5 years old (put citation here). The estimate represented a daily toll of about 800 children under the age of

5 years old (UNICEF, 2016). Most of these deaths occurred in sub-Saharan Africa (UNICEF, 2016). Since 2010, mortality rates among children under five decreased by 37% (UNICEF, 2016).

Literature Search Strategy

Literature searches were carried out using electronic databases. The Academic Search Premier, CINAHL, Google Scholar, Google, PubMed or Medline, WHO, Library database and the CDC were databases through which relevant information or literature searches about the study topic were obtained. Information for this literature review was also acquired through electronic versions of dissertations found on the Walden University website, and other electronically accessible thesis and dissertations available from other school websites. Additional articles were identified by searching the bibliographies of research papers or articles.

Searches were conducted using key search terms based on word combinations, including *malaria prevalence, malaria prevalence in Africa, malaria prevalence in Ghana, malaria prevalence in children* [TX All Text]. The key search terms are listed in Table 2 below. Search terms also included *global malaria, malaria in Africa,* and *malaria in Ghana* [TX All Text]. Other searches related to malaria prevalence and mosquito net use included: *Malaria and Cognitive deficit, Malaria and cognitive function, Malaria and educational attainment* [TX All Text].

A sample of the aggregate result from the literature search using the terms specified above in *PubMed* are as follows: *Malaria prevalence* resulted in 23,762 articles out of which 68 articles were selected, representing 29%. Out of 68 articles,15 (22.06%) were

used for the literature review because they were within five years of publication and directly related to the study. In contrast, out of 68 articles, 43 (63.24%) were not used because they were too broad and not very specific to the research. *Malaria prevalence in Africa* produced 10,665 articles and only 26 articles were selected which represented 24% of the literature. Out of 26 articles, only 14 (53.85%) were specifically related to this current study. On the other hand, 12 (46.15%) unrelated journals were not selected out of 26 articles.

Malaria prevalence in Ghana generated 636 articles but only 22 articles were selected which represents 3.46% journals. Out of 22 articles, 6 (27.27%) were chosen while 16 (72.73%) were found to be too broad and were not selected for the literature review.

Malaria prevalence in children produced 9,295 articles and 25 articles were selected for further screening which represented 0.27% of the articles. Out of 25 journals, 5 articles (20%) were within five years and were used for the literature review. Out of the 25 articles, 20 (80%) were found to be too general and were rejected for the literature review. For the *global malaria* search term using google, scholars yielded 17,700 articles but only 26 articles were selected for review representing 0.15% of the total articles. Out of the 26 articles, 2 (7.7%), were selected and included in the literature review. However, 24 (92.3%) out of 26 articles were rejected because the contents were broad. *Malaria in Africa produced* 4,774 articles of which 25 were selected for further screening. This represented 0.52% of the articles, but 15 (60%) out of 25 articles were selected for the study. Out of 25 articles, 10 (40%) were rejected for being too broad.

Malaria and cognitive function also produced 181 journal articles and while 18 were selected representing 9.94% of the literature. Out of 18, the number of articles included in the literature review was reduced to 7 (38.89%). Out of 18 articles, 11(61.11%) could not be used for the literature review because they are not specific to the topic under investigation. The search term '*Malaria and educational attainment'* generated 241 articles of which 21 (8.71%) were selected. Out of the 21 articles, 5 (23.81%) were qualified for inclusion because they were within the 5 years requirement range. In contrast, out of 21 articles, 16 (76.19%) were older than the five years and were rejected for the literature review discussed in Table 2.

The study gathered relevant information on references from peer-reviewed published articles within databases such as PMC (*PubMed*), BMC (*BioMed Central*), *Public Health*, *AcademicJournal*, and *Malaria Journal*). The articles reviewed were published from 1979 to 2017. Most of the articles were current and within 5 years. Literature from 1979 were articles published on the theoretical framework used in the study. Websites such as the WHO, CDC, UNICEF, Ministry of Health – Ghana, were explored for relevant articles. Individual medical journals were searched regarding malaria prevalence including references for literature libraries. Extensive literature reviews were carried out to determine the appropriateness of the theoretical framework (Social-Ecological Model (SEM)) used in this study. The SEM is discussed in the next section of this chapter.

Table 2: ***Keywords for the Literature Search and Key Electronic Databases***

Search Element	PubMed	Google Scholar	Google
Keywords	Malaria prevalence	Malaria prevalence	Malaria prevalence
	Malaria prevalence in Africa	Malaria prevalence in Africa	Malaria prevalence in Africa
	Malaria prevalence in Ghana	Malaria prevalence in Ghana	Malaria prevalence in Ghana
	Malaria prevalence in children	Malaria prevalence in children	Malaria prevalence in children
	Malaria burden	Malaria burden	Malaria burden
	Plasmodium falciparum	*Plasmodium falciparum*	*Plasmodium falciparum*
	Falciparum malaria	Falciparum malaria	Falciparum malaria
	Cerebral malaria	Cerebral malaria	Cerebral malaria
	Malaria and cognitive function	Malaria and cognitive function	Malaria and cognitive function
	Malaria and educational attainment	Malaria and educational attainment	Malaria and educational attainment

Note: table 2 shows keywords for literature search to be used in this study for Pubmed, Google Scholar and Google search engines.

Theoretical Foundation: Social-Ecological Model

The Social-Ecological Model is the theoretical framework chosen for this study. The SEM was derived from the Systems' Theory (Urie Bronfenbrenner, 1979). It consists of personal and environment-focused interventions designed to promote health (CDC, 2015). The SEM focuses on how the environment and people influence each other (CDC, 2015). The SEM operational foundation is based on the proposition that the individual efforts at the behavioral change are more likely to succeed within supportive environments than any other environment (Mcleroy, Bibeau, Steckler, & Glanz, 1988; Reis et al., 2015). The model could be used to target the social, institutional, and cultural environments in addition to biologic processes and geographic issues for health promotion measures or evidence-based interventions (EBI) (Caprara et al., 2015).

According to the SEM, human behavior is shaped by recurring patterns of activity that take place in structured environments; examples include residential, educational, occupational, recreational, religious, and healthcare environments (McLeroy et al., 1988). These environments have a cumulative influence on population or individuals' well-being. These social roles, personal behaviors, and situational conditions are leverage areas where the health promotion programs could be applied to accomplish the maximal amount of behavioral change possible (Stokols, 1996).

Several versions of SEM have been developed. The initial and most commonly used model was authored by Urie Bronfenbrenner (1979), which is called the Ecological Systems Theory. His work was influenced by Kurt Lewin's proposition that behavior is influenced by the person and the environment (Bronfenbrenner, 1979). McLeroy, Bibeau,

Steckler, and Glanz (1988) developed another version of the SEM. The chief idea is that health status is determined by influences at multiple levels (e.g., public policy, community, institutional, interpersonal, and intrapersonal factors) (McLeroy, Bibeau, Steckler, & Glanz, 1988).

The SEM by McLeroy et al. (1988) is a theory-based framework for understanding the multifaceted and interactive effects of personal and environmental factors that determine behaviors, and for identifying behavioral and organizational leverage points and intermediaries for health promotion within organizations (McLeroy et al., 1988). The SEM concept promotes focus beyond the individual-level behavior and toward an understanding of a wide range of factors that influence health outcomes (CDC, 2015).

This model provides a theory-based framework for understanding how the social determinants of health influence and maintain health-related issues. This can help identify promising points of intervention and provide a better understanding of how social problems are produced and sustained within and across the various subsystems (Texas HIV/STD Prevention Community Planning Group, 2011). For instance, provides an in-depth understanding of an individual's decisions and behaviors outcome from interactions with the social surroundings. According to Moore, Murphy, and Moore (2011), SEM encourages holistic interventions in settings appropriate for health promotion measures. It also addresses the explicit understanding of how focused interventions' effectiveness, efficiency, and sustainability might depend on factors at other levels of the system interactions (Moore, Murphy, & Moore, 2011). The five nested and hierarchical levels (the

individual, interpersonal, community, organizational, and policy or enabling environments) of the SEM as described above are represented in Table 3.

Table 3: *Description of the Social-Ecological Model (SEM) Levels Continued*

Institutional/Organizational	• Organizations or social institutions with rules and regulations for operations that affect how, or how well, for example, MNCH services are provided to an individual or group.
Policy/Enabling Environment	• Local, state, national and global laws and policies, including policies regarding the allocation of resources for maternal, newborn, and child health and access to healthcare services, restrictive policies (e.g., high fees or taxes for health services), or lack of policies that require childhood immunizations.

Note. Adapted from the Centers for Disease Control and Prevention (CDC, 2014), The Social-Ecological Model.

According to McLeroy et al. (1988), health status and behavior are the outcomes of interest and determined by the following:

(1) Intrapersonal factors — characteristics of the individual such as knowledge, attitudes, behavior, self-concept, skills, and developmental history.

(2) Interpersonal processes and primary groups — formal and informal social networks and social support systems, including family, workgroup, and friendship networks.

(3) Institutional factors — social institutions with organizational characteristics and formal (and informal) rules and regulations for operations.

(4) Community — relationships among organizations, institutions, and informational networks within defined boundaries.

(5) Public policy — local, state, national, and global laws and policies.

An implicit assumption of these levels of analysis is that health promotion interventions are based on the beliefs, understandings, and theories of the determinants of behavior and that these five levels of analyses reflect the range of strategies currently available for health promotion programming (McLeroy et al., 1988). Other levels of analyses could be employed to understand the causes and potential interventions that could modify health-related behavior (McLeroy et al., 1988). Several studies have examined the application of the social-ecological model in the context of malaria. Similarly, Azunie (2017) conducted a study on an integrated approach to examine malaria prevention and control in rural Cameroon. In the study, the goal was to provide information necessary to bridge the gap on the lack of proper use of insecticide-treated nets (ITNs) and antimalarial drugs and to also understand the roles of education and socioeconomic status in malaria prevention and control efforts in rural Cameroon (Azunie, 2017).

In the study, the socio-ecological model was applied in the quantitative cross-sectional study as the basis for the theoretical framework to explain the observed phenomenon (Azunie, 2017). Secondary data from the 2011 Cameroon Demographic and Health Survey, with a sample size of 216 was used in the study (Azunie, 2017). The result showed that there was a significant association ($p < 0.05$) between proper use of ITNs and

malaria prevalence among children under 5 years old accounting for education, proper use of antimalarial drugs, socioeconomic status, and health-seeking behaviors (Azunie, 2017). There was also a significant association between healthcare preference and malaria treatment outcomes among children under the age of 5 years and pregnant women (Azunie, 2017).

Khairy et al. (2017) assessed the level of knowledge, attitudes, and practices (KAP) concerning malaria and malaria prevention among rural populations residing in the southwestern region of Saudi Arabia using the social-ecological framework. The study was a household-based cross-sectional survey. A structured questionnaire approach was developed and distributed among randomly selected households from 19 villages (clusters) located in a southwestern region of Saudi Arabia and north of the border with Yemen (Khairy et al., 2017). The majority of respondents (98.4%) reported that they had heard about malaria, but only 21.7% reported that they had sufficient information about the disease (Khairy et al., 2017). Surprisingly, the most popular source of information was the internet and social media (25.5%), followed by family (21.7%), while information from health facilities contributed to only 12.4% (Khairy et al., 2017). Most respondents were aware that malaria is a communicable (89.1%) and deadly (70%) disease; however, only 30.2% of the respondents understood that malaria is a treatable disease (Khairy et al., 2017).

Almost all the respondents (97.5%), those that are aware of the disease or knew about malaria were inclined to seek treatment from health facilities, and 63.2% preferred to seek treatment within 24 hours of presenting with the symptoms (Khairy et al., 2017).

Regarding personal precautions, the most widespread practices adopted by respondents are indoor residual spraying (IRS) (47.3%), followed by anti-mosquito spraying (29.8%), mosquito bed nets (13.2%), and combined anti-mosquito sprays and nets on windows (4.7%) (Khairy et al., 2017). The KAP study did not show any statistically significant differences (Khairy et al., 2017). However, the practices of preventive measures against malaria differed significantly by nationality (Saudis versus non-Saudis) (Khairy et al., 2017). The authors concluded that most populations living in the villages have an acceptable level of knowledge and awareness about malaria and seek timely treatment (Khairy et al., 2017). However, the positive attitudes and practices concerning personal protection and prevention measures against malaria require marked improvement (Khairy et al., 2017). The obvious gap between the knowledge and practice related to malaria prevention requires innovative strategies based on the local evidence that suits the immediate circumstances to promote and encourage the adoption and practice of personal protective measures against malaria (Khairy et al., 2017).

Dlamini et al (2017) assessed the knowledge and perceptions of malaria issues to identify practices that support or hinder the progress of malaria control programs, within the framework of the social-ecological model. A triangulation study involving individual interviews, focus group discussions, and an observatory analysis between 2003 and 2010 at Lomahasha, a malarious community on the eastern border of Swaziland and Mozambique, was conducted (Dlamini et al., 2017). The results of the study indicated that a high knowledge level and good perception of the disease were observed among individuals younger than 40 years old, an observation contrary to those in the higher age

groups (Dlamini et al., 2017). However, the behavior of certain community groups included practices that were not supportive of the national control program's aspirations, such as delay in seeking medical attention, staying outdoors until late, maintaining stagnant water on roadside excavations, and seeking medical assistance from wrong sources (Dlamini et al., 2017). Malpractices were also common among men, boys, and those who drink alcohol (Dlamini et al., 2017).

Clouston, Yukich, and Anglewicz (2015) examined the role of socioeconomic inequalities by broadly predicting malaria knowledge and use of preventive technology among women aged 15–49, and malaria among children aged 6–59 months in Madagascar, using the social-ecological model. Data came from women aged 15–49 years (N = 8279) interviewed by Madagascar's 2011/2013 Malaria Indicator Studies, and their children under the age of 5 years old (N = 7644) (Clouston, Yukich, & Anglewicz, 2015). Because geographic location may be associated with socioeconomic factors and exposure to malaria, multilevel models were used to account for unobserved geographic and administrative variation (Clouston et al., 2015). Models also account for observed social, economic, demographic, and seasonal factors (Clouston et al., 2015). The prevalence of malaria among children aged 4 years old and younger was 7.8 % (Clouston et al., 2015). Results showed that both mother's education and household wealth strongly influence knowledge about efforts on malaria prevention and treatment (Clouston et al., 2015). Also, the prevalence of malaria among children aged 6–59 months was influenced by household wealth (richest vs poorest: *OR = 0.25, 95 % CI [0.10, 0.64]*) and maternal education (secondary vs none: *OR = 0.51, 95 % CI [0.28, 0.95]*) (Clouston et al., 2015). The authors

suggested that malaria may be subject to socio-economic forces arising from a broad set of behavioral and geographic determinants, even after adjusting for geographic risk factors and seasonality (Clouston et al., 2015). Nearly 21 % of the sample participants lacked primary schooling (Clouston et al., 2015). They concluded that to improve malaria reduction efforts, broad-based interventions may be needed to address inequalities, preventive measures, treatment improvements, and awareness or knowledge acquisition on the issue among those who are most vulnerable (Clouston et al., 2015).

Serengbe et al. (2015) applied a pilot survey in communities in the Central African Republic to evaluate malaria symptoms, perceptions of the causes, and knowledge of key preventive measures using the social-ecological framework. The cross-sectional study was conducted in four districts (Serengbe et al., 2015). Households were randomly selected through multi-stage cluster sampling from the village (Lobaye, Ouham, and Ouaka) and boroughs (Bangui City) as the first-stage units and households as the second-stage units (Serengbe et al., 2015). A total of 2,920 householders were interviewed (Serengbe et al., 2015). Most of the respondents attributed malaria to mosquito bites (65.5%), but less than 50% were familiar with the classical symptoms of malaria (Serengbe et al., 2015). Hygiene and sanitation were the most frequently mentioned methods for preventing malaria (81.1%) (Serengbe et al., 2015). Despite the relatively high rate of ownership of insecticide-treated nets (72.1%), the community perception of these nets as a preventive measure against mosquito bites was very low (6.5%) (Serengbe et al., 2015). Based on the study, the perceptions about mosquitoes' role with malaria transmission were encouraging; however,

increased awareness about the usefulness of insecticide-treated nets for malaria prevention must be advanced (Serengbe et al., 2015).

Nsagha and Njamnshi (2010) studied the knowledge, attitudes, and practices relating to malaria in a semi-urban area of Cameroon, using the social-ecological model, *to* understand how people recognize malaria, its cause, and prevention including identification of personal modifiable behaviors that are important in planning approaches for its prevention and control. A structured questionnaire on malaria determinants was administered to inhabitants of a malaria-endemic setting in a cross-sectional study (*Nsagha & Njamnshi, 2010)*. A majority (97.64%) of the respondents knew at least a symptom of malaria (*Nsagha & Njamnshi, 2010)*. Symptoms such as 'nyor yayan', 'mbeb kansi', 'tu-lu', 'chirr', and 'mngan yayan' corresponded respectively to fever, chills, headache, vomiting, and joint pains agree with the description of orthodox medicine (*Nsagha & Njamnshi, 2010)*. The commonest (15%) symptom mentioned was a headache (*Nsagha & Njamnshi, 2010)*. The respondents had a rating score of 27.7% for the cause of malaria to be mosquito bites (*Nsagha & Njamnshi, 2010)*. Some incorrect causes of malaria mentioned included bad weather (9.5%), the curse from an elder (7.1%), witchcraft (3.5%), unhealthy food (9.0%), unclean water (5.9%) and drinking alcoholics (2.4%) (*Nsagha & Njamnshi, 2010)*. About 60.5% of respondents reported practicing a correct preventive measure against malaria (*Nsagha & Njamnshi, 2010)*. Prominent correct preventive measures included environmental sanitation (21.3%), use of aerosol insecticides (10.3%), mosquito coil (7.9%), chemoprophylaxis (5.9%), mosquito net (1.2%) and traditional medicines (13.8%), as well as incorrect methods such as avoiding the hot early morning

sun rays (9.5%) (*Nsagha & Njamnshi, 2010)*. The practice of malaria prevention was found to be related to the educational status of the participants with less educated people practicing it more than educated people (*Nsagha & Njamnshi, 2010)*. Based on the findings, proper health education messages on malaria determinants were required to improve upon the understanding of the study population (*Nsagha & Njamnshi, 2010)*. This could be done by using non-scientific term messages with the help of the village members and community health workers (*Nsagha & Njamnshi, 2010)*.

Behavior change is notoriously difficult to initiate and sustain, and the reasons why efforts to promote healthy behaviors fail are coming under increasing scrutiny. To be successful, health interventions should build on existing practices, skills, priorities, and recognize the constraints on human behavior (*Nsagha & Njamnshi, 2010)*. Community mobilization or targeted intervention among those receptive to change should be maintained and encouraged (*Nsagha & Njamnshi, 2010)*. Furthermore, interventions should strive to be culturally compelling, not merely culturally appropriate (*Nsagha & Njamnshi, 2010). In other words, interventions* must engage local communities and nestle within social and ecological landscapes (*Nsagha & Njamnshi, 2010)*.

In this study, the social ecology perspective was proposed to advance explicit links between intention to change, actual behavior change, and subsequent health impact, as the basis for both theory-based models and practical strategies in triggering behavior change. A social ecology model focuses attention on the contexts of behavior when designing, implementing or critically evaluating interventions (Stokols, 1996). Panter-Brick et al. (2005) conducted a community-directed intervention in the rural Gambia designed to

reduce malaria by promoting a relatively simple and low-cost behavior: repairing holes in mosquito bednets. In phase 1, contextual information on bed net usage, transactions, and repairs (the ‘social lives' of nets) were documented (Brick et al., 2005). In phase 2 (intervention), songs were composed, and posters displayed by community members to encourage repairs, creating a sense of ownership, and a compelling medium for the transmission of health messages (Brick et al., 2005). In phase 3 (evaluation), qualitative and quantitative data showed that household responses were particularly rapid and extensive, with a significant increase in bed net repairs, despite considerable constraints on the human agency (Brick et al., 2005). They highlighted a promising approach—using songs—as a vehicle for change, and present a framework to embed the design, implementation and critical evaluation of interventions within the larger context—or social ecology—of behavior practices that are the bedrock of health interventions (Brick et al., 2005).

The SEM is the theoretical model that is the best fit for this study. The model addresses the complexities and interdependences between socioeconomic, cultural, political, environmental, organizational, psychological, and biological determinants of behavior (Stokols, 1996). It recognizes that whereas individuals are responsible for establishing and retaining lifestyle changes necessary to reduce risk and improve health, individual behavior is influenced by factors at various levels of the model (Elder et al, 2007). In this study, the five levels of the SEM identified by McLeroy et al. (1988) were applied to explain the association between malaria infections and ITN, and also to examine

the association between insecticide mosquito net use policy and practices and bed net utilization among children.

Intrapersonal level. At the intrapersonal level, considering the fact parents have a lot of influence over their children, especially, juveniles, there is however no intrapersonal level of influence for malaria prevalence among children, rather the intrapersonal level of malaria prevalence among the children is determined by that of their parents (McLeroy et al., 1988). It appears the application of the SEM in this study deals with the characteristics of the parents such as knowledge, attitude, belief, level of education, gender, and socioeconomic status. These characteristics may affect the likelihood of a parent to engage in the proper use of malaria preventive measures (net use). In return, it could affect malaria prevalence and frequency of episodes among the school children, and in effect influence children's school performance.

Interpersonal processes and primary groups level. The Interpersonal processes and primary groups' level includes family, friends, spouse, culture, ethnic group, tradition, and caretaker behavior (McLeroy et al., 1988). The level involves relationships and interactions between individuals in a community that has a considerable influence on how the individuals engage in the proper use of malaria prevention measures. In malaria prevention and control, the family unit is the most common target for interpersonal interventions (Amoran 2013; Andrew et al., 2014; Diala et al., 2013). Amoran (2013), stressed that families are the primary context within which most health problems and illnesses occur, and they exert a powerful influence on the person's health outcome, in this case, that of the school children. Interpersonal processes and primary groups of the parents influence the

school children the proper use of malaria prevention measures including going to the hospital for proper malaria diagnosis and taking a proper dosage of antimalarial drugs. These factors depend on family support, relationship with healthcare providers, socioeconomic status, and disclosure of health status (Amoran 2013; Andrew et al., 2014; Diala et al., 2013). This level of SEM provides avenues to fully grasp the influences of the multi-interrelated factors that make it difficult for those vulnerable school children to have proper malaria prevention and control. This, therefore, could influence malaria prevalence and frequency among the school children, and in the long run, affects their performance at school.

Institutional level. At the institutional level, various community groups can educate members about the proper use of malaria preventive measures like the ITN, antimalarial drug, importance of taking the recommended full curative dose, and disseminating information that can be understood and assist them in making better personal choices (Amoran, 2013; Andrew et al., 2014; Diala, et al., 2013). Institutions provide important economic and social resources, for example, village associations provide financial resource to village at an affordable interest rate for villagers to be able to borrow money to improve their businesses, pay hospital bills, and build homes that are ventilated (Amoran, 2013; Andrew et al., 2014; Diala, et al., 2013). Institutions also transmit social norms and values to the public and therefore great element in the SEM to educate and empower rural people about malaria and to take ownership of the preventive activities within their communities to improve malaria prevention, especially among the school children, which could have impact on their school performance (Amoran, 2013; Andrew et al., 2014; Diala, et al.,

2013). The level of the SEM constructs was measured in the study by identifying the family income, and the geographical location or place of residence of the parents of the school children.

Community Level. This includes the location in the community, built environment, neighborhood associations, community leaders, etc (Amoran, 2013; Andrew et al., 2014; Diala, et al., 2013). The availability and location of resources that promote health such as health centers, transportation, skilled health professionals, consistent medication supply, communication using various local media, and community health workers who provide one-on-one information on proper use of medication and education on how use treated bed nets are crucial for a community to engage in effective malaria prevention (Amoran, 2013; Andrew et al., 2014; Diala, et al., 2013). Therefore, the community in which the parents of the school children live also affects malaria prevalence and the frequency among the school children, which may influence the performance of the school children. This level of the SEM is measured in this study by identifying the geographical location or place of residence of the parents of the school children.

Policy Level. The policy level refers to legislation, regulatory or policy-making actions that have the potential to affect how malaria preventive tools are properly used to effect change in malaria prevalence (Ghana Health Service, 2016). These are often formal legal actions taken by local and national governments but also can be informal local policies or rules in settings such as schools and various community groups. Policies should be in place to promote community accessibility of malaria services, promote local understanding and ownership of malaria preventive activities.

In addtiion, the policy should encourage corporation between health workers and community leaders to ensure that any loopholes in providing malaria services in the community are properly addressed. The government of Ghana through the Ministry of Health made several interventions in the prevention of malaria, including the campaign to sleep under treated mosquito nets as well as the free distribution of mosquito nets to pregnant women and school children (Ghana Health Service, 2016). In May 2016, under the auspices of the National Malaria Control Program (NMCP) of the Ghana Health Service in collaboration with Schools Health Program of the Ghana Education Service, over one million children in 14,000 public and private primary schools in the six southern regions of the country will benefit from a free distribution of Long Lasting Insecticide Nets (LLINs) Campaign (Ghana Health Service, 2016). The initiative is also supported by the USAID/PMI Vector Works project (Ghana Health Service, 2016). This campaign forms part of Ghana's intervention to sustain the prevention of malaria by targeting primary school children in the Eastern, Volta, Central, Western, Ashanti and Brong Ahafo regions of Ghana (Ghana Health Service, 2016). The challenge, therefore, is to accurately capture whether the school children sleep under the LLINs, had access to the LLINs, and whether the parents ensure that the children sleep under the LLINs. These measures could be evaluated based on whether the school children sleep under LLINs or other mosquito nets. In summary, the social-ecological model will be used to explain the relationship between malaria infection and insecticide-treated net and non-treated mosquito bed net use among school children.

School Performance and Malaria Infections

Several studies have examined the effect of malaria infection and school performance in the context of experimental data or non-archival data. Fernando et al. (2006) investigated the impact of malaria and its prevention on the educational attainment of school children in a malaria-endemic area of southern Sri Lanka where both *Plasmodium falciparum* and *P. vivax* infections are prevalent. A double-blind, placebo-controlled trial approach was employed in a nine months duration (Fernando et al., 2006). A total of 587 children attending grades 1–5 in four schools and residents in the area were randomly allocated to chloroquine (n =295) and placebo (n =292) arms (Fernando et al., 2006). Language and mathematics scores of end-of-term school examinations for 1998 and 1999 and the number of days absent and reasons for absenteeism for seven months pre-intervention and nine months of the intervention were recorded (Fernando et al., 2006).

The results indicate that there were no differences in language (95% confidence interval [CI] = 48.44–53.78 in chloroquine group and 50.43–55.81 in placebo group) and mathematics (95% CI=49.24–54.38 in chloroquine group and 51.12–56.38 in placebo group) scores between the two groups prior to the intervention (Fernando et al., 2006). During the intervention, the malaria incidence rate decreased by 55% (95% CI = 49–61%) and school absenteeism due to malaria was reduced by 62.5% (95% CI = 57–68%) in children who received chloroquine compared with the placebo group (Fernando et al., 2006). Post-intervention, children who received chloroquine scored approximately 26% higher in both language (95% CI =21–31%) and mathematics (95% CI =23–33%) than children who received a placebo (Fernando et al., 2006). In a multivariate model,

educational attainment was significantly associated with taking chloroquine prophylaxis and absenteeism due to malaria for both) but not due to health causes other than malaria or non-health causes (Fernando et al., 2006). Language scores were associated with several malaria attacks (Fernando et al., 2006). Educational attainment was significantly better among children whose compliance with chloroquine prophylaxis was higher (Fernando et al., 2006). The authors, therefore, suggested that malarial attacks harm the educational attainment among school children and that prevention of these attacks significantly improves the educational attainment of children living in malaria-endemic areas (Fernando et al., 2006).

Malaria and Mental/Cognitive Impairment

Malaria hampers children's schooling and cognitive development. Many children who survive a serious malaria attack develop physical and mental impairment (UNICEF, 2017). Evidence suggests that malaria can impair cognitive development (Holding & Snow, 2001). Cerebral malaria – malaria accompanied by coma – can cause severe neurological impairment in survivors, including speech and behavioral disorders, hearing impairment, blindness, epilepsy, hemiplegia, and cerebral palsy (Brewster, Kwiatkowski & White, 1990; Jukes et al., 2006). Less severe impairments in cognitive functions were observed in children, at least within 2 years after an episode of cerebral malaria (Carter et al., 2006).

Fink et al. (2013) assessed the associations between early childhood exposure to malaria and pre-school development and suggested that exposure to the malaria parasite is associated with lower ability to cope with cognitive tasks administered, as well as

decreased overall socio-emotional development. Kihara et al. (2006) reviewed the existing literature on the effects of *Plasmodium falciparum* on cognition and concluded that infected children perform worse on fine motor skill tasks. Jukes et al. (2006) investigated the long-term impact of early childhood malaria prophylaxis on cognitive and educational outcomes. Their results are suggestive of a long-term effect of malaria prophylaxis on cognitive function and educational attainment (Jukes et al., 2006).

Vitor-Silva et al. (2009) examined the relationship between malaria and school performance in children living in an endemic area where *Plasmodium vivax* is the species responsible for most of the cases. A cohort study design was employed and students from two schools in grades 1-8, aged between 6-14 years old were followed from March to December 2008 (Vitor-Silva et al., 2009). The study was conducted in the Municipality of Carreiro, Amazonas, Brazil (Vitor-Silva et al., 2009). After an initial active case detection, during the nine-months of follow-up, passive malaria cases detection was instituted through a thick blood smear performed on every child with fever (Vitor-Silva et al., 2009). School performance was evaluated by the final notes in Mathematics and Portuguese Language (Vitor-Silva et al., 2009). The performance was considered poor when either of the final notes in these disciplines was below the 50th percentile for the respective class and grade (Vitor-Silva et al., 2009). The total number of students followed-up in the cohort was 198 pupils (Vitor-Silva et al., 2009). Malaria attacks were reported in 70 (35.4%) of these students, with no cases of severe disease (Vitor-Silva et al., 2009). *Plasmodium vivax* was detected in 69.2% of the attacks, *Plasmodium falciparum* in 25.5%, and both species in 5.3% of the cases (Vitor-Silva et al., 2009). In the multivariate analysis, adjusting for

age, mother's education, time living in the study area and school absenteeism, presenting with at least one episode of malaria independently predicted a poor performance at school [*OR = 1.91 (1.04-3.54); p = 0.039*] (Vitor-Silva et al., 2009). Non-severe malaria compromises the school performance of children even during a nine-month follow-up (Vitor-Silva et al., 2009). Overall, these findings are suggestive of an association between malaria and cognitive function and school performance of children (Vitor-Silva et al., 2009). Based on the foregoing research findings, there is the need to assess the association between malaria infections and ITN and non-treated mosquito net use in parasitic hyperendemic areas, which remain unexplored (Vitor-Silva et al., 2009).

Clarke et al. (2017) used a cluster-randomized trial carried out in 80 primary schools in southern Mali to evaluate the impact of a school-based malaria intervention package. Intervention schools received two interventions sequentially: (a) teacher-led participatory malaria prevention education, combined with distribution of LLINs, followed 7 months later at the end of the transmission season; (b) mass delivery of artesunate and sulfadoxine-pyrimethamine administered by teachers, termed intermittent parasite clearance in schools (IPCs) (Clarke et al. (2017). The control schools received LLINs as part of the national universal net distribution program (Clarke et al. (2017). The impact of the interventions on malaria and anemia was evaluated over 20 months using cross-sectional surveys in a random subset of 38 schools (all classes), with a range of cognitive measures (sustained attention, visual search, numeracy, vocabulary and writing) assessed in a longitudinal cohort of children aged 9–12 years in all 80 schools. There was no evidence of impact on cognitive measures (Clarke et al. (2017). The authors concluded that

the combination of malaria prevention education, LLINs and IPCs can reduce anemia and improve sustained attention of school children in areas of highly seasonal transmission (Clarke et al. (2017). These findings highlight the impact of asymptomatic malaria infection on cognitive performance in schoolchildren and the benefit of IPCs in reducing this burden (Clarke et al. (2017).

Bangirana et al. (2014) assessed the neurocognitive impairment in children with cerebral malaria (CM) less than 5 years of age, or in children with severe malarial anemia (SMA), a form of severe malaria estimated to affect as many as 5 million children annually. Children less than 5 years of age presenting to Mulago Hospital, Kampala, Uganda, with CM (n = 80) or SMA (n = 86) were assessed for overall cognitive ability, attention, and associative memory 1 week after discharge and 6 and 12 months later (Bangirana et al., 2014). The z-scores for each domain were computed based on scores of 61 healthy community children (CC), who were also tested at enrollment and 6 and 12 months later (Bangirana et al., 2014). Groups were compared using mixed linear models, adjusted for age, weight for age, and child's education at 12 months, children with CM had lower adjusted scores than CC in cognitive ability, attention, and associative memory (Bangirana et al., 2014). Children with SMA had lower scores than CC in cognitive ability ($p = .01$) but not attention or associative memory. Cognitive ability scores in children with CM and SMA did not differ significantly (Bangirana et al., 2014). In children less than 5 years of age, SMA was associated with long-term impairment in cognitive ability, whereas CM was associated with additional impairment in the areas of attention and associative memory (Bangirana et al., 2014). The authors, therefore, concluded that SMA may be a major

contributor to long-term neurocognitive impairment in children in sub-Saharan Africa (Bangirana et al., 2014).

Brooker and Halliday (2015) examined the impact of school-based malaria prevention and enhanced literacy instruction on the health and educational achievement of school children in Kenya. A factorial, cluster-randomized trial was implemented in 101 government primary schools on the south coast of Kenya between 2010 and 2012 (Brooker & Halliday, 2015). The interventions were: (a) intermittent screening and treatment (IST) of malaria in schools by public health workers using rapid diagnostic tests (RDTs) once a school term; and (b) training workshops and support for teachers to promote explicit and systematic literacy instruction (Brooker & Halliday, 2015). Schools were randomized to one of four groups: (a) receiving either the malaria intervention alone; (b) the literacy intervention alone; (c) both interventions combined; or (d) control group where neither intervention will be implemented (Brooker & Halliday, 2015). A total of 5,233 children from Classes 1 and 5 were randomly selected and followed up for 24 months (Brooker & Halliday, 2015). The primary outcomes were educational achievement and anemia, the hypothesized mediating variables through which education is affected (Brooker & Halliday, 2015). Secondary outcomes included malaria parasitemia, school attendance and school performance (Brooker & Halliday, 2015). Data were analyzed in the intention-to-treat basis (Brooker & Halliday, 2015). A nested qualitative evaluation investigated the community acceptability, feasibility, and cost-effectiveness of the interventions (Brooker & Halliday, 2015). During the intervention period, an average of 88.3% of the children in

the intervention schools was screened for malaria at each round, of whom 17.5% were RDT-positive (Brooker & Halliday, 2015).

About 80.3% of children in the control and 80.2% in the intervention group were followed up at 24 months (Brooker & Halliday, 2015). No impact of the malaria IST intervention was observed for the prevalence of anemia or P. falciparum at either 12 or 24 months or on scores of classroom attention (Brooker & Halliday, 2015). No effect of IST was observed on educational achievement in the older class, but an apparent negative effect was seen on spelling scores in the younger class at 9 and 24 months and on arithmetic scores at 24 months (Brooker & Halliday, 2015). In contrast, there was a significant impact of the literacy intervention on key educational outcomes (Brooker & Halliday, 2015). Significant improvements were observed in the intervention group compared with the control group at nine months for two of the three literacy assessments, with a mean adjusted difference in spelling scores of 1.43 (95% CI [0.86, 2.00]) and in Swahili sounds scores of 5.28 (95% CI [3.18, 7.39]) between study groups (Brooker & Halliday, 2015). The significant impact of the literacy intervention on these outcomes was sustained at 24 months and was also observed in Swahili word reading, with a mean difference of 2.30 (95% CI [0.03, 4.58]) observed between intervention and control groups (Brooker & Halliday, 2015).

Clarke et al. (2008) examined the effect of intermittent preventive treatment (IPT) in reducing anemia and improving classroom attention and educational achievement in semi-immune schoolchildren in an area of high perennial transmission. A stratified, cluster-randomized, double-blind, placebo-controlled trial of IPT was done in 30 primary schools

in western Kenya (Clarke et al., 2008). Schools were randomly assigned to treatment (sulfadoxine-pyrimethamine in combination with amodiaquine or dual placebo) by the use of a computer-generated list (Clarke et al., 2008). Children aged 5–18 years received three treatments at 4-month intervals (IPT n=3535, placebo n=3223) (Clarke et al., 2008). The primary endpoint was the prevalence of anemia, defined as a hemoglobin concentration below 110 g/L (Clarke et al., 2008). This outcome was assessed through cross-sectional surveys 12 months post-intervention (Clarke et al., 2008). The analysis was by both intention to treat, excluding children with missing data, and per-protocol (Clarke et al., 2008). Prevalence of anemia at 12 months averaged 6·3% in the IPT group and 12·6% in the placebo group (adjusted risk ratio *0·52, 95% CI 0·29–0·93; p=0·028*) (Clarke et al., 2008). Significant improvements were also seen in two of the class-based tests of sustained attention, with a mean increase in code transmission test score of *6·05* (*95% CI 2·83–9·27; p=0·0007*) and counting sounds test score of *1·80 (0·19–3·41; p=0·03*), compared with controls (Clarke et al., 2008).

No effect was shown for inattentive or hyperactive compulsive behaviors or on educational achievement (Clarke et al., 2008). The per-protocol analysis yielded comparable results (Clarke et al., 2008). About 23 serious adverse events were reported within 28 days of any treatment (19 in the IPT group and four in the placebo group); the main side-effects were problems of balance, dizziness, feeling faint, nausea, and/or vomiting shortly after treatment (Clarke et al., 2008). Based on the findings, the IPT of malaria improves the health and cognitive ability of semi-immune schoolchildren (Clarke

et al., 2008). Effective malaria interventions could be a valuable addition to school health programs (Clarke et al., 2008).

While numerous studies have explored the relationship between malaria infection and school performance in the context of experimental data or non-archival data, few have looked at the effect of malaria infection and ITN and non-treated mosquito net use in the context of archival data. Fink et al (2013) using the 2010 Zambian Early Childhood Development Project linked with malaria parasite prevalence data from the 2006 Zambia Malaria Indicator Survey, investigated the associations between early childhood exposure to malaria and pre-school development (Fink et al., 2013). Linear and logistic models were used to estimate the effect of early childhood exposure to malaria on anthropometric outcomes as well as on a range of cognitive and behavioral development measures (Fink et al., 2013). No statistically significant associations were found between parasite exposure and children's height and weight (Fink et al., 2013). Exposure to the malaria parasite was, however, associated with lower ability to cope with cognitive tasks administered by interviewers (z-score difference *−1.11, 95% CI −2.43–0.20*), as well as decreased overall socio-emotional development as assessed by parents (z-score difference *−1.55, 95% CI −3.13–0.02*) (Fink et al., 2013). No associations were found between malaria exposure and receptive vocabulary or fine-motor skills.

Thuilliez (2009) explored the link between *P. falciparum malaria* – the causative agent of most malaria-related morbidity and mortality – and primary education in terms of school performances at the macroeconomic level. The cross-country panel regression analysis showed that the link between the level of *P. falciparum* malaria endemicity and

primary repetition rates is strong and positive Thuilliez (2009). In contrast, the link between the level of *P.falciparum* malaria endemicity and primary completion rates is strong and negative (Thuilliez, 2009). These results, therefore, suggested that malaria influenced children's human capital accumulation at the macroeconomic level (Thuilliez, 2009).

Vorasan et al. (2015) examined the long-term impact of malaria infection on school performance among school children living in a malaria-endemic area along the Thai–Myanmar border. A retrospective cohort study design was applied to the study among school children aged 6–17 years in a primary-secondary school of a sub-district of Ratchaburi Province, Thailand (Vorasan et al., 2015). History of childhood malaria infection was obtained from the medical records of the sole malaria clinic in the area (Vorasan et al., 2015). School performance was assessed by using scores for the subjects Thai Language and Mathematics in 2014 (Vorasan et al., 2015). Other variables, such as demographic characteristics, perinatal history, nutritional status, and emotional intelligence, were also documented (Vorasan et al., 2015). The Student t-test and analysis of variance were used to analyze mean differences between groups (Vorasan et al., 2015). Logistic regression was used to determine the crude odds ratio (OR) and 95 % confidence interval (CI) for predictive factors of school performance (Vorasan et al., 2015). Factors that showed significant associations were then included in multivariate analysis to estimate adjusted ORs and 95% CIs (Vorasan et al., 2015). A total of 457 students were included, 135 (30 %) of whom had a history of uncomplicated malaria infection (Vorasan et al., 2015). About half of the malaria-infected children had suffered infection before the age of four years (Vorasan et al., 2015). The mean scores for both Mathematics and Thai

Language decreased concerning the increasing number of malaria attacks (Vorasan et al., 2015). Most students had their last malaria episode for more than two years previously (Vorasan et al., 2015). The mean scores were not associated with duration since the last malaria attack (Vorasan et al., 2015). The association between malaria infection and school performance was not significant after adjusting for potential confounders, including gender, school absenteeism over a semester term, and emotional intelligence (Vorasan et al., 2015). The study of Vorasan et al. (2015) provides a good starting point for research efforts focused on malaria infection on insecticide-treated net and non-treated mosquito bed net use among school children living in a hyper-endemic area.

Evidence in the literature reveals mixed findings on the association between malaria infection and ITN among school children, although the majority of the literature supports the link between malaria prevalence and mosquito bed net use among school children. The results of past studies also demonstrate that the social-ecological model may provide a framework for understanding the relationship between malaria prevalence and school performance. Considering the mixed findings on the association between malaria infection and school performance among school children and the paucity of research focused on using archival data to examine the problem, a study dedicated to examining the effect of malaria infection and insecticide-treated net and non-treated mosquito net use among school children using archival data is relevant and necessary. This study examines the effect of malaria infection on insecticide-treated and non-treated net use among children in families that have bed net for sleeping compared to those without bed net in parasitic hyper-endemic areas in Ghana, using archival data to contribute to the body of knowledge on the

impact of malaria on infection risks of children, and to help policymakers in Ghana advance informed decisions on this public health problem.

Summary and Conclusions

Malaria prevalence and infection risks among school children were reviewed in this chapter. It was found that an important reason underlying a recent interest in malaria in school-age children is the concern that malaria may interfere with a child's educational development (Clark et al., 2017). The strongest evidence that malaria impairs cognitive function comes from intervention trials. In Sri Lanka, a randomized, placebo-controlled, double-blind trial of chloroquine prophylaxis in children aged 6–12 years showed that educational attainment improved, and that school absenteeism was reduced significantly in children who took malaria prophylaxis (Fernando et al. 2006).

In the Gambia, the educational achievement of children with an average of 17 years was better in those who had received malaria chemoprophylaxis during their first five years of life than in children who had received a placebo (Jukes et al. 2006). In a more recent, larger, stratified, cluster-randomized, double-blind, placebo-controlled trial conducted in Kenya, IPT with SP + AQ significantly improved sustained attention of 10–12-year-old schoolchildren (Clarke et al. 2008) and similar findings were obtained in a recent trial in school children in Mali (Clarke et al. 2013a, b).

Cerebral malaria, a relatively uncommon outcome of malaria infection, is not a pre-requisite for cognitive impairment which may occur during the course of an uncomplicated clinical episode of malaria (Fernando et al. 2003a, b), and continuous episodes of uncomplicated malaria may have long-term effects (Fernando et al., 2003a, b). There is

even some evidence that asymptomatic parasitemia can impair cognitive function (Nankaberwa et al., 2013). In Yemen, Al Serouri et al. (2000) showed that children with parasitemia performed less effectively on formal cognitive testing than children without parasitemia, even after adjusting for confounding factors. This was also the case in Uganda (Nankabirwa et al. 2013) and in Mali, although in Mali, the effect was not as marked as in children with clinical malaria (Thuilliez et al. 2010). In Zambia, a strong association was found between exposure to malaria and cognitive skills and socio-emotional development in young children (mean age 74 months) (Fink et al. 2013).

Evidence from the literature also suggested no significant association between malaria infection and school performance. Vorasan et al. (2015) found no significant association between malaria infection and school performance after adjusting for potential confounders, including gender, school absenteeism over a semester term, and emotional intelligence. Brooker and Halliday (2015) found no significant impact of the IST intervention for the prevalence of anemia or *P. falciparum* at either 12 or 24 months on scores of classroom attention. They also found no effect of the IST on educational achievement in an older class, but an apparent negative effect on spelling scores in the younger class at 9 and 24 months and on arithmetic scores at 24 months (Brooker & Haliday, 2015).

The gap in literature, therefore, shows that mixed findings on the association between malaria infection and ITN and non-treated mosquito net use among school children, despite the fact that majority of the literature supports the link between malaria prevalence and mosquito bed net use among school children, and also the paucity of studies

on malaria infection and mosquito net use using archival data. The mixed findings on the association between malaria infection and mosquito bed net use among school children and also the paucity of studies on using archival data to examine the effect of malaria infection and ITN use among school children has necessitated a study to examine the effect of insecticide-treated net and non-treated mosquito net use on malaria infection of children in parasitic hyper-endemic areas in Ghana, using archival data, to contribute to the body of knowledge on malaria infection and treated an non-treated net use of school children. The results from the past studies showed that the social-ecological model is suited for understanding the relationship between malaria prevalence, infection risks and among school-going children. As a result, this study applies the social-ecological model to explain the effects of malaria infection risk treated and non-treated net use among school children. Chapter 3 addressed the nature of this study and how the analysis of the study will address the gap in the literature, by describing the design and methodology of the study.

Chapter 3: Research Method

Introduction

The purpose of this study was to investigate the effectiveness of major malaria control policies in reducing malaria cases as a means of improving academic performance among school children in the greater Accra region as a core part of the IMVMP. Due to the current challenges regarding the control of malaria, various mosquito-endemic countries have adopted the Integrated Vector Management Approach (USAID, 2017). The Integrated Vector Management Approach is a rational decision-making process for the optimal use of resources for vector control (USAID, 2017). IMVMP aims to improve the efficiency, effectiveness, and ecological soundness of vector control interventions, and to contribute to achieving national and global targets set for vector-borne disease control (USAID, 2017). To achieve this, vector control programs need to be increasingly based on local evidence, integrate interventions where appropriate, collaborate within the health sector and across other sectors, and actively engage communities (USAID, 2017).

IMVMP has three key intervention components: ITMs, adulticiding and larviciding, and environmental management. The objectives and application of the ITMs are to increase the use of mosquito nets both indoors and outdoors (USAID, 2017). The intervention is a key strategy in malaria control (USAID, 2017). The aim is through the ITM approach to reduce malaria morbidity and mortality among all age groups in Ghana (USAID, 2017). In addition to the adulticiding and larviciding objectives, the idea is to reduce the mosquito population density to decrease the rate of malaria transmission (USAID, 2017). Inclusively, the objective of the environmental management policye is to

ensure and promote advocacy of the practices to reduce factors in the environment that contribute to the breeding of mosquitoes and malaria transmission (USAID, 2017). The policy focus of this current study is the ITMs, which included insecticide mosquito net use as one of its key components or features. The effects of the net use policy among the target population will be evaluated as well in this study. The key element of this chapter includes the following: research design and rationale, the population of the study, sampling and sampling procedure, instrumentation and operationalization of constructs, threats to validity, and ethical procedures.

Research Design and Rationale

The main dependent variable for this study was malaria infection risk. The malaria infection risk was measured by examining the relationship between malaria infections among school-age children in hyperendemic areas who sleep under ITN compared to those who sleep under a nontreated mosquito net. The independent variables for RQ1 include bed net use practices while the dependent variables for the RQ2 were malaria infection (≤1 or ≥2 malaria infection per year), and insecticide mosquito net use (use of net during sleep or no net use during sleep) respectively.

Child gender, parents' education, and age are confounders. The effect of the net use policy or insecticide-treated and nontreated mosquito net use on malaria infection among school children was examined by controlling for age, gender, and socioeconomic characteristics. Uncontrolled or unaccounted confounders specified above could distort the effect of the malaria infection and net use practices among children in families that have ITN for sleeping and those who did not have mosquito bed nets for sleeping. As a result,

the uncontrolled or unaccounted confounders were controlled or accounted for via interaction evaluation/computation using multivariate analysis to stratify the selected confounders/covariates.

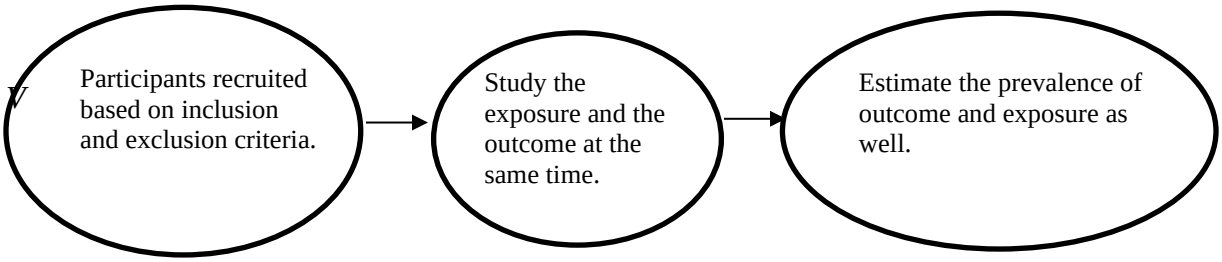
I conducted the study based on a quantitative research approach. A quantitative research approach is appropriately selected for this study because the inquiry is based on the nature of the objectiveness of the categorized mosquito net use via treated and nontreated net (low or high infection risks). Similarly, the independent variables in this study, which are ITN and nontreated mosquito net and the net use status, are both quantifiable. Most importantly, the quantitative nature of the posed research questions supports the need for the application of a quantitative method in this study. Quantitative data can be used to accurately represent health conditions, healthcare needs, and disparities affecting a specific population in the community (Shea et al., 2012).

I used a cross-sectional research design in this study. A cross-sectional design is often applied in a study to evaluate the prevalence or incidence of an outcome upon exposure to a risk factor (Barratt & Kirwan, 2009**).** It provides a snapshot of the frequency of a disease or other health-related characteristics (e.g., exposure variables) in a population at a given point in time (Barratt & Kirwan, 2009**)**. Also, a cross-sectional design could be used to assess the burden of disease or health needs of a population and are particularly useful in informing the planning and allocation of health resources (Barratt & Kirwan; Hennekens & Buring, 2009). Unlike in the case-control studies (participants selected based on the outcome status) or cohort studies (participants selected based on the exposure status), the participants in a cross-sectional study are selected based on the inclusion and

exclusion criteria of the study (Ncogo et al., 2015). Once the participants have been selected for the study, the investigator follows the study to assess the exposure and the outcomes (Ncogo et al., 2015). A cross-sectional design could be applied to population-based or clinic-based surveys (Setia, 2016).

For a cross-sectional study, after the entry into the study, the participants are measured for outcome and exposure at the same time, as seen Figure 1 (Setia, 2016). With a cross-sectional study, associations could be evaluated, and it is possible to examine the outcomes comparatively (Setia, 2016).

Figure 1: *Cross-Section Research Design*



Note. Adapted from Setia (2016)

In this cross-sectional study, secondary data from the archives of the Demographic and Health Survey (DHS) that contains a variety of information and measures related to malaria prevalence, the economic burden of malaria, and the burden of malaria on school children (University, 2016). The DHS has been surveying to collect data related to the burden of malaria on school children, every 2 years (University, 2016). A sample of 1,627 participants covering the period of 2014 to 2018 will be obtained for this study (University, 2016). The survey instrument is adapted from the Ghana DHS and the Malaria Indicator Cluster Survey.

In this study, the application of the cross-sectional driven survey was used to address the outcome or event at a single point in time. However, the secondary data will be used for this analysis. Secondary data analysis has benefits and limitations. Some of the benefits are cost and time savings, while one of the limitations is the challenges with the future application of a cross-sectional design (Kiecolt & Nathan, 1985). The DHS database contains information that is consistent with the type and quality used in prior studies related to the malaria burden on school children. The DHS database has been cited in numerous published studies related to the economic burden of malaria in Ghana (University, 2016). The DHS is widely used, and the DHS database contains more than 10 years of data, therefore, it is a credible source for this study.

Methodology

Population

The population of this study was comprised of all the school children in Ghana who live in the hyperendemic areas shown to have high prevalence and incidence of mosquito and *Plasmodium falciparum* or malaria infections. The target population includes all school children aged 0–6 years old who are living in hyperendemic areas of the Greater Accra region of Ghana. The study population included boys and girls residing in the Ablekuma North and South Districts.

Sampling and Sampling Procedure

The data for the study was obtained from the 2014 and 2016 malaria burden on school children under the survey of the economic burden of malaria, conducted by the DHS. A two-stage stratified sample design was used for the survey (University, 2016).

Stratification was based on the regions of Ghana. The first stage involved selecting geographical precincts, or clusters, from an updated master sampling frame constructed from the 2000 Ghana Population and Housing Census (Ghana Statistical Service, 2016). A total of 334 clusters (census enumeration areas, or EAs) were selected from the master sampling frame (University, 2016). The clusters were randomly selected from the list of EAs in each region (University, 2016). The selection was based on a simple random technique (University, 2016).

The second stage of selection involved a listing of all the households in the selected enumeration areas (clusters) and a simple random sampling of 15 of the listed households from each selected cluster (University, 2016). The primary objective of the second stage of selection was to ensure adequate numbers of completed individual interviews to provide estimates for key indicators with acceptable precision at the regional level (University, 2016). Other sampling objectives were to facilitate manageable interviewer workload within each sample area and to reduce the effects of intra-class correlation within a sample area on the variance of the survey estimates (University, 2016). Since the design is not self-weighing, household sample weights have been computed and applied for the estimation of the survey results in secondary data (University, 2016). This was done to facilitate the estimation of the true contribution of each selected cluster in the sample (University, 2016).

As estimated with the G*Power analysis (for 80% power), a simple random sampling technique was used to select the minimum required number of school children residing in the Ablekuma North and South Districts and its environs in the city of Accra where the *Plasmodium falciparum* is hyperendemic from the DHS survey database.

However, the sample size in the archive or secondary data exceeded the estimated G*Power sample size, I will consider using the all sample size in the data set to increase the statistical power of the study. From the survey review, the information on school children was not supplied by the children themselves but by their parents. The questionnaire for the children was administered to the parents or caretakers of the children living in the households. Information on their academic records or school performances were supplied by the schools to the parents. In cases where the parents are not listed in the household roster, a primary caretaker for the child was identified and interviewed.

Power Analysis

Power analysis is now integral to the health and behavioral sciences, and its use is steadily increasing whenever the empirical studies are performed (Suresh & Chandrashekara, 2015). Power analysis is used to calculate the minimum effect size that is likely to be detected in a study using a specific sample size (Suresh & Chandrashekara, 2015). Sample size calculation is determined using the power analysis, and it takes into consideration the effect size, alpha level, statistical power level and types of the statistical analysis intended (Fugard & Potts, 2015).

The statistical power is the probability of correctly rejecting the null hypothesis that sample estimates (e.g. Mean, proportion, odds, correlation co-efficient, etc.) do not statistically differ between study groups in the underlying population (Fugard & Potts, 2015). Large values of power are desirable, at least 80%, is desirable given the available resources and ethical considerations (Fugard & Potts, 2015). Power proportionately increases as the sample size for study increases (Fugard & Potts, 2015). Accordingly, the

statistical power of a study could be influenced by adjusting the sample size (Wittes, 2002; Desu & Raghavarao, 1990).

The effect size measures the strength between variables under study and provides a scale-free measure that reflects the practical meaningfulness of the relationship among variables (Maher, Markey, & Ebert-May, 2013). Cohen (1988) classified effect sizes as *small* ($d = 0.2$), *medium* ($d = 0.5$), and *large* ($d \geq 0.8$). According to Cohen, a medium effect of .5 is visible to the naked eye of a careful observer (Cohen, 1988). A small effect of 0.2 is noticeably smaller than medium but not so small as to be trivial (Cohen, 1988). A large effect of .8 is the same distance above the medium as small is below it (Cohen, 1988). These designations large, medium, and small do not take into account other variables such as the accuracy of the assessment instrument, and the diversity of the study population (Cohen, 1988). However, these ballpark categories provide a general guide that should also be informed by context.

A sample of 1,627 cases was obtained from the DHS survey database. Using the G*Power software, the statistical power associated with the minimal sample size for a logistic analysis in this study was calculated. Given an OR value of 1.30, an alpha level of 0.05, and a sample size of 1,188 for a two-tail test, the statistical power for this study is 0.95. Therefore, the sample size is adequate for this study in conjunction with the design of the study, which provided reasonable assurance that a Type II error is not likely.

Archival Data Procedures

Central to most quantitative research concepts is the implementation of precise, unbiased estimation on the parameters of interest covering the entire population with

existing data (Bergsma, 2015). Archival data is useful for studying social and infectious phenomena of the past overtime. In some instances when conducting archival research, social science researchers analyze survey data accessed from existing records. Utilization data form part of the public and private archives consisting of various topics including social science and social change. Researchers can benefit from the use of archival data in researching due to the low sampling and measurement error (Creswell, 2009). Researchers sometimes develop instruments and conduct their surveys (Creswell, 2014). However, many researchers use archival data which often contain variables longitudinally and cross-sectionally. The data offers the potential for replication by future researchers and saving them both time and cost (Creswell, 2014). Publicly available data set requires no special permission to access some of which is collected by academic institutions and various government agencies (Bergsma, 2015; Martin and Bridgmon, 2012). Also, data sets are made available to the public for research purposes.

Most quantitative studies include the use of existing or secondary data due to availability and ease of accessibility thereby offering researchers enormous time-saving benefits (Bergsma, 2015). However, some limitations exist since variables could be underreported and the data may not always be collected in the most appropriate form (Frankfor-Nachmias & Nachmias, 2008). Therefore, researchers must be creative and thoughtful in making the existing data most meaningful for their purposes (Frankfort-Nachmias & Nachmias, 2008).

The information regarding the participants in this study will be accessed through the DHS database on the economic burden of malaria. The DHS database contains

information related to the malaria burden on school children (University, 2016). The time frame covered within the DHS database ranged from 2014 through 2018. The survey was intended to address information related to the following modules:

- household characteristics;
- age;
- birth history;
- early childhood development;
- diet diversity;
- malaria;
- insecticide-treated nets;
- National Health Insurance;
- anthropometry;
- anemia and malaria testing;
- sickle cell or sickle cell carrier;
- parents' background; and school characteristics, including school performance.

The survey was designed to collect detailed information on each of the modules about the school children. There were 1,627 participants represented in the DHS database (University, 2016). Each participant represented a school child (University, 2016). Concerning the time frame represented by the data, the survey is administered every two years, therefore, the 2014 survey contains responses representing cases from April 2014

through May 2014 (University, 2016). Each successive survey that will be administered following the same timing pattern (University, 2016).

Instrumentation and Operationalization of Constructs

General and Socioeconomic Characteristics of School Children

The general and socioeconomic characteristics of the school children will be assessed throughout the various modules of the questionnaire on the malaria burden on school children of the DHS database. These include gender, age (years), grade level, ethnicity, perinatal history, parent's occupation, parent's educational attainment, parent' ethnic group, family income, maternal health insurance, and geographical location or place of residence, nutritional status, and school absenteeism (during a term). The Household characteristics of the school children will also be retrieved from the database. This household characteristics will include the material used for the construction of walls, floor, and roof, and will be classified into three groups: good, medium, or poor.

Malaria Infection. Malaria infection which is the number of malaria attacks the school children have had or been diagnosed within a year will be retrieved from the Malaria and Insecticide Treated Nets Module of the DHS database. Malaria infection is the presence of disease caused by the protozoan parasites from the *Plasmodium* family of vectors transmitted by the bite of the *Anopheles* mosquito. The intensity of transmission varies and depends on factors associated with the parasite, vector, the human host the environment. Also, malaria infection and transmission depend largely on climatic conditions that aide the survival of mosquitoes in large numbers. Seasonal patterns which

include rainfall, temperature, and humidity may favor transmission leading to malaria epidemics.

Frequency of Episodes/Diagnosis. Frequency of malaria episodes/diagnosis which is the duration since the last malaria attack of the school children was assessed through the Malaria and Insecticide Treated Nets Module of the DHS database as well. The frequency of malaria exposures will depend largely on vector control to reduce transmission. In areas where vector control interventions are high enough ensures a measure of protection across the community. Long-lasting insecticidal net (LLINs), indoor residual spraying (IRS) and a combination of antimalarial drugs (AD) are an integrated approach to prevent frequent episodes of malaria infection. Malaria endemic areas of the world include Sub-Saharan Africa where many people are at risk of contracting malaria at a time when the transmission is experiencing insecticide resistance.

Assessment of Malaria Infections

The malaria infections of school children which were assessed through their use of mosquito net in two areas, those who have bed net for sleeping and those who did not have bed net for sleeping in the hyperendemic areas will be obtained from net use characteristics including malaria infections from the DHS database. The ITN is (a chemical infused net) approved by the Ghana Health Service which children must sleep under. All children must sleep under the net to adequately reduce the likelihood of infection risks. All children in families are placed in categories and ratings are either those who have bed-net for sleeping and those who did not own a mosquito bed net for sleeping.

Operationalization of Variables

The general and socioeconomic characteristics of the school children are operationally defined as the demographic characteristics and socioeconomic status of the school children. These include gender, age (years), grade level, ethnicity, perinatal history, parent's occupation, parent's educational attainment, parent's ethnic group, family income, maternal health insurance, geographical location or place of residence, and school absenteeism (during a term). The house type of school children is based on the material used for the construction of residential homes.

These variables independent (net use) and dependent (malaria infections) will be classified into nominal scale or categorical variables. The nutritional status of the school children – weight and height of students will be measured on a ratio scale. The nutritional status of the school children will be assessed following the standard guidelines of WHO. The poor nutritional status will be considered when weight for age and height for age is below 2.0 of the standardized z-score.

Malaria infection is operationally defined as the number of malaria attacks the school children have had or been diagnosed within a year. Malaria infection of the school children will be categorized into ($\leq$1 or $\geq$2 groups or exposure level). Insecticide-treated net is operationally defined as a chemically treated net used during sleep to prevent/reduce mosquito bites. A non-treated mosquito net is operationally defined as a non-chemical bed net for sleeping to prevent malaria infections from mosquito bites.

Data Analysis Plan

The data for this study will be analyzed using the SPSS software package version 20, a common statistical application developed by IBM. IBM SPSS will be selected for the analysis of the data for two reasons: a) It has the capability to assist in conducting both descriptive and inferential statistical analyses using binary and multinomial logistic regression to address the research questions in this study; and b) the researcher has the proficiency and skill set required to use the IBM SPSS.

The data will be supplied in the Microsoft Excel® format by a representative of the Demographic and Health Survey (DHS) and will then be imported into IBM SPSS®. Each record within the DHS database will represent one school child. Records will be searched for missing data to ensure that all records contained the values necessary for computation. The following research questions and hypotheses emanating from the problem of the study will be addressed by the data analysis plan:

RQ1: What is the relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana?

H_o1: There is no relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

H_a1: There is a relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

RQ2: What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net?

Ho2: There is no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net.

Ha2: There is a significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a non-treated mosquito net.

Table 4 shows a summary of the data analysis plan for each of the research questions. The details of how the results will be determined and what will specifically be looked at to interpret the results are presented in the paragraphs following the table. Descriptive statistics of frequencies and percentages would be used for the description of the sample included in the study. Frequencies and percentages will be used for the description of the sampled data because of the nominal level of measurement associated with the variables. On the other hand, where the level of measurement of the variable is interval or ratio, mean, standard deviation, median, mode, skewness, and kurtosis will also be used to describe the sampled data.

The assumptions of binary and multinomial logistic regression will also be carried out to test their suitability for the analysis of the data as well as its ability to address the

research questions. Binary and multinomial logistic regression by design, overcome many of the restrictive assumptions of linear regressions (Garson, 2009). For example, linearity, normality and equal variances are not assumed, nor is it assumed that the error term variance is normally distributed. However, the major assumptions are that: (a) the outcome must be discrete, otherwise explained as, the dependent variable should be dichotomous; (b) there should be no outliers in the data, and (c) there should be no high intercorrelations (multicollinearity) among the predictors. These assumptions will be addressed as follows: (a) the assumption that the outcome variable must be dichotomous in nature will be addressed by categorizing the dependent variable - malaria infection and into dichotomous variables (See Table 4); (b) the assumption that there should be no outliers in the data will be assessed by converting the predictors to standardized z scores and remove values which are below and above the standardized z score criterion of 3.29 (Tabachnick & Fidell, 2012); and (c) the assumption that there should be no high intercorrelations among the predictors will be assessed by performing a correlation matrix among the predictors. The predictors that show a high correlation coefficient will be removed. Tabachnick and Fidell (2012) posit that so long as the correlation amongst the IVs is less than .90, the assumption is met.

The assumption of Chi-Square test of independence will be addressed by ensuring that: (a) the data in the cells is frequencies, or counts of cases rather than percentages;

(b) the subject fit into one and only one level of each of the variables – malaria infection and insecticide mosquito net use;

(c) each subject may contribute data to one and only one cell;

(d) the study groups are independent by grouping the subjects into non-overlapping groups;

(e) there are 2 variables, and both are put into categories; and

(f) the value of the cell *expected* are 5 or more in at least 80% of the cells, and no cell have an expected of less than one, which would be met as a result of the large sample size of the study (McHugh, 2013).

Table 4*: Data Analysis Plan*

Research Question	**Dependent Variable**	**Independent Variable**	**Level of Measurement**	**Statistical Test**	**Rationale for the Test**
RQ1.	Malaria Infection (MI)	Insecticide Mosquito Net Use (Net Use vs. no Net Use)	Nominal	Chi-Square Test of Independence and Cramer's V Test	Test the association between two categorical variables
RQ2.	MI	ITN (ITN net vs. non-ITN net)	Dichotomous (Poor or Not Poor) for DV. Nominal, dichotomous (≤1 or ≥2 MI per year) for IV.	Binary Logistic Regression (BLR)	Test the extent of association between the variables
				Multivariable Logistic Regression (MLR)	Test the extent of association

Note: The assumption of the Cramer's V test is similar to that of the Chi-Square test of independence. The key difference between the tests is that the Cramer's V test is used in analysis when the Chi-Square test estimates produce a statistically significant p-value for the variables being compared. This test will be used to evaluate the strength of the correlation if any is observed (McHugh, 2013). In cases where the Chi-Square test estimates did not produce a statistical significance value, the Cramer's V test will not be performed.

The results of research question one will be presented and interpreted by performing cross-tabulation of the two categorical variables. The p-value of the Chi-Square test of independence will be used to determine the statistically significant relationship between the variables, at a 5% level of significance, which is an ideal level of significance to ensure a good balance between the Type I and Type II error. The Cramer's V test will be used to assess the strength of the association between the two categorical variables when the Chi-Square test indicate a statistically significant association between the variables (Frankfort-Nachmias & Nachmias, 2008). Table 5 shows how the value of the level of association of the Cramer’s V test will be interpreted.

Table 5: *Interpretation of Level of Association of Cramer's V Test*

Level of Association	**Interpretation**
0.00	No relationship
0.00 - 0.15	Very weak relationship
0.15 - 0.20	Weak relationship
0.20 - 0.25	Moderate relationship
0.25 - 0.30	Moderately strong relationship
0.30 - 0.35	Strong relationship
0.35 - 0.40	Very strong relationship
0.40 - .0.50	Worrisomely strong relationship
0.50 - 0.99	Redundant
1.00	Perfect relationship

Note. Adapted from the Fort Collins Science Center (USGS, 2018), Science for a changing world,

http://www.fort.usgs.gov/search/content/Cramer's V Test

The results for research questions two and three will be presented and interpreted by examining the crude odds ratio (unadjusted odds ratio), the adjusted odds ratio (ORs), and the Nagelkerke R^2. The crude odds ratio of the binary logistic regression, which makes of χ^2 will be used as the omnibus test to test the overall model's significance of the model coefficients. The factors that will be found significant will be included in the multinomial logistic regression for the estimation of the adjusted ORs. The Nagelkerke R^2 will also be

used to assess the attributable percent of how much of the outcome that could be explained by the predictor variable.

In the analysis of research questions two, four models will be fitted. Model, I will determine the crude association between malaria infection and mosquito net use (ITN in the hyperendemic area – non-treated bed net use) while model II will examine the association between malaria infection and net use when age, gender and the socioeconomic characteristics of the school children are considered. Model III will estimate the association between malaria infection risks and mosquito bed net use after adjusting for socioeconomic factors of the students. In model IV, all identified possible confounders will be incorporated, including parentage, child gender, and parents' education.

Threats to Validity

Internal and external validity are two important concepts in research that help evaluate research findings. Internal validity is concerned with establishing that there is a reliable consistency in the relationship between the independent variable and the dependent variable, while external validity is concerned with the ability to generalize the findings of a study beyond the study sample (Frankfort-Nachmias & Nachmias, 2008). Internal validity addresses whether the tests measured the variables they were designed to measure (Trochim, 2000).

Internal validity is a method of establishing that a high degree of reliable association consistently exists between the independent variable and the dependent variable. The concept of internal validity is to address factors that are designed to measure the specific variables in the study (Trochim, 200). The researcher consciously looks for internal validity

within a study concerning how well the research favors choosing other alternatives for explaining a variable (Trochim, 2000). Internal validity, the purpose of which includes an inverse relationship between the independent variable and dependent variable, good measurement, representative sampling, and study design are important (Trochim, 2000; Frankfort-Nachmias & Nachmias, 2008).

This study relies on secondary data and does not seek to make causal inferences; therefore, threats to internal validity are limited. The overall threats to validity in this study are associated with the limitations inherent in using secondary data. Secondary data have some disadvantages when it comes to using them in a new research study since the new study does not influence the purpose and collection method of the original data and as such the researcher has no control over what is already in the data set that may not be applicable to the new study (Boslaugh, 2007). Another problem is that the variables may not be categorized as the researcher would have chosen for the new study; this may mean manipulating the existing data which can lead to an error that can hinder the validity of the study results (Boslaugh, 2007). Boslaugh, (2007) points out that researchers must read between the lines and consider what problems might have been encountered in the data collection process.

External validity is whether the study findings are relevant to a larger population beyond the scope and context of the research (Creswell, 2009). The transferability of conclusions of a research study refers to the extent that the results are relevant, applicable and can be generalized to many situations (Trochim, 2000). Also, external validity would determine whether the outcomes can be inferred universally. For the final analysis of

research to be generalized back to the population, the sample needs to be randomly selected (Trochim, 2000).

This study relies on archival data which is based on cross-sectional research. In this instance, the archival data was collected through methods that did not require a random assignment of exposure. As such, the results of the study cannot be used to infer a causal relationship. Lack of generalizability and causality does not negate the merit of this study. However, it will limit how the findings of this study are interpreted.

Content validity and face validity are research methodologies in research that are used as tools for assessment or measurements (Frankfort-Nachmias & Nachmias, 2008). Content validity is used to evaluating how well an assessment or measurement tool measures the specific construct for which it is intended, while face validity is concerned with the degree an assessment or test appears effectively covering the specific concept to be measured (Frankort-Nachmias & Nachmias, 2008). In social science, researchers use assessment and measurement tools such as questionnaires and surveys. To be considered standard, an instrument should present clarity and a high degree of agreement and represents all facets of the questionnaires from DHS.

Empirical validity looks at statistical evidence that a measuring instrument has a strong correlation with the outcome (Frankfort-Nachmias & Nachmias, 2008). Empirical validity is to remove or do away with any inconsistency that may lead to skepticism from an analysis of research studies (Frankfor-Nachmias & Nachmias, 2008). Empirically, statistical analysis can be used to examine differences and draw conclusions based on estimates (Frankfort-Nachmias & Nachmias, 2008). The statistical description of an

instrument when used in predicting outcomes in a research context, should be externally consistent and capable of producing facts for it to be empirically valid.

Construct validity concerns the assessment of the intended instrument for use and the quality it possesses for measuring the research construct. The theoretical construct in this study is the social-ecological model which will be tested to ensure accuracy and determine how well construct validity measures this concept (Frankfort-Nachmias & Nachmias, 2008). In other words, construct validity is a valid measuring instrument that can undergo analysis and adequately establish a strong connection with the theoretical framework or external correlates. It is achieved when aligned with the framework in a study and covers the boundaries of the construct.

Ethical Procedures

This study will use secondary data from the DHS. At the time the survey was conducted, ethical issues at the collection and collation stages were strongly considered and implemented (University, 2016). Therefore, there is no risk of breaking interviewee confidentiality (University, 2016). Hence, this study relies on the ethical consideration of the DHS in collecting the data. However, a formal application and a written project proposal will be presented to the Ethics Committee of DHS for access to the data, and permission to use the data for the study.

As the principal investigator of this study, I will seek the approval of the IRB for the study by following all the protocols. All Ethical Guidelines and Procedures for Research Using archival data by the board will be duly followed before and after the study.

The data for this study will not be shared with another party and approval from DHS will be required before disseminating the results of the study.

Summary

The study is conducted based on a quantitative, cross-sectional study design. An archival or secondary data from the DHS. The dependent variable of the study is the malaria infection of the students, which was measured by using the actual net use of the school children in the affected communities and the independent variable of the study is the effects of insecticide-treated nets and non-treated mosquito bed net, which was obtained from the DHS database.

The target population of the study, however, is all the school going children 0–6 years old who are living in hyperendemic areas of the Greater Accra region of Ghana. A simple random sampling technique was used to select the school children residing in the Ablekuma North and South Districts and its environs in the city of Accra where the *Plasmodium falciparum* is hyperendemic from the DHS survey database. The sample size for this study is 1,627 students' households. For multiple logistic regression analysis, a minimum sample size of 1,188 equates to a power of 0.95 (95%) with a pre-defined effect size or OR of 1.30 and an alpha level of 0.05 for a two-tail test. The dataset for this study will be analyzed using the IBM SPSS software package version 20. The result and conclusions of this study will be presented in chapters 4 and 5 respectively. The descriptive and inferential analysis will provide clear detail of how the data was collected, sampling of the population and the statistical analysis based on the the research questions and

hypotheses. Presentation of data in tables and graphs is to give a clear description of how the data trends.

Chapter 4: Results

Introduction

The purpose of this study was to investigate the effectiveness of major malaria control policies in reducing malaria cases as a means of improving academic performance among school children in the greater Accra region as a core part of the IMVMP. In view of this purpose, data collection yielded results based on the research questions outlined below. This chapter shows results in tables and graphs and results presented in frequencies and percentages as well as inferential analysis and follow the research questions.

In view of investigating the association between malaria infections and the use of ITN and nontreated mosquito nets among children in the Greater Accra Region of Ghana, the following research questions and the hypotheses were addressed.

RQ1: What is the relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have a mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana?

$H_0$1: There is no relationship between cases of malaria among children in families that have an insecticide mosquito bed net for sleeping compared to those who did not have a mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

H_a1: There is a relationship between cases of malaria among children in families that have an insecticide mosquito bed net for sleeping compared to those who did not have a mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

RQ2: What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleep under a nontreated mosquito net?

$H_0$2: There is no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under an insecticide-treated mosquito net compared to those who sleep under a nontreated mosquito net.

H_a2: There is a significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under an insecticide-treated mosquito net compared to those who sleep under a nontreated mosquito net.

I sought to make a connection between the contracting of malaria and its effect on a child's education. The study findings answered the two research questions and the hypotheses generated in the introductory chapter of the study. The first question was directed to determining the relationship between cases of malaria among children in families that had insecticide mosquito bed nets for sleeping compared to those who did not. The hypothesis to this research question was designed to determine whether there is a relationship between the dependent and independent variables.

The second research question was aimed at investigating the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito nets compared to those who sleep under a nontreated mosquito net. Arising from this research question, I sought to address

whether the use of an insecticide-treated mosquito bed nets for sleeping reduces the chances of contracting malaria in school-going aged children compared to those who do not sleep with a net. To achieve this objective, the data stemming from this research question were subjected to inferential statistics. The purpose of this study was to provide anecdotal evidence regarding the effectiveness of the ITMs or mosquito net use policy, a core part of the IMVMP.

The covariates in this study were chosen because they are factors that are not directly handled in solving the malaria infection problem. A covariate is a continuous control variable that is observed rather than manipulated but can influence the outcome of an experiment or study but not the independent variable (Day et al., 2016). As a result, the covariates that were chosen for this study are age, gender, income status, and educational background.

According to Paintsil et al. (2019) age is one of the factors that significantly influence malaria infection. Children under school going age have a greater chance of being affected by malaria because they are often not kept inside and away from been exposed to the weather and mosquitos preying on humans. According to the description provided by Mahamar et al. (2017), malaria is a disease of the poor. This means that families with lower income status have a greater chance of being affected by malaria. Therefore, it is not surprising that malaria is endemic in Africa where poverty is rampant (Mahamar et al., 2017).

Educating the general public as well as the clinicians is one of the factors that significantly reduce malaria infections (Levitz et al., 2018). Levitz et al. (2018) indicated

that well-educated families have fewer chances of being affected by malaria as compared to the less educated families. Also, health centers where technicians are highly skilled and are well-equipped with modern tools have a greater chance of reducing malaria cases than less endowed health centers where the technicians are less skilled (Levitz et al., 2018). Malaria transmission is determined in large part by social, economic, and cultural factors. These factors intersect with gender-specific and gender-specific vulnerabilities to impact women's and men's ability to prevent malaria infections and access medicine to prevent and treat infections both for themselves and for their children(Mahamar et al., 2017). Some of these vulnerabilities are known; however, many vulnerabilities are unknown due to lack of research funding. Women and men, and boys and girls are vulnerable to malaria in different ways that are shaped by their socially-determined roles within their communities and families(Moise et al., 2016). Specifically, women have less access to information about how to protect themselves from malaria than men, due to lower literacy rates(Mutegeki et al., 2017). Women's traditional household roles, such as cooking the evening meal outdoors or waking up before sunrise to prepare the household for the day, may also put them at greater risk of malaria infection. Additionally, women may be less likely to sleep under LLINs due to sociocultural pressures within customs and lifestyles that characterize the society (Levitz et al., 2018). The same traditional gender roles, however, can also heighten males' risk of malarial infection. Men working outdoors in forestry, fishing, mining, agriculture, or ranching are at greater risk of contracting malaria when they work during peak biting times(Moise et al., 2016).

Introduction to Data Collection Process

Secondary data collected during GMIS carried out within 2 years period; between 2014-2016 was used for this study. The survey was conducted in the malaria hyper endemic area in the Greater Accra region, specifically Ablekuma. Data were collected from families who have child within the age range of 0-6 years. The population was chosen due to vulnerability to malaria infections as their immunity was low. The time for the survey was during rainy season to make a good capture of the cases of malaria as predicted by the variables of bed net ownership and usage.

Recruitment and Training of Staff for Data Collection

In the GMIS, there was a very high response rate of above 90%. The 2010 Public and Housing Census sampling frame was employed for the GMIS sampling frame. During the survey, each area sampled was divided into urban and rural areas and further divisions into strata were made. The stratification was aimed at making purposive sampling of residential selected easy and coordinated in the community.

The researchers were recruited from tertiary institutions in the country and they received training on interviewing techniques and fieldwork procedures, a detailed review of the questionnaire content, instruction on how to administer the paper and electronic questionnaires. Pretest interviews between participants in the classroom, and practice interviews with real respondents in areas outside the surveyed sample. Training was facilitated by professionals from GSS, NMCP, NPHRL, and ICF. The training took place from September 12–27, 2016 at Winneba in the Central Region of Ghana where 72 field staff including 15 biomarker technicians, 43 interviewers, and 14 supervisors were trained

for 3 weeks. Sixty-one field staff were selected for the fieldwork and 11 were placed on stand-by at the end of the training program.

Duration for Data Collection

The data collection process by the GMIS took a period of 6 weeks. In the 12 teams formed, each was assigned 16 clusters of houses in the Ablekuma North and South areas. Data were collected by requesting participation of the parent in the selected household in the survey area. For those respondents who could not read no write, the data collection staff asked the questions on the questionnaire in a language understandable by the respondent and made the filling themselves. Prior to data collection, announcement was made on radio and television stations informing people about the data collection and its important in malaria prevention strategy for the study area and other hyperendemic areas.

Response Rate During Data Collection

Response rate during data collection was high above 50% and it was attributed to the awareness program on electronic media prior to the commencement of the study. The general public acknowledged the importance of the study to the families and the nation in general, considering the level of corporation. Parents, especially the mothers showed great enthusiasm in giving useful information on the malaria infection and the use of insecticide treated nets.

Data Retrieval from Archives

I retrieved the data for this study at a single time. The original data was also collected in a period of 6 months in a continuous fashion and not in bits, to reduce the cost of recruitment of staff as well as reduce transportation cost. Relevant data for this study

were obtained from the GMIS dataset and since this study was retrospective, data obtained were analyzed within the time frame. There were no identified discrepancies in the dataset with regards to the demographic characteristics of the sample. The families with a child aged between 0-6years attending school were evaluated.

Sampling Procedure

In the GMIS sampling process, stratified sampling technique was adopted because of the large land area to be covered by the data collection staff. Stratification prevented possible omission of the areas within the study area as the staffs were able to chart the different subdivisions of the study area and cross out where they had already completed sampling. The distribution of respondents was unbiased as probability sampling was done in each cluster of houses under the strata. Distribution of gender of children followed the general demography of births in the area as recorded by the birth registry.

Variables and Covariates Used

Inclusion of covariates in this study is to show their impact on the main variables of the study. In this study, the main variables were malaria episodes among school children within the period of the data collection, and child sleeping under mosquito nets. To be able to test hypotheses generated, the age of the child, educational background and the age range of the parents were set as the covariates which was used to make statistical inferences on the main variables.

Data Analysis

In this section, simple frequency and percentages were used to present the data. The aim of this presentation was to give a clear description of the nature of results obtained.

Simple bar graphs were employed to show the patent of data for each variable. These variables considered were usage of mosquito nets, type of mosquito nets, malaria episodes in the past 12 months, gender of children, parents` educational background and ages of parents.

Mosquito Net Use Status (Have a Mosquito Bed Net for Sleeping)

Out of the total *N* = 5,150 (100%) participants, *n* = 883 (17.1%) indicated that they did not have a mosquito bed net for their children. In contrast, *n* = 4267 (82.9%) indicated that they have a mosquito bed net for their children for sleeping. Figure 2 is a graphic representation of the percentage of the participants that were sleeping under nets.

Type of Mosquito Bed Nets Child Slept Under

Of the total of 5,150 (100%) participants, *n* = 2258 (43.8%) reported they did not use mosquito nets, while *n* = 2892 (56.2%) did not respond, they were captured as missing data and were not included in the valid percentage calculation. Among those who responded to this question, 1288 (57.0%) reported using treated nets, 19 (0.8%) were using untreated nets, while 1 (0.01) added that they used both treated and untreated nets.

Malaria Episode Status in the Past 12 Months

Majority of the participants *n* = 1,727 (33.5%) had malarial episodes in the past 12-months, while the contrary was recorded for *n* = 3,423 (66.5%) participants. About two-thirds of the sample did not record malaria episodes in the last 12months before the survey. Figure 4 graphically shows the distribution of malarial episodes.

Parent Education Level

Results show that out of the 5,150 participants surveyed in this study, 918 (17.8%) attained basic education, 2,620 (50.9%) had secondary level of education, while 329 (6.4%) attained college /university education level. On the other hand, 1,283 (24.9%) of the participants had no formal education. The findings indicated that more than half of the participants had secondary school level education.

Distribution of Gender of Child

It was found that male children were higher in number than females based on the data analysis result. The study identified that n = 2560 (59.7%) of 5150 indicated the gender of a child while n = 2590 (50.3%) did not and were recorded as missing values. Out of the participants who responded to the question on the gender of the child, 1318 (51.5%) were males, while 1242 (48.5%) were female. It is observed that much difference numerically did not occur between males and females whose parents were sampled in this study. Figure 6 shows the results graphically.

Distribution of Parent Age Groups

From a total of 5150 parents that participated in the study, n = 4731 (91.9%) indicated their age groups, while n = 419 (81%) did not. Among those who indicated their age groups 2523 (53.3%) of the parents were aged 20-34years, 1244 (26.3%) were aged 35-49years, while 964 (20.4%) were aged 15-19years. Additionally, the results indicated that middle-aged parents consisted of most of the distribution.

Inferential Statistics

This section of the results and data analysis is a presentation of results that have been subjected to inferential analysis. This format of analysis shows the relationship between variables, gives the direction of the association, and the strength of the association. In this study, inferential statistics have been used to determine the impact of independent variables on dependent ones and presents a concise and reliable means of making hypotheses analysis. Cross-tabulations were used to further trends in the results with regards to the dependent and independent variables under frequency and percentage considerations. Logistic regression analysis was also employed as well as Cox & Snell R Square and Nagelkerke R Square values to indicate the extent to which the dependent variables are affected or influenced by the independent ones.

Table 6: *Malaria Episode in the Past 12 Months and Net Use Cross-Tabulation*

Count

		Net Use		Total
		No	Yes	
Malaria in the past 12	No	561(10.9%)	2,862(55.6%)	3,423(66.5%)
months	Yes	322(6.2%)	1,405(27.2%)	1,727(33.5%)
Total		883(17.1%)	4,267(82.9%)	5,150(100%)

Note: Data source from Ghana Malaria Indicator Survey (GMIS) 2014-2016.

Cross-tabulation shown in Table 6, the distribution of the participants who responded on net use status and malaria episode was stated below. Of 883 (17.1%) participants that reported that they did not have a mosquito bed net, 561 (10.9%) therefore,

only322 (6.2%) reported malaria episodes. Of 4267 (82.9%) that indicated that they have a mosquito bed net, 2862 (55.6%) reported that they did not have a malaria episode while 1405 (27.2%) indicated that they had malaria episodes in the past 12-months prior to the data collection period. There was no missing response to this question. The bar graph in Figure 8 shows clearly that net utilization was high as more than 75 percent reported using this technique of malaria prevention.

Table 7: *Chi-Square Tests for malaria episodes and bednet use among children*

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.112[a]	1	.043		
Continuity Correction[b]	3.955	1	.047		
Likelihood Ratio	4.068	1	.044		
Fisher's Exact Test				.046	.024
Linear-by-Linear Association	4.111	1	.043		
N of Valid Cases	5150				

Note: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 296.11. b. Computed only for a 2x2 table

Table 7 presents the results for a chi-square analysis between the independent variable; bednet use and the dependent variable; malaria episodes done at 95% confidence interval and an alpha of 0.05 in 1 degree of freedom yielded a Pearson chi-square value of 4.112[a] and a p-value of 0.43. The p-value being less than 0.05 indicates a significant relationship between the two variables and explains that the dependent variable being

malaria episodes is influenced by the independent variable which is bednet use. The significance value of the chi-square computation shows the significance in relationship between the two variables but does not indicate the extent of relationship.

Table 8: *Symmetric Measures*

		Value	Approximate Significance
Nominal by	Phi	-.028	.043
hNominal	Cramer's V	.028	.043
N of Valid Cases		5150	

Cramer`s V value following the chi-square is 0.28 as shown on table 8 and indicates moderately strong relationship between malaria episodes and bednet use among children.

Table 9

Malaria Episode and Net Use, Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	6566.260[a]	.001	.001

Note: a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Without accounting for the parents' education, child gender and parents' age confounders in the model, using binary logistic regression analysis to address research question 1. Both Cox-Snell R–Square and Nagelkerke modes proposed that only 0.1% of malaria episodes observed in the past 12-months in children within families who

participated in the survey can be explained by mosquito bed net use practices/behavior (Table 9). It was therefore highly improbable that the children who slept under mosquito bed nets could have malaria episodes. The statistic proves the effectiveness of malaria prevention using the mosquito nets among children.

Table 10: *Malaria Episode and Net Use, Variables in the Equation*

								95% C.I.for EXP(B)	
		B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Step 1	Net Use (Yes)	-0.156	0.077	4.107	1	0.043	0.855	0.735	0.995
	Constant	-0.555	0.070	63.053	1	0.000	0.574		

Note: Variable(s) entered on step 1: Net Use.

Similarly, without accounting for age and gender confounders in the regression model the above table 9 shows that families that have net use for their children significantly protected the children from malaria episodes. *β= -0.156, W (1) = 4.107, p = 0.043, OR = 0.855, 95% CI [0.735, 0.995]* (Table 16).

Children sleeping under a mosquito net have a lower risk (*OR = 0.855*) or 14.5% lower odds of contracting malaria compared to those that do not sleep under a bed net. Moreover, it can be interpreted that children who sleep under mosquito bed nets reduce their chance of contracting malaria by 15%. The standard deviation of 0.077 also makes indication that there were no significant outliers in the data. With a p = 0.043, a significant relationship exists between the independent variable which is Net Use and the dependent variable which was also Malaria Episodes though this relationship is not a strong one. In simple terms, children who slept under mosquito nets were significantly protected from

having malaria but the odd ratio of 0.855 predicts that just 15% of the children had malaria with the use of Bed Nets.

Accounting for Child Gender, parents' Age, and Parents Education Level

According to table 9, holding independent variables; child gender, parents` age and parents` educational level of parents fixed in the model and using binary logistic regression analysis to address research question 1, Cox-Snell R–Square and Nagelkerke models proposed that 0.6% and 0.8% of the malaria episodes observed among children in the 12-month period can be explained by the mosquito bed net use behavior or practice. It is worth noting that these statistics makes clear the contribution of the use of bed nets to the incidence of malaria episodes in the last 12 months among children, explaining that the use of bed nets was highly preventive for malaria episodes in children.

Table 11: *Malaria Episode and Net Use, Model Summary*

Step			
1	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
	3204.557[a]	.006	.008

Note: a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Table 12 : *Malaria Episode and Net Use, Variables in the Equation*

								95% C.I .for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Net Use (Yes)	-0.174	0.120	2.078	1	0.149	0.841	0.664	1.064
	Parents Age groups	0.048	0.029	2.636	1	0.104	1.049	0.990	1.111
	Gender of child	0.019	0.085	0.051	1	0.821	1.019	0.863	1.204
	Highest educational level of parents	0.152	0.045	11.498	1	0.001	1.164	1.066	1.270
	Constant	-0.986	0.209	22.338	1	0.000	0.373		

Note: a. Variable(s) entered on step 1: NetUse, Age in 5-year groups, Gender of child, Highest educational level of parents.

From table 12, it is observed that the Wald values for net use, ages of parents, and gender of children were less than 3 however that of highest educational background of parents was more than 11. The variation makes a connection with the significance values where only level of parents` education was lower than an alpha of 0.05. The p-values obtained for each independent variable is confirmed by the odd ratios obtained. It is worth noting that it was only highest educational background of parents that had a significant relationship with the incidence of malaria episodes in the last 12 months. Also, highest educational background of parents had an odd ratio that predicted the likely occurrence of malaria episodes in the past 12 months.

In determining the statistical impact of independent variables—net use, parents' age groups, gender of child, and the highest educational level of parents, net use did not have any significance to occurrence of malaria episodes in the 12-month period with the following statistic: $\beta = -0.174$, $W(1) = 2.078$, $p = 0.149$, $OR = 0.841$, 95% CI [0.664, 1.064]

and a prediction that malaria episodes associated with net use was 16% less likely to occur with net use.

Parents age groups did not show a significant association with malaria episodes following the statistic: β= -0.048, W (1) = 2.636, p = 0.104, OR = 1.049, at 95% CI [0.99, 1.111]. Further, malaria episodes were 4% more likely to occur related to parents age group. Also, gender of the child did not have a statistical significance with children experiencing malaria episodes evident by β = 0.19, W (1) = 0.051, p = 0.821, OR = 1.019, at 95% CI [0.863, 1.204]. An odd ratio of 1.019 predicts that malaria episodes were 1% more likely to occur as associated with the gender of the child.

These results are an indication that the use of mosquito bed nets did not predict incidences of malaria episodes in children of respondents sampled. Hence, if there were some cases of malaria episodes, they cannot be ascribed to any cause than chance statistically.

On the contrary, it was observed that the independent variable, the highest educational background of parents, had a significant impact statistically on the dependent variable, which was the malarial episode in 12 months. This is evident by the statistic obtained that shows: β = 0.152, W (1) = 11.498, p = 0.001, OR = 1.164, at 95% CI [1.066, 1.270]. It is observed that there is a strong association between educational level in general and malaria episodes and there is a 16% more likelihood of episode occurring.

Results on Hypothesis Testing for Research Question 1.

The null hypothesis is rejected indicating that there is a significant relationship between malarial episodes and the use of mosquito bed nets although the relationship is

not strong as p = 0.045 at a 95% confidence interval. To answer the first research question per the model, it can be stated that a weak relationship occurred between the independent and dependent variables, that is the dependent variable which is malaria episodes was significantly influenced by the children sleeping under mosquito nets. The null hypothesis that states that the use of bed nets did not affect malaria episodes is rejected and the alternate hypothesis which is the reverse is accepted.

Malaria Episode and Type of Mosquito Bed Net(s)

Table 13 shows results obtained from cross-tabulating responses from those that experienced malaria episodes in the past 12-months against the type of mosquito bed nets children of respondents slept under. Cross tabulation aimed at establishing the relationship that exists between the two variables and covers participants who indicated that they either used mosquito bed nets or did not use nets. Altogether, they totaled 2258 participants. Among 950 participants who reported not using mosquito bed nets, 649 (29%) of the total participants 2258 did not experience an episode of malaria, while 301 (13.3%) reported malaria attack within 12 months. There is an indication that a higher number of participants whose children did not use mosquito bed nets did not have malaria in the previous 12 months. With regards to those who used bed nets without any anti-malarial treatment, 879 (39%) did not record malarial episodes in the previous 12 months while 409 (18.1%) reported cases of malaria attack out of 1288. The only child who used both treated and untreated mosquito bed nets did not report malaria episodes in the past 12 months. Finally, out of the 19 children who used only untreated mosquito bed nets 12 (0.5%) did not have

malaria in the 12 months, while 7 (0.3%) had malaria. Table 20 and Figure 20 shows the graphical representation of the results.

Table 13: *Malaria Episode and Type of Mosquito Bed Net(s), Cross-Tabulation*

Count

		Type of Mosquito Bed Net(s)				
		No Net	Only Treated Nets	Both Treated and Untreated Nets	Only Untreated Nets	Total
Malaria Episode in the past 12 months	No	649(29.0%)	879(39%)	1(0.04%)	12(0.5%)	1541(69.0%)
	Yes	301(13.3%)	409(18.1%)	0(0%)	7(0.3%)	717(31.0%)
Total		950(42.3%)	1288(57.1)	1(0.04)	19(0.8%)	2258(100%)

Note: Data for cross tabulation from Ghana Malaria Indicator Survey (GMIS) 2014-2016.

Table 14: *Chi-Square Tests between malaria episode and type of bednet use*

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.993[a]	3	.574
Likelihood Ratio	2.306	3	.511
Linear-by-Linear Association	1.225	1	.268
N of Valid Cases	5150		

Note: a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is .34.

Table 14 presents the results for a Pearson Chi-Square analysis between malaria episodes as the dependent variable and type of bednet as independent variable. Pearson Chi-Square value was 1.993[a] and a p-value of 0.574. The p-value indicates that there is no significant relationship between the two variables as the value is higher than the alpha (0.05). Cramer`s V value was not computed since there was no significant relationship between the two variables.

Table 15: *Malaria Episode vs. Type of Net (ITN vs. non-ITN), Model Summary*

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	2821.510[a]	0.000	0.001

Note: a. Estimation terminated at iteration number 20 because maximum iterations has been reached.

By adjusting for the independent variables—child gender, parents` age group, and parents` educational level—in the model and using binary logistic regression analysis to address research question 2, Cox-Snell R–Square and Nagelkerke modes proposed 0.0% and 0.1% respectively of the malaria episodes observed among children in the 12-month

period can be explained by the type of mosquito bed net use behavior or practice as shown in Table 15. This simply explains that there is a 0.0% with regards the Cox-Snell R–Square statistic and or 0.1% per the Nagelkerke R Square statistic likelihood that the bed net use behavior affected the malaria episodes in children whose parents were sampled.

Malaria Episode vs. Type of Net (ITN vs. Non-ITN)

Regression analysis between the malaria episode run against types of bed nets obtained the results displayed on table 16. Adjusting for a child`s gender and age groups of parents as confounders in the model. The regression presented a poor association between malaria episodes and the types of mosquito nets that child slept under. The statistic for children who used only treated nets in a regression analysis with malarial episodes gave the following: W (1) = 8.731, p = 0.973, no treated bed nets recorded β = -0.229, W (1) = 0.481, p = 0.633, with an OR of 0.795, at 95% CI [0.310, 2.040] indicates a non- significant relationship between malaria episodes and children not sleeping under mosquito nets. An odd ratio of 0.795 indicates a 20.5% less likely that malarial episodes occurred among children who slept under mosquito nets than those who do not use the nets. Children who slept under only treated mosquito nets had a 20.2% less likelihood of getting malaria compared with those who slept under the nets with an odd ratio of 0.798 and p = 0.637 indicating a poor relationship with malarial episodes at 95% CI (0.312, 2.040). The results point out statistically that the type of mosquito net was not that necessary in preventing the school going children from getting malaria.

Table 16:*Malaria Episode vs. Type of Net (ITN vs. Non-ITN), Variables in the Equation*

								95% C.I. for EXP(B)	
		B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Only Untreated Nets			0.228	3	0.973			
	No Net	-0.229	0.481	0.228	1	0.633	0.795	0.310	2.040
	Only Treated Nets	-0.226	0.479	0.222	1	0.637	0.798	0.312	2.041
	Treated and Untreated Nets	-20.664	40192.97	0.000	1	1.000	0.000	0.000	0. 0
	Constant	-0.539	0.476	1.284	1	0.257	0.583		

Note: a. Variable(s) entered on step 1: Type of mosquito bed net(s) child slept under last night.

Malaria Episode vs. Parents Educational Level and Net Use

Adjusting for child`s gender and age groups of parents as confounders in the model, Table 16 shows the results obtained from a multivariate regression analysis with malaria episodes as the dependent variable and the different educational backgrounds of parents as the independent variables as well as against Net use in general among children. From the table, the variables; no education, primary education, secondary education and higher education recorded p-values that indicated a significant relationship with malaria episodes in the last 12 months. Emphasis lies on two statistics, the p-value and the odd ratio. The regression table shows all educational backgrounds had p-values less than 0.05. This indicated a significant relationship between the individual variables under educational background and malaria episodes in the past 12 months. Odd ratio predicts the occurrence of a variable and it is the ratio of the probability of an event occurring to its failure to occur.

Primary education versus malaria episodes recorded the following statistics; β = 0.275, W (1) = 8.731, p = 0.003, OR = 1.317, at 95% CI [1.097, 1.580]. With an odd ratio of 1.317, it is predicted that there is a 31% more likely chance of malaria episodes occurring associated with parents having primary level of education. Secondary level of education versus malarial episode yielded the statistic: β = 0.310, W (1) = 17.371, p = 0.000, OR = 1.363, at 95% CI [1.178, 1.577]. Secondary level of education predicts 36% more likelihood with an OR of 1.363. Results for higher education in the multivariable regression with malarial episodes yielded: β = 0.418, W (1) = 10.378, p = 0.001, OR = 1.519, at 95% CI [1.178, 1.960]. There was an established 51% more likelihood that malarial episodes would occur with an odds ratio of 1.519. Finally, net use had poor association between net use and malaria episodes as was confirmed with a 13% less likelihood of occurring for children who slept under the nets as compared to children who did not sleep under the nets. The statistic obtained was β = 0.-130, W (1) = 2.793, p = 0.095, OR = 0.878, at 95% CI [0.754, 1.023]. The p-value obtained was higher than 0.05 showing no significant relationship between the type of bednet and malaria episode. The odd ratio of 0.878 indicates a 12% unlikelihood of the occurrence of malaria episode contributed by type of bednet children slept under. The results are tabulated in Table 17.

Table 17: *Malaria Episode vs. Educational Level of Parents and Net Type Use, Variables in the Equation*

								95% C.I. for EXP(B)	
		B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Step	No education			20.541	3	.000			
1[a]	Primary Education	.275	.093	8.731	1	.003	1.317	1.097	1.580
	Secondary Education	.310	.074	17.371	1	.000	1.363	1.178	1.577
	Higher Education	.418	.130	10.378	1	.001	1.519	1.178	1.960
	Net Type Use	-.130	.078	2.793	1	.095	.878	.754	1.023
	Constant	-.814	.091	79.680	1	.000	.443		

Note: a. Variable(s) entered on step 1: Highest educational level, Net Use.

Academic Performance against Malaria Episodes in the Past 12 Months

Table 17 presents the results on analysis of the influence of malaria infection on academic performance using chi-square yielded a chi-square value of 31.197[a] and a p-value of 0.000. This results explains that there is a significant relationship between academic performance and malaria infection. Children who had malaria infection most of the time were highly likely to have problems with academic performance.

Table 18: *Likelihood Ratio Tests*

	Model Fitting Criteria	Likelihood Ratio Tests		
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	41.079[a]	.000	0	.
ChildEduPerfomance	72.276	31.197	5	.000

Note: The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Results on Hypothesis Testing for the Second Research Question

With regards to the second research question, which states: What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito nets compared to those who sleep under non-treated mosquito nets, from which the hypothesis was derived.

There is no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito nets compared to those who sleep under a non-treated mosquito net. Hence the null hypothesis is accepted and alternate rejected.

Summary

By way of summarizing the findings of results, a total of 5150 participant were recruited for this study. Out of this number, 82.8% had mosquito nets for their children. Among the participants 43.8% did not use mosquito nets. Malaria episodes were 33.5% among participants while the rest, 65.5% did not record malaria episodes in the past 12

months from the period of the study. Bed net use and malarial episodes in children of participant recorded a significant association with a p-value of 0.43 which was observed to be a moderately strong association using the Cramer`s V consideration.

The likelihood of child getting malaria when they slept under the mosquito net was low as p = 0.637 was obtained by chi-square analysis between the malaria episodes and sleeping under the net. In addition, the type of ITNs bednet child slept under was not precictive of malarial episodes since an odd ratio of 0.878 was obtained representing a 12% unlikelihood of the occurrence. Finally, the impact of malarial infection on academic performance was observed to be positively associated. With a p-value near 0.000.

There was a significant relationship between malarial episodes and the use of mosquito bed nets although the relationship is not strong as p = 0.045 at a 95% confidence interval. Hence the null hypothesis derived from the first research question was rejected and alternate accepted. On the contrary, there was no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito nets compared to those who sleep under a non-treated mosquito net. This led to the acceptance of the null hypothesis.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to investigate the effectiveness of major malaria control policies in reducing malaria cases as a means of improving academic performance among school children in the greater Accra region as a core part of the IMVMP. This is in view of obtaining circumstantial evidence regarding the effectiveness of the ITN policy and how far the IMVMP has come in the quest to eliminate malaria infection from the children population. I found the relationship between malarial episodes and the use of ITNs and made determination of the risk factors that contributed to malaria infection. Also, the association with use of type of mosquito nets and malarial infection were found as well as the association between parents' educational background and malarial infection prevention. Malaria infection has been identified to have debilitating effect on children medically and could be life threatening if quick care is not sought (citation). Academically, malaria infection could have a negative effect on the progress of education as patients most often than not lose the whole week in managing the condition. Children of school going age who are infected stay home and lose many lesson hours and might not be able to catch up with the rest of the class.

In view of the impact of malaria in areas that are malaria endemic, policies such as IVMP (USAID, 2017) have been employed which has its mainstay to be, providing insecticide treated materials, adulticiding and larviciding, and environmental management. The policy prescribes an all-inclusive approach which brings together, health care officers, environmentalists, and the community as well. In this study, I sought to identify the how

effective this policy has proven to be. According to Chanda et al. (2016) there is a need to have an all-inclusive approach is required for a good turnaround in the issue of malarial incidence through prevention. This is due to the mentioned 88% cases and 90% related deaths in sub-Saharan Africa by Chanda et al.. The policy`s environmental prescription is also of great importance as was identified that *Bti* could be used for the management of mosquitoes at the breeding sites (Nartey et al., 2013) indicating that it was not only the use of mosquito nets but also environmental practices that eliminate the larvae of the vector.

The importance of determining the rate of malaria prevention through its incidence and to predict the effectiveness of malaria prevention policies is being highlighted by Brewster et al., (1990) and Jukes et al. (2006). From their delivery, it was mentioned that malaria led to serious health issues such as cerebral infections and could affect the cognitive development of the child. The academics of children frequently affected by malaria episodes was also impeded and become low achievers.

Interpretation of the Findings

As a summary to the findings, the demographics of parents indicated gender distribution of children whose parents were sampled observed a higher percentage for males (51.5%) as compared to females (48.5%) among those who indicated the gender of their children. With regards to the age ranges of parents, more than half of them (53.3%) were aged 20-34years while least were also aged 15-19years (20.4%).

The vast majority of children sleep with mosquito nets, the majority of which were handled or untreated. In the last 12 months, parental education had a significant impact on mosquito net use, but parents' age groups, child gender, and mosquito net form had no

significant impact on malaria infection. The report also discovered that malaria episodes in the previous 12 months were smaller in those who had not had malaria, suggesting an increase in those who had not had malaria. The finding of Serengbe et al. (2015) confirmed a high rate of ownership of mosquito nets (72.1%) as was confirmed in this study where 82.9% of the parents reported their children slept under mosquito nets. With this high ownership, it is expected that malaria prevention should be very high, however this is not so. According to Serengbe et al. malaria prevention is multifaceted and involves a personal, family or community behavior as well as institution inputs for success.

The following are the details of the descriptive research discussion. The use of mosquito nets was common in the sample region (82.9 %), but not universal for all children. There was no evidence of a 100% consumption rate. Results should that 17.1% of the children remain at risk of getting infected with malaria. The use of treated mosquito nets was higher than the use of untreated nets as indicated by 1,288 (57.0%) among those who indicated the type of nets their children slept under. Normally, the mosquito nets that are in circulation are the treated ones and washing is not frequent. It could also be that parents thought as it was treated before, even after washing, it kept its chemical treatment. This might have caused the high percentage of use of treated mosquito nets over the untreated ones. The SEM, as explained by CDC (2015), indicated interventions that are personal and environmentally related as having impact on the health of individuals in the population. The mere use of mosquito nets is therefore inadequate for a comprehensive strategy in malaria prevention among children.

Relationship between Malaria Episodes and ITNs Use

The results reflected a 33.5% incidence of malaria among the children in the past 12 months. The value could have arisen from not from only night sleep but other possibilities of mosquito bites. These could be bites outside the house as mainly people spend some time outdoor and go into their rooms when it was time to sleep. Other forms of protection such as insecticide gels and creams might have been neglected posing risk of mosquito bites on children. It is a fact that the success of malaria prevention is not dependent only on the use of ITNs but a complete change in attitude towards all issues related to health. As indicated by Moore et al. (2011), the SEM perceives holistic interventions in settings appropriate for health promotion measures as the ultimate means to prevent malaria in malaria hyperendemic areas. There is a need to identify the level of knowledge of parents with regards to the diseases in terms of transmission mostly such that the knowledge gaps exhibited can be bridged appropriately (Moore et al., 2011).

Another very important consideration was the parental educational level against the incidence of malaria in the last 12 months. The cross tabulation conducted on the variables malaria episode in last 12 months and educational level of parents yielded interesting findings. It was observed that parents with secondary school or higher educational background mostly employed mosquito nets as a means of preventing malaria episodes among their children. UNICEF (2016) added that 70% of the cases recorded in 2016 were children under 5 years hence, more premium is placed on the prevention of malaria in children and more importantly, there is a need to get their parents well informed on the technological basis of malaria prevention available so they can implement them as

required. The strict use of ITNs surely provides protection but only at bedtime. Other times where the child is outside the ITN serves as a risk for getting bitten by mosquitoes and getting malaria transmitted to them. The need for education in a holistic manner on issues regarding malaria prevention should be heightened as indicated by Moore et al. (2011).

Discussion on Inferential Analysis

This section of the discussion deals with analysis of the impact of variables on another and their relevance to this study. The research questions that are being answered are;

What is the relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana?

And the second is;

What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleep under insecticide-treated mosquito net compared to those who sleeps under non-treated mosquito net?

In view of answering these questions, a set of hypothesis were derived to serve as a statistical guide.

In an attempt to answer the first research question, the following hypotheses were tested;

> H_o1: There is no relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

H_a1: There is a relationship between cases of malaria among children in families that have insecticide mosquito bed net for sleeping compared to those who did not have mosquito bed net for sleeping, in hyperendemic areas of Accra Ghana.

Appropriate variables that could enable the test`s success were analyzed including; sleeping under mosquito nets the incidence of malaria in 12 months as recorded in the data collection process. Hence the study sought to determine the relationship between these two variables mainly and accept the null hypothesis or reject it and accept the alternate.

Findings on Hypothesis Tested for RQ1.

Following the models used in this study and results of regression analysis, child gender and parents' age did not have a significant relationship with the incidence of malaria episodes among children in the past 12 months. However, educational background of parents had a significant relationship with the incidence of malarial episodes. With a p-value of 0.043 from both chi-square and regression analysis and an odd ratio of 0.855 indicating a 14.5% rate of unlikelihood of getting malaria as compared with those who did not use mosquito nets. It was also found that there only 1% of the malarial episodes that occurred could be explained by the use of mosquito nets according to Cox-Snell R–Square and Nagelkerke tests. There is a clear indication of the usefulness of the use of mosquito nets in the prevention of malaria episodes and the level of effectiveness of the implementation of the anti-malaria policy. The SEM as elaborated by Clouston, Yukich and Anglewicz (2015) calls upon institutions and the community to spread knowledge about malaria prevention technology. In their delivery the ages of mothers and the educational level of mothers was evaluated in regression analysis and identified a

significant relationship between malaria prevention and treatment. According to Serengbe et al. (2015) hygiene and sanitation were the most important preventive measures against malaria. These findings assert to the findings made in this study.

The Impact of Demographic and Net Use on Malaria Episode

Further in determining the impact of other variables on malarial episodes in children, parents age group, educational background and gender of child were tested with net use against the incidence of malaria in the last 12 months. Per the results obtained, the kind of net used yielded p=0.149 and an OR of 0.841 predicting that malarial episodes were 16% less likely to occur with net use than without nets. The demography of parents according to Amoran (2013), Andrew et al. (2014) and Diala et al. (2013) was pointed out as vital in targeting malaria prevention through interpersonal interventions. Variables such as age ranges of parents, educational background were important factors to consider. With age ranges, it is noteworthy that for most cases, as mothers get older they get more experienced with malaria prevention in their children where there is flexibility of behavior. For skeptical mothers who will ignore new ideas of malaria education as given during antenatal meetings tend to fall back technologically in terms of preventive measures available and clench to older ineffective ways.

A similar finding was obtained for parents age groups where a p value of 0.104 and an odd ration of 1.049 was obtained indicating no relationship between the two variables and a 1% likelihood of malaria episodes occurring to be explained by age grouping of parents. Gender of child did not yield any significance in terms of relationship with the

incidence of malaria episodes following a p-value of 0.821 and odd ratio of 1.019 also indicating a 1% likelihood of occurrence.

The reverse was accounted for when educational level was considered in relation with net use against incidence of malarial episodes. Here a p-value of 0.001 and an odd ratio of 1.164 indicated 16% of a possibility of malarial episode occurring among children did not use the nets as compared to those who used it. It was identified that it was only when net used was considered with educational background of parents of children that significance relationship was achieved. It can be opined that having formal education sets the platform for new change of attitude to health matters. It is noted *Nsagha & Njamnshi, (2010) and* Panter-Brick et al. (2005) who involved in interventional studies measures indicate the need for community based education where the smallest unit if the community is targeted for effective results. It is worth mentioning that infection prevention being part of basic school curriculum and higher education also help prepare individuals for infection prevention when they enter family life as presented by Nsagha & Njamnshi, (2010) and Panter-Brick et al. (2005).

Answering the Second Research Question

Infections Risk for Malarial Episode and ITNs

The second research question posed in this study was: What is the relationship between malaria infection risks among school-aged children in hyperendemic communities of Ghana who sleeps under insecticide treated mosquito net compared to those who sleeps under non-treated mosquito net? From this question the hypothesis derived to attempt to statistically answer the questions were;

Ho2: There is no significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleeps under insecticide treated mosquito net compared to those who sleeps under non-treated mosquito net.

Ha2: There is a significant relationship between malaria infections' risk among school-aged children in hyperendemic communities of Ghana who sleeps under insecticide treated mosquito net compared to those who sleeps under non-treated mosquito net.

The research question as evaluated is aimed at determining the malaria infection risks among the children whose parents were sampled from the malaria prone areas in the country and the practice of children sleeping under mosquito nets or the reverse. Here the risk of getting the infection is the dependent variable while sleeping under mosquito nets is the independent variables. The research question was answered following the significance test results after multivariable regression and a statistical conclusion made from the test of hypothesis. Amoran, (2013) expressed the need for an evaluation of the risk behavior for malaria. The use of ITNs was highlighted, though not an all-round prevention technique, hence the rate of children sleeping under nets was introspected.

Malaria episodes in the last 12 months and type of bed nets used

Findings from the regression conducted between the dependent and independent variables as indicated by the models employed in this study pointed out the following; there was a non-significant relationship between the risk factors and the incidence of malarial episodes evident by a p-value of 0.633 and an odd ratio of 0.795 which explains that there

is a 20% unlikelihood of the occurrence of malaria episodes among children who slept under only treated nets as compared to those who did not use treated nets. In the second consideration, those who slept under untreated nets scored a p-value of 1.000, a clear indication of a poor relationship between the two variables.

The use of bed nets as indicated by UNICEF (2016) has proven to be one of the most effective ways of preventing malaria during sleep. Despite the prescription the use of ITNs, there is a somewhat silence on whether malaria infection considered the type of nets. It is worth mentioning that the physical barrier created against mosquitoes gaining access to bite is the main purpose of its use. The type of net is therefore not as much important as using a mosquito net. This ideology is confirmed in the findings in the preceding paragraph. In furtherance on this evaluation, the Cox-Snell R–Square and Nagelkerke modes run on the variables, it was found that there was a 0.0% and a 1% possibility of malaria episodes being explained by the use of a type of nets. In simple explanation, the type of net used did not have any significant impact on the incidence of malaria episodes among the children.

Malaria Episodes in the Last 12 Months Versus Net Use in Terms of Educational Background of Parents

Despite the non-significance between incidence of malaria episodes in the last 12 months and the use of ITNs or non ITNs, in terms of parents' educational level and net use, there was a significant relationship achieved for particular educational levels. It was found that parents who had had formal education recorded significance with the use of mosquito nets and its impact on the incidence of malaria episodes in the past 12 months.

McLeroy et al. (1988) in their study identified that the social-demographic nature of parents affected their knowledge about health choices and behaviours. They mentioned, education, attitude, knowledge gender and other socio-economic status. The importance of evaluating the impact of education on the use of ITNs which is indirectly testing the appreciation of malaria prevention among parents was priceless for this study.

Findings specifically indicated a p-value of 0.003 and an OR of 1.317 after running a regression between incidence to malaria episodes and mosquito nets use among parents with primary school education, $p = 0.000$, $OR = 1.363$ for secondary education and $p = 0.001$, $OR = 1.519$ for higher education. In rationalizing these results, it can be mentioned that there was a significant difference between parents under the different educational levels the use of ITNs, as compared to parents with no formal education. This group recorded a poor relationship between malaria episodes and ITN use. There is a prediction that there was a 13% ($p = 0.095$, $OR = 0.878$) less likelihood that children who slept under the nets will get malaria as compared to children who did not sleep under the nets. Parents who were educated might have been agreeing to the policy and actually contributed their quota as part of the community to make the policy effective and translated into better protection for their children.

Amoran (2013) Andrew et al. (2014) and Diala et al. (2013) reiterates that the family unit is the most important target for interpersonal intervention against malaria. The knowledge of parents therefore as predicted by having formal education certainly had impact on ITN utilization among children. The findings in this study regarding educational

background of parents and ITN use is therefore in agreement. The findings of McLeroy et al. (1988) is also confirmed by that of this present study.

Fernando et al. (2006) made a point on the need for malaria prevention through the use of ITNs and drugs for prophylaxis as a means of reducing cases of poor academic performance. In this study also it is observed that children of school going age will be negatively affected if they did not sleep under or did sleep under mosquito nets at home. It can also be inferred that the study area is malaria endemic and there is a need to encourage parents to adhere to the malaria prevention policy and contribute their quota to it for the policy to be effective and yielded the needed results.

Impact of Malaria Infection on Academic Performance of Children

The impact of malaria infection on academic performance of children in malaria hyperendemic areas was explored directly and indirectly in this study`s data. Directly, likelihood tests using chi-square analysis was run to determine whether there is a significant relationship between malaria infection and academic performance of children whose parents were sampled in this study. Indirectly, other variables such as bednet usage and demographics characteristics were explored to determine their impact on malaria episodes in children which will in turn affect the academic performance of children as it will lead to absenteeisms. According to findings from the chi-square a significant relationship was established ($p = 0.000$) that indicated malaria infection affected academic performance and certainly, it will have a negative impact on academic performance hence the need to prevent infection through the use of bednets and environmental practices that such as larcividing was necessary especially in hyperendemic areas of the country. Despite

the fact that malaria infections contribute to absenteeisms, children who have malaria more stand a chance of cerebral issues when the malaria attached the cerebrum. This situation can lead to serious neurological impairments affecting learning, speech, sight or hearing. According to Brewster, Kwiatkowski & White, (1990) and Jukes et al. (2006) more serious health impact such as epilepsy, hemiplegia, and cerebral palsy can ensue if malaria is frequent and unchecked in children. This trend of malaria having impact on the cognitive development and achievements linked to cognitive strength is confirmed in this study as well as malaria infection has a negative impact on academic performance.

Conclusion Based on Hypothesis Testing

Based on findings from the hypothesis tested, there is a definitive and significant relationship between malarial episodes in children in the last 12 months and the use of mosquito nets following the models employed for this study. This was evident with a p-value of 0.045 which is lower than the alpha of 0.05, which is considering at 95% confidence interval. It can be further indicated that the use of mosquito nets was a strong variable in terms of determining whether malaria episodes will occur in a population of children using or not using mosquito nets.

The second research question posed sought to determine the relationship between the risk factors for malarial infections among school going aged children in the malaria hyperendemic area of Ghana who slept under insecticide treated mosquito nets as compared those who did not.

The results from the regression analysis pointed out a poor relationship between the malaria incidence and the type of mosquito nets used by children. It was when educational

background of parents were also considered that some strong relationship were found. It is worth mentioning that the dependent variable was not impacted by the independent variable in this multivariable regression run.

Limitations of the Study

Pair-wise comparison could not be attained to enrich the statistics of the results as data from the exposure group was from a non-primary source. Effectively, the variables that were involved in this study were not controlled and limited the outcome of the analysis to correlational analysis. The study per its models sought to determine the relationship between malarial episodes and the use of ITNs but did not really delve into the effectiveness of the malaria prevention policies. Also, there was no assurance of a continual usage malarial prevention techniques apart from the use of ITNs or mosquito nets generally. The records of malaria infection could also be from other factors such as exposure to mosquito bites from the environment and cannot be prevented by the use of ITNs.

Finding that malarial infections could affect educational achievement cannot be of exact certainty. This is due to the fact that the quality of education could overcome the problem of absenteeism where proper plans are made to enable children to catch up with lessons. The generalization in that sense will therefore be erroneous. To explain further that the poor performance of pupils in the public schools presently could be a measure of poor quality of teaching and pupils who are faced with malarial episodes intermittently are sure to be absent from school and their performance affected.

Recommendations

It is recommended that policy makers should strategize malarial interventions to be sensitive to socio-cultural and socio-economic status. This will enable all and sundry to identify with the policy and participate as required.

ITNs distribution should have an education program going with it to enlighten the general public on how to use the nets and also treat them when washed. This education program should be powered by the multimedia and television broadcast service in order to reach a wider coverage. For remote areas, health workers and educators should take up education programs by organizing durbars on non-farming days so that proper education can be given to ensure its use. Education on the use of ITNs should be done by making the general public appreciate the importance of this method of malaria protection.

In a more direct attempt to disseminate information on the use of ITNs, mothers and mother-to-be individuals should be captured and educated. This step will not only create knowledge of the importance of ITNs but also it will inculcate the behavior of continual use of this technology of malaria prevention. Education of the mother will go a long way to improve their human capital as well as improve child health.

The use of ITNs in malaria prevention is vital but other means of malaria prevention should be research into to aid the completeness of the malaria prevention policy. Malaria prevention behaviours that are related to the environment, socio-economic status, and other factors that hold prospects should be delved into in later studies. It is also recommended that studies on malaria prevention and the effectiveness of related policies should be periodically conducted to identify changes in trends as prescribed by the changing

environment and to prescribe newer and more effective preventive modalities that need to be implemented.

Finally, the use of malaria chemoprevention (SMC) and indoor insecticide paints should be introduced to the general public to cater for the discomfort that some individuals are faced with when sleeping under the mosquito net. The Health Directorate in collaboration with Ministry of Health and other Stakeholders should join effort to improve malaria prevention indicators.

Implications for Positive Social Change

Findings from this study points out the need for planning a more effective education on malaria prevention that covers all possible and available technology. It is clear that the use of ITNs is integral in the prevention of malaria in children of school going age, however, this behavior or practice is not complete. There is a need for education on the other forms of malaria prevention that go beyond the use of ITNs. The environmental sanitation as well as personal hygiene factors should also be implemented in the educational methodologies.

The health seeking behavior of parents for malaria infection should be delved into in other studies. This is important as some parents often delay in seeking care or might try other less effective malaria treatment modalities which could worsen the condition of the child. There is also a need to have a well carved educational system for parents and the general public that will fit into all socio-demographics and socio-cultural dispositions. The education should be able to meet the public in terms of their age, religious identity, racial/ethnic identity, sexual orientation, economic status, financial resources, values,

goals, expectations, literacy, stigma, and others as indicated by CDC (2014) to enhance the right health seeking behavior and malaria prevention practices.

Conclusions

Based on the objectives set for this study which were to determine the relationship between malarial episodes and the use of ITNs, and determining the relationship between the risk factors for malaria infection and malaria infections, the following conclusion have been made.

Malarial episodes was associated with the use of mosquito nets in general and did not really identify the type of net used. Hence it can be stated that the physical prevention of mosquitoes gaining access to children was the main issue worth indicating though the use of ITNs was a preferable situation. It is also conclusive that parents` age range and genderg of child did not have any relationship with the prevention of malarial episodes in the 12 months period of the study. It was however identified that parents' educational level had a significant relationship with the incidence of malaria episodes hence impacted on the prevention of malaria.

It is also conclusive that the use of bednets will prevent malaria episodes among school children and will help improve their academic performance and help reduce or eliminate the risk of cerebral malaria that could affect cognitive development and wellbeing of children. It is clear that malaria control policy is a vibrant means of improving the academic performance of children in the Greater Accra Metropolis.

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