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UNIVERSITY OF GHANA

INFLUENCE OF ENVIRONMENTAL SANITATION PRACTICES ON PREVALENCE OF MALARIA AMONG CHILDREN UNDER FIVE YEARS OLD IN BANKUMAN IN TEMA NEW TOWN, GHANA

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH (MPH) DEGREE

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DECLARATION

I, **CECILIA AMILAH E. ACKAH**, do hereby declare that apart from references that have been duly acknowledged, this dissertation is the result of my efforts under able supervision. I take full responsibility for this work.

Date: 09/09/21

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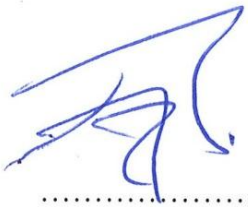

Date: 09/09/21

Dr. Reginald Quansah

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DEDICATION

This dissertation is dedicated to my family.

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ACKNOWLEDGEMENT

I thank the almighty God for his abundant grace and strength that has seen me complete my dissertation. Special thanks go to my supervisor for his guidance and support throughout the development of this dissertation.

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Table of Contents

University of Ghana http://ugspace.ug.edu.gh

University of Ghana http://ugspace.ug.edu.gh

University of Ghana http://ugspace.ug.edu.gh

University of Ghana http://ugspace.ug.edu.gh

University of Ghana http://ugspace.ug.edu.gh

LIST OF FIGURES

University of Ghana http://ugspace.ug.edu.gh

LIST OF TABLES

University of Ghana http://ugspace.ug.edu.gh

LIST OF ABBREVIATIONS

CHPS	-	Community-Based Health Planning Services
CWC	-	Children Welfare Clinic
DHIMS	-	District Health Information Management Systems
ITNs	-	Insecticide Treated Nets
NMCP	-	National Malaria Control Programme
RDT	-	Rapid Diagnostic Test
RPC	-	Reasonable Preventable conditions
UNICEF	-	United Nations International Children‘s Emergency Fund
WHO	-	World Health Organisation

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ABSTRACT

Introduction: In 2018, there was an estimated 219 million episodes of malaria globally, of which approximately 92% were in Africa (WHO, 2019). The poor standard of environmental sanitation plays a significant role in disease transmission, especially for endemic diseases such as malaria in sub-Saharan Africa (Amoran, Onwumbe, Salami & Mautin, 2014). Children under five years old are the most vulnerable group affected by malaria, as they account for over 60% of all malaria deaths worldwide (Ahmed, Mulatu, Elfu, 2021). According to the DHIMS (2019), outpatient malaria cases in children under five years old rose from 545 in 2017 (1.7%) to 612 (2.23%) in 2018 in Tema New Town. Knowledge of how environmental sanitation practices influence malaria prevalence among children under five years old in Tema New Town seems inadequate.

Objective: To assess the influence of environmental sanitation practices on malaria prevalence among children under five years old in Bankuman in Tema New Town.

Methods: An analytical cross-sectional study design with quantitative methods were used to conduct the study. A multi-stage sampling method was employed, and data were analyzed with STATA 16.0 with chi-square and simple logistic regression. Variables with a p-value less than 0.05 were statistically significant for multiple logistic regression with statistical significance set at $p < 0.05$

Results: The prevalence of malaria among children under five in Tema New Town was 8.5%. Age (AOR: 0.97, 95% CI: 0.94-1.00), No open drainages (AOR: 0.06, 95% CI: 0.01-0.28) No uncovered dustbins (AOR: 0.13, 95% CI: 0.03-0.52), Always de-silting open drains (AOR: 0.07, 95% CI: 0.01-0.70) were found to be significant predictors of Malaria by RDT testing among children under five in Tema New-Town.

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Conclusion: Malaria prevalence was higher than previous figures reported in Tema New Town and the Greater Accra Region. The use of insecticide-treated mosquito nets, indoor residual spraying, the use of mosquito repellents, and antimalarial prophylaxis, as well as proper waste storage and disposal, proper covering, and regular de-silting of open drains or gutters should be encouraged among residents.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Malaria is caused by infection with *Plasmodium* parasites transmitted through the bites of female *Anopheles* mosquitoes (Mwangangi et., 2013). According to Ahmed, Mulatu and Elfu (2021), malaria is a common infectious disease caused by protozoan parasites of the genus *Plasmodium* that have four species to infect humans, namely P. falciparum, P. vivax, P. ovales, and P. malarie. Malaria is a complex and deadly disease that puts approximately 3.3 billion (40%) people at risk globally (Ahmed, Mulatu & Elfu, 2021). Under-five year children are the most vulnerable group affected by malaria; they account for 61% of all malaria deaths worldwide (World Health Organization [WHO], 2018). An estimated 440,000 people died from malaria in 2015, with 90% of such deaths coming from Africa (WHO, 2015). In 2018, there was an estimated 219 million episodes of malaria globally, of which approximately 92% were in Africa (WHO, 2019).

Estimates suggest that the world‘s cities produce 1.3 billion tonnes of waste annually, with Asia being accountable for 1 million tonnes per day. Increasing urbanization and population growth rate put the global waste to an estimated 2.2 billion tonnes by 2025
(Global Waste Management Conference, 2017). The World Counts on Household Waste Statistics estimates that 1,451,676,470 and counting tonnes of household waste will be produced in 2019. They stated that people make enough waste every two hours to fill 12 container ships every day and 4,380 container ships in one year, with the majority ending up in our water bodies and a bigger proportion burnt, resulting in air pollution (Global Waste Management Conference, 2017).

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Apart from contamination of water and air pollution, the health hazard is another critical issue. Improper disposal of waste has been found to provide breeding grounds for various zoonotic and parasitic organisms causing harm to health. Notable among these is the female *Anopheles* mosquito, which is responsible for bites and transmission of malaria. It is reported that a child dies every minute from malaria in Africa, with an estimated 435,000 malaria deaths recorded in 2017 (WHO, 2018). Approximately 61% of malaria deaths in 2018 were of children under five years of age (WHO, 2019), with the majority coming from sub-Saharan Africa.

Kobina et al. (2010) reported that malaria is caused by infection with *Plasmodium* parasites transmitted through the bites of female Anopheles mosquitoes whose main breeding grounds, in sub-Saharan Africa, are poor sanitation indiscriminate dumping of refuse. According to Mokuolu, Coker, and Sridhar (2016), poor sanitation, indiscriminate disposal of refuse, poorly managed wastes, choked gutters, and open drains contribute to the prevalence of malaria in humans. They explain that poorly managed waste often ends up in ponds, reservoirs, or drainage systems blocking drainage channels, resulting in the ponding of water: these surface waters are often polluted with organic waste, becoming breeding sites for mosquito larvae (Mokuolu, Coker, & Sridhar, 2016). Bourne (2003) adds that mosquitoes may breed wherever stagnant water is, especially in flooded areas, tidal or fresh water wetlands, lakes, and ponds. He explains that mishandled household articles and poorly discarded trash such as tyres, drums, pails, garbage cans, plant pots may serve as breeding grounds for mosquitoes. There is a high potential of malaria-related cases and deaths increasing since our household wastes are estimated to keep growing (Mokuolu, Coker, & Sridhar, 2016). Therefore, there is the need to address issues concerning improper household environmental sanitation and its malaria-mortality-driven potential.

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1.2 Statement of the Problem

It has been reported that there are some 3.5 million cases of malaria in Ghana yearly (UNICEF, 2007). According to NMCP Annual Report (2015), the share of malaria in all outpatients' cases in Ghana is 38% and, it accounts for 50% of hospital admission among children under five years old. Malaria has been described as a predominantly rural disease in Ghana on the evidence that mosquito breeding sites are increasingly reduced with proximity to urban areas (Warren et al., 1999). However, there is incessant malaria transmission in urban areas due to population increase in Ghana, with a projected 50% of the population living in the urban areas (Robert et al., 2003; Ghana Statistical Service, 2010; Awuah et al., 2018). This rapid urbanization contributes to urban poverty, with the poor urban residents being the most affected by the disease (Awuah et al., 2018).

Poor housing, low socioeconomic status, knowledge, and education levels, among others common among rural folks (due to poverty), also characterize urban poor, thereby heightening their risk of malaria contraction (Awuah et al., 2018). Although increasing surface water pollution caused by rapid urbanization is believed to have hampered the development of Anopheles larvae and eliminate certain species like Anopheles funestus, others such as species of the Anopheles gambiae complex have adapted well and continue to breed even in organically polluted water bodies (Chinery, 1984). This is contrary to the conventional view that Anopheles mosquitoes breed only in clean or clear water habitats (Muirhead-Thomson, 1951).

Anopheles mosquitoes exploit varying habitats for breeding. They breed in and around vicinities of deteriorating infrastructure such as broken water pipes, open tins/cans, poorly maintained drains, culverts, market gardens/urban agricultural sites, pools at construction

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sites, lorry tyre tracks on unpaved roads, low lying areas that are liable to flooding, hydrants, and catch pits (Klinkenberg, McCall, Wilson, Amerasinghe & Donnelly, 2008).

According to Kudom, Mensah, and Agyemang (2012), most Anopheles mosquito breeding habitats in urban areas are artificial. Perceivably, all available landscapes within the city, whether natural or man-made, that collect any form of stagnant water are potential breeding places for mosquitoes and may possibly be habitats for Anopheles mosquitoes. Such habitats are most often maintained by human activities, which have poor hygiene practices supported by a lack of proper sanitation facilities (Songsore et al., 2005).

Mattah et al. (2017) reveal that Anopheles larval density is high in wet seasons and more associated with puddles, urban farms, and drains. These have prospects for targeted interventions to manage, reduce, or eliminate Anopheles breeding habitats and eventually prevent malaria prevalence in humans. To achieve this, they suggest the need to adopt sound environmental sanitation practices.

Tema New-Town, a suburb of Tema, presents issues of poor sanitation and poor waste disposal practices and the general characteristics of rural and urban poor communities acknowledged above. It is common to find heaps of waste, choked gutters, open drains, and pools of water with all kinds of waste, particularly household waste. These sites, which are found close to homes, become breeding grounds for mosquitoes encouraging the spread of malaria. Pregnant women and children under five are the most vulnerable in these conditions (NMCP Annual Report, 2015). According to the District Health Information Management System (DHIMS) (2019), there has been an increase in outpatient malaria cases in children under five from 545 in 2017 (1.7%) to 612 (2.23%) in 2018 in Tema New-Town- a community with poor urban inhabitants. There has been no documented evidence on

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practices related to environmental sanitation and their association with the prevalence of Malaria among children under five in the Tema New-Town.

1.3 Conceptual Framework

1.3.1 Narrative of Conceptual Framework

Factors influencing malaria prevalence in Tema New Town in this study will be viewed under three broad umbrellas. These are environmental sanitation practices, sociodemographic characteristics, and malaria preventive factors.

Environmental sanitation practices that will be considered in this study to influence malaria prevalence include solid and liquid waste disposal, leaving drains and dustbins uncovered, accumulation of RPCs, presence of weed, and stagnated water. Open drains may harbour stagnated water that serves as breeding grounds for mosquitoes. Uncovered dustbins, collection of reasonably preventable conditions (RPCs) such as empty car tyres, and cans also collect rain water that serves as breeding places for mosquitoes. The presence of weeds provides a moisturized environment where mosquitoes thrive. As mosquitoes thrive in these places, malaria transmission from person to person may increase, increasing the incidence of malaria in the community.

Socio-demographic factors include the child's age, sex of the child, educational level of the mother, occupation of mother, and marital status of the mother. The sex of the child may confound the prevalence of Malaria in the presence of sanitation practices. Older children under five years old may have higher odds of having malaria than younger children since malaria preventive factors such as the use of ITNs may be influenced by the child's age. Children‘s malaria status may vary with different educational levels, marital status, and mother's occupation. Modifying such variables may result from the variations in sanitation practices and malaria preventive factors influenced by these socio-demographic variables.

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For instance, educated mothers are more likely to sleep under ITNs than uneducated mothers; hence their children are at lower risk of having malaria.

The use of insecticide-treated nets (ITNs) among children under five can reduce the prevalence of Malaria. Children who have received Anti Malaria recently (in 3 months) may not test positive for RDTs, which may influence the prevalence of Malaria. The knowledge that mothers have about mosquitoes and Malaria can control their sanitation practices and inform the preventive measures they put in place against malaria.

Socio-demographic factors such as Age of the child, Educational Level, Marital status, and Occupation of mothers may influence environmental sanitation practices, and preventive measures such as the use of ITNs may confound the relationship between these factors on the prevalence of Malaria.

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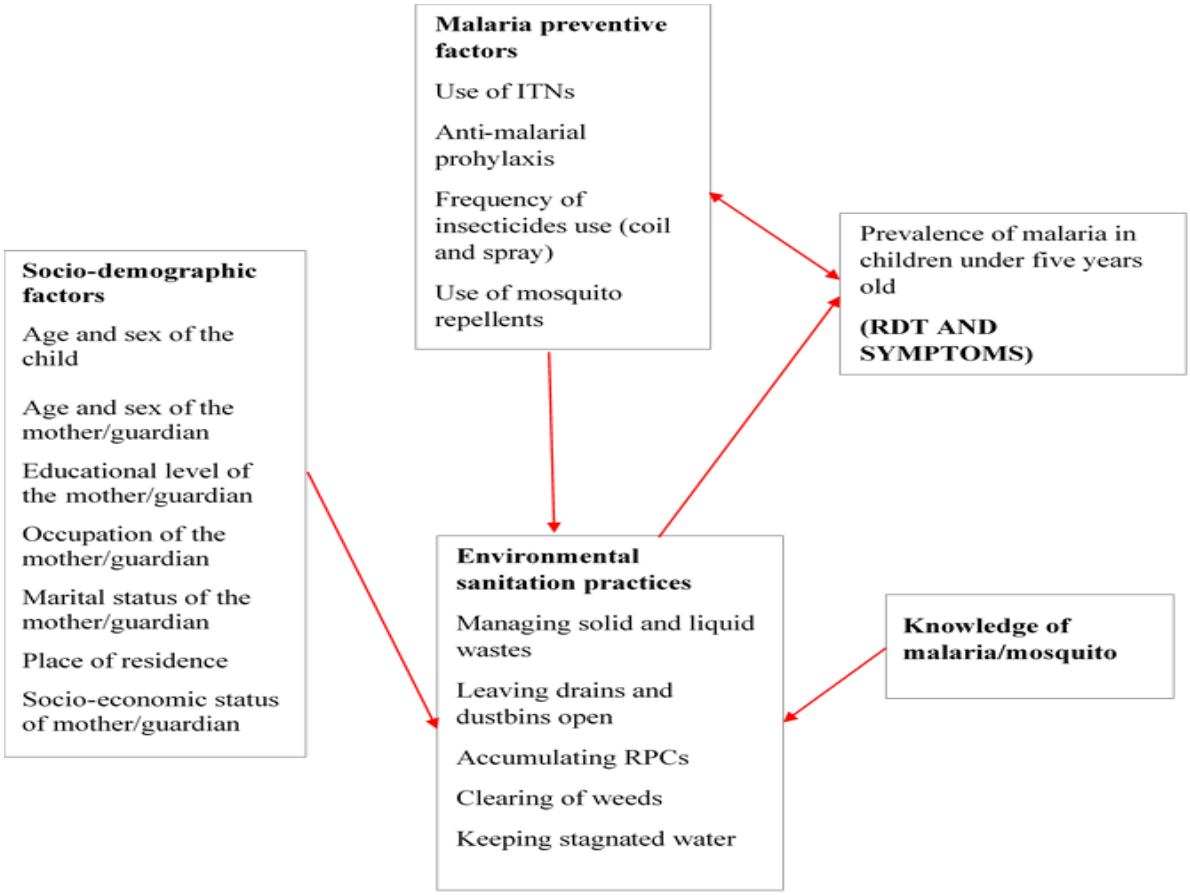

Figure 1.1: Conceptual Framework of the study

1.4 Justification

The increase in malaria cases among children under five in Tema New Town is a worry that needs to be dealt with, necessitating this study. Also, there is limited literature on household environmental sanitation and its relationship with malaria in children under five in Ghana. Hence, this work through the data collection stage would educate guardians of children under five on environmental sanitation and its role in malaria among children. It will also add to the literature in Ghana and the world at large and provide suggestions to policy makers on household environmental sanitation and its link with malaria and children under five.

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1.5. Objectives of the study

1.5.1 General Objective

To assess practices related to environmental sanitation and their association with Malaria prevalence among children under five at Tema New Town.

1.5.2 Specific Objectives

The specific objectives of this study are to:

1. Determine the prevalence of malaria among children under five.
2. Examine the environmental sanitation practices of households.
3. Determine the association between environmental sanitation practices and the prevalence of malaria among children under five.

1.6 Definition of terms

For this study;

Malaria Status: Malaria positive or negative as indicated by a rapid diagnostic test kit

Solid Waste: Solid waste includes non-biodegradable substantial portions of discarded material such as glass bottles, plastic containers, and metals.

Liquid Waste: Liquid waste includes waste water from households, e.g., Bathhouses and broken pipes.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Domestic or residential waste is disposable materials generated by environments and comprises non-hazardous and hazardous waste products. Non-hazardous environmental waste can be recycled or composted and are not dangerous to health. These include food leftovers, papers, and bottles. On the other hand, hazardous environmental waste cannot be recycled or composted and is dangerous to our health, especially when disposed of improperly.

Examples are batteries, chemicals for cleaning, and pesticides. (Environmental Protection Agency, 2016). A study by Yoada et al. (2014) in Sunyani, Ghana, reported that 93.1% of environmental waste was food debris while 77.8% was plastic materials. The study also showed that 61.0% of environmental waste is disposed at community bins, picked up by private contractors, and the remaining 39.0% is disposed of into gutters, on the streets, holes, and nearby bushes near homes. These reminders collect waste and rain water and encourage the breeding of zoonotic and parasitic vectors such as houseflies, mosquitoes, cockroaches, and rats which spread many infections, thereby affecting the health and well-being of household and community members (Global Waste Management Conference, 2017; Yoada et al., 2014; Celestino et al., 2012). Notorious amongst them is the female *Anopheles* mosquito that spreads malaria. It has been shown that malaria transmission is encouraged mainly by indiscriminate dumping of refuse and poor sanitation practices (Kobina et al., 2010).

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2.2 Environmental Sanitation Practices

Currently, 1.3 billion tonnes of waste is produced every year all around the world. Developed countries have since been on the list as the highest producers of waste globally. But in recent times, the developing world is catching up with this trend due to increasing urbanization and population growth rate (Global Waste Management Conference, 2017). Several studies indicate that majority of waste produced from developing countries is generated from households (55% - 80%), market areas (10% - 30%), and reminders from institutions (Nabegu, 2010; Nagabooshnam, 2011; Okot-Okumu, 2012). In Ghana, the waste generation rate is 0.47 kg/person/day, which translates into about 12,710 tons of waste per day per the current population of 27,043,093. It is estimated that throughout the country, only about 10% of refuse generated are properly disposed leaving large proportions of the waste to be disposed of by residents unto roadsides, in drains, streams, backyards, open spaces, gutters, and bushes (Douti et al., 2017).

2.3 Epidemiology of Malaria among Children under Five

Malaria is a non-communicable disease transmitted to humans by the bites from infected female *Anopheles* mosquitoes (WHO, 2006), and pregnant women and children under five are the most vulnerable to its effects and complications. It is endemic in the African continent, where it claims a child's life every two minutes (UNICEF, 2019). There were an estimated 198 million episodes of malaria globally in 2013, of which approximately 178 million cases were found in Africa. Of this global figure, 584 000 people died, and about 78% of these deaths were of children under five years of age (WHO, 2014).

In Ghana, the scenario is not different, with malaria accounting for 4% of the global malaria burden and 7% of the malaria burden in West Africa (WHO, 2018). In 2015, malaria was

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responsible for 19% of all recorded deaths in Ghana (The Global Fund), which declined to 4.2% in 2016 (WHO, 2017), with most children under five. The case fatality rate for children under five years has also reduced from 15% to 11% from 2010 to 2016 respectively (UNICEF, 2016). Also, the health facility malaria case fatality rate among children under five years of age declined from 14% in 2000 to less than half a percent in 2016 (Presidents Malaria Initiative, 2018). However, in 2017, malaria admissions increased from 280,000 to 340,000 (Ghana Urban Malaria Study, 2013). Tema New-Town, a fishing community in Ghana, is not left out as an increase in outpatient malaria cases in children under five has moved from 1.7% to 2.23% (DHIMS, 2019), showing that more has to be done to stabilize and achieve zero or close to zero malaria cases in Ghana.

2.3 Factors Associated with Environmental Sanitation Practices and Prevalence of Malaria among Children under Five

Several factors have been discussed in previous studies to influence the link between environmental waste and malaria prevalence among children under five. These factors have been categorized into environmental sanitation practices, socio-demographic characteristics, and malaria preventive factors.

Environmental sanitation practices considered in this study to influence malaria prevalence include leaving drains and dustbins uncovered, accumulation of RPCs, not clearing weed, and stagnated water.

Socio-demographic factors include age and sex of the child, age of mother, sex of guardian, educational level of the mother, occupation of mother, marital status of the mother, and place of residence.

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Malaria Preventive factors include the use of insecticide-treated nets (ITNs), Anti-Malarial Prophylaxis, Insecticide use (Coil and Spray), and Use of Mosquito Repellent.

2.3.1 Environmental Sanitation Practices

Urbanization coupled with increased domestic activities have been linked to the generation of high volumes of domestic or environmental wastes (Yoada et al., 2014), with growing evidence that some of these wastes are dumped on the streets, road sides, gutters, holes, open spaces and in nearby bushes (Douti et al., 2017). These have the potential of serving as breeding grounds for rodents and insects that could increase the risk and spread of parasitic and zoonotic diseases (Abeyewickreme et al., 2012). Most Ghanaians are aware that improper environmental sanitation leads to sicknesses or conditions, but unfortunately, this high level of knowledge on the effects of poor environmental sanitation does not correspond with the observed practices (Yoada et al., 2014). Most Ghanaians (82.7%) do not separate their waste compared to only 17.3% who separate their waste before storage. This situation creates a suitable environment for breeding disease vectors, such as mosquitoes and cockroaches, and the proliferation of rodents, such as rats and mice, which pose threats to public health. Studies show that majority of Ghanaians do not take responsibility for the waste they produce because they think that proper environmental sanitation is the job of municipal directorates and the environmental protection agencies (Yoada et al., 2014; Douti et al., 2017), showing an issue of behavior and attitude shaped by local cultural and social context (Douti et al., 2017).

2.3.1.1 Open Drains and Prevalence of Malaria among Children Under Five Years

The environment in and around our homes is very critical to health. Drainage systems, canal irrigation, and increased building constructions leave open holes and drains in our

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environment, accumulating torpid water and wreckage suitable for mosquito reproduction and larval growth (Salami & Umego, 2018). A study by Mokuolo et al. (2018) in Nigeria on modeling a covered drainage system to reduce malaria prevalence discovered that 99% of households had open drains immediately around their surroundings. They further stated that 91.9% of these drains had stagnant water while 8.1% of the drains had flowing water, which is similar to reports by Salami & Umego (2018), stating that households amounting to more than half had open gutters with stagnant water around their houses while 28.3% reportedly poured water on the ground around their home. Due to the lack of waste collection systems and uncontrolled disposal of wastes, drains are clogged, creating environments for mosquito breeding. This corresponds with the findings from (Bugoro et al., 2011) in their study in the Solomon Islands, which reported that the presence and abundance of mosquito larvae are influenced by environmental factors such as open drains. They also documented that the presence of open drains within the surroundings related positively to malaria prevalence.

2.3.1.2 Uncovered Dustbin and Prevalence of Malaria among Children Under Five Years

Proper refuse storage is a significant problem in many households. The best practice is to store domestic waste in covered plastic bins, but unfortunately, most people do not practice this, providing breeding grounds for mosquitoes. The use of covered containers protects debris from direct exposure to flies, vermin, and scavengers, and they also prevent odour nuisances and unsightliness. A study by Salami and colleagues (2018) on the household environment and malaria revealed that only 28% of study respondents stored waste in a covered dustbin, while a more significant majority dumped refuse in uncovered bins at their backyards and on public ground. Similar results were obtained in a study by Yoade et al.

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(2014), revealing that only 29.9% of Ghanaians use covered plastic bins to store their waste, while the majority used uncovered containers, backyards, gutters, bushes, dug holes, and incineration. Other studies were done in the same year (Musoke et al., 2014; Obi et al., 2014) established that most malaria episodes were attributed to open water pools in the environment. They reported that these pools were created due to the pouring of waste water from households or broken pipes and commercial activities around houses that gather, forming puddles and promoting mosquito breeding.

2.3.1.3 Accumulation of Reasonable Preventable Conditions and Prevalence of Malaria among Children Under Five Years

Accumulation of RPCs that enhance mosquito breeding, such as empty tyres, empty cans, broken plastic containers, bottles, toys, and flowerpots, collect rain water which serves as breeding places for mosquitoes. It is estimated that 64.3%-77.9% of household waste generated in Ghana are broken plastic items, the majority of which are recyclable (Yoada et al., 2014). They suggested that this increased use of plastics is due to changes in lifestyle and industrialization replacing other forms of packaging with plastics. Improper disposal of these encourages malaria proliferation. Onyido et al. (2011), in their study "Ecology of Malaria Vectors in a Rainforest Suburban Community," revealed that discarded tyres yielded the highest number of mosquito larvae, 204 (54.84%), compared to other breeding grounds.

2.3.1.4 Stagnated Water and Prevalence of Malaria among Children Under Five Years

Stagnated water is formed chiefly from rain and household wastewater. Poorly drained rain or waste water starts stagnant pools that provide breeding sites for mosquitoes making malaria familiar in the wet season compared to the dry season (WHO, 2019). Water

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stagnation is mainly caused by a lack of a proper disposal system resulting in the disposal of sewage and solid wastes into flowing water bodies and drains, causing them to be stagnant. Salami and Umego (2019) reported that many households captured in their study had stagnant water pools around their homes serving as viable breeding grounds for mosquitoes. Children under five residing in households located one kilometre or less away from the stagnant water, rivers, swamps, or unprotected dug wells had 2.246 increased odds of having malaria than those who reside more than a kilometre away from water such water sources (Hajison et al., 2018). They also stated that households close to communal standpipes might lack control of water which spills over when used, creating water puddles that may become stagnant and provide a conducive environment for mosquito breeding.

2.3.1.5 Presence of Weeds and Prevalence of Malaria among Children Under Five Years

The presence of weeds provides a moisturized environment where mosquitoes thrive. As mosquitoes thrive in these places, malaria transmission from person to person may increase, increasing the incidence of malaria and the overall prevalence of malaria in the community. Some weed species which grow well in malaria-endemic areas of Africa have been reported to be preferred host plants for some species of mosquitoes (Nyasembe et al., 2015; Stone et al., 2018). The success of mosquitoes as disease vectors is dependent on their prolonged survival, ability to feed on multiple hosts, and support pathogen development. Feeding on nectar and honeydew from these weeds enhances mosquito longevity and serves as a ready energy source for flight (Nyasembe et al., 2015). A study by Oluwasogo et al. (2016) on the assessment of mothers' knowledge and attitude towards malaria management among children under five years showed that only 4% of mothers considered trimming bushes around the

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house and cleaning dark corners an approach to reducing malaria prevalence. Garley et al. (2013) also stated similar results reporting growth of bushes and malaria prevalence. They said that only a few, 14.5% of respondents, cleared bushes around their homes.

2.3.2 Socio-demographic Factors

2.3.2.1 Age of Child and Prevalence of Malaria among Children under Five Years

Age of children and malaria prevalence is correlated. The bulk of malaria has been revealed to be significantly higher among older children under five years (Pullan et al., 2010). Similar to Pullan et al. (2010), another study stated that the odds of malaria infection among children under five increased with increasing age (Gahutu et al., 2011), showing that the older a child gets, the higher the risk and prevalence of malaria. Prevalence was shown to increase with a child‘s age, with younger children having the lowest prevalence of 16% among children below 12 months, while older children showed the highest prevalence of 28% among children between 48 and 59 months (Yankson et al., 2019).

2.3.2.2 Sex of Child and Prevalence of Malaria among Children under Five Years

Prevalence was found to be insignificant to the sex of the child (Roberts & Matthews, 2016). They stated that the distribution of malaria prevalence was the same for both males and females, which is in line with Okebe et al. (2014). However, minor differences were found in prevalence between males and females in a study on the Geostatistical analysis and mapping of malaria risk in children under five using point referenced prevalence data in Ghana (Yankson et al., 2019). They revealed that Ghanaian males exhibited a slightly higher prevalence of malarial attacks at 23% than 22% for females.

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2.3.2.3 Educational Level of Mother and Prevalence of Malaria among Children under Five

The education level of a child's caretaker, particularly the mother, has been shown to have clear positive relations with malaria prevalence (Synman et al., 2015; Roberts & Matthews, 2016), and it has been named a significant risk factor for malaria prevalence (Roberts & Matthews, 2016). They assume this because the more educated an individual is, the better their chances or odds of understanding health-related issues. Roberts and colleagues also revealed that children whose mothers have at least a secondary school education have less risk and prevalence of malaria than those whose mothers had lower or no education. These reports correlate with Gahutu et al. (2011), stating that the odds of malaria infection increased with low educational levels.

2.3.2.4 Occupation of Mother and Prevalence of Malaria among Children under Five Years Old

Occupation is the source of income for families to survive and has been shown to exhibit a relationship with malaria prevalence in children under five. This relationship is more evident in the occupational status of mothers. A study conducted by Kolawole and Asalou (2016) revealed that swift attempts to prevent malaria, take an ill child to health centres, or seek malaria treatment increased with occupation, implying that mothers who are working are more likely to experience low malaria prevalence in their children as compared to those who were not in any form of occupation. This is in line with recent studies done by Sina (2018), in which he stated that the employment of mothers has a positive correlation with malaria prevalence. In his research, he found out that most mothers were engaged in small-scale farming, others were fully housewives, while others were salaried workers and self-employed. He stated that because most of the women were engaged in some kind of

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economic activity even though not sufficient, they could meet the daily requirements of their households and afford to prevent and curative measures.

2.3.2.5 Marital Status of Mother and Prevalence of Malaria among Children under Five Years

The marital status of mothers with children under five is correlated with malaria prevalence. A study to identify the sociodemographic determinants of malaria among under-five children revealed that most malaria cases were found among children of divorced or single women compared to married women (Nyarko & Cobblah, 2014; Houmsou et al., 2014). This is to studies by Ahiati (2015) showing malaria prevalence was highest among children whose mothers were formerly married. They related this to the fact that stable marriages provide children with the best physical health outcomes, stating that children of single or divorced mothers may not have the complete care they need to survive. However, other studies reported no statistically significant relationship between malaria prevalence and marital status (Asiedu & Okwabi, 2014; Paul & Msengwa, 2018).

2.3.2.6 Place of Residence and Prevalence of Malaria among Children Under Five Years

The place of residence where children live is significantly associated with the prevalence of malaria. Children residing near a source of water, rain prone, or waterlogged areas have been found to have the highest plurality to malaria compared to those in the dry areas (Kibret et al., 2014; Roberts & Matthews, 2016). In their Tanzanian study, Liu et al. (2014) showed that living in rural areas increased malaria prevalence compared to urban areas. Malaria prevalence was high in rural areas at 29% compared to 11% among children in urban centers

This is in line with previous studies by Nyarko and Cobblah (2014), where malaria prevalence was highest among children from rural settings compared to urban environments.

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However, Roberts & Matthews (2016) showed that the area of residence, whether rural or urban, has no significant association with malaria prevalence.

2.3.2.7 Other Socio-Demographic Characteristics of Mothers/Guardians and Prevalence of Malaria Among Children Under Five Years Old

Sociodemographic factors such as ethnic group, parent's education and occupation, use of protective measures, and family living standard are suggested to be significant risk factors for malaria and malaria epidemics (Kreuels et al., 2008; Samani, Willett & Ware, 1987). According to Afoakwah, Deng, and Onur (2018), rural dwelling, number of children a mother/guardian has, level of parents' income, and level of mother's'/guardian's knowledge about malaria significantly influence the odds of malaria infection among children under five. The prevalence of malaria in rural areas is about 38% compared to 15% for people who live in urban environments (Ghana Demographic and Health Survey [GDHS], 2014 cited in Ameyaw, 2018).

Regarding the level of mother's'/guardian's knowledge about malaria, it has been shown that a higher level of mother's'/guardian's knowledge about malaria is associated with lower odds of malaria prevalence among children under five years old (Afoakwah, Deng & Onur, 2018). Similarly, Afoakwah, Deng, and Onur (2018) reveal that the higher the number of children a mother has, the more likely malaria prevalence among them. A plausible explanation is that congestion in homes may produce better breeding grounds for mosquitoes and less time and resources for preventive measures. An enormous household may create less space for sleeping, making it challenging to mount ITNs to protect all household members. It is common in rural Ghana that an area is used for a living room in the daytime and a bedroom at night. In such cases, the ITN needs to be mounted on the wall every night. This is a burden for the household and may discourage the use of an ITN. Large homes might be busy, and

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early disease symptoms, especially in young children, can remain unnoticed, resulting in delays in treatment and therefore lead to more adverse effects (Heaton, Forste, Hoffmann & Flake, 2005).

It has also been shown that malaria prevalence in children under five years old is correlated with parents' level of income. Afoakwah, Deng, and Onur (2018) reveal that the odds of malaria prevalence among children aged below five years decrease as income levels of their parent's increase. This may be attributed to the fact that parents/guardians with higher income levels can afford better goods and services, leading to more positive health outcomes.

2.3.3 Malaria Preventive Factors

According to the WHO (2019), vector control is the primary way to prevent and reduce malaria transmission in three ways – sleeping under insecticide-treated mosquito nets, indoor residual spraying, and antimalarial prophylaxis. Sleeping under an insecticide-treated net can facilitate contact between mosquitoes and humans by providing physical and insecticidal barriers. Indoor residual spraying with insecticides is another powerful way to reduce malaria transmission rapidly. It involves spraying the inside of housing structures with an insecticide, typically once or twice per year. Antimalarial medicines can also be used to prevent malaria through chemoprophylaxis, which suppresses the blood stage of malaria infections, three doses of intermittent preventive vaccination with sulfadoxine-pyrimethamine for infants, and administration of monthly courses of amodiaquine plus sulfadoxine-pyrimethamine to all children under five years of age living in high-transmission areas of
Africa.

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2.3.3.1 Insecticide Treated Nets and Prevalence of Malaria among Children under Five Years

The topic concerning the use of insecticide-treated nets and its impact on mosquito prevalence remains unclear. In 2019, the WHO reported that about half of all people at risk of malaria in Africa were protected by an insecticide-treated net, compared to 29% in 2010, with a marginal increase from 2015 to 2017. The use of a mosquito net, whether treated or not, the number of mosquito nets in the household, and whether or not the child slept under a net the night before the survey were insignificantly associated with a child's malaria status (Roberts & Matthew, 2016; Okebe et al., 2014). However, other papers (Ayele et al., 2012; Winskill et al., 2011; Gahutu et al., 2011; Wotodjo et al., 2015) reveal otherwise, stating that sleeping under treated insecticide nets was associated with reduced malaria prevalence. Gahutu et al. (2011) further noted that the likelihood of malaria infection increased in those who did not use a bed net. This disparity can be attributed to inconsistent or inappropriate use of the nets, or perhaps a child was exposed to mosquito bites during other times of the day or evening when the net was not in use.

2.3.3.2 Anti-Malarial Prophylaxis and Prevalence of Malaria among Children under Five Years

Chemoprophylaxis is effective in preventing malaria in infants. Though effective, there have been reports on rebound malaria, implying a marked increase in malaria incidence in the same period after chemoprophylaxis was stopped. Three doses of SP given during the first year of life at the time of routine immunization saw positive results showing a nearly 50% reduction in clinical attacks of malaria. Results from Ghana, Mali, Senegal, and The Gambia also showed that intermittent preventive treatment in children was highly effective in reducing malaria by 70 - 90% (Greenwood, 2010; Okebe et al., 2014; Kweku et al., 2017). In

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Burkina Faso, studies suggest that malaria treatment or any other medication within 14 days decreased the prevalence of malaria infection (Diallo et al., 2017).

2.3.3.3 Insecticide and Prevalence of Malaria among Children under Five Years

Popular indoor insecticide for mosquito control in Sub Saharan Africa is the use of coils containing oil of citronella (Diallo et al., 2017) and sprays even though other natural methods are based on burning of orange peels, some leaves, or cow dung (Oluwasogo et al., 2016). Research shows that continuous indoor residual spraying was significantly associated with reduced malaria prevalence (Roberts & Matthews, 2016). They stated that this effect was much evident if spraying lasts for at least six months. However, the WHO (2019) stated that indoor residual spraying declined from a peak of 5% in 2010 to 3% in 2017, with decreases seen across all regions. Afoakwah et al. (2018) revealed that the odds of malaria infection among children who sleep in rooms sprayed with insecticide are significantly lower than those who do not. They also stated that this association is even higher among children in poor households sleeping in insecticide-sprayed rooms than those who do not. Similar studies showed (Nyarko & Cobblah, 2014; Yusuf et al., 2010) a significant association between mosquito net ownership and malaria in children under-five malaria cases. However, Paul and Msengwa's (2018) study showed no significant association between these two variables.

2.3.3.4 Mosquito Repellent and Prevalence of Malaria among Children under Five Years

Repellents are substances formulated on bare skin that help people avoid mosquito bites but do not kill mosquitoes. They are sold as aerosols, creams, solid sticks, pump sprays, and liquids, and their effect could last for up to 10 hours. They contain ingredients such as diethyl phthalate, diethyl carbate; N, N-Diethyl-3-Methylbenzamide (DEET), metofluthrin, oil of lemon-eucalyptus, picaridin, and ethyl hexanediol, with DEET being the gold standard in mosquito repellents (American Mosquito Control Association, n.d). Studies in Senegal show

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that the second most common malaria control measure is traditional repellents. It was reported that 37.3% of children were found using these conventional repellents and had reduced mosquito prevalence (Diallo et al., 2017). In the study, Malaria prevalence, knowledge, perception, preventive and treatment behaviour among the military in Champasak and Attapeu provinces revealed that the majority (91.3%) of military persons used a mosquito repellent (Vilay et al., 2019).

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CHAPTER THREE

METHODS

3.1 Study Design

This study was a community-based cross-sectional design among children under five at Tema New Town. RDT and mothers determined malaria were asked of malaria symptoms in their children.

3.2 Study Location

The study was conducted in Tema New Town, located near the fishing habour and made up of Awudum, Ayigbe Town, Bankuman, and Ashamang. These places are close to the sea, and most constituents are fishers and fish mongers. However, the study was restricted to Bankuman. Bankuman is a single CHPS zone with a population of 11,973 children under age five. The main occupation of the study area is fishing, and the languages spoken by the inhabitants of Bankuman include Ga and Twi. A more significant percentage of the populace are youth with a high female population. About 70% of the inhabitants are not natives of the area, with most seeking greener pastures. The site is characterized by a high level of teenage pregnancy and a high level of homelessness. Indiscriminate dumping of waste is rampant, with evidence sourced from waste in gutters, stagnant waters, and sea pollution with faecal and general waste.

Bankuman was selected because it constitutes the largest geographical size of the Tema New Town. Also, Bankuman has the largest population of children under five in Tema New Town with high malaria cases as per Child Welfare Clinic (CWC) records from the Tema Metro office of the Ghana Health Service. Several studies have been conducted at Bankuman but

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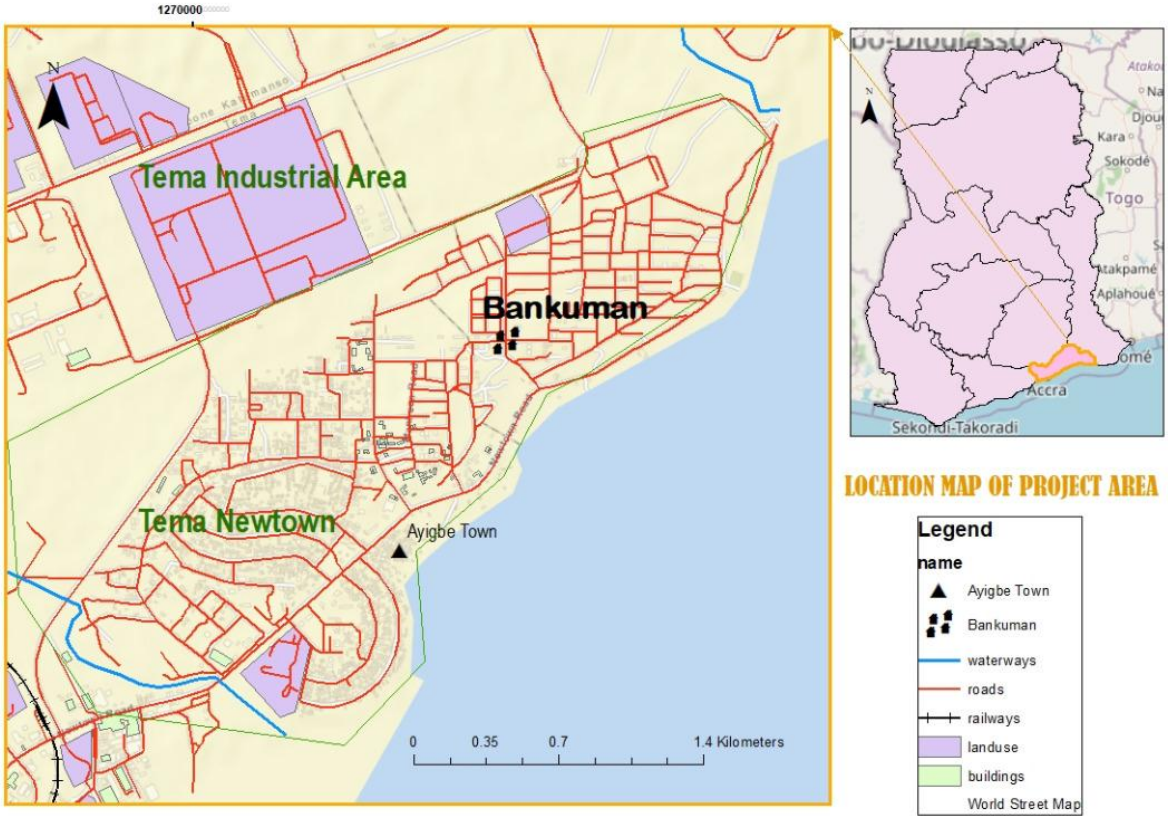
none have assessed the high prevalence of malaria in children under five years old. With this notion, I became interested in evaluating the environmental sanitation practices and prevalence of malaria among children under five years old at Tema New Town.



The map of Tema New Town- Bankuman

Figure 3.1 Map of Tema New Town Bankuman

3.3 Source/Study Population

The study sources included all children under the age of five and their mothers/care takers. From this population, 354 children and their mothers were selected for the study (see section 3.6).

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3.4 Inclusion and Exclusion Criteria

3.4.1. Inclusion Criteria

1. A mother whose child is under five years of age.
2. A mother together with the child who is a permanent resident of Bankuman.
3. A mother who gave consent to partake in the study with her under five years old child.
4. Mothers who are older than 18 years.

3.4.2. Exclusion Criteria

1. A mother whose child is under five years of age, but the mother is not a permanent resident of Bankuman.
2. A mother and child is a permanent resident of Bankuman, but the child is older than four years.
3. A mother gave consent to partake in the study with her child, but the child is older than four years.
4. A mother who is older than 18 years but does not have a child

3.5 Sample Size Calculation

Sample size of this study was calculated using a formula by Cochran (1977)'

$$N_o = \frac{Z^2 pq}{e^2}$$

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$Where\ No\ =\ minimum\ sample\ size;\ \ z\ =\ standard\ normal\ deviate$ (1.96);

$p\ \ =\ prevalence\ of\ Malaria\ by\ RDT\ =$ 29.9% (Afriyie & Tarkang, 2019); $q\ \ =$

70.1% $e\ \ =\ degree\ of\ precision, set\ at$ 5% $\ =$ 0.05

Therefore, the sample size was calculated as follows

$$N_o = \frac{(1.96)^2 \times 0.299 \times 0.701}{0.05^2} = 322$$

However, to cater to the non-response rate, an attrition rate of 10% was used to adjust the sample size upward. The choice of 10% was based on the researcher's expectation of no more than 10% nonresponse, which similar studies also employed (Muhammad, Oyewole & Dipeolu, 2021; Nekaka, Nteziyaremye, Oboth, Iramiot & Wandabwa, 2020). Thus, $\frac{110}{100} \times 322 = 354.2 \approx 354$. Three hundred fifty-four respondents were surveyed in this study.

3.6 Sampling Method

This study made use of a consecutive sampling approach to enrol study participants. All straight households within the community were visited in a systematic order beginning from one end to the other. A child under age five and their mother or caretaker meeting inclusion criteria were selected in each home. For households with more than one child under age five, one child was randomly selected through balloting.

3.7 Data Collection

3.7.1 Data Collection Tool

A structured questionnaire was used to elicit information from study participants. This questionnaire is modified from a WHO study conducted in Abokobi in the Ga West District of Ghana. This questionnaire had three sections. The first part of the questionnaire focused

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on the demographic characteristics of participants. The other sections elicited information on Environmental Sanitation Practices and Preventive Measures.

The questionnaire was administered in English for literate respondents and translated into Twi or Ga for non-English literate respondents. This lasted for 30 minutes per child.

3.7.2 Data Collection Procedure

Before administering questionnaires, nurses and assembly members were engaged in a meeting to explain to them the aim of the study and data collection procedures. This was to ensure that there was complete comprehension and to rule out any form of ambiguity. After the meeting, three qualified nurses were selected and a community health nurse from the Manhean Polyclinic in charge of home-visits at the Bankuman to assist with data collection with the questionnaires and assessed the malaria status using the RDT kits. These selected nurses were trained on research ethics, quantitative data collection methods, and data entry and validation.

Rapid Diagnostic Test (RDT) Kits were used to test the malaria status of each respondent each respondent malaria status. A negative test result indicated that a respondent does not have malaria, but a positive test result showed that a respondent has malaria. The results were documented in the questionnaire.

Symptoms of Malaria, if present, were also documented.

To ascertain the symptoms, the children were examined and asked how they were feeling. Also, their mothers were asked about the changes they have observed in their children‘s health and their complaints, such as chills, fever, and headache. Data for the symptoms was not informative, so the additional analysis was not carried out. The following steps were followed;

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1. The procedure was explained to the mother/caretaker by a qualified nurse.
2. The child was made to sit on a chair with the help of the mother/caretaker
3. An alcohol wipe was used to clean the thumb of the child.
4. The child was pricked with a sterile needle.
5. A drop of the child's blood was dropped on the RDT kit.
6. The pricked area was cleaned with dry cotton.
7. The malaria status of the child (positive /negative) as indicated by the RDT kit was documented in the questionnaire.
8. Symptoms of Malaria were assessed and documented for each child. Malaria symptoms are defined as chills, fever, and headaches.

3.8 Study Variables

3.8.1 Health outcome

The primary health outcome was the prevalence of Malaria, defined as symptoms of fever, headache, loss of appetite, chills, body pains, nausea, or vomiting. This was confirmed with the RDT test (**see section 3.7.2**). Malaria negative was interpreted as no malaria and positive as yes malaria.

3.8.2 Determinants of interest

The determinant of interest was environmental sanitation practices defined as the presence of open drainage (yes or no), presence of stagnant waters (yes or no), presence of weeds (yes or no), presence of uncovered dustbins (yes or no), accumulation of RPCs (yes or no), presence of dump site (yes or no), presence of solid waste and liquid waste (yes or no) all around the household.

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Confounders

Potential cofounders considered in this were the age of the child (in months), sex of the child, educational level of mothers, mother‘s occupation, marital status of mothers, use of insecticide-treated nets, use of insecticides, use of mosquito repellent, and knowledge of factors contributing to malaria

3.9 Quality control

Before actual data collection, the questionnaire was pretested among residents of Nungua Accra, another fishing community along the Gulf of Guinea with similar sanitation and waste disposal practices as Tema New Town.

After data collection, the data was sorted, coded, and entered into Microsoft excel. The accuracy of the entered data was checked, and the clean database was then converted into the Stata software version 16.0 file (Stata Corporation, Texas, USA) before analysis.

3.10 Data Analysis

STATA IC version 16 was used to analyze the data. The mean age and standard deviation of the children were computed. Frequency and percentages were used to describe the socio-demographic characteristics, environmental sanitation factors, malaria prevention factors, and the caretaker's knowledge in the study. The bar chart was used to describe the interviewer's observed sanitation and environmental factors. The malaria prevalence was described using frequency and percentages, and a 95% confidence interval was estimated.

The Pearson‘s chi-square test was used to assess the socio-demographic, environmental sanitation, malaria prevention, and knowledge factors associated with malaria RDT positive test results among the children. In cases where at least 25% of the crosstab cells have

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expected frequencies less than 5, Fisher‘s exact chi-square test is used instead of Pearson‘s chi-square test. The prevalence and 95% confidence interval of malaria RDT positivity were described across the independent variables' various categories.

For the logistic regression model, all variables assessed using the chi-square were run together in a multiple binary logistic regression model. The backward stepwise selection model using a removal threshold of 0.200 p-values and re-entry threshold of 0.100 was used to select the final variables for the final binary logistic regression model. In the final model, the age of the child was the only demographic factor chosen. The interviewer observed that environmental sanitation factors that were selected included the presence of stagnant water around households and uncovered dustbins. The self-reported environmental sanitation factors set were desilting open drainage, removing materials that collect rainwater, covering dustbins to prevent water from gathering in them, and clearing all bushes in the surroundings. The malaria prevention factors selected were malaria treatment in the past three months and mosquito repellent by the child. All selected variables were run together in the adjusted binary logistic regression model.

In this study, all statistical analysis was considered significant at an alpha level of 0.050. The alpha level means the margin of error the researcher allowed in the analysis of the data.

Determination of the knowledge level.

Eleven knowledge questions relating to malaria were asked of the caretaker of the children in the study. A correct response was scored 1, while an incorrect or “do not know the response” was scored 0. The composite scores were then expressed in percentage terms, with those scoring from 0% to 49% categorized as having low knowledge on malaria, those who scored 50% to

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74% were classified as having a moderate understanding of malaria, and those who scored from 75% to 100% were categorized as having a high knowledge of malaria.

3.11 Ethical Considerations

Ethical Clearance: Clearance was sought from the Ghana Health Service Ethics Review Committee.

Permission: Approval was also sought from the District health directorate and community leaders

Informed Consent: Written informed consent was sought from eligible respondents after explaining the benefits and risks involved in participation. Parental consent was sought from parents /guardians before enrolment into the study. Respondents were made to understand that participation was purely voluntary; hence they could opt-out at any time, and this would not affect them in any way.

Compensation: They were also made to understand that there was compensation involved in participating in the study. Individuals who participated in the survey by answering questionnaires were given hand sanitizers worth Ghc3.00 as compensation for their time spent.

Confidentiality: Respondents were allowed to fill the questionnaires at convenient places of choice to ensure privacy. In ensuring anonymity, respondents were only identified with codes and numbers. No information regarding participants‘ names or any other information that traces the data collected to the respondents was taken. Participant information was kept on a computer with a secure password. Filled questionnaires were kept under lock and key, with only the principal investigator having access.

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Benefits: Participating in this study allowed respondents to gain knowledge and awareness on environmental sanitation practices and malaria since each participant was educated after data collection.

Risks: The children were exposed to some needle prick to assess the malaria status, which caused some of the children to cry. Respondents were assured that the data collectors were trained, qualified nurses who have the experience to ensure that the needle pricks, apart from the pain, did not pose any further danger to the child's health. Also, there were potential risks of contracting COVID-19 from answering the questionnaire in this study under the current circumstances of COVID-19. Therefore, the following interventions were put in place to ensure safety of the respondents..

1. Respondents received education on the COVID-19, mode of transmission, and prevention.
2. Respondents washed their hands with soap under running water as observed by research assistants before receiving the questionnaire from research assistants
3. Respondents sanitized their hands with alcohol hand rubs after filling the questionnaires
4. Pens used to fill questionnaires were not passed on from one respondent to another.
5. Social distancing was maintained between research assistants and respondents
6. Research assistants did not engage respondents who were not wearing face masks.
7. Respondents complied with any restrictions to movements imposed by national or local COVID-19 response team (e.g., self-quarantine, isolation, lock down)
8. Respondents provided information to the study team on any COVID-19 tests that they may have had since their last study visit.
9. The following preventive measures were put in place to protect study teams from

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COVID-19.

a. All researchers ensured adequate protection by practicing good personal hygiene through regular hand washing, sanitizers, protective gloves, and wearing facemasks.

b. Social/physical distancing was observed, keeping at least 6ft between people.

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CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics of respondents

The study interviewed 328 caretakers/mothers of children under five years. The mean age of the children was 27.6 months with a standard deviation of 15.3 months. Most of the children were males (58.2%). Most of the careers/mothers were Christians (85.7%), employed (75.0%), married (85.1%), and had a family size of 4-6 members (69.8%) (Table 1).

Table 1: Sociodemographic characteristics of study respondents

Variable	Frequency (N=328)	Percentage
Age of child in months (Mean ± SD)	27.61 ± 15.33	
<1 year	55	16.77
2-3 years	151	46.04
4-5 years	122	37.20
Sex of child		
Male	191	58.23
Female	137	41.77
Educational level of mother		
None	34	10.37
Primary	191	58.23
Secondary or higher **Religion**	103	31.40
Christian	281	85.67
Muslim	47	14.33
Employment status of mother		
Employed	246	75.00
Unemployed	82	25.00
Marital status of mother		
Married	279	85.06
Cohabiting	10	3.05
Single	34	10.37
Divorced	5	1.52
Place of residence		
Aunty Kate	10	3.05
Sweet Mother	159	48.48
Jerusalem	36	10.98
Gas Pipe Area	102	31.1
Valco Area	21	6.4
Family size		
<4	71	21.65

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4-6	229	69.82
7+	28	8.54
Household income		
Lowest earners (<750)	113	34.45
Middle earners (751-1000)	120	36.59
Highest earners (1001-4500)	95	28.96

4.2 Environmental sanitation practices

Of the 328 respondents interviewed, the interviewers observed open drainage around 53.1% of the respondents, stagnant water was 54.8%, and the accumulation of preventable materials that collects rain water serving as breeding spaces for mosquitoes was 20.4%, and the presence of uncovered dustbins was 14.9%. (Fig. 1)

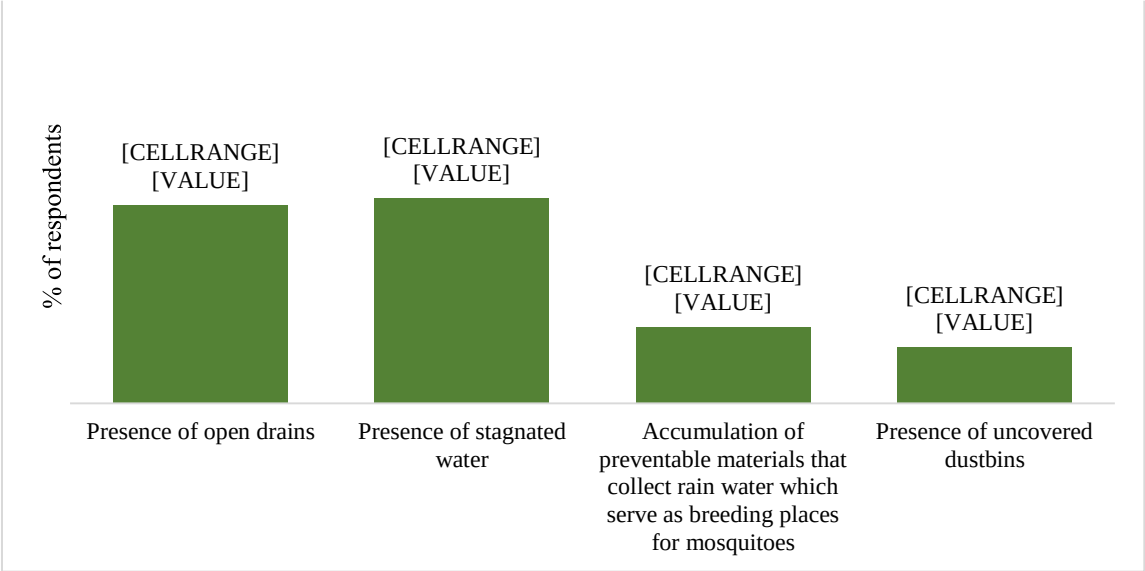

Figure 4. 1: Interviewer observed environmental sanitation practices

When caretakers/mothers were interviewed on environmental sanitation practices, 59.8% always desilt all surrounding open drains, 42.4% constantly sweeps away all form of surrounding stagnated water 39.0% rarely gets rid of materials that collect rain water to serve

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as mosquitoes breeding place, 77.7% always covers dustbins to prevent water from gathering in them and 37.8% always clear bushes around the house (Table 2)

Table 2: Self-reported Environmental sanitation practices

	Frequency	Percentage
Self-reported sanitation practices		
Always desilting of all open drains around respondent's house		
No	132	40.24
Yes	196	59.76
Always sweeping away of all forms of stagnated water around respondent's house		
No	189	57.62
Yes	139	42.38
Always gets rid of all materials that collect rain water to serve as breeding places for mosquitoes in and around respondent's house		
No	200	60.98
Yes	128	39.02
Always cover dustbins to prevent water from gathering in them		
No	73	22.26
Yes	255	77.74
Always clears all bushes around respondent's house		
No	204	62.20
Yes	124	37.80
Overall sanitation practice assessment		
Poor	51	15.55
Moderate	214	65.24
Good	63	19.21

Of 328 caretakers/mothers/mothers interviewed, usage of mosquito net was prevalent among 65.8%. All but one of the caretakers/mothers who uses mosquito nets had treated nets (99.5%), 94.9% had the child sleeping under nets, 76.9% of the children slept under a mosquito net the night before the interview, and 60.2% of the children always sleep under mosquito nets. Among the 86 children who do not always sleep under a bed net, heat (78.1%) and skin itches (9.4%) were stated reasons. Only 4 of the 328 children had received a vaccination, and 13.7% of all the children had received malaria treatment in the last three

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months. Two-third (66.5%) use insecticides, and only 6 (1.8%) use mosquito repellent on the child (Table 3).

Table 3: Malaria preventive factors and practices among study respondents

Variable	Frequency	Percentage
Use of mosquito net		
No	112	34.15
Yes	216	65.85
If yes, is it treated?		
No	1	0.46
Yes	215	99.54
If yes, does respondent's child sleep under the net?		
No	11	5.09
Yes	205	94.91
If yes, did respondent's child sleep under the net yesterday?		
No	50	23.15
Yes	166	76.85
If yes, does respondent's child sleep under the net all the time?		
No	86	39.81
Yes	130	60.19
If no, reasons why respondent does not use mosquito net [M] *Skin*		
Itches	3	9.38
Heat	25	78.13
Other reasons	7	21.88
Vaccinated for malaria		
Yes	4	1.22
No	324	98.78
Treatment for malaria in the last three months		
Yes	45	13.72
No	283	86.28
Use of insecticides		
Yes	218	66.46
No	110	33.54
If yes, type of insecticides used		
Mosquito Coil	88	40.37
Mosquito Spray	130	59.63
If yes, frequency of usage of the insecticide		
Once a week	44	20.18
Twice a week	47	21.56
Thrice a week	50	22.94
More than four times a week	77	35.32
Child uses repellent		
No	322	98.17
Yes	6	1.83
If yes, how often does the respondent use the repellent on the child		
Twice a week	5	83.33
Thrice a week	1	16.67

M: Multiple response variables

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4.3 Knowledge of caretakers/mothers about malaria and the malaria vector

Over three quarters of the caretakers/mothers knew that *Anopheles* mosquitoes carry the malaria parasite (76.8%), that the anopheles mosquitoes rest in cool and dark places (95.4%), that the anopheles mosquito lays eggs in water (87.8%), that mosquito meshes on windows and doors prevent the entry of mosquitoes into the rooms (93.0%), that bed nets can prevent mosquitoes bites (88.1%), that ―tankas‖, earthen pots, pits, and stagnant water are main breeding places for mosquitoes (98.2%), that by covering _tankas' and proper drainage system mosquitoes cannot breed (92.7%) and that malaria can take human life (93.9%). All the caretakers were aware that drugs are available to treat malaria.

Overall assessment of the caretakers/mothers showed that none of them had insufficient knowledge of malaria, 36.6% had moderate knowledge of malaria, and the majority (63.4%) had a high knowledge level of malaria. (Table 4)

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Table 4: Knowledge of caretakers/mothers about malaria and the malaria vector

Respondent	n	%
knows that the *Anopheles* mosquito carries the malaria parasite	252	76.83
Can identify male/female mosquitoes?	4	1.22
knows the feeding time of malaria mosquitoes	190	57.93
knows that *Anopheles* mosquito rest in a calm and dark place	313	95.43
knows that *Anopheles* mosquitoes lay eggs in the water	288	87.8
knows that anopheles takes 5–6 days to complete life-cycle	3	0.91
knows that mosquito meshes on windows and doors can prevent the entry of mosquitoes in the house	305	92.99
knows that bed net can prevent mosquito bites in the open field knows that _tanka', earthen pot, pits, and stagnant water are the primary sources of mosquitoes breeding	289 322	88.11 98.17
knows that by covering _tankas' and by proper drainage, the mosquito cannot breed	304	92.68
knows that malaria take human life	308	93.9
knows that drugs are available to cure the malaria patients	328	100
Knowledge level		
Low (0-49.9%)	0	0.00
Moderate (50-74.9%)	120	36.59
High (75-100%)	208	63.41

4.4 Malaria prevalence among children under five

Prevalence of malaria by the rapid diagnostic test (RDT) was 8.5% among the children, with a 95% confidence interval estimate of 6.0% to 12.1%. Three children showed fever, headache, loss of appetite, fatigue, nausea or vomiting, chills, paleness, and body pains (Table 5), and this was not analyzed any further.

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Table 5: Malaria prevalence among children under five

Variable	Frequency	Percentage
RDT results		
Malaria Negative	300	91.46
Malaria Positive	28	8.54
95% Confidence interval of RDT positivity	(5.95% - 12.11%)	
SYMPTOMS		
Fever	3	0.91
Headache	3	0.91
Loss of appetite	3	0.91
Fatigue	3	0.91
Nausea/Vomiting	3	0.91
Chills	3	0.91
Paleness	3	0.91
Body pains	3	0.91

Association between demographic characteristics and malaria prevalence among children

The prevalence of mosquitoes was described across the socio-demographic characteristics of the children, and the Pearson chi-square or the Fisher‘s exact chi-square were used to assessing the level of associations.

The prevalence of malaria was significantly higher among children below 1 year (20.0%, 95% CI: 11.4-32.7%) compared to those aged 2-3 years (7.3%, 95% CI: 4.1-12.7%) and those aged 4-5 years (4.9%, 95% CI: 2.2-10.5%). The Fisher‘s exact chi-square test showed a significant association between the child's age and the malaria prevalence test (p=0.003). None of the other socio-demographic characteristics showed significant association with malaria prevalence test from the RDT test (Table 6)

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Table 6: Test of Association between Socio-demographic characteristic and malaria prevalence among children

		Prevalence of malaria			
Variable	**N**	**n**	**% (95%CI)**	**Chisquare**	**P-value**
Prevalent	328	28	8.54 (5.95 - 12.11)		
Socio-demographic factors					
Age of child				11.61	0.003**
<1 year	55	11	20.00 (11.35 - 32.67)		
2-3 years	151	11	7.28 (4.07 - 12.70)		
4-5 years	122	6	4.92 (2.22 - 10.54)		
Sex of child				0.08	0.781
Male	191	17	8.90 (5.59 - 13.89)		
Female	137	11	8.03 (4.48 - 13.97)		
The educational level of mother/caretaker				1.93	0.381
None	34	1	2.94 (0.40 - 18.70)		
Primary	191	19	9.95 (6.42 - 15.11)		
Secondary or higher	103	8	7.77 (3.91 - 14.85)		
Religion				#	0.780
Christian	281	25	8.90 (6.07 - 12.86)		
Muslim	47	3	6.38 (2.04 - 18.26)		
Employment status of mother/caretaker				0.21	0.648
Employed	246	20	8.13 (5.29 - 12.29)		
Unemployed	82	8	9.76 (4.92 - 18.42)		
Marital status of mother/caretaker				#	0.224
Married/cohabiting	289	27	9.34 (6.48 -13.30)		
Single/divorced	39	1	2.56 (0.36 -16.18)		
Place of residence				#	0.554
Aunty kate	10	0	0.00 (empty)		
Acheampong village	159	16	10.06 (6.24 - 15.84)		
Jerusalem	36	4	11.11 (4.16 - 26.48)		

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Sweet mother	102	8	7.84 (3.95 - 14.99)		
Valco area	21	0	0.00 (empty)		
Family size				0.25	0.884
<4 members	71	7	9.86 (4.73 - 19.40)		
4-6 members	229	19	8.30 (5.34 - 12.67)		
7+ members	28	2	7.14 (1.74 - 25.07)		
Household income				1.60	0.450
Lowest earners (< Ghc 750.00)	113	8	7.08 (3.56 - 13.59)		
Middle earners (Ghc 751-1000.00)	120	9	7.50 (3.93 - 13.85)		
High earners (Ghc 1001-4500.00)	95	11	11.58 (6.49 - 19.80)		

N: frequency. CI: confidence interval
#: The Fisher‘s exact chi-square test. All other tests are the Pearson‘s chi-square test P-value notation: **: p<0.01.

4.5 Malaria preventive factors associated with malaria prevalence among children under five (5)

Table 8 shows the association between malaria preventive factors and methods use by caretakers and malaria prevalence test results among children using the Pearson‘s and Fisher‘s exact chi-square tests. From the table, none of the malaria preventive factors showed a significant association with malaria prevalence test results (p>0.05). (Table 7)

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Table 7: Test of Association of malaria preventive factors with malaria prevalence among children under five (5) years old

Variable	N	Prevalence of malaria		Chi-square	Pvalue
		n	95%CI		
Use of mosquito net				0.03	0.855
No	112	10	8.93 (4.85 - 15.87)		
Yes	216	18	8.33 (5.30 - 12.87)		
Access to treated mosquito net				0.02	0.883
No	113	10	8.93 (4.86 – 15.84)		
Yes	215	18	8.33 (5.30 – 12.86)		
The child sleeps under a bed net				0.04	0.838
No	123	10	8.13 (4.42 – 14.48)		
Yes	205	18	8.78 (5.59 – 13.53)		
The child slept under the bed net yesterday				0.11	0.743
No	162	13	8.02 (4.71 – 13.35)		
Yes	166	15	9.04 (5.51 – 14.47)		
The child always sleeps under the bed net				0.01	0.969
No	198	17	8.59 (5.39 – 13.40)		
Yes	119	11	8.46 (4.74 – 14.66)		
Vaccinated for malaria				#	1.00
Yes	4	0	0.00 (empty)		
No	324	28	8.64 (6.02 - 12.25)		
Treatment for malaria in the last three months				#	0.563
Yes	45	5	11.11 (4.64 - 24.31)		
No	283	23	8.13 (5.45 - 11.96)		
Use of insecticides				2.01	0.156
Yes	218	22	10.09 (6.72 - 14.88)		
No	110	6	5.45 (2.45 - 11.68)		
Child uses repellent				#	0.085
No	322	26	8.07 (5.54 - 11.62)		
Yes	6	2	33.33 (7.18 - 76.37)		

N: frequency. CI: confidence interval
#: The Fisher‘s exact chi-square test. All other tests are the Pearson‘s chi-square test P-value notation: **: p<0.01.

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Association between knowledge and malaria prevalence among children under five

Table 9 shows the association between caretakers' knowledge on malaria and malaria prevalence test results among children using Pearson‘s and Fischer‘s exact chi-square tests. From the table, none of the knowledge items showed a significant association with malaria prevalence test results (p>0.05). (Table 8)

Table 8: Association between knowledge and malaria prevalence among children under five (5)

		Prevalence of malaria			
Variable	**N**	**n**	**95%CI**	**Chi-square**	**P-value**
Anopheles mosquito carries malaria parasite				0.05	0.819
No	76	6	7.89 (3.56 - 16.60)		
Yes	252	22	8.73 (5.80 - 12.93)		
Can you identify male/female mosquitoes?				#	1.00
No	324	28	8.64 (6.02 - 12.25)		
Yes	4	0	0.00 (empty)		
The feeding time of malaria mosquitoes is before dawn or after the dusk period				0.10	0.755
No	138	11	7.97 (4.45 - 13.87)		
Yes	190	17	8.95 (5.62 - 13.96)		
Anopheles mosquito rest in cool and dark place				#	0.627
No	15	0	0.00 (empty)		
Yes	313	28	8.95 (6.24 - 12.67)		
Anopheles mosquitoes lay eggs in the water				#	0.552
No	40	2	5.00 (1.23 - 18.26)		
Yes	288	26	9.03 (6.21 - 12.95)		
Anopheles takes 5–6 days to complete life-cycle				#	1.000

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No	325	28	8.62 (6.00 - 12.22)		
Yes	3	0	0.00 (empty)		
Mosquito-meshes on windows and doors can prevent the entry of mosquitoes in the house				#	1.000
No	23	2	8.70 (2.10 - 29.67)		
Yes	305	26	8.52 (5.86 - 12.25)		
Bed net can prevent the mosquito bites in the open field				0.17	0.682
No	39	4	10.26(3.84 - 24.65)		
Yes	289	24	8.30 (5.62 - 12.11)		
'Tankas', earthen pots, pits and stagnant water are the main sources of mosquitoes breeding				#	1.000
No	6	0	0.00 (empty)		
Yes	322	28	8.70 (6.06 - 12.33)		
By covering 'tanks' etc. and by proper drainage, the mosquito				#	1.000
No	24	2	8.33 (2.02 - 28.62)		
Yes	304	26	8.55 (5.88 - 12.29)		
Malaria takes a human life				#	0.684
No	20	2	10.00 (2.41 - 33.34)		
Yes	308	26	8.44 (5.80 - 12.13)		
Knowledge score				0.01	0.920
Moderate	120	10	8.33 (4.52 - 14.86)		
High	208	18	8.65 (5.50 - 13.35)		

N: frequency. CI: confidence interval

#: The Fisher's exact chi-square test. All other tests are the Pearson's chi-square test P-value notation: **: p<0.01.

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4.6 Binary logistic regression model of factors associated with malaria prevalence test results among children

All variables that were assessed using the chi-square were run together in a multiple binary logistic regression model. The backward stepwise selection model using a removal threshold of 0.200 p-values and re-entry threshold of 0.100 was used to select the final variables for the final binary logistic regression model. In the final model, the age of the child was the only demographic factor chosen. The interviewer observed that the selected environmental sanitation factors included the presence of stagnant water around households and the accumulation of preventable materials that collect rain water, which serve as breeding places for mosquitoes. The self-reported environmental sanitation factors selected were covering dustbins to prevent water from gathering in them, clearing all bushes in the surroundings, and the overall sanitation assessment. The malaria prevention factors set were malaria treatment in the past three months and mosquito repellent by the child. All selected variables were run together in the adjusted binary logistic regression model. (Table 9)

From the adjusted binary logistic regression model, a month increased in the age of the child saw a 4% decrease in the odds of malaria prevalence (AOR: 0.96, 95% CI: 0.931.00), children living in the household with open drainages had a 4.4 times high odds of malaria prevalence (AOR: 4.43, 95% CI: 1.46-13.40) and children living in households with uncovered dustbins had a six times high odds of malaria prevalence (AOR: 6.18, 95% CI: 1.80-21.24). The odds of malaria prevalence were also six times high among children who had received malaria treatment in the past three months (AOR: AOR: 6.11, 95% CI: 1.61-23.14).

The odds of malaria prevalence were 81% less among households that had an accumulation of preventable materials that collects water to serve as breeding places for mosquitoes

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(AOR: 0.19, 95% CI: 0.04-0.93). The odds of malaria prevalence among children were Fifteen times high among caretakers/mothers who reported always desilt open drainages (AOR: 15.27, 95% CI: 2.55-9.43). The odds of malaria prevalence were 29 times higher among those who had poor sanitation assessment than those who had good sanitation assessment (AOR: 29.06, 95% CI: 2.92-289.16). (Table 9)

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Table 9: Binary logistic regression model of factors associated with malaria prevalence test results among children

Variables	Unadjusted Logistic Regression COR [95% CI]	Pvalue	Adjusted Logistic Regression COR [95% CI]	Pvalue
Age of child	0.97 [0.95-1.00]	0.036*	0.96 [0.93-1.00]	0.027*
Presence of open drains				
No	1.00		1.00	
Yes	2.88 [1.19-6.98]	0.019*	4.43 [1.46-13.40]	0.009**
Presence of stagnated water				
No	1.00		1.00	
Yes	3.30 [1.30-8.36]	0.012*	6.18 [1.80-21.24]	0.004**
Treatment for malaria in the last three months				
No	1.00		1.00	
Yes	1.41 [0.51-3.93]	0.508	6.11 [1.61-23.14]	0.008**
Accumulation of preventable materials that collect rainwater which serve as breeding places for mosquitoes				
No	1.00		1.00	
Yes	0.63 [0.21-1.87]	0.403	0.19 [0.04-0.93]	0.041*
Does the respondent use repellent on the child?				
No	1.00		1.00	
Yes	5.69 [1.00-32.56]	0.051	2.27 [0.30-17.08]	0.427
Always cover dustbins to prevent water from gathering in them No				
Yes	1.00 2.54 [0.74-8.65]	0.137	1.00 15.27 [2.55-91.43]	0.003**
Always clear all bushes around respondent's house				
No	1.00		1.00	
Yes	0.91 [0.40-2.03]	0.812	3.43 [0.93-12.63]	0.064
Overall sanitation practice assessment				
Good	1.00		1.00	
Moderate	0.51 [0.18-1.45]	0.210	0.88 [0.19-4.18]	0.875
Poor	2.61 [0.89-7.64]	0.080	29.06 [2.92-289.16]	0.004**

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CHAPTER FIVE

DISCUSSION

5.1 Major Findings

Malaria prevalence was 8.5%, with a 95% confidence interval estimate of 6.0% to 12.1%. The presence of open drainage was 53%, stagnated water bodies was 55%, accumulated materials that collected rain water was 20.4% and uncovered dustbins was 14.9%. Access to mosquito net was 65.8% among the caretakers/mothers, while constant utilization of ITNs among children who owned ITNs was 60.2%. Vaccination against malaria was 1.2% among the children and malaria treatment in the last three months was 13.7%. None of the caretakers/mothers had a low level of knowledge of malaria, with 36% having moderate knowledge level and 63.4% having high knowledge level. The knowledge of caretakers/mothers about malaria was not associated with malaria prevalence. Increased age of the child was associated with decreased odds of malaria prevalence. The presence of open drains, stagnated water, and uncovered dustbins were associated with increased odds of malaria prevalence. The odds of malaria prevalence were associated with decreased odds among children who had not received malaria treatment in the past three months. The practice of desilting open drainage was associated with decreased odds of malaria prevalence.

5.2 Methodological validity

5.2.1 Strength and limitations

This study has several strengths. The study used a consecutive sampling approach to enrol study participants where systematic order was used, beginning from one end to the other. This ensured that it has a high participation rate, and selection biased was minimized.

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The study's variables were measured using a structured questionnaire; this questionnaire is modified from a WHO study conducted in Abokobi in the Ga West District of Ghana. Also, qualified health professionals were deployed in data collection, thereby limiting likely mistakes. Such professionals can distinguish between false negatives and false positive Rapid Diagnostic Tests (RDTs).

Test efficacy was a challenge to the study. Some of the Rapid Diagnostic Tests (RDTs) resulted in false positives and false negatives, leading to an inflated estimate of disease prevalence. A second or third test had to be undertaken in some cases to get the actual valid results. Symptoms of malaria such as fever, headache, loss of appetite, chills, body pains, nausea, or vomiting solve such a problem. Rapid Diagnostic Test (RDT) efficacy was also inhibited by environmental factors such as high temperature and humidity. The Rapid Diagnostic Test (RDT) was carried out early in the mornings to avoid such interference.

Mother's or caregiver's age may influence environmental sanitation practices and prevalence of malaria among the children, but this study did not assess how the mothers or the caregivers contribute to malaria among the children. Also, none of the discarded containers with water were sampled to find out if they contained mosquitoes.

5.3 Comparison with previous studies

5.3.1 Prevalence of malaria among children under-5 years

The current prevalence of malaria among children under five in Tema New Town is 8.5% in this study. This current prevalence is higher than the figures of 1.7% and 2.23% recorded by the District Health Information Management Systems in 2017 and 2018 respectively (DHIMS, 2019) and Greater Accra regional prevalence at 4% (Yankson et al., 2019). In the Hohoe municipality, Kweku and colleagues (2017) observed a higher malaria prevalence of

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39.8% among children under five. The Northern Region of Ghana recorded an under-five malaria prevalence of 32%, followed by Central (30%) and

Eastern Region (31%) (Yankson et al., 2019). According to some researchers (Yankson et al., 2019; Nyarko & Cobblah, 2014), malaria prevalence usually is higher in rural areas as compared to urban settings hence making it unsurprising that the current prevalence of malaria among children under five in Tema New Town, a coastal peri-urban environment, is higher than that of the more urban Greater Accra Region. It is also evident that the coastal nature of Tema New Town could be an attributed factor that provides ambiance for mosquito breeding. The comparatively lower malaria prevalence rate among the children in Bankuman may be due to differences in study scopes as larger study scopes, including municipality and regions, may produce higher malaria prevalence rates in children under five (5) years old.

5.4 Environmental sanitation practice associated with malaria prevalence among children under five years

Although the association was not significant, open drains increased the odds of children under five having malaria. In agreement with this, researchers (Mokuolo et al., 2018; Salami & Umego, 2018) discovered an increase in malaria cases in households with open drains or gutters and poured water on the ground in their immediate vicinity surroundings compared to those who did not. This corresponds with the findings (Bugoro et al., 2011) in the Solomon Islands, which reported increased malaria prevalence and the abundance of mosquito larvae that were positively associated with open drains. According to Mokuolo et al. (2018) and Salami & Umego (2018), households with drains or gutters with stagnant water contributed more to the prevalence of malaria than those with drains with flowing water. This makes it understandable why families with children under five in Tema New Town who live near sources of stagnated water had significantly increased odds of having malaria in this present-

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day study. Stagnated water from rains and household wastewater provide breeding sites for mosquitoes exposing children to malaria, especially in the wet season (WHO, 2019). In line with this, Salami & Umego (2019) and Hajison et al. (2018) reported that children under five residing in households located one kilometre or less away from stagnant water sources such as puddles, canal irrigations, construction sites, rivers, swamps, or unprotected dug wells had increased odds of having malaria than those who reside more than a kilometre away from such water sources. Other studies (Musoke et al., 2014; Obi et al., 2014) also established that most malaria cases were seen in areas with open water pools created due to the pouring of wastewater, broken pipes, and commercial activities forming puddles and promoting the breeding of mosquitoes.

According to Hajison et al. (2018), spills from communal standpipes also create water puddles that may become stagnant and provide a conducive environment for mosquito breeding. Salami & Umego (2019) also argues that a lack of proper disposal system can cause water stagnation. This current study shows that respondents who had uncovered dustbins in their households significantly increased the odds of their children under five having malaria. In affirmation, another Ghanaian study obtained results that showed that only a handful of Ghanaians use covered plastic bins to store their waste. At the same time, the majority made use of uncovered containers, backyards, gutters, bushes, dug holes, and incineration (Yoade et al., 2014), allowing the proliferation of mosquitoes. Salami & Umego (2019) also revealed that most Nigerians dumped refuse in uncovered bins, at their backyards, and on public ground. This refuse was seen to breed mosquitoes by clogging drains and containing cans and bottles that trapped water (Salami & Umego, 2019). The environment in and around our homes is critical to our health; hence, people must be

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encouraged to practice proper refuse storage and disposal and proper covering and regular de-silting of open drains or gutters to prevent the breeding of mosquitoes.

Mothers who use mosquito repellents on their children under five did not significantly reduce the odds of their children having malaria compared to mothers who do not use mosquito repellents on their children. This contrasts with Dadzie et al. (2013), who revealed that repellent use was associated with a decrease of absolute malaria prevalence in the Kassena Nankana district of Northern Ghana. Studies in neighbouring Senegal showed that traditional repellents as a malaria control measure reduced mosquito prevalence drastically among children (Diallo et al., 2017). In the Champasak and Attapeu provinces, most military persons found mosquito repellent to be effective in warding off mosquitoes (Vilay et al., 2019).

5.4.1 Socio-demographic factors associated with malaria prevalence among children under five years

A one-year increase in age significantly reduced the odds of a child having malaria in Tema New Town. Age and malaria prevalence have long been shown to be correlated but opposite to what was observed in this study (Pullan et al., 2010; Gahutu et al., 2011; Yankson et al., 2019). As revealed by Pullan et al. (2010), the prevalence of malaria was significantly higher among older children under five years. Gahutu et al. (2011) concedes that the odds of malaria infection among children under five were found to increase with increasing age, showing that the older a child gets, the higher the risk and prevalence of malaria. Again, the majority was shown to grow with a child‘s age, with Yankson et al. (2019) revealing that younger children under five have the lowest likelihood of falling victims to malaria. Increased exposure or prevalence could be because parents may be more liberal in allowing their older children to spend more time playing outdoors at night than the younger ones.

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CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Malaria prevalence among children under five Tema New Town was 8.5%, with a 95% confidence interval estimate of 6.0% to 12.1%. Three children showed symptoms of malaria during the survey.

The presence of open drainage and stagnated water was found in more than half of the households, accumulation of materials that collects rainwater was 20.4%, and uncovered dustbins was 14.9%.

Nearly 66% of the caretakers/mothers had a mosquito net, and out of these caretakers/mothers who owned ITN, 60.2% constantly utilize it for their children under 5.

Vaccination against malaria was 1.2% among the children and had had Malaria treatment in the last three months was 13.7% .

None of the caretakers/mothers had a low level of knowledge of malaria, with 36% having moderate knowledge level and 63.4% having high knowledge level

The knowledge of caretakers/mothers about malaria was not associated with malaria prevalence.

Access and utilization of insecticide-treated net was not associated with malaria prevalence

Increased age of the child was associated with decreased odds of malaria prevalence

The presence of open drains, stagnated water, and uncovered dustbins were associated with increased odds of malaria prevalence.

The practice of de-silting open drainage was associated with decreased odds of malaria prevalence.

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6.2 Recommendation

1. Parents must be encouraged to be more active in protecting their children from mosquito bites no matter their age through the use of insecticide-treated mosquito nets, indoor residual spraying, mosquito repellents, and antimalarial prophylaxis.
2. The environment in and around our homes is critical to our health; hence, people must be encouraged to practice proper refuse storage and disposal and proper covering and regular de-silting of open drains or gutters to prevent the breeding of mosquitoes.

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APPENDICES

APPENDIX A: RESPONDENTSINFORMATION SHEET

This information sheet provides information about the research for mothers of children under five in Tema New Town to make an informed decision of whether to participate in the study or not. It outlines the nature of the research, what the research involves, risks, benefits, and compensation.

Title of Study: ENVIRONMENTAL SANITATION PRACTICES AND PREVALENCE OF MALARIA AMONG CHILDREN UNDER FIVE AT TEMA NEW TOWN

Introduction: I am Cecilia Ackah, a Master of Public Health (MPH) student at the School of Public Health of the University of Ghana, Legon. My email address is ceama37@gmail.com, and my telephone number is 0244172688. I am researching the topic:

ENVIRONMENTAL SANITATION PRACTICES AND PREVALENCE OF MALARIA AMONG CHILDREN UNDER FIVE AT TEMA NEW TOWN

Nature of research: This study is a quantitative research study, focusing on Environmental Sanitation Practices and prevalence of malaria among children under five at Tema New Town.

Respondents Involvement: I would like to invite you to participate in this study because you are a mother of a child under five and live in Tema New Town. I believe that you can help me by providing the appropriate responses.

Potential Risks: The study will pose no threat to life but involves pricking your child‘s fingertip for Malaria testing.

Benefits: Though you may not have any immediate or direct benefits from the study, your responses would be helpful in policy planning and formulation of recommendations to appropriate authorities concerning malaria and sanitation

Costs: Participation in this study will not cost you any money.

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Compensation: You will receive an amount of GH¢3.00 as incentives for participating in this research compensation for your participation and loss of time

Declaration of Conflict of Interest: The researcher has no conflict of interest in this study.

Confidentiality: Your name and identity will not be taken in this study. However, the information you are going to provide will be coded and will be treated strictly confidential. You are assured of total confidentiality to the information you will give. Apart from the researcher and supervisor of this research, no one else will have access to information provided, whether in part or whole. Data files would be kept for six months, after which they will be destroyed or discarded.

Voluntary participation/withdrawal: Participation is voluntary. You are free to choose if you want to take part in this study. Also, you can withdraw your consent at any time without further explanation and any adverse consequences.

Outcome and Feedback: Data gathered would help to improve policy formulation on malaria and sanitation.

Feedback to participant: No feedback will be given to you as an individual, but a report will be given to the various stakeholders involved in formulating policies on malaria and sanitation in Ghana (GHS, MOH, to mention a few).

Funding information: The principal investigator is funding this study.

Sharing of respondents Information /Data: Data gathered will be kept in my possession and will not be shared with any other organization(s) or individuals. It will be solely mine.

Storage of samples: Data files would be kept for six months, after which they will be destroyed or discarded. Clearance will be sought from the Ethics Review Committee before it would be used for any other purpose.

Provision of Information and Consent for participants: You will be given a copy of the Information Sheet and Consent after it has been signed or thumb-printed to keep.

Whom to Contact for Further Clarification/Questions: If you have a concern about any aspect of this research, don't hesitate to get in touch with **Cecilia Amilah E. Ackah** at the

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School of Public Health, Legon, or speak to me on telephone number 0244172688. For further clarification on ethical issues, don't hesitate to contact Madam Abena Apatu, the Ghana Health Service Ethics Review Committee administrator, on the telephone at 0503539896.

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APPENDIX B: CONSENT FORM FOR STUDY RESPONDENTS

Study title ENVIRONMENTAL SANITATION PRACTICES AND PREVALENCE OF MALARIA AMONG CHILDREN UNDER FIVE AT TEMA NEW TOWN

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and satisfactorily explained to me in a language I understand

English ☐ Twi ☐ Ga ☐ Ewe ☐

I fully understand the contents and any potential implications and my right to change my mind (i.e., withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

Name or Initials of Participant……..

Participants' Signature ……

Date:…….

INTERPRETERS' STATEMENT

I interpreted the purpose and contents of the Participants' Information Sheet to the aforenamed participant to the best of my ability in the (English, ☐ Twi, ☐ Ga Ewe ☐) language to his proper understanding.

All participants answer all questions, appropriate clarifications, and answers were also duly interpreted to their satisfaction.

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Name of Interpreter……

Signature of Interpreter……..

Date:……

Contact Details

STATEMENT OF WITNESS

I was present when the purpose and contents of the Participant Information Sheet was read and explained satisfactorily to the participant in the language; they understood

(English, ☐ Twi, ☐ Ga, ☐ Ewe☐)

I confirm that they were allowed to ask questions/seek clarifications, and the same was duly answered to their satisfaction before voluntarily agreeing to be part of the research.

Name: ……

Signature…….

Date: ……

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INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Researcher‘s name……

Signature ……

Date……

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APPENDIX C (QUESTIONNAIRE)

QUESTIONNAIRE ON ENVIRONMENTAL SANITATION PRACTICES AND PREVALENCE OF MALARIA AMONG CHILDREN UNDER FIVE AT TEMA NEW TOWN

This is research on Environmental sanitation Practices and the Prevalence Of Malaria among Children under Five at Tema New Town. The study is trying to uncover environmental sanitation practices that impact malaria prevalence among children under five in Tema New Town. Kindly share related information you have to help make this study successful by responding to the following questions.

	QUESTION	CODING CATEGORIES	SKIP TO	CODEE
	1. SOCIODEMOGRAPHIC FACTORS			
1	Age of child (State his/her last birthday age)	**Please state……**		age
2	Sex of child	**1.Male [ ]** **2.Female [ ]**		sex
3	Educational level of mother	**1. Primary [ ]** **2. Secondary [ ]** **3. Tertiary [ ]** **4. Vocational [ ]** **5. None [ ]**		educ
	Religion	**1. Christian [ ]** **2. Muslim [ ]** **3. Africa traditional [ ]**		reli
	Employment status of mother	**1. Employed** **2. Unemployed**		employ
	Occupation of mother	**Please state……**		occupy

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	Marital status of the mother	**1. Married [ ]** **2. Cohabiting [ ]**		mstat
		3. Single [ ] **4. Divorced [ ]**		
	Where do you live? (Place of residence)	**Please state……..**		residence
8b	How many are you in the household? (Family size)	**……..**		fam_size
8c	How much do you and your husband bring monthly to take care of your household? (Household income)	**…….**		hh_income
	A. ENVIROMENTAL AND SANITATION PRACTICES (researcher observation as confirmation)			
	Presence of open drains	**1. Yes [ ]** **2. No [ ]**		open_drains
10	Presence of stagnated water	**1. Yes [ ]** **2. No [ ]**		stag_water
	Accumulation of reasonably preventable conditions (tyres, empty cans, broken plastic containers, bottles, toys and flowerpots, and other objects that collect rainwater which serve as breeding places for mosquitoes)	**1. Yes [ ]** **2. No [ ]**		rpc
12	Presence of uncovered dustbins	**1. Yes [ ]** **2. No [ ]**		uncovered_dustin
	SELF-REPORTED SANITATION PRACTICES For each of the following statements about sanitation, indicate whether each **'always,' 'sometimes,' 'rarely,' or 'never'** applies to you			

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S1	I de-silt all open drains around the house to ensure the flow of liquid waste/ water	**1. Never [ ] 2. Rarely [ ] 3.Sometimes [ ] 4. Always [ ]**
S2	I sweep away all forms of stagnated water around the house	**1. Never [ ] 2. Rarely [ ] 3.Sometimes [ ] 4. Always [ ]**

S3	I clean in around the house to clear tyres, empty cans, broken plastic containers, bottles, toys and flowerpots, and other objects that collect rainwater which serve as breeding places for mosquitoes	**1. Never [ ] 2. Rarely [ ] 3.Sometimes [ ] 4. Always [ ]**
S4	I cover dustbins to prevent water from gathering in them	**1. Never [ ] 2. Rarely [ ] 3.Sometimes [ ] 4. Always [ ]**
S5	I clear all bushes around the house	**1. Never [ ] 2. Rarely [ ] 3.Sometimes [ ] 4. Always [ ]**

C. MALARIA PREVENTIVE FACTORS

13	Do you use a mosquito net?	**1. Yes [ ]** **2. No [ ]**	**If No skip to Q19**	bednet
14	If yes, in (13), are mosquito nets treated?	**1. Yes [ ]** **2. No [ ]**		treated net
15	If yes, in (13), does your child sleep under the net?	**1. Yes [ ]** **2. No [ ]**		childsleepnet
16	Did your child sleep under the net yesterday?	**1. Yes [ ]** **2. No [ ]**		yesterdaychildsleepnet
17	Does your child sleep under the nets all the time?	**1. Yes [ ]** **2. No [ ]**		net_allthetime

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18	If No in (17), what is (are) the reason(s) for which your child does not sleep under a net? **(You can choose more than one)**	**1. Skin Itches [ ]** **2. Heat [ ]** **3. Others (please specify)** **……..……..**		
19	Have you ever had any vaccine for malaria? (Antimalarial prophylaxis)	**1. Yes [ ]** **2. No [ ]**		malavaccine

20	Have you had a treatment for malaria in the last three months? (Antimalarial prophylaxis)	**1. Yes [ ]** **2. No [ ]**		malatreat
21	Do you use insecticides?	**1. Yes [ ]** **2. No [ ]**	**if no skip to 24**	insecticides
22	If yes, in (21), which insecticide do you use? (Tick as many as apply)	**1. Mosquito Coil [ ]** **2. Mosquito Spray [ ]**		type_of_insec ticide
23	If yes, in (21), how often do you use the insecticide?	**1. Once a week [ ]** **2. Twice a week [ ]** **3. Thrice a week [ ]** **4. More than four times a week [ ]**		often_isectici de
24	Do you use mosquito repellents on the child?	**1. Yes [ ]** **2. No [ ]**	**if no skip to**	repellent

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25	If yes, in (24), how often do you use the repellents on the child?	**1. Once a week [ ]** **2. Twice a week [ ]** **3. Thrice a week [ ]** **4. More than four times a week [ ]**		
	D.KNOWLEDGE ABOUT MALARIA AND THE MALARIA VECTOR **Provide knowledge of the following statement by indicating Yes, No, or I don't know**			
26a	*Anopheles* mosquito carries the malaria parasite	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26 b	Can you identify male/female mosquitoes?	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26c	The feeding time of malaria mosquitoes is before dawn or after the dusk period	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26 d	Anopheles mosquito rest in cool and dark place	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
	Anopheles mosquitoes lay eggs in the water	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26f	Anopheles takes 5–6 days to complete life-cycle	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26 g	Mosquito-meshes on windows and doors can prevent the entry of mosquitoes into the house	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26 h	Bednet can prevent mosquito bites in the open field	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26i	_tanka', earthen pots, cess pits, and stagnant water are the main sources of mosquitoes breeding	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26j	By covering _tanks' and by proper drainage, the mosquito	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
26 k	Malaria take human life	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		

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26l	Drugs are available to cure the malaria patients	**1. Yes [ ] 2.No [ ] 3. I don't know [ ]**		
D. MALARIA PREVALENCE AMONG CHILDREN UNDER FIVE				
27	RDT results	**0.MalariaNegative [ ]** **1.Malaria Positive [ ]**		malaria_test
28	Tick if the child has any of the following symptoms	**Fever** **1.yes [ ] 2. No [ ]** **Headache** **1.yes [ ] 2. No [ ]** **Loss of appetite** **1.yes [ ] 2. No [ ]** **Fatigue** **1.yes [ ] 2. No [ ]** **Nausea/ Vomiting** **1.yes [ ] 2. No [ ]** **Chills** **1.yes [ ] 2. No [ ]** **Paleness** **1.yes [ ] 2. No [ ]** **Body pains** **1.yes [ ] 2. No [ ]**		

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APPENDIX D: ETHICAL CLEARANCE LETTER

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
GPS Address: GA-050-3303
Tel: +233-302-681109
Fax + 233-302-685424
Email: ethics.research@ghsmail.org

MyRef. GHS/RDD/ERC/Admin/App/20/130
Your Ref. No.

5th May, 2020

Cecilia Amilah Elimah Ackah
Port Health
Box CO76
Tema

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC 010/04/20**
Project Title	Environmental Sanitation Practices and Prevalence of Malaria among Children Under Five at Tema New Town
Approval Date	5th May, 2020
Expiry Date	4th May, 2021
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
Dr. James Akazili
(Head, Ethics & Research Management Department)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

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