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Assessment of the Knowledge, Prevalence, and Control Strategies of Malaria Among Households in Sunyani Municipality, Bono Region, Ghana

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ABSTRACT

BACKGROUND: Malaria remains a global public health concern for centuries. The study assessed the knowledge, prevalence and control strategies of malaria among households in the Sunyani Municipality, Bono Region, Ghana.

METHOD: A simple random sampling method was used to administer semi-structured questionnaires to the respondents (n = 422). STATA version 14.0 was used to analyse the data and the results were presented in charts, graphs, and tables.

RESULT: The study shows that the knowledge level of malaria, its vector of transmission and mosquitoes breeding sites among the respondents was quite high. Among the respondents, 43% reported to have been infected by malaria once in a year and 94% indicated that, their relatives have been infected with malaria parasites previously. Also, majority, 65% of the respondents selected environmental management and sanitation (EMS), followed by settlement (building houses) away from wetlands, 20.0% as alternative vector control methods to be employed to supplement the core vector control methods in the Municipality. Further, majority, 69% of the respondents indicated that enforcement of environmental sanitation bye-laws will compel residents to clean their environment, and this is likely to eliminate most mosquito breeding sites, whiles 46% called on Government to support, and employ more Environmental Health Officers and Sanitary Labourers, and adequately resource them to work effectively.

CONCLUSION: Health authorities in the Sunyani Municipality must intensified education on malaria at all levels with the aim to influence the attitudes of households towards its prevention and control. Central and Local Government must employ more Environmental Health Officers, and empower and adequately resourced them to strictly enforce the environmental sanitation bye-laws. Malaria control authorities in the study area must consider employing environmental management and sanitation (EMS) and application of larvicides for mosquito larval control as alternative/supplementary malaria prevention and control methods to compliments the current core vector control methods.

KEYWORDS: Assessment, households, knowledge, malaria control strategies, prevalence, Sunyani Municipality

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Introduction

Malaria remains a global health concern, however public health determinations are currently centred on controlling the infection. Malaria is caused by infection with single-celled parasites of the genus *Plasmodium*. Female *Anopheles* mosquitoes are the vectors that transmit these parasites from one host to a new host during blood meal or biting. Among the signs and symptoms of malaria are severe chills and high fever. Severe cases of malaria could cause death when not treated.[1] Sadly, over one million people die from malaria infection every year, typically in Africa. Malaria has been declared prevalent in North America and other temperate regions.[1] Presently, the infection ensues generally in tropical and subtropical regions, predominantly in Sub-Saharan Africa (SSA) and Southeast Asia. Also, the infection can be seen in Central and South America, Oceania, as well as some Caribbean islands. Public health officers through their tireless efforts had worked to eliminate malaria infection in the 20th century[1] However, nearly 40% of the world's population particularly in Sub-Saharan Africa and other developing nations are malarious endemic regions and sadly, the African continent is associated with 80% of the total reported malaria cases and 90% of deaths globally.[2] Amidst

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2015 and 2018, only 31 malaria-endemic countries remained endemic with the infection and had shrunk case prevalence meaningfully as well as made progress to lessen occurrence by 40% or more by 2020. Deprived of an advanced amendment, the Global technical strategy (GTS) for malaria 2016 to 2030 indicators for morbidity in 2025 and 2030 cannot be accomplished with the current vector control methods.[3] In Ghana, malaria is ranked the number one cause of mortality accounting for about 37.5% of all Out Patient Department (OPD) turnout. However, it is also the leading cause of morbidity in children under 5 (U5) years, a substantial cause of adult ailment, and the principal cause of workdays lost due to illness.[4] Additionally, malaria impacts poorly on the productivity of all sectors of the economy. Malaria is hyper endemic in all parts of the country, with an estimated 24 million population at risk.[4,7] In 2018, amongst the top 10 causes of outpatient department (OPD) morbidity in the Sunyani Municipality, malaria tops with 18% of confirmed cases. Despite a significant reduction from 61.2% in 2014, malaria infection is remains a major public health burden in the Sunyani Municipality.[5] Interestingly, it is noted that, indigenous knowledge and practices linked to the malaria disease are crucial to the execution of traditionally appropriate, workable, and effective interventions.[6] Communal awareness, views, and approaches to malaria control, symptom identification, management, and prevention impact determinations to tackle malaria and are frequently ignored in control activities.[7] Furthermore, Castro et al[8] opined that, individual awareness of health risks and intervention goals were significantly higher among sensitized neighbourhoods in a study on malaria as well as a high risk of malaria was observed at the control site than the intervention site after cleaning of drains and application of larvicides was recorded during the study.

Heggenhougen et al[9] opined that successful disease control at the community level needs to take human behaviour, and socio-cultural and economic context into account together with biomedical interventions. Employing vector control is an essential constituent in every malaria control and elimination scheme.[1,14] Currently, malaria control is grounded on the long-lasting insecticide-treated net (LLINs) and indoor residual spraying (IRS) as core vector control methods recommended by the World Health Organization (WHO).[1,14] A quarter of persons at risk of malaria in Sub-Saharan Africa sleep under a long-lasting insecticide-treated net (LLINs); in the year 2018, 50% of the populace was protected by this malaria prevention strategy, a rise from 29% in 2010. Moreover, the proportion of the populace who possess and use LLINs amplified from 33% in 2010 to 57% in 2018 whilst, households possessing a minimum of one LLIN for every 2 people amplified to 72% in 2018, from 47% in 2010.[3] Unfortunately, the effectiveness of LLINs and IRS has been dented due to the development of resistance of *Plasmodium parasites* against several anti-malarial drugs and the *Anopheles* mosquitoes against a lot of insecticides as well as increasing worries as a result of the longstanding ecological effect of certain insecticides been used.[1,14] The growing challenge of insecticide resistance in adult mosquitoes as well as high echelons of outdoor transmission has however lessened the effectiveness of insecticide-treated nets thereby shifting the problem of control to larval control strategies aimed at thwarting the occurrence of adult mosquitoes, and novel interventions that can serve as supplementary methods that would deal with outdoor transmission and insecticide resistance are needed immediately.[10]

Though, LLINs and IRS with insecticides are the core vector control interventions to protect households from mosquito bites, which seek to prevent malaria residual transmission. However, a remaining challenge facing malaria control currently is the transmission that occurs outdoors[11]

Further, malaria control interventions used more often to lessen *Plasmodium Falciparum* infection and malarial disease include: (i) intermittent preventive treatment with pyrimethamine-Sulphadoxine in the second and third trimesters of pregnancy (IPTp) to reduce placental malaria and its neonatal consequences, (ii) treatment of malaria with Artemisinin-based combination therapy (ACT) to clear infections promptly, and may also include (iii) seasonal malaria chemoprevention (SMC) for children under 5 years.[12]

Other vector control methods include larviciding and environmental management which are used whenever applicable based on scientific evidence.[13] Malaria control programmes must take into consideration the impact that could be accomplished by environmental management as a vector control strategy in its way whilst working together alongside the recommended methods of malaria control employed worldwide[14] Environmental management (EM) seeks to fortify malaria control actions because it is very economical. Factually, the effectiveness of environmental management as a malarial vector control method, proper coordination, and collaboration among diverse public and private sector players are needed.[14]

Additional vector control interventions such as larviciding and environmental management are of superior significance in continual control as the problem diminishes and targetted methods tackling breeding sites could be precise and effective in decreasing vector populaces.[13] Innovative, underexploited, effective vector control strategies as well as methods are immediately required to tackle residual transmission and fast-track advancement in line with malaria elimination and eradication globally.[15]

Materials and Methods

Profile of the study area

Sunyani Municipality is one of the 27 districts in the Brong-Ahafo region (now Bono Region). The Sunyani Municipal Assembly covers a total land area of 506.7 km^2. It is located at the heart of the Bono Region lying between Latitudes 70 20′N and 70 05′N and Longitudes 20 30′W and 2010′W. The monthly temperatures vary between 23°C and 33°C with the lowest around August and the highest around March and

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April. The average rainfall is 88.99cm. The district experiences a double maxima rainfall pattern with the main rainy season between March and September and the minor season from October up to December. The relative humidity averaging between 75% and 80% during the rainy seasons and below 70% during the dry seasons is ideal for luxurious vegetative growth. Sunyani Municipality falls largely within the moist–semi-deciduous forest vegetation zone. The Municipality is predominantly urban with more than 8 out of every 10 persons living in urban areas. The Sunyani Municipality has a total population of 123 224 made up of 61 610 males and 61 614 females.[16,17]

Sample Size

Sample size calculation

Cochran sample size calculation formula was used to arrive at the number of respondents as indicated below,[18]

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where: n is the sample size,

Z is the value for the selected alpha level, for example, 1.96 for the z value in the Z table, 95% confidence level, (1.96, z value)

p is the estimated proportion of an attribute that is present in the population, and q is 1-p. (p)(q) is the estimate of variance.

d is the acceptable margin of error for proportion being estimated, so the confidence interval, in decimals. That is, the desired level of precision.

Therefore; $Z = 1.96$ (95% confidence level); $P = .5$; $q = 1-q$. (p) (q); $d = 5\%$ (0.05). This was calculated as: $(1.96)^2(0.5)(1-0.5)/(0.05)^2$; 384.16 = 384. Non-response of 10% was added (38), summing up to 422. Therefore, 422 respondents were sampled in this study.

Semi-structured questionnaires

The semi-structured questionnaires for data collection from households were divided into 5 parts. Part one dealt with demographic characteristics of the respondents, part 2 dealt with knowledge about malaria and mosquito breeding sites, part 3 dealt with the prevalence of malaria, and part 4 dealt with control strategies of malaria (anti-mosquito practices) and part 5 dealt with households, community and stakeholders contributions towards malaria prevention and control in the Municipality. In all, 34 open and closed-ended questions were involved.

Sampling frame

The Municipality was demarcated into 5 zones due to proximity and similar demographic characteristics, which is made up of 21 communities/suburbs. A lottery method was used to select at least 2 communities/suburbs from each zone. In all, the following communities/suburbs were selected from all the 5 zones. Namely; Newtown, Baakoniaba and Asufufu (Zone 1); Area 1, Area 2 and Area 4 (Zone 2); Zongo Abetifi, Nkwabeng North and Berlin Top (Zone 3); Penkwase, New Dormaa, Kotokrom/ Yawhima (Zone 4), and Abesim and Magazine (Zone 5). The questionnaires (n = 422) were distributed among the 5 zones accordingly. All households who were 15 years and above, who resided in the selected communities/suburbs and were willing or consented to participate in the study by answering the research questionnaires were included and eligible for the study. However, all households (residents) of the non-selected communities/suburbs who were less than 15 years of age were excluded in the study.

Content validation and reliability

The content of the semi-structured questionnaires were validated and its reliability was determined by authors who are experts and vested in the field. Content validity and reliability can be defined as the extent to which questionnaires to carry out research work are deem appropriate to entirely represent the theoretical construct research questionnaires are designed to measure.[19] The expert team established whether the research questionnaires was adequate enough to measure the hypothesis they intend to investigate. Content validity and reliability was done to ascertain whether the questionnaires were quite clear and easy to be answered by the respondents, the research items (questions) sufficiently covered knowledge about malaria and mosquito breeding sites, prevalence of malaria, and control strategies of malaria and households, community and stakeholders contributions towards malaria prevention in the Municipality as well as whether the questionnaires were deficient in key research items on the subject matter, and whether the questionnaires could be adopted and used future researchers, and lastly whether there were any research items that might probably violate the privacy of the respondents.[20]

Pre-testing

The semi-structured were pre-tested on 15 respondents (households) in the Sunyani West Municipality, Odomase December, 2019 which has very similar demographic characteristics with the study area. It is noted that, the pre-tested questionnaires offered the researchers the chance and insight as to whether the questionnaires were clear or had errors in their design or otherwise and that needs to be addressed prior to the administration at the study area. However, key issues, omissions and errors identified were carefully addressed and effected into the final draft and administered to the respondents in the study area.[21]

Administration of semi-structured questionnaires

A simple random sampling was employed to administer the questionnaires, whereby every household was entered. Consent

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was sought from heads of households to participate in the study and the consent form was filled, if the occupants/inhabitants agreed to participate, a questionnaire was given out and if they declined, then the researchers moved on to the next household without filling the consent form, this was done until all the questionnaires (n = 422) were well administered across the entire Municipality. During the administration of the questionnaires, respondents who were able to fill them out without assistance from the research team were allowed to do so. However, those who could not fill it were assisted by the research team by explaining the questions to them in the local dialect and using their response to fill the questionnaires.

Strength and limitations

The findings of the study can be generalized among Municipalities with geographic characteristics (profile) very similar to the Sunyani Municipality, since the sample size used and selection process was well-designed and the sample size (n = 422) is a representative of the study population. The limitation of the study is the fact that, some of the respondents could not answer or fill the questionnaires using the English language and they were assisted by the research assistants by using the local dialect (Twi) and later translate into English. This could have changed the meaning or responses of the original respondents. Also, factor (factorial) and inferential analysis could not be performed in this study, but only descriptive statistics were used.

Results

Demographic characteristics

Table 1 above indicates that of the 422 respondents, 161 (38.2%) were in the age range of 15 to 25 years, the most numerous group, 120 (28.4%) were in the age range of 26 to 35 years, 83 (19.7%) were in the age range of 36 to 45 years, and 58 (13.7%) were in the age range of 46 to 55 years. Of the 422 respondents, the majority, 219 (51.9%) were women, while 203 (48.1%) were men. Of the 422 respondents, 134 (31.7%) had tertiary education background, 127 (30.1%) had a basic/junior high school background, 105 (24.9%) had a secondary/senior high school background, and 56 (13.3%) had a vocational/technical school background. Christians make up the majority –315—which is 74.6 % of the total; 95 (22.5%) were Muslims, and 12 (2.9%) were traditionalists. The breakdown of the marital status of the 422 respondents was 260 (61.6%) single, 105 (24.9%) married, 31 (7.3%) widowed, and 26 (6.2%) divorced. According to the table above, of the 422 respondents, traders constituted 187 (44.3%), followed by students at 101 (23.9%), 69 (16.4%) were teachers and 65 (15.4%) were farmers. The survey found that 221 (52.4%) respondents speak Twi, which represents the highest, 63 (14.8%) speak English, 61 (14.5%) speak Fante, and 36 (8.5%) speak Ga. Of the remaining, 23 (5.5%) and 18 (4.3%) speak Ewe and Hausa, respectively.

Knowledge about the prevalence of malaria among households

Table 2 shows that 404 (95.7%) of 422 respondents knew about malaria, while 18 (4.3%) did not. When respondents were asked whether they had ever heard of malaria, 405 (95.9%) said yes and 17 (4.1%) said no. The table reports that 401 (95.0%) knew that malaria occurs in Sunyani, while the remaining 21 (5%) said they were not sure. The survey found that 393 (93.1%) said they experience mosquito bites in the community; the remaining 29 (6.9%) said they do not. When asked whether settlements around swampy areas contribute to malaria prevalence, 349 (82.7%) of the respondents said yes, while 73 (17.3%) said no. Of the 422 respondents, 201 (47.6%) said they heard about malaria at a hospital or clinic, 88 (20.8%) said they heard about malaria on the radio, 80 (19.0%) said they heard about it in school, and 53 (12.6%) said they heard about it on television. The survey found that 170 (40.3%) said mosquitoes bite in the evening, 124 (29.4%) said they bite at night, 76 (18.0%) said they bite in the morning, and 52 (12.3%) said they bite in the afternoon. Of the 422 respondents, 205 (48.6%) agreed that fever is a sign (symptom) of malaria, 95 (22.5%) said that fever, headache, and loss of appetite are the signs suggesting that someone is suffering from malaria, 64 (15.2%) said headache and 58 (13.7%) said loss of appetite. Regarding how often a person can be infected with malaria in a year, less than half (181, 42.9%) said once, 103 (24.4%) said twice, 73 (17.3%) said three, and 65 (15.4%) said 4 or more times. Of the 422 respondents, 397 (94.1%) said they had relatives who had been infected with malaria before; only 25 (5.9%) reported that no one in their family had ever been infected with malaria. However, when asked whether poor solid and liquid waste management account for mosquito breeding, 204 (48.3%) indicated that they strongly agreed, 142 (33.6%) said they agreed, 57 (13.5%) somewhat agreed, and 17 (4.0%) and 2 (0.5%) answered that they disagreed or strongly disagreed, respectively. When asked whether the lack of engineered storm drains contributes to mosquito breeding, the majority 356 (84.4%) said yes, while the remaining 66 (15.6%) said no.

Knowledge about the vector that transmits malaria

Figure 1 above shows that, of the 422 respondents, 409 (96.9%) indicated that mosquitoes transmit malaria, 5 (1.2%) said bed bugs transmit malaria, 7 (1.7%) said houseflies, and 1 (0.2%) answered 'other/ do not know'.

Knowledge of respondents about where mosquitoes breed

Figure 2 above shows that 367 (86.9%) of the 422 respondents agreed that mosquitoes breed in stagnant waters, 23 (5.5%) said refuse dumps, 19 (4.5%) said bushes, 10 (2.4%) said septic tanks, and 3 (0.7%) said 'other'.

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Table 1. Demographic characteristics of respondents in the study population.

VARIABLE	RESPONDENTS CHARACTERISTICS	FREQUENCY	PERCENTAGE (%)
Age (Years)	15–25	161	38.2
	26–35	120	28.4
	36–45	83	19.7
	46–55	58	13.7
Sex	Men	203	48.1
	Women	219	51.9
Educational Background	Basic/Junior High School	127	30.1
	Secondary/Senior High School	105	24.9
	Vocational/Technical School	56	13.3
	Tertiary	134	31.7
Religion	Christianity	315	74.6
	Muslim	95	22.5
	Traditionalist	12	2.9
Marital Status	Married	105	24.9
	Single	260	61.6
	Divorce	26	6.2
	Widowed	31	7.3
Occupation	Teaching	69	16.4
	Farming	65	15.4
	Trading	187	44.3
	Student	101	23.9
Language Spoken	Fante	61	14.5
	Twi	221	52.4
	Ewe	23	5.5
	Ga	36	8.5
	Hausa	18	4.3
	English	63	14.8

Source: Fieldwork, 2020.

Knowledge of respondents about other contributing factors to mosquitoes breeding in the community

Figure 3 indicates that of the 422 respondents, 206 (48.8%) noted that stagnant waters/uncovered pits/containers/receptacles on premises are contributing factors to mosquitoes breeding in the community, 63 (14.9%) said in bushes around the house, 55 (13%) said empty lorry tyres and cans in the community, 45 (10.7%) said choked gutters, 24 (5.7%) said poor sanitation. The remaining 18 (4.3%) and 11 (2.6%) said building houses in swampy areas and poor drainage systems, respectively.

Vector control strategies employed in the prevention and control of malaria in the municipality

From Table 3 above, it was clear that of the 422 respondents, the majority, 287 (68.0%), indicated that they employ insecticide-treated nets (ITNs) as malaria prevention method, 69 (16.4%) said they employ indoor residual spraying (IRS), 46 (10.9%) said they employ environmental management/sanitation measures, 17 (4.0%) said they employ the use of traps/repellent, and 3 (0.7%) said they provide screens on doors and windows as a malaria prevention method. When asked about the best anti-malaria prevention methods, the majority, 273

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Table 2. Knowledge about the prevalence of malaria among study respondents and households in the study area.

VARIABLE	RESPONSES	FREQUENCY	PERCENTAGE (%)
Do you know the disease malaria	Yes	404	95.7
	No	18	4.3
Ever heard of malaria	Yes	405	95.9
	No	17	4.1
Do we have malaria in Sunyani	Yes	401	95.0
	No	21	5.0
Mosquito bites in the community	Yes	393	93.1
	No	29	6.9
Do settlements around swampy areas contribute to malaria prevalence	Yes	349	82.7
	No	73	17.3
Where you heard about malaria	Hospital/Clinic	201	47.6
	School	80	19.0
	Radio	88	20.8
	Television	53	12.6
Time mosquito bites	In the morning	76	18.0
	In the afternoon	52	12.3
	Early in the evening	170	40.3
	At night	124	29.4
Symptoms of malaria	Fever	205	48.6
	Headache	64	15.2
	Loss of Appetite	58	13.7
	All of the above	95	22.5
How often does malaria affect in a year	Once	181	42.9
	Twice	103	24.4
	Thrice	73	17.3
	Four and above	65	15.4
Relatives infected with malaria before	Yes	397	94.1
	No	25	5.9
Knowledge of respondents in the study population about mosquito breeding sites			
Poor solid and liquid waste management account for mosquito breeding	Agreed	142	33.6
	Fairly agreed	57	13.5
	Strongly agreed	204	48.3
	Disagreed	17	4.0
	Strongly disagreed	2	0.5
The lack of construction of engineered storm drains contributes to mosquito breeding	Yes	356	84.4
	No	66	15.6

Source: Fieldwork, 2020.

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(64.7%), said employing environmental management and sanitation measures, 84 (20.0%) indicated that building houses/settlements away from swampy areas, and 49 (11.6%) said the use of indoor residual spraying (IRS). The remaining 13 (3%) and 3 (0.7%) said the use of insecticide-treated nets (ITNs) and traps/repellent, respectively. Of the 422 respondents, 194 (46.0%) indicated that heads of household make the decisions on malaria prevention/protection in the house, 89 (21.1%) said the father, 65 15.4%) said the mother, 44 (10.4%) said the grandmother, and 30 (7.1%) said the children.

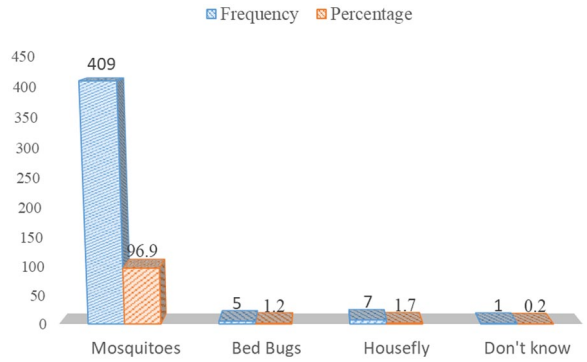

Figure 1. Vectors that transmit malaria (Source: Fieldwork, 2020).

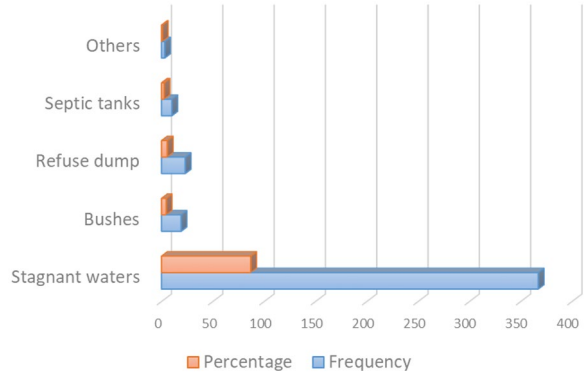

Figure 2. Where mosquitoes breed (Source: Fieldwork, 2020).

Anti-malaria prevention and control methods stakeholders recommend for households in the municipality

As shown in Table 4, when asked about recommended methods for control of malaria in the community during radio discussions with health inspectors/nurses, of the 422 respondents, 227 (53.8%) said sleeping under ITN/LLINs, 51 (12.1%) said IRS (indoor residual spraying), 50 (11.8%) said practicing good environmental sanitation, 36 (8.5%) said clearing or weeding bushy areas by communal labour, 28 (6.6%) said draining/desilting choked gutters/ stagnant waters, 22 (5.2%) said the use of mosquito repellent/traps, and 8 (2.0%) said fumigation of stagnant waters/refuse dumps.

Responses of respondents on households, community, and stakeholders' contributions towards malaria control in the municipality

Table 5 above shows that of the 422 respondents, 210 (49.8%) indicated Assemblyman/Woman in the community as stakeholders in malaria control, 90 (21.3%) indicated Ghana Health Service, 69 (16.4%) indicated Health Inspectors, 27 (6.4%) indicated non-governmental organizations (NGOs) while 26 (6.1%) indicated School children. When asked how many times respondents had engaged in activities such as draining/flushing stagnant waters, desilting choked gutters, removing empty lorry tyres, and filling potholes in the community, of the 422 respondents, 132 (31.2%) said once, 115 (27.3%) said more than twice, 91 (21.6%) said twice, while 84 (19.9%) said never. The table above pointed out that of the 422 respondents, 246 (58.3%) indicated that they are aware of clean-up exercise

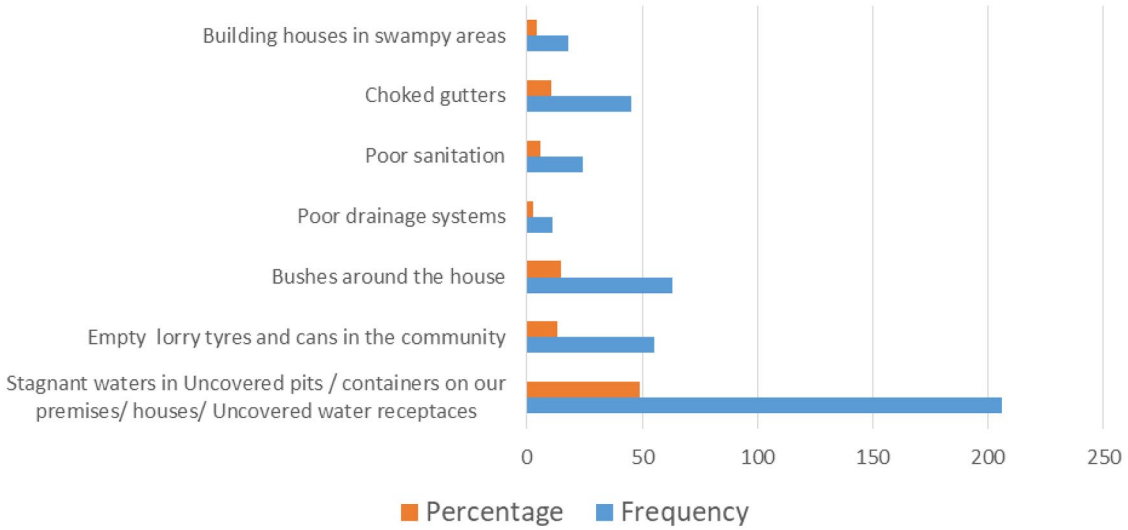

Figure 3. Other contributing factors to mosquito breeding in the community (Source: Fieldwork, 2020).

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Table 3. Knowledge about anti-mosquito practices of respondents in the study area.

VARIABLE	RESPONSES	FREQUENCY	PERCENTAGE (%)
Malaria prevention methods	Insecticide Treated Nets (ITNs)	287	68.0
	Indoor Residual Spraying (IRS)	69	16.4
	Traps/Repellent	17	4.0
	Environmental Management/Sanitation	46	10.9
	Screening of doors and windows	3	0.7
Best Anti-malaria prevention methods	Insecticide Treated Net (ITNs)	13	3.0
	Indoor Residual Spraying (IRS)	49	11.6
	Traps	3	0.7
	Environmental Management/Sanitation	273	64.7
	Building houses away from swampy areas	84	20.0
Prevention/Protection decision making	Head of household	194	46.0
	Grandmother	44	10.4
	Father	89	21.1
	Mother	65	15.4
	Children	30	7.1

Source: Fieldwork, 2020.

Table 4. Health inspectors'/nurses' recommended methods for control of malaria in the community, given in radio discussions (open-ended responses).

RESPONDENTS' RESPONSES	FREQUENCY	PERCENTAGE (%)
The practice of good environmental sanitation (keeping homes and environment clean and proper waste disposal)	50	11.8
IRS (indoor residual spraying)	51	12.1
Mosquito repellent /traps	22	5.2
Sleep under ITN/LLINs	227	53.8
Draining /desilting of choked gutters/ stagnant waters	28	6.6
Clearing or weeding bushy areas by individuals or through communal labour	36	8.5
Fumigation of stagnant waters/refuse dumps	8	2.0

Source: Fieldwork, 2020.

organized by Assemblyman/Woman in their community while 176 (41.7%) said they are not aware. Of the 422 respondents, 347 (82.2%) majority, indicated that they have ever listened to a radio discussion while 75 (17.8%) said they have never listened to such radio discussion held by Health Inspectors/ Nurses on the control of malaria in the community. When asked whether robust educational campaigns on environmental management and sanitation would go a long way in the prevention and control of malaria, and to what extent respondents agreed, 268 (63.5%) noted that they strongly agreed, 101 (24.0%) noted that they agreed, 31 (7.3%) noted that they disagreed whiles 22 (5.2%) noted that they strongly disagreed.

Open-ended responses from respondents on how enforcement of environmental sanitation bye-laws will make community members clean their environment to help prevent mosquitoes from breeding

According to Figure 4 above, of the 422 respondents, 292 (69.2%) respondents indicated that enforcement of environmental sanitation bye-laws will compel everyone to clean their environment to eliminate mosquito breeding sites, , 40 (9.5%) said will make individuals clean their environment to avoid court sanctions. Also, 34 (8%) said the laws will serve as barrier to stop the people from un-tidying the environment, 29 (6.9%)

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Table 5. Households, community, and stakeholders' contributions towards malaria control in the municipality of respondents in the study area.

VARIABLE	RESPONSES	FREQUENCY	PERCENTAGE (%)
Stakeholders in the community	Assemblyman/woman	210	49.8
	Ghana Health Service	90	21.3
	Non-Governmental Organization	27	6.4
	Health Inspectors	69	16.4
	School Children	26	6.1
No. of times engage in activities draining/flushing of stagnant waters, desilting choked gutters, removing empty lorry tyres, and filling potholes in the community	Once	132	31.2
	Twice	91	21.6
	More than twice	115	27.3
	Never	84	19.9
Aware of any clean-up exercise organized by Assemblyman/ woman	Yes	246	58.3
	No	176	41.7
Listen to radio discussions by Health Inspectors/Nurses on the control of malaria in the community	Yes	347	82.2
	No	75	17.8
Robust educational campaigns on Environmental Management and Sanitation would lead to the prevention and control of Malaria	Agreed	101	24.0
	Strongly agreed	268	63.5
	Disagreed	31	7.3
	Strongly disagreed	22	5.2

Source: Fieldwork, 2020.

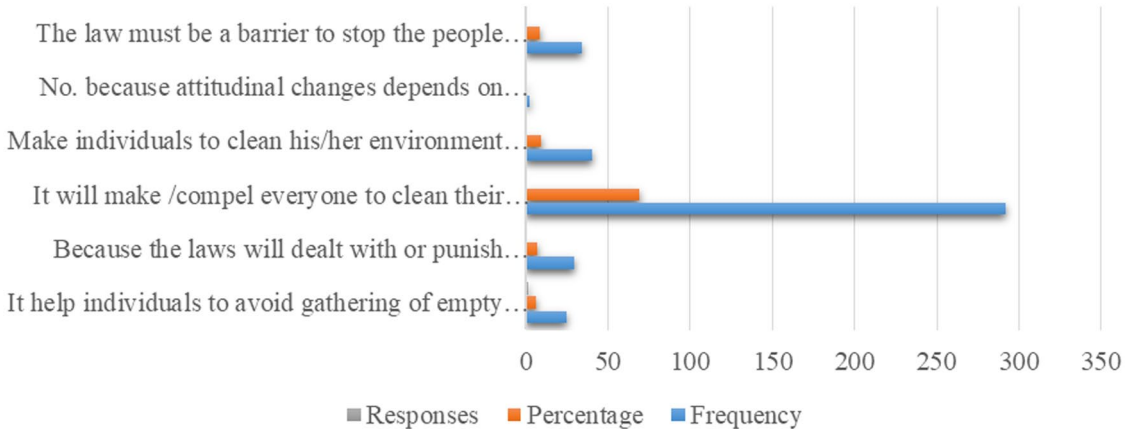

Figure 4. Enforcement of environmental sanitation bye-laws will make community members clean their environment to help prevent mosquitoes from breeding (Source: Fieldwork, 2020).

said because the laws will punish offenders if caught up while 25 (5.9%) said will help individuals avoid gathering empty lorry tyres and cans in their homes.

Open-ended responses from respondents on how people can manage their environment to prevent mosquitoes from breeding in their community

Table 6 above shows that, of the 422 respondents, 82 (19.4%) suggested engaging in /doing communal labour /clean-up exercise by the entire community on monthly basis, 55 (13.0%) suggested individuals clearing bushes or weeding around their houses regularly, 51 (12.1%) suggested avoiding the practice of indiscriminate dumping of refuse in the community and 50 (11.9%) suggested construction of gutters to drain stagnant waters. Further, 48 (11.4%) suggested by removing/ burning of empty lorry tyres and empty cans and other refuse, 45 (10.7%) suggested desilting gutters/stagnant waters, 30 (7.1%) suggested proper drainage systems, 26 (6.2%) suggested strict enforcement of sanitation bye-laws, 25 (5.9%) suggested

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Table 6. Suggestions as to how people can manage their environment to prevent mosquitoes from breeding in their community.

RESPONDENTS RESPONSES	FREQUENCY	PERCENTAGE (%)
By clearing bushes or weeding around our houses regularly by individuals	55	13.0
By removing/ burning empty lorry tyres and empty cans and other refuse	48	11.4
Construct gutters to drain stagnant water	50	11.9
Desilting gutters/stagnant waters	45	10.7
Proper drainage systems	30	7.1
Building houses away from swampy areas	25	5.9
Covering of water receptacles/containers	10	2.4
Avoiding the practice of indiscriminate dumping of refuse in the community	51	12.1
Engaging in /doing communal labour/work/clean-up exercise by the entire community monthly	82	19.4
Strict enforcement of sanitation Bye-laws	26	6.2

Source: Fieldwork, 2020.

Table 7. How High Government support/political will towards environmental management and sanitation would ensure the prevention and control of malaria.

RESPONDENTS RESPONSES	FREQUENCY	PERCENTAGE (%)
Provision /distribution of free ITNs/LLINs / Repellent by Government	40	9.5
Government should provide household waste/dust bins to every house/in the community	31	7.3
Government support Health Inspectors in organizing malaria campaigns/public education in the communities, via local information centres, TV & Radio	81	19.2
Government should employ more sanitary labourers/workers and pay them regularly to work	47	11.1
Government should employ more Sanitation Officers/Health Inspectors and resource them adequately to work effectively	65	15.4
Support communal labour/Clean up exercises	34	8.1
Enactment and enforcement of strict laws on Sanitation	33	7.8
Government must construct proper drains/ gutters in the community	22	5.2
Adopting biological vector control methods	5	1.2
Government must invest in sanitation infrastructure and build the capacity of Health Inspectors with higher budgetary allocation	64	15.2

Source: Fieldwork, 2020.

building houses away from swampy areas while 10 (2.4%) suggested covering water receptacles/containers.

Open-ended responses from respondents on how high government support/political will towards environmental management and sanitation would ensure the prevention and control of malaria

From Table 7 above, when the respondents were asked about how high government support/political will towards environmental management and sanitation would ensure the prevention and control of malaria, of the 422 respondents, 81 (19.2%) said government must support Environmental Health Officers (EHOs)/Health Inspectors to organize malaria campaigns/public education in the communities via local information centres, TV & Radio etc., 65 (15.4%) said government should employ more Sanitation Officers/Health Inspectors and adequately resource them to work effectively, 64 (15.2%) said government must invest in sanitation infrastructure and build the capacity of Health Inspectors as well as with a higher budgetary allocation. Furthermore, 47 (11.1%) said government should employ more Sanitary Labourers/Workers and ensure they are paid on time, 40 (9.5%) said provision/distribution of free ITNs/LLINs/ repellent by government, 34 (8.1%) said support communal labour/clean up exercises, 33 (7.8%) said enactment and

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enforcement of strict laws on sanitation, 31 (7.3%) said government should provide household waste/dust bins to every house in the community, 22 (5.2%) said government must construct proper drains/ gutters in the community, while 5 (1.2%) said adopting biological vector control methods.

Discussion

With Ghana's reported 2% of global malaria cases and 3% of deaths, the country is among the 15 highest burden malaria countries in the world. However, between 2016 and 2019, Ghana made significant progress in malaria control cases decreased by 32% and deaths decreased 7%.[22] Despite this success recorded, malaria remains on top of the list of diseases reported/detected at the outpatient department (OPD) of health facilities in the Sunyani Municipality. The study aimed to assess the knowledge, prevalence and control strategies of malaria among households in the Sunyani Municipality, Bono Region, Ghana. The results of the study shows that majority of the respondents were above the age of 15. Women dominated among the respondents which is very positive because routinely, women do the cleaning in the homes such as sweeping and dumping of refuse and at the same time cater for sick malaria patients, therefore, it is implicit that they understand the subject matter. It was evident that, majority of the respondents were educated (have had former education) ranging from basic/junior high school, secondary/senior high school, vocational/technical school, and tertiary education. The researchers believed that, the educational background might have helped the respondents to answer the questionnaires more correctly. This results validates findings by Dike et al[23] in study, which revealed that, higher levels of education were associated with enhanced knowledge and practice with regards to the appropriate strategies against the prevention and treatment of malaria, and added that, education could have a positive impact on the malaria burden if both medium and long-term overall literacy rates can be improved. Also, according to Kouamé et al[24] in a study revealed that, high educational level resulted in good knowledge of malaria, ITNs use and insecticide usage (both for public health and agricultural).

The results revealed that, overwhelming majority of the households (residents) had a quite high knowledge about malaria and its vector of transmission. This therefore confirms to a previous study by Konlan et al,[25] conducted in Godokpe, Ho Municipality of Ghana, which indicated that about, 54% and 20% of the respondent had satisfactory and good levels of knowledge of malaria respectively. Also, the findings conforms to a study by Stephen[26] which pointed out that, the periodic organization of malaria campaigns by the District Assemblies may have helped the people to become aware and more knowledgeable about the disease. A large proportion of the respondents were sure that malaria is endemic (prevalent) in the Sunyani Municipality, whereas majority of the households reported that, they had experience mosquito bites in the community, with settlements around swampy areas as contributing factor to the prevalence of deadly infection. However, the findings of the study with regards to where the respondents had heard (sources of information) about the deadly disease is contrary to a previous study conducted by Konlan et al,[25] which indicated that, the major sources of information on malaria were television (74%), health professionals (66%), schools (62%), family/friends (60%), and the Internet (51%). Effective communication messages must be delivered by health authorities to the communities, so that people will have adequate knowledge of and understand malaria.[27] Moreover, there were diverse opinions with respect to when (timing) mosquitoes take blood meal (bites households) among the respondents. Majority of the respondents indicated that mosquitoes bite mostly in the evening, a little over 29% said they bite at night, whilst the remaining said they bite in the morning and the afternoon respectively. Due to mosquito behavioural changes, the vector is noted to have been biting more often during the evening and early morning as well as outdoors.[28,29] Also, the results validates findings of a study by Hamon[30] which stated that, anopheline biting occurs during daytime (not restricted to some hour's right before sunset or after sunrise). Further, a 48-hours around-the-clock sampling revealed that, the major malaria vectors (ie, *A. gambiae, A. coluzzii, A. funestus*, and *A. pharoensis*) significantly take blood meal (bite the human host) during the daytime indoors Sangbakembi-Ngounou et al[31] whereas Najera and Zaim[32] has pointed out that, the impact of diurnal (daytime) biting must be completely appreciated by malaria control authorities or personnel, because this could be helpful in the development of applicable strategies or interventions as well as the execution of reliable tools for vector surveillance and control at locations and areas households (people) spend substantial amounts of time during daytime.

Majority of the respondents were able to point out the signs and symptoms of the deadly infection as fever whilst the rest indicated that fever, headache, and loss of appetite as signs and symptoms of the disease. This findings validates that of a study according to Ghana Health Service,[33] which states that, malaria detection and diagnosis are based on the signs and symptoms of malaria which includes; fever, shivering/shills/rigours, headaches, muscle/joint pains, nausea and vomiting. It was evident from the study that, the respondents were being infected with malaria throughout the year as well as their immediate and distanced relatives. According to Mensah and Kumaranyake,[34] malaria is a public health problem throughout the world, of the estimated 300 million cases each year worldwide. Also, according to a study conducted by Ingabire et al,[35] participants expressed the need for repeated intensive education with a focus on malaria symptoms, early diagnosis and treatment preferably at the hospital, correct use of bed nets, the benefits of indoor residual spraying, hygiene and environmental cleaning. Greater part of the respondents indicated that mosquitoes are the vectors that transmit malaria. This confirms a study that

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pointed out that, Ross discovered the mosquito as the vector of the malaria parasites and duly advocated vector control for malaria control.[36] According to Carter et al,[37] malaria is transmitted through the bite of female *Anopheles* mosquito in humans, emerging from a definite breeding habitation since the spread of the infection routinely transpires in a definite radius that is the flying array of adult vectors arising from breeding sites. Further, Kouamé et al[24] reported in a study that, majority of the households, about 89% were able to identify mosquitoes as the principal vector that transmit the parasites that cause malaria.

By and large, representing majority of the respondents corroborated that, stagnant waters breed mosquitoes whilst the rest of the respondents indicated, that refuse dumps, bushes, and septic tanks as others places where mosquitoes breed. This however, endorses a previous study according to Killeen et al[38] aquatic stages of the mosquitoes were predominantly concentrated in stagnant waters because these stages are known to be less movable in comparison with the adult mosquitoes, therefore control measures can be introduced where breeding sites were identified. Also, larvae of Anopheline species can be found in a wide diversity of habitats, ranging from small, temporary pools and puddles to large and more permanent water bodies, whereas other malaria vector species prefer forested, and hence more shaded sites. The aquatic life cycle of all these species starts when a gravid female mosquito deposits her eggs on or very near the water.[39] However, with regards to the contributing factors to mosquito breeding in the community, the results of the study rightly confirms to a study which stated that, rapid urban growth characterized by lack of access to sanitation and safe drinking-water, precarious housing, overcrowding, and inefficient waste collection and management has added yet another layer of challenges for vector control and proliferation of mosquitoes breeding sites, with an estimation of 70% of the population in Dar es Salaam living in unplanned settlements.[40] Furthermore Ahmad and Asghar,[41] pointed out that, environmental factors play a key important role in maintaining malaria transmission through substantial alteration in the environment as a results of irrigation, road building, mining, forest as well as other important economic development activities, that proliferate chances for transmission thereby forming new vector habitats and bringing immunologically immature people into malaria areas.

With respect to the knowledge of the respondents about mosquito breeding sites in this study, the assertion of the majority was consistent with a recent study conducted by Sankoh et al[42] which opined that solid waste management is one of the most poorly rendered services by Municipal and District authorities in developing countries as the systems applied are unscientific, outdated, and inefficient. Solid waste disposal sites are found both within and on the outskirts of developing urban cities and rural communities and with the increase in the global population and the rising demand for food and other essentials, there has been an increase in the amount (tonnage) of waste generated daily by each household. This waste is ultimately thrown into Municipal disposal sites and due to poor and ineffective management, the dumpsites turn into sources of environmental and health hazards to people living in the vicinity of such dumps and one of the main aspects of concern is the pollution caused to the earth on land, air, and water as well as health implications such as cholera, malaria, diarrhoea, and chest pains.

In this study, insecticide-treated nets (ITNs) were the most frequently used for malaria prevention, followed by indoor residual spraying (IRS), and environmental management/sanitation measures. The rest were traps/repellent and provision of screens to doors and windows according to the respondents. This findings confirms a previous study which indicated that, long-lasting insecticide-treated nets (LLINs) and indoor residual spraying (IRS) are the core malaria vector control tools recommended by the World Health Organization in the fight against the deadly infection in its endemic countries.[11] Also, according to a study conducted by Konlan et al,[25] the methods used in malaria prevention included mosquito coils (72%), cleaning and prevention of water stagnation (EM) (62%), mosquito spray (IRS) (54%), and mosquito net (LLINs/ITNs) (59%). Further, the findings validates a previous study which stated that, some known methods such as drainage, house screening and personal protection (eg, bed nets), are part of malaria vector control efforts today. At the same time, many new vector control technologies have been developed and added to our toolbox.[43] However, equally, IRS and ITNs are thought-out to be the most effective among the presently existing vector control interventions and chiefly aim at the adult stages of the mosquito thereby intending to reduce complete transmission including the provision of communal protection through the reduction of mosquitoes' abundance and infectivity.[44] On who makes malaria prevention/protection decisions in the household, this study conforms to a previous study by Mensah and Kumaranyake,[34] conducted in Benin to found out the perceived eminence of elements that contributed to the incidence of malaria, which demonstrated that features of family heads, that is, age, knowledge of malaria, education, and size of household meaningfully affected the incidence of malaria.

According to the respondents, sleeping under ITN/LLINs was the most frequently recommended method for control of malaria in the community during radio discussions by Health Inspectors/Nurses, followed by indoor residual spraying (IRS), the practice of good environmental sanitation and embarking on communal labour activities by resident to clean the environment. This however, validates findings from a previous study which stated that, interrupting malaria transmission may require different combinations of mosquito control methods addressing each mosquito behaviour at risk for transmission, but also taking into account possible changes in housing conditions, sleeping habits, and outdoor occupation.[45] There is no silver bullet in vector control and malaria prevention. New

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paradigms for controlling and/or interrupting malaria transmission should then be explored for their protective efficacy and adapted to the local context for good efficiency. Although the implementation of such new approaches might be very expensive, they will be crucial if malaria elimination is the final aim.[45] Further, results from various studies pointed out that, enlightening the knowledge level of community members on malaria transmission and its prevention and control methods could significantly contribute to the successful execution of interventions to tackle the infectious disease.[46]

Environmental Management and Sanitation (EMS) measures were chosen by majority of the respondents as the best and likely alternative malaria prevention method, followed by building houses/settlements away from swampy areas, indoor residual spraying (IRS) and insecticide-treated nets (ITNs). This findings confirms to a recent study by Agyemang-Badu et al,[47] which stated that, the prospects of environmental management and sanitation (EMS) as a malaria vector control strategy or a complementary method to the current core method (LLINs and IRS), could be of a dire need with regards to the fight against malaria in recent times as results of the documented residual transmission taken place outdoors. Further, the researchers noted that, EMS can be used as a malaria vector control strategy on condition that a number of challenges and obstacles are tackled holistically. Namely; effective and efficient collaboration between vital stakeholders; high central and local Government support and political will at all levels towards Environmental Health Practitioners (EHPs) and local Assembly Members; enactment of a sustainable educational campaigns across every educational levels and various media outlets on EMS activities and measures; adequate recognition, empowerment, and timely resourcing of Environmental Health Practitioners in their enforcement of the environmental sanitation and local byelaws duties and responsibilities, to compel households to eliminate mosquito breeding sites. Also, effective application of the building regulation to deter residents from settlement around natural wetlands and/or swampy/marshy areas characterized with high *Anopheles* mosquito population dynamics among others. Moreover Mitchell,[48] classified environmental management into 3, namely; modification, manipulation, modification and manipulation. Where modification, involves drainage, filling, land levelling and transformation, and impoundment and complete removal or destruction of mosquito breeding sites such as cans, bottles tyres, coconut husk; the manipulation is the act producing temporary conditions unfavourable to the breeding of vectors in their habits such as water salinity changes, stream flushing, regulation of water levels in reserviour, dewatering of flooding of swamps, vegetation removal, shading and exposure to sunlight, and straightening and steeping shorelines whilst the modification and manipulation, is reduction of man-vector-pathogen contact which includes sitting of settlement away from vector sources, and mosquito proofing.

Findings from this study showed that, Assemblymen/Women, staff of Ghana Health Service, Environmental Health Officers (Health Inspectors), non-governmental organizations (NGOs), and School children were indicated by the households as stakeholders in the community responsible for malaria control either directly and/or indirectly. This results corroborates to a recent study by Agyemang-Badu et al,[47] which indicated that, the participants in the study reported to have being working in close collaboration and partnership with indigenous and foreign organizations and bodies including but not limited to key development partners (DPs), non-governmental organization (NGOs), government entities/agencies mandated with malaria control responsibilities and activities and local religious bodies and traditional authorities (Chiefs and Unit Committee Members) who have demonstrated a strong interest in ensuring high standards of environmental sanitation and/or cleanliness at all times in their communities. Also Duodu,[49] reported that Zoomlion Ghana Limited (ZGL), a private waste management company, joins the fight against Malaria in the Volta region by organizing clean-up exercises and activities to ensure the communities are clean and free of filth. Findings from this study pointed out that, households in the Sunyani Municipality sometimes engaged in communal clean-up activities such as draining/flushing stagnant waters, desilting choked gutters, removing empty lorry tyres, and filling potholes in the community, though almost 20% of the households had never engaged in such activities. This seems unpatriotic from the researchers perspective, to see about 20% of the community members not participating in organized communal labour (clean-up exercise) activities to tidy-up their environment to ensure it is safe, serene, and conducive for healthy living free of mosquitoes and other vectors and diseases in this 21st century. However, the findings corroborate with a report by Duodu[49] which stated the National Commission for Civic Education (NCCE) and the National Malaria Control Programme (NMCP) organized a communal labour and sensitization exercise aimed at creating behavioural change among communities by enhancing individual's motivation and adherence to good environmental management practices, use of insecticide-treated nets, and the use of Intermittent Prevention Treatment (IPT) as a way of preventing malaria among pregnant women.

This study has revealed that, Assemblymen/Women in various electoral areas of the Sunyani Municipality do organize clean-up exercises where majority of the respondents had ever participated in these clean-up activities. Though, a little over 41% of the respondents indicated that they were not aware of any clean-up exercise organized by Assemblymen/Women in the community. Therefore, it could be deduced from the researchers point of view that, the 41.7% of the respondents who were not aware of clean-up exercises organized by the Assembly Members in their electoral areas in the Municipality do not engage in such activities to ensure the communities are clean, sanitize and free of mosquito breeding and high

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prevalence of malaria. This results clearly validates findings from a study by Agyemang-Badu et al,[47] which stated that, some stakeholders (Environmental Health Officers and Honourable Assembly Members) decried about poor attendance and participation in communal labour activities by residents coupled with very small court fines against sanitary offenders when found culpable via summons. *'There is indiscipline among community members of late. This has led to a vast decline in the commitment and zeal of community members towards communal* labour *compared to the olden days, when we were children'* as indicated by one of the participant.

This study has further showed that, a lions' share of the respondents revealed that they have ever listened to radio discussions held by Health Inspectors/Nurses on the prevention and control of malaria in the community while majority strongly agreed that robust educational campaigns on environmental management and sanitation would go a long way in the prevention and control of malaria. This findings confirms to a study by Agyemang-Badu et al[47] which stated that, unanimously, all the stakeholders (ie, Regional Malaria Control Focal Person, Environmental Health Officers and Honourable Assembly Members) affirms that they do embark on discussions on various media outlets (especially Radio and TV stations) more often on malaria prevention and control in the Municipality with particular emphasis on the need for households to always keep their environment clean, such as regular desilting of gutters as well as flushing/draining of stagnant waters to prevent the proliferation of mosquito breeding sites. However, all the stakeholders utterly endorsed the fact that, the enactment of a very sustainable robust educational campaigns by the auspices of the national malaria control programme, central and local Government, as well as appropriate bodies starting from the local community level through to formal and informal institutional levels could be good tool in fighting against malaria Agyemang-Badu et al.[47] Further, this findings confirmed a report by Ahmed and Isaac,[50] who said that, it took education and leadership at various levels, before the populaces in San Fernando, Philippines, cleaned up the community. San Fernando, Philippines, has been publicized as a classical city for solid waste management. Although it was once normal to see garbage discarded on thoroughfares, authorities, and occupants of a city of about 300 000 have joined forces to avert 80% of refuse from landfills. Amid 2012 and 2018, the city amplified the proportion of garbage averted from landfills from 12% to 80%, an achievement several local governments could simply dream about. As a substitute for visiting disposal sites or, worse, into watercourses, a greater part of the waste collected in the city currently turns into compost or is traded for recycling.

Enforcement of the environmental sanitation bye-laws is likely to compel everyone (households) to clean their environment to help eliminate and/or prevent mosquito breeding sites in the Municipality, encourage people to be law-abiding and clean-up the gutters and punish offenders if caught up (found culpable) were noted among overwhelming majority in this study. This results validates findings of previous studies which stated that, lack of law enforcement units, the absence of waste management services and ignorance were identified as key factors, playing a fundamental role in the indiscriminate dumping of refuse in and around the Keta Lagoon in Ghana.[51] Further, inadequate or lack of enforcement of the environmental sanitation bye-laws by Environmental Health Officers due to political interference is swiftly aiding the proliferation of mosquito breeding sites and poor environmental sanitation. The researchers asserts that, various stakeholders during their study called on central and local governments authorities to desist from any sort of political interference in the performance of the duties (work) of Health Inspectors/Environmental Health Officers thereby allowing them to strictly enforce the environmental sanitation bye-laws to the later.[47] Again, according to Dunn et al,[52] enforcement of the laws relative to environmental sanitation might support the execution and applicability of environmental management and sanitation (EMS) as an alternative or complementary malaria vector control strategy against the fight of the deadly disease thereby sinking the entire vector population's densities and outdoor biting rates.

This study revealed that, the respondents suggested engaging in communal labour/clean-up exercises by the entire community on monthly basis aimed at open, vintage and public places, clearing bushes or weeding around our houses regularly by individuals, construction of gutters to drain stagnant waters, avoidance of the practice of indiscriminate dumping of refuse (proper waste management) in the community, strict enforcement of sanitation bye-laws, building houses away from swampy areas as some of the measures households (people) can manage their environment to prevent mosquitoes from breeding in their community. The findings agrees with a study in Eastern Rwanda, whereby a local community-based programme involving indigenous residents were engaged in a series of monthly communitywide clean-up exercises with the sole purpose of eliminating mosquito-breeding sites on premises were magnificently executed to promote and maintained high standards of environmental sanitation conditions at local levels which in turn demonstrated a recorded reduction of the malaria disease burden in the communities.[53] Changing agricultural technologies, practices, and modes of transportation, as well as the relocation of labourers living quarters away from marshes and swamps, began to lower malaria transmission rates in the 19th century.[54] Fundamentally, 2 key methods are known and used in larval source management (LSM) and these are; environmental management which involves temporary or permanent elimination of Anopheline larval habitats, and larviciding with chemical or biological agents.[55]

This study has revealed amongst others that, Government should support Health Inspectors (Environmental Health Officers) as a matter of necessity to organize malaria campaigns and public health education in the communities in the communities via local information centres, TV & Radio etc.,

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employ more Environmental Health Officers and Sanitary Labourers/Workers, and adequately resource them (capacity building and higher budgetary allocation) to work effectively and massive investment in Sanitation infrastructure. Also, Government should provide/distribute free ITNs/LLINs/repellents to households, support communal labour/clean up exercises as well as the provision of household waste/dust bins to every house in the community as well as enactment and strict enforcement of environmental sanitation bye-laws, including a robust oversight responsibility of monitoring and supervision of Environmental Health Officers and Assembly Members in carrying out their duties and lastly, application of biological vector control methods (larvicides) would ensure the prevention and control of malaria. This results validates findings from a recent study by Agyemang-Badu et al,[47] which reported that, most among the stakeholders were of the view that government's support and political will in the allocation of funds for the preventive task has not been quite encouraging. The stakeholders further underscored that, central and local government authorities must desist from political interference in order to allow the Environmental Health Officer to strictly enforce the environmental sanitation byelaws. *'If the government supports environmental management and sanitation, it is likely to go a long way to help reduce malaria cases or burden, the amount/funds for malaria control and has a rippling effect. With high government support, if we can enforce the environmental sanitation bye-laws, to ensure good environmental sanitation in our communities, majority of mosquito breeding sites will be prevented, reduced or eliminated'* as one participant said. According to Impoinvil et al,[56] unavailability of dependable funding regimes for mosquito control activities are among the challenges affecting malaria control in Africa, the Middle East, and the Americas.[49] Reported that, a Medical Entomologist, Madam Aba Baffoe-Wilmot, in an address to commemorate World Malaria Day in April 2011, said despite the successes chalked by the programme, malaria still poses many challenges. She, therefore, called for continuous political commitment and resource mobilization to ensure a holistic approach to move Ghana from the control to the elimination stage of the programme and finally to the eradication stage. One such approach is the employment of the Vector Control Unit (VCU) of Zoomlion Ghana Limited which undertakes indoor residual and outdoor spraying of mosquito breeding places to prevent malaria and yellow fever. Further, Sande et al,[57] pointed out that, due to the nonexistence of capacity building as a results of shortage of human resources as well as insufficient infrastructure has been accounted for as the cause of the little government support for malaria prevention and control.

Conclusions

Malaria is endemic in the study area and ranked first among the top 10 outpatient department cases in the Municipality, while the inhabitants (households) always experience mosquito bites throughout the day. Government must support Health Inspectors (Environmental Health Officers) and other Health professionals as a matter of necessity to organize malaria campaigns and public health education in the communities. Further, Government must employ more Environmental Health Officers and Sanitary Labourers/Workers, and adequately resource them to work effectively as well as embark on massive investment in Sanitation infrastructure. Also, Assemblymen and Women must often organize communal labour/clean-up exercises to desilt gutters and clear overgrown bushes by community members aimed at proper management of the environment to prevent breeding of mosquitoes. Environmental management and sanitation (EMS) must be considered and/ or employed as alternative or supplementary malaria prevention and control method to compliments the current core vector control methods as well as the application of biological vector control methods (larvicides) for mosquito larval control.

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Author Contributions

Conceptualization, SYAB, EA, and SOK.; methodology, SYAB, EA and JYWD; validation EA, SOK, and JYWD; formal analysis, SYAB and SAA; data curation, EA and SOK; writing—original draft preparation, SYAB; writing—review and editing, EA, SOK, JYWD and SAA; supervision, EA and SOK; project/questionnaires administration, SYAB; funding acquisition, SYAB, EA and SOK. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Not applicable.

Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and School of Graduate Studies, KNUST, and approved by the Committee on Human Research Publication and Ethics, School of Medical Sciences, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana with protocol code *CHRPE/AP/143/20.*

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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