The Implications of Some Water, Sanitation and Hygiene (WASH) Practices on Malaria Prevalence among Primary School Children in Gombe State, Nigeria

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Authors' contributions

Article Information

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ABSTRACT

Background: The sanitary state of the environment and general hygiene has long been known to play a critical role in the cause and spread of infectious diseases, be it directly or indirectly.
Objective: This study was aimed at exploring the implications of some WASH practices on the prevalence of malaria infection among school children in Gombe State, Nigeria.
Methodology: A cross sectional survey design was employed to study 745 school children (aged 6 to 15 years) who were selected using a multi-stage sampling technique from 12 public and 6

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private schools in six Local Government Areas (LGAs) of the State. Rapid Diagnostic Test (RDT) was used to screen the children for malaria. Descriptive statistics were generated to summarize research findings while chi square statistics was used to compare proportions at 0.05 significance levels. Risks were estimated using odd ratio (OR).

Results: The mean age of the pupils was 9.96±2.26 years and slightly more than half (50.9%) of them were males while the rest (49.1%) were females. Out of the 745 subjects only 101 (13.6%) tested positive for malaria. And even though, 86.4% of them indicated availability of toilets in their residences, not all (98.6%) of them used the toilets. Slightly more than half (51.5%) of the participants dwell in houses without proper drainage while 46.7% reside in mud houses. Children from households without toilets had more than five times odds of having malaria (OR=5.230; 95% CI= 3.236-8.453, P=0.000). Furthermore, children from households that were sourcing their drinking water from streams, rivers and wells suffered more from malaria than those using portable/pipe borne water (OR=0.230, CI= 0.131-0.405, p=0.000). While children who dwelt in cement houses had less odds of malaria infection (OR=0.270, 95% CI=0.169-0.431, P=0.000), those who dwelt in houses without drainages had more than twice odds of malaria infection (OR=2.642, 95% CI= 1.671- 4.176). Again, proper waste disposal was associated with lower odds of malaria infection.

Conclusion: The findings of this study suggests the existence of association between selected WASH practices and malaria prevalence among the school children. This should inform an integrated WASH and malaria advocacy as well as high level engagement with concerned authorities and communities.

1. INTRODUCTION

As malaria continues to take its toll on human health and life in the developing world, sub-Saharan Africa and Nigeria in particular bears the most brunt [1]. According to world health organization (WHO) recent world malaria report, an estimated 228 million cases of the disease occurred worldwide [2]. Out of these cases, 213 million (93%) were reported from the WHO African region where Nigeria alone was responsible for 25% of the disease's global burden. The report also estimated that 405, 000 people died from the disease in 2018, and again Africa, especially Nigeria is home to most of these fatalities. Though children under five years and pregnant women are believed to be the most vulnerable for these malaria morbidities and mortalities, an age group often forgotten in most surveys are school age children who are though mostly asymptomatic could as well be the most critical as they constitute a "reservoir" for the unseen huge iceberg of the disease [3]. Besides, malaria among school children has been indicted for some debilitating consequences such as school absenteeism, poor academic performance, low productivity etc [4,5].

Malaria is a febrile disease caused by anyone of the five species of *Plasmodium* (*Plasmodium ovale, Plasmodium falciparum, Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium Knowlesi)* occasioned by an infective bite of a female Anopheles mosquito [6,7]. This disease has been reported to be holo-endemic in the rural areas and meso-endemic in the urban areas of Nigeria [7]. Hence, people may develop partial immunity which usually results in asymptomatic infection statuses in the general populace including school children [8]. According to the Nigeria Demographic and Health Survey 2018, in Nigeria malaria prevalence among children under five ranges from 2% to 52% [9]. Differences in malaria prevalence and endemicity is determined by a number of factors, most of which relates to the state of the environment, water hygiene and sanitation (WASH) [10,11] .

The world health organization (WHO) and UNICEF reports that though 5.2 billion (71%) people worldwide use safely managed drinking water service (one located on premises, available when needed and free from contamination), there is still about 159 million people who get their drinking water directly from surface water sources, 58% of whom live in sub-Saharan Africa [12]. In a multi-country study of Sub-Saharan Africa, Yang et al [13] observed increased malaria risks among unprotected water and no facility users and also noted that the odds of malaria infection were 48% and 49% less among piped water and flush-toilet users,

respectively. In another meta-analysis on housing improvements and malaria risk in Sub-Saharan Africa, Tusting et al [14] showed that malaria prevalence was higher among children living in traditional houses than those living in modern houses. Overall, several studies have shown that household-sanitation related variables [15,16,17], water supply and other infrastructural characteristics [18,19] influence the risk of malaria infection through the creation of suitable habitats for mosquitoes to thrive.

The most recent demographic and health survey in Nigeria [9] show that 65.3% households have access to improved source of drinking water, 53.4% have basic sanitation service (use of improved facilities that are not shared with other households) while 22.9% practice open defaecation. On the other hand in Gombe state 43.0% households have improved source of drinking water, 67.8% have basic sanitation service and 12.9% still practice open defaecation. The survey equally reported that the North Eastern region of Nigeria recorded the lowest availability of soap and water (12% and 44%, respectively). For a vulnerable age group like school children the investigation of water sanitation and hygiene (WASH) practices versus malaria prevalence may provide an important

clue into some actionable control measures for the disease. This study aimed to;

i.   Assess the distribution of some common WASH practices among the study participants
ii. Determine the association between such WASH practices and malaria prevalence among the school children

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in the Nigerian north eastern State of Gombe which is located between latitudes 90°30' and 12°30' N, longitudes 8°45' and 11°45' E. A number of other states are contiguously related - Yobe state to the north, Bauchi state to the west, Taraba State to the south whereas Borno and Adamawa states flanks Gombe State eastward. The state consists of eleven local government areas (LGAs) demarcated into three geographical districts, namely; north, central and southern senatorial districts. A total of eighteen (18) primary schools scattered across the six LGAs were involved in this study. As at the year 2017 Gombe State had an estimated projected population of 3,256,962
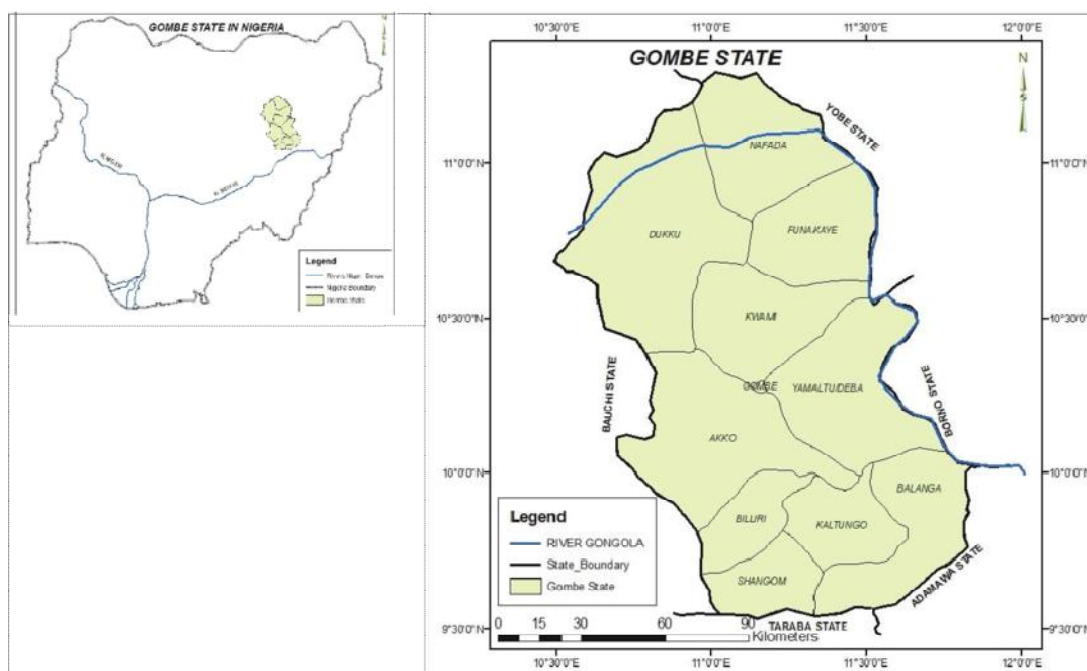

Fig. 1. Map of Gombe State

and a landmass area of 20,265 square kilometers [20]. Dry and rainy seasons constitute the two major climatic features of the state – the dry season usually begins in November and ends in March while the rainy season is witnessed from April to October with the mean annual rainfall of 684.56mm in the southern zone and 650.27mm in the north [21].

2.2 Study Design

The design of this study was a cross sectional survey

2.3 Population of Study

The population of Study were primary school children aged 6 to 15 years in Gombe State.

2.4 Exclusion Criteria

All school children not within the age group of 6 - 15 years who were not enrolled in the selected primary schools in Gombe State and all those who did not participate in the study. Also excluded were school children who may not have stayed in the state for at least a year.

2.5 Sample Size Determination

The sample size formula for comparing two proportions was used to compute the sample size for this study [22].

$$n = [P1\,(1-P1) + P2\,(1-P2)]\,(Z\alpha/2 + Z\,\beta)2\,/(P1-P2)2$$

Where:

n: required sample size
$P1$: estimated proportion for malaria in urban areas (about 12%) [23,24]
$P2$: estimated proportion for malaria in rural areas (comparison group) in the North East (about 36%) [23,24]
α: level of statistical significance
Zα/2: Stands for the desired level of statistical significance (usually 1.96 for α = 0.05)
Z β: Stands for the desired power (estimated to be 0.84 for 80% power)
n for each group x 2= total sample (i.e. for the 2 groups)

The calculations ensured that the minimum detectable difference in malaria infection among the school children in rural and urban areas was 10%.

Hence, a minimum sample size of 295 pupils from urban schools and 295 from rural schools were computed. When added together a minimum sample size of 590 was determined. However, this was adjusted upwards to a final sample size of 748, though only 745 were eventually found duly completed.

2.6 Sampling Technique

The participants of this study were selected using multistage sampling technique. According to the Gombe State Bureau for statistics there were 1, 914 Primary schools where 492, 962 pupils were enrolled in Gombe state at the time of this study [25]. This figure comprised 573 private and 1, 341 public primary schools amounting to a private-public schools ratio of 1:2.3. Therefore, 6 private and 12 public primary schools were randomly selected from urban and rural areas of the state. Thereafter a sample of 748 children were selected from the participating schools. From each senatorial district two LGAs were selected using simple random sampling. This was followed by the selection of three primary schools - a public primary school from a rural area and a public and a private school from an urban or suburban area per LGA. Overall, 18 schools that were selected and in each school four classes were randomly selected from among any of primary one to primary six. Finally, a minimum of 10 pupils per school were picked from each of the 4 classes (40) using systematic random sampling.

2.7 Data Collection Methods

Two methods that were used to collect data for study include face-to-face interview and Malaria Rapid Diagnostic Test (mRDT) screening which lasted from March to June, 2019.

2.7.1 Face to face Interview

A face-to-face oral interview was first conducted with each of the subjects to collect socio-demographic and other information related to malaria, using a validated questionnaire/data collection template.

2.7.2 Malaria Rapid Diagnostic Test (mRDT) screening

The SD BIOLINE Malaria Ag P.f (HRP-II) ™ Rapid Diagnostic Test (RDT) kits which uses qualitative techniques to detect histidine-rich

protein II antigen of *Plasmodium falciparum* in human whole blood was used to screen the subjects for presence (positive) or absence (negative) of malaria parasites [23]. Blood samples were taken from the peripheral blood by finger pricks on the pupils using micropipettes. Two drops of assay buffer were then added into the small well of the test kits and after 10-15 minutes the readings were taken. The presence of two color bands in the result window indicates a positive result and a negative result was indicated by a single band. All the 101 school children that tested positive for malaria were treated with artemisinin-based combination therapy (ACT) in line with national and WHO treatment guidelines [26].

2.8 Data Analysis

The 748 instruments retrieved during the data collection were first screened for completeness, and 745 of them were found to be complete and usable. The IBM Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc. Chicago, IL, USA) was used for the data analysis. The descriptive and inferential statistics generated were used to summarize and make inferences on the data. The dependent variable (malaria positive or negative using mRDT) was cross tabulated against the different WASH (independent) variables, namely: availability of toilet in residence, toilet being put to use, uses shared toilet with neighbours, type of residential facility, method of refuse disposal, source of drinking water, residential environment with drainage or not water-logged and type of residential housing material. The risk feature in the SPSS crosstabs were checked to generate odd ratios (ORs). Thus, Chi square (χ^2) and odd ratio (OR) were computed and used to compare proportions and estimate risks of malaria infection among the pupils, respectively. Simple frequency tables and charts with percentages were used to present the results and findings of this study. Significance level of findings were set at P-values less than 0.05.

3. RESULTS

The pupils' ages ranged from 6 to 15 with a mean of 9.96±2.26 years and they came from families with a mean size of 7.47± 2.425 within the range of 1 to 15 persons (Table 1). On average their birth order was 3.37±2.325[th] ranging from 1 to 13. Gender wise, there were slightly more males (50.9%) than females (49.1%). Table 2, show that though 86.4% of the school children reside in households where toilets are available, not all (98.6%) of them used the toilets. Eighteen percent (18%) of them admitted using shared toilets with neighbours and a small proportion (12.4%) resided in rented houses. Majority (79.1%) of the pupils admitted practicing open dumping as a method of waste disposal and only about a half (51.7%) of them had access to improved (Pipe borne water) source of drinking water. In the same vein while about a half (51.5%) of the respondents resided in houses that lacked drainage, only 48.5% of them dwelt in houses with drainage or not water-logged. Again, while slightly more than half (53.3%) of the respondents resided in cement or modern house, 46.7% reside in mud houses.

Out of the 745 participants that were screened using malaria Rapid Diagnostic Test (mRDT) only 101 (13.6%) tested positive for malaria (Fig. 2). Table 3 depicts that children from households without toilets had greater than five times odds of having malaria than those from households with toilets (36.6% vs.10.0%) at P=0.000 (OR: 5.230, CI: 3.236-8.453). In the same vein children from households that take advantage of a shared toilet had lower prevalence (8.3% vs. 14.2%) of malaria than those that didn't use toilets at all (OR=1.838, CI=0.952-3.548, F-exact =0.040). In terms of waste disposal, this study showed that children from households that disposed their household wastes improperly (by dumping, or by a mix of dumping and burning or burial) suffered more (13.5%& 20.5% vs. 6.0%) from malaria than those from households that disposed their waste more properly i.e. waste collection (OR=0.247, CI= 0.079-0.769, p=0.033). Finding from this work also demonstrated that children from households sourcing their drinking water from streams, rivers and wells suffered more (45.0% & 26.9% vs. 7.8%) from malaria than children using portable/pipe borne water as their source of drinking water (OR=0.230, CI= 0.131-0.405, p=0.000). Children who dwelt in cement or modern houses had less odds of malaria infection (OR=0.270, 95% CI=0.169-0.431, P=0.000), than those who dwelt in mud houses (6.8% vs. 21.3%). Again, study participants who dwelt in houses without drainages had more than twice odds of malaria infection (OR=2.642, 95% CI= 1.671- 4.176) than those that dwelt in houses with proper drainage.

Table 1. Some socio-demographic information of study subjects

Variable	Frequency (n)	Mean± Std. Dev./%	Min	Max
Age of Child	745	9.96±2.26	6	15
Family Size	739	7.47± 2.425	1	15
Birth Order	745	3.37±2.325	1	13
Sex				
Male	379	50.9		
Female	366	49.1	-	-
Total	745	100.0	-	-

Table 2. Environmental factors (WASH Indicators) around the school children

S/N	Variable/Category	Frequency	Percentage
1	**Availability of toilet in residence**		
	No	101	13.6
	Yes	643	86.4
	Total	744	100.0
2	**Toilet being put to use**		
	No	9	1.4
	Yes	634	98.6
	Total	643	100.0
3	**Uses shared toilet with neighbours**		
	No	605	82.0
	Yes	133	18.0
	Total	738	100.0
4	**Type of residential facility**		
	Rented	92	12.4
	Owned by parent or guardian	652	87.6
	Total	744	100.0
5	**Method of refuse disposal**		
	Dumpsite	587	79.1
	Burning	74	10.0
	Burying	3	0.4
	Refuse collectors	67	9.0
	Dumpsite + Burning	11	1.5
	Total	742	100.0
6	**Source of drinking water**		
	Stream/river	60	8.1
	Well	108	14.5
	Water vendors/Truck pushers/Tanks	192	25.8
	Pipe borne water	385	51.7
	Total	745	100.0
7	**Residential environment with drainage – not water-logged**		
	No	384	51.5
	Yes	361	48.5
	Total	745	100.0
8	**Type of residential housing material**		
	Cement/Brick	397	53.3
	Mud, cornstalk etc	348	46.7
	Total	745	100.0
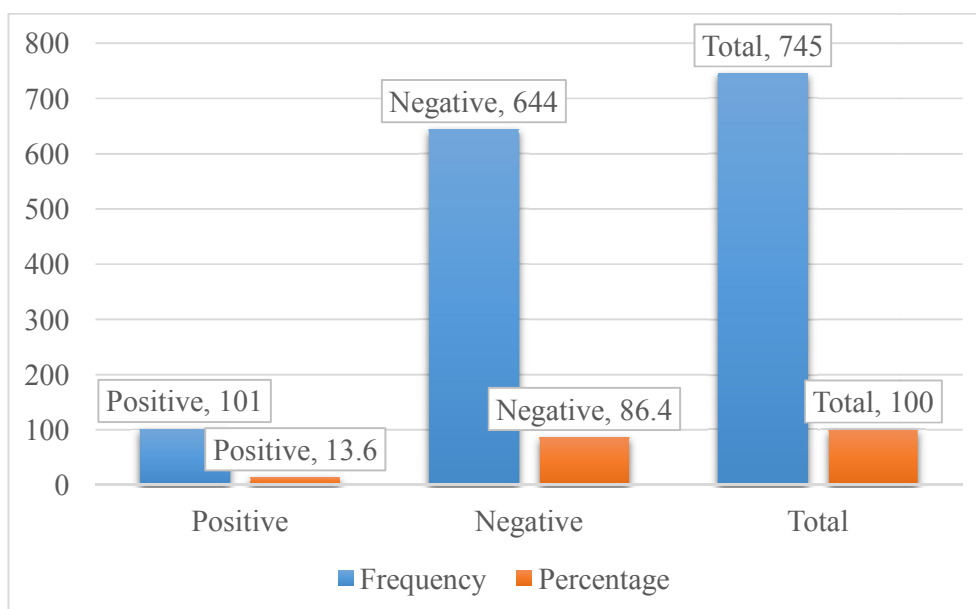
Fig. 2. Result of Malaria Rapid Diagnostic Test (mRDT)

4. DISCUSSION

This survey determined that the school-age children studied fell within the age range of 6-15 years with a slight male preponderance (50.9% vs. 49.1%) which are in tandem with the findings of other studies and demographic and health surveys in Nigeria [9,27,28]. The mean family size of 7.47± 2.425 persons per household is higher than the national average of about 5 based on most national demographic and health surveys [9,29]. From the findings of this study though toilets are available in 86.4% of households where the respondents reside, not all of them (98.6%) used the toilets. This obvious gap in availability and utilization of toilets may imply that at least 13.6% of people in the study area may be involved in the practice of open defaecation (OD). Except for open defaecation, these findings are higher than the national, geopolitical zone and state figures reported by the most recent demographic and health survey as well as the UNICEF multiple indicator cluster survey [9,24]. According to the results of this work, 18% of households in the study area shared toilets with neighbours and 12.4% stay in rented poor housing facilities which indicates suboptimal level basic sanitation services in the area [30]. The commonest (79.1%) means of waste disposal in the households as indicated by the pupils is dumping which potentially renders such households unsafe for human health and wellbeing. And only about a half (51.7%) of the

households have access to portable source of drinking water which proportion is lower than the national (66%) even though slightly higher than the state (43%) figures as reported in a national survey [9].

When cross tabulated against selected WASH practices (Table 3) the odds of malaria prevalence were about five times higher among children from households without toilets (36.6% vs.10.0%) at P=0.000, OR: 5.230, CI: 3.236-8.453. Similarly, children from households that take advantage of a shared toilet had lower malaria prevalence (8.3% vs. 14.2%) than those that didn't use toilets at all (F-exact =0.040). Other WASH related factors such as improper waste disposal, residence in mud houses (poor housing), lack of drainage in residential environment, and poor source of drinking water (streams, rivers and wells) were found to be significantly (P<0.05) associated with higher odds and prevalence of malaria infection among the study subjects. These findings so squarely aligns with those of Enebeli et al [28] in Abia state south eastern Nigeria. The findings also concurs with the work of Yang et al [13] who in what, to date, could be considered as the most comprehensive study on the association between WASH conditions and malaria prevalence across the Sub-Saharan Africa (SSA), clearly demonstrated that drinking water and sanitation is a risk factor for malaria infection.

Table 3. Association between malaria (mRDT) and WASH Indicators

SN	Variable	Malaria (mRDT)		OR	CI	Chi Sq	df	P-Value/ F-Exact
		Positive n (%)	Negative n (%)					
1	**Availability of toilet in residence**							
	No	37 (36.6%)	64 (63.4%)					
	Yes	64 (10.0%)	579 (90.0%)					
	Total	101 (13.6%)	643 (86.4%)	5.23	(3.236-8.453)	52.961	1	0.000/0.000*
2	**Toilet being put to use**							
	No	1 (11.1%)	8 (88.9%)					
	Yes	63 (9.9%)	571 (90.1%)					
	Total	64 (10.0%)	579 (90.0%)	1.133	(0.139-9.206)	0.014	1	0.907/1.000
3	**Uses shared toilet with neighbours**							
	No	86 (14.2%)	519 (85.8%)					
	Yes	11 (8.3%)	122 (91.7%)					
	Total	97 (13.1%)	641 (86.9%)	1.838	(0.952-3.548)	3.375	1	0.066/0.040*
4	**Type of residential facility**							
	Rented	10 (10.9%)	82 (89.1%)					
	Owned by parent/ guardian	91 (14.0%)	561 (86.0%)					
	Total	101 (13.6%)	643 (86.4%)	0.752	(0.376-1.503)	0.655	1	0.418/0.516
5	**Method of refuse disposal**							
	Dumpsite	79 (13.5%)	508 (86.5%)					
	Dumpsite and Burning or burying	18 (20.5%)	70 (79.5%)					
	Refuse collectors	4 (6.0%)	63 (94.0%)					
	Total	101 (13.6%)	641 (86.4%)	0.247	(0.079-0.769)	6.843	2	0.033*
6	**Source of drinking water**							
	Stream/river	27 (45.0%)	33 (55.0%)					
	Well	29 (26.9%)	79 (73.1%)					
	Water vendors/Truck pushers/Tanks	15 (7.8%)	177 (92.2%)					
	Pipe borne water	30 (7.8%)	355 (92.2%)					
	Total	101 (13.6%)	644 (86.4%)	0.230	(0.131-0.405)	83.231	3	0.000*
7	**Residential environment with drainage – not water-logged**							
	No	72 (18.8%)	312 (81.3%)					

SN	Variable	Malaria (mRDT)		OR	CI	Chi Sq	df	P-Value/
		Positive	**Negative**					**F-Exact**
		n (%)	**n (%)**					
	Yes	29 (8.0%)	332 (92.0%)					
	Total	101 (13.6%)	644 (86.4%)	2.642	(1.671- 4.176)	18.235	1	0.000*
8	**Type of residential housing material**							
	Cement/Brick	27 (6.8%)	370 (93.2%)					
	Mud/corn stalk etc	74 (21.3%)	274 (78.7%)					
	Total	101 (13.6%)	644 (86.4%)	0.270	(0.169-0.431)	33.102	1	0.000*

5. CONCLUSION

The findings of this study reveals that even though toilets are available in 86.4% of households in the study area, not all (98.6%) of them used the available toilets implying that there may be not less than 13.6% of households in the study area that still indulge in the ignoble of practice open defaecation (OD). On the whole, WASH related factors such as non-availability of toilets, improper waste disposal, poor drainage around residential areas, poor housing and poor source of drinking water such as stream, river and unprotected well were found to be significantly (P<0.05) associated with higher odds of malaria prevalence among the school children. The foregoing implies that households in the study area still leaves much to be desired in the attainment of optimal levels on both drinking water and sanitation ladders (SDG 6.1 & SDG 6.2). And in light of the association established between WASH practices and malaria prevalence, concerned authorities must scale up efforts at improving WASH conditions of households with a view to curbing the menace of malaria and other related untoward health outcomes.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL APPROVAL

Permission and approval for access to the study area were secured from the Gombe State Universal Basic Education Board (SUBEB) and the Local Education Authority (LEA) of the six Local Government Areas (LGAs). And an ethical clearance was also obtained from the Gombe State Ministry of Health Research and Ethics Committee (GSMoHREC) with reference number, MoH/ADM/S/658. Official consent of the heads of the 18 schools visited, as well as the parents and school children were all obtained before commencement of the study.All school children aged 6 - 15 who were currently enrolled in the selected primary schools in Gombe State

and who consented to participate in the study. The study subjects must have domiciled in the state for not less than one year.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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