Socio-economic and demographic disparities in ownership and use of insecticide-treated bed nets for preventing malaria among rural reproductive-aged women in northern Ghana

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Abstract

Background: Insecticide-treated bed nets (ITNs) remain a cost-effective intervention for preventing malaria in endemic settings. Ghana has made tremendous efforts to ensure widespread ownership and use of ITNs. However, national coverage statistics can mask important inequities that demand targeted attention. This study assesses the disparities in ownership and utilization of ITNs among reproductive-aged women in a rural impoverished setting: Ghana's Upper East Region.

Methods: Population-based cross-sectional data of 5,074 women between the age of 15 and 49 years were collected using a two-stage cluster sampling approach. Bivariate and multivariate regression models were used to assess the social, economic and demographic disparities in ownership and utilization of ITNs and to compare utilization rates among women in households owning at least one ITN.

Results: As high as 79% of respondents were found to own ITNs while 77% of ITNs owners used ITNs the night preceding the survey. We identified disparities in both ownership and utilization of ITNs in occupational status, religion, district of residence and wealth index. Respondents in the relative richest wealth quintile were 49% more likely to own ITNs compared to those in the poorest quintile (p-value=0.001, CI=1.17-1.90), however, they were 35% less likely to use ITNs compared to the poorest (p-value=0.001, CI=0. 5-0.84).

Conclusion: Interventions aimed at mitigating inequalities in distribution and ensuring consistent use of ITNs in rural Ghana and other similar settings should take into consideration the social, economic and demographic factors identified by this study. More specifically individuals of lower socio-economic status should be given more attention.

Introduction

In spite of global efforts aimed at controlling and preventing Malaria, it is still the leading cause of ill health, death, poverty and low productivity in most developing countries [1,2]. The World Health Organization (WHO) estimates that in the year 2016 alone, 216 million clinical cases of malaria were recorded while 445,000 deaths occurred globally due to malaria infection [1]. Sub-Saharan Africa alone accounted for 90% of all malaria cases and 91% of deaths due to malaria infection according to the 2017 World Malaria Report [1].

In Ghana, malaria remains highly endemic, even after considerable progress has been achieved in delivering effective prevention and treatment interventions. About 38.1% of all Out-Patient Department (OPD) cases and about 50% of under-five child admissions to hospitals are due to malaria infection while 48.4% of all under-five deaths was also attributable to malaria [3]. Malaria is thus ranked among the top ten causes of morbidity and mortality in Ghana [4]. The disease affects people of all ages but children under five years of age and pregnant women are the most vulnerable groups [5].

The use of Insecticide Treated bed-Nets (ITNs) is one of the effective strategies recommended by World Health Organization (WHO) for preventing malaria infection and its consequences during pregnancy, such as maternal anemia, stillbirths and intrauterine growth restriction in malaria-endemic settings [6,7]. ITNs have been proven to be a cost-effective method of protection against malaria. It is effective in reducing approximately 50% of malaria episodes among children under-

five years of age and a 17% reduction in all-cause mortality [8,9]. In view of this, the WHO recommends the supply of ITNs free of charge or at a highly subsidized fee in malaria-endemic places using a variety of approaches including mass campaigns and routine distribution channels in order to achieve greater equity of coverage [6,10].

In Ghana, the Ministry of Health (MoH) strongly recommends the use of ITNs for malaria prevention. ITNs are freely distributed through mass distribution campaigns at schools, antenatal clinics and child welfare clinics [11]. Also from 2002, the government of Ghana waived taxes on the importation of ITNs in an effort to make them accessible and affordable [12]. However, despite these efforts, key targets of Ghana's National Malaria Strategic Plan (2008-2015) on ITNs were not fully achieved [13]. Recent surveys in Ghana have shown that a significant proportion of households who have ITNs do not actually use them [12,14]. The most recent malaria indicator survey reveals that just about 51% of the households have an ITN for every two people in the household [14]. Also, there exist rural and urban disparities in the utilization of ITNs in Ghana [12,14]. In addition, the proportion of household population who sleep under ITN is found to decrease with increasing wealth [12,14].

Thus, Ghana is yet to reach universal coverage of ITNs (defined as use by 80% or more of a population in an endemic area in order to have the optimum protection [10]). There is, therefore, the need for continuous monitoring and assessment of ownership and utilization of ITNs, especially among critical sections of the population so as to inform policy and practice in the area of malaria prevention.

Although some studies have examined ITNs ownership and use in Ghana, none has focused on a predominantly rural and deprive setting [5,14–16]. This paper aims to identify and highlight the social, economic and demographic disparities in ownership and utilization of ITNs among reproductive-aged women in a predominantly rural setting of Ghana.

Materials and Methods

Study Setting

The data that underlie this analysis were collected in the Upper East Region of northern Ghana. The Upper East Region is one of the three poorest regions in Ghana. It has a population of about 1,188,800 people and is located in the north-eastern corner of the country [17]. It has a total land area of 8,842km with a savanna grassland vegetation [18]. It is inhabited by seven major ethnic groups and currently has 15 administrative districts. Subsistence farming is the main economic activity of people in the region [19]. Christianity, Islam and African traditional religion are the major religions of the people in the region [18]. This area is typical of most rural Sahelian African settings. Findings from this region would, therefore, have relevance for most rural settings in Sub-Saharan Africa. Figure 1 shows the map of Ghana indicating Upper East Region in red.

Insert Figure 1 here

Source of Data

Data came from an independent cross-sectional survey that collected information from women between 15 and 49 years of age. The purpose was to provide end-of-project data for the evaluation of a health systems plausibility trial that was implemented by the Ghana Essential Health Intervention Project (GEHIP) to improve maternal and child survival. GEHIP was a five-year health system strengthening and research program implemented in the Upper East Region from 2010 to 2015. The GEHIP approach involved strengthening the capacity of the health system around six WHO health system building blocks and improving the effectiveness of Ghana's comprehensive Community-based Health Planning and Service (CHPS) program. Details of the GEHIP program are described elsewhere [19,20].

Data Collection

A two-stage sampling approach was used in the data collection process. First, the Ghana Statistical Service (GSS) sampled and provided the research team a total of 66 predominantly rural Enumeration Areas (EAs) based on the 2010 Population and Housing Census, from across all districts in the region except two districts (Kassena-Nankana East and West Districts). Guided by this sampling frame, physical identification of EAs was done and a household listing of all members of households in sampled EAs was carried out. The second stage of sampling then involved the sampling of households proportional to the population size of each EA. Within sampled households, all females between the ages of 15 to 49 years of age were eligible to be interviewed. In the case of the two Kassena-Nankana districts, sampling was done using Navrongo Health Research Center (NHRC) Health and Demographic Surveillance System data [21]. These two districts are field sites of the NHRC, which has been carrying out intensive research activities for well over 25 years. The NHRC has developed the HDSS that continuously monitors the health and 2,500 women were sampled from these two districts for the survey.

The paperless "Open Data Kit" (ODK) software was used in collecting the data. This technique was first developed at the University of Washington, it permits instantaneous data entry, editing and correction at the time of interviews [22]. Data collection started on the 2nd of October 2014 and ended on the 31st of January 2015.

The survey collected data on maternal and child health indicators, fertility, family planning, universal health coverage among others. During the survey, two questions that relate to Insecticide Treated bed-net (ITNs) were; *"Does your household have an insecticide-treated bed net?"* and *"Did you sleep under an insecticide-treated bed-net last night"*. This analysis relies on these two

questions to explore the disparities in ownership and utilization of ITNs among this cohort of the reproductive-aged women.

Data Analysis

STATA 12 software was used for all analysis in this study. Basic descriptive statistics were used to describe the composition of variables while bivariate analysis was done using chi-square test of association to identify variables associated with household ownership of ITNs. Furthermore, multivariate analysis using binary logistic regression models are used to explore the disparities in ownership and utilization of ITNs. Utilisation of ITNs was examined only among respondents who reported having ITNs within their household. The variable for wealth index was generated using Principal Component Analysis (PCA) where household assets were used as a proxy for wealth. Ten independent variables were included in this analysis. Independent variables were first tested for multi co-linearity using the Variance Inflation Factor (VIF) before they were included in the logistic regression models. However, this was found not to be a problem since a mean VIF of 1.32 was found (VIF more than 20 indicates multi co-linearity). In this analysis, p-values of 0.05 or below are regarded as showing significant relationship while p-values above 0.05 are regarded as not showing a significant association. Both p-values and confidence intervals have been reported in the regression models.

Ethical Considerations

The data used in this paper emanates from the Ghana Essential Health Intervention Project (GEHIP). Ethical approval was obtained from the Ethical Review Committee of the Ghana Health Service and Institutional Review Board (IRB) of the Navrongo Health Research Centre prior to the conduct of this study. Inform consent was administered to participants in their preferred

language and all protocols were followed to ensure confidentiality during data collection, analysis and reporting of findings.

Results

Data from a total of 5,074 women were used in this analysis, 79% of them reported having at least one ITN in their household. Table 1 shows the background characteristics of respondents and the results of chi-square test of association with ITNs ownership within the household. Variables that were significantly associated with ownership of ITNs at bivariate level are age, level of education, functional literacy, occupation, religious affiliation, place of residence, district of residence and wealth index.

Table 1: Background Characteristics of Respondents

Variable	Categories	Have ITNs		Don't Have ITNs		P-value	Total
		Number	%	Number	%		N= 5074
Age Group	15-19	139	74	50	26	<0.001	189
	20-34	2081	82	453	18		2534
	35-49	1806	77	545	23		2351
Level of Education	None	2649	78	769	22	<0.001	3418
	Primary/Junior High School	1079	83	220	17		1299
	Secondary/ Tertiary	289	84	57	16		346
	Other	9	82	2	18		11
Functional Literacy (Ability to read and understand)	Yes	809	82	174	18	0.011	983
	No	3217	79	874	21		4091
Marital Status	Not Married yet (single)	149	77	45	23	0.204	194
	Married	3566	80	909	20		4475
	Widowed	260	78	73	22		333
	Divorced/ Separated	51	71	21	29		72
Availability of Co-Wives	Yes	1169	80	296	20	0.954	1,465
	No	2369	80	605	20		2,974
	Don't know	28	78	8	22		36
Occupation	Farming	1586	78	454	22	<0.001	2,040
	Trading	991	81	231	19		1,222
	Artisan	539	82	115	18		654
	No occupation/housewife	616	76	197	24		813
	Civil Servant	85	83	18	17		103
	Student	67	83	14	17		81
	Other	142	88	19	12		161
Religion	Christianity	2560	82	572	18	<0.001	3132
	Traditional	461	78	127	22		588
	Islam	902	74	325	26		1227

	No religion	103	81	24	19		127
Location of Residence	Urban	347	77	106	23		453
	Semi-Urban	647	74	230	26	<0.001	877
	Rural	3032	81	712	19		3744
District of Residence	Bolga M.	302	83	60	17		362
	Bongo	398	84	76	16		474
	Builsa	608	87	94	13		702
	Kasena-Nankan East	520	82	118	18		638
	Kasena-Nankana West	356	80	87	20	<0.001	443
	Garu/Tempani	620	70	265	30		885
	Bawku West	335	82	74	18		409
	Talensi/Nabdam	508	81	117	19		625
	Bawku East	360	71	149	29		509
Wealth Index	Quintile1 (Poorest)	799	74	282	26		1081
	Quintile2	1334	79	351	21		1685
	Quintile3	327	83	68	17	<0.001	395
	Quintile4	791	82	175	18		966
	Quintile5 (Richest)	775	82	172	18		947

Ownership of ITNs

Table 2 shows the multivariate analysis of ITNs ownership. There were disparities in ownership of ITNs by age group. Women between 20-34 years old were almost twice more likely to have ITNs compared to those between 15-19 years of age (p-value 0.001, OR= 1.96). However, this is not surprising because women in this age group are more likely to have begun childbearing and so more likely to be advised to use ITNs and to also benefit from clinic-based distribution of ITNs.

Table 2: Multivariate Analysis of ITNs Ownership; Logistic Regression Model

Determinants	Adjusted Odds Ratio	P>z	95% Conf. Interval	
Age Group (Compared to 15-19)				
20-34	1.96	0.001	1.30	2.66
35-49	1.34	0.135	0.91	1.97
Level of Education (Compared with No education)				
Primary/Junior High School	1.22	0.078	0.98	1.53
Secondary/Tertiary	1.25	0.305	0.81	1.94
Other	1.00	0.996	0.21	4.82
Functional Literacy (Compared with Yes)				
No	1.10	0.500	0.83	1.45
Occupation (Compared with Farming)				
Trading	1.05	0.599	0.87	1.28
Artisan	0.94	0.647	0.73	1.21
No Occupation/Housewife	0.69	0.001	0.56	0.86
Civil Servant	0.84	0.579	0.46	1.54
Student	0.81	0.523	0.54	1.54

Other	1.55	0.104	0.91	2.61
Religion (Compared with Christianity)				
Traditional religion	0.76	0.020	0.60	0.96
Islam	0.95	0.596	0.77	1.16
No religion	1.03	0.899	0.65	1.64
Location of Residence (Compared with Urban)				
Semi-Urban	1.23	0.165	0.92	1.64
Rural	2.00	<0.001	1.53	2.62
District of Residence (Compared with Bolgatanga)				
Bongo	1.55	0.029	1.05	2.31
Builsa	2.08	<0.001	1.41	3.06
Kasena-Nankan East	1.15	0.452	0.80	1.66
Kasena-Nankana West	1.08	0.668	0.73	1.59
Garu/Tempani	0.56	0.001	0.39	0.80
Bawku West	1.06	0.789	0.71	1.57
Talensi/Nabdam	1.24	0.250	0.86	1.79
Bawku East	0.61	0.013	0.41	0.90
Wealth index (Compared with Quintile1; Poorest)				
Quintile2	1.29	0.008	1.07	1.56
Quintile3	1.65	0.001	1.22	2.25
Quintile4	1.56	<0.001	1.24	1.95
Quintile5 (Richest)	1.49	0.001	1.17	1.90

They were no significant disparities in ITNs ownership by level of education or functional literacy in the multivariate analysis. Significant disparities existed by occupational status, women who were housewives or had no occupation were 31% less likely to own an ITNs compared to those engaged in farming (p-value =0.001, OR=0. 69). For religious affiliation, respondents who were affiliated with African traditional religion were 24% less likely to own ITNs compared to respondents affiliated with Christianity (p-value=0.020, OR= 0.76).

Also, there were significant disparities in ownership of ITNs by the location of residence. Respondents in rural settings were twice more likely to own an ITN compared to those in urban settings (p-value<0.001, OR= 2.00). Disparities also existed by District of residence; women resident in Bongo and Builsa districts were 1.55 and 2.08 times respectively more likely to have ITNs compared to residents of Bolgatanga the regional capital (p-value= 0.029 and <0.001, OR= 1.55 and 2.88). However, respondents of Garu-Tempane and Bawku East districts were 44% and

39% less likely to own an ITNs compared to those of Bolgatanga (p-value= 0.001 and 0.013, OR= 0.56 and 0.61).

With regards to wealth index, it is apparent from Table 2 that the likelihood of ownership of ITNs increases with higher wealth index. While those of quintile2 and quintile3 were 29% and 65% more likely to have ITNs (p-value= 0.008 and 0.001, OR= 1.29 and 1.65 respectively), those belonging to quintile4 and 5 (next richest and richest categories) were 56% and 49% more likely to own ITNs compared to those in quintile1; the poorest category (p-values <0.001 and 0.001, OR= 1.56 and 1.49 respectively)

Utilization of ITNs

Table 3 presents the multivariate analysis of ITNs utilization the night before the survey. As shown in the table, there was no significant disparities in ITNs utilization by age group, level of education, functional literacy and location of residence. However, occupation, religion, district of residence and wealth index had significant disparities with utilization of ITNs.

Table 3: Multivariate Analysis of ITNs Utilization; Logistic Regression Model.

Determinants	Odds Ratio	P>z	95% Conf. Interval	
Age Group (Compared with 15-19)				
20-34	0.98	0.940	0.62	1.56
35-49	0.65	0.077	0.40	1.05
Level of Education (Compared with No Education)				
Primary/Junior High School	1.05	0.677	0.84	1.32
Secondary/Tertiary	0.99	0.971	0.65	1.51
Other	1.18	0.841	0.23	5.96
Functional Literacy (Compared with Yes)				
No	1.15	0.327	0.87	1.52
Occupation (Compared with Farming)				
Trading	0.90	0.327	0.73	1.11
Artisan	0.98	0.886	0.75	1.29
No occupation/housewife	0.87	0.268	0.68	1.11
Civil Servant	0.61	0.076	0.36	1.05

Student	0.56	0.049	0.31	1.00
Other	1.23	0.384	0.78	1.93
Religion (Compared with Christianity)				
Traditional religion	0.98	0.908	0.76	1.28
Islam	1.29	0.046	1.00	1.65
No religion	0.87	0.550	0.54	1.38
Location of Residence (Compared with Urban)				
Semi-Urban	0.88	0.422	0.63	1.21
Rural	0.94	0.685	0.70	1.26
District of Residence (Compared with Bolgatanga)				
Bongo	1.17	0.390	0.81	1.70
Builsa	1.43	0.048	1.00	2.03
Kasena-Nankan East	1.17	0.374	0.83	1.66
Kasena-Nankana West	1.14	0.495	0.78	1.66
Garu/Tempani	1.27	0.053	0.99	2.10
Bawku West	4.24	<0.001	2.59	6.95
Talensi/Nabdam	1.22	0.266	0.86	1.72
Bawku East	1.28	0.260	0.83	1.96
Wealth index (Compared with Quintile1; Poorest)				
Quintile2	1.09	0.458	0.87	1.36
Quintile3	1.37	0.074	0.97	1.94
Quintile4	1.07	0.587	0.83	1.39
Quintile5 (Richest)	0.65	0.001	0.50	0.84

Respondents who reported that they were students were 44% less likely to used ITN compared to those engaged in farming. Also, those affiliated with the Islamic religion were 29% more likely to use ITNs compared with their Christian counterparts. Residents of the Bawku West district were more than four times more likely to used ITNs compared to residents of Bolgatanga, the regional capital (p-value<0.001, OR= 4.24). Women in quintile5 (richest category) were 35% less likely to use ITNs compared with those in quintile1 (the poorest category) (p-value= 0.001, OR= 0.65)

Discussion

Results reported in this paper show that efforts of the malaria control program in improving ownership and use of ITNs in the Upper East Region is almost near the attainment of the universal

coverage mark which is pegged at 80% and above. However, there exist significant socio-economic and demographic disparities in ITNs ownership and use in this rural setting. Specifically, we found significant disparities in both ownership and utilization of ITNs by occupational status, religion, district of residence and wealth index among reproductive-aged women in the region. They were disparities in ITNs ownership by age and location of residence, but this was not the case with ITNs utilization. There was, however, no disparities in ownership nor utilization of ITNs by educational level, functional literacy or marital status.

Previous studies in other settings have recorded mixed outcomes with regards to the association of these variables with ITNs ownership. While we did not find any significant disparities between educational level with either ownership or utilization of ITNs, a review by Signh et al. found educational level to be a determinant of ITNs ownership [6]. Other studies that were undertaken in Nigeria, however, did not find a significant association between educational level with either ownership or utilization of ITNs [23]. Alberto et al. in their study of bed net use among under-fives and household ownership of ITNs in Equatorial Guinea found the educational level of household head to be a strong predictor of ownership and utilization of ITNs [24]. Our findings do not also support those of Baume & Franca-Koh in an earlier study in Ghana, who found educational attainment to influence ITN use [15]. From the foregoing, it is clear that the disparities by educational level on ownership and use of ITNs varies with location and may indeed be time and place specific.

There was no significant disparity by marital status with either ownership or use of ITNs in this analysis. A study conducted in southwestern part of Ethiopia found marital status of household head to be associated with utilization [25]. Many other studies reviewed, however, did not examine the association of marital status with ownership and utilization [15,24,26,27].

This study has revealed that mothers without occupation were 31% less likely to own ITNs. However, it was not so when it comes to utilization. Most studies reviewed did not consider the occupational status of the respondent in relation to ownership and utilization of ITNs [6,15,24,26]. One study from Ethiopia that examined occupation status of household head did not find any significant disparity with either ownership nor utilization of ITNs [25]. This study has revealed that practitioners of African traditional religion were less likely to own an ITN compared to those of Christian religion. This calls for a further investigation as to why religious affiliation is associated with ownership of ITNs in the study setting. Previous studies have not examined this either.

Residents of rural areas were two times more likely to possess ITNs compared to residents of urban settings but there was no significant association with utilization of ITNs. Other studies have highlighted disparities by rural/urban residents with ownership and use of ITNs at the household level; however, there seems to be a mix in the direction of association perhaps due to the targeting strategies employed in different settings. For instance, in a study involving two states of Nigeria, urban households were more likely to own ITNs compared to their rural counterparts [28]. However, another study in the same country that assessed ownership and use among pregnant women found those who reside in urban settings to be less likely to own ITNs compared to those in rural areas [23]. It, however, found women living in urban areas to be almost twice more likely to use ITNs compared to rural women [23]. A study in Equatorial Guinea also revealed higher utilization rates for urban dwellers than rural dwellers [24]. However, we believe that high ownership of ITNs in rural northern Ghana is perhaps due to the fact that the malaria control efforts and free distribution of ITNs largely targets rural settings.

Findings of this study also reveal disparities in ITNs ownership and use among the districts in the Upper East Region of northern Ghana. While two districts (Bongo and Builsa districts) were

significantly more likely to have ITNs compared to Bolgatanga (the regional capital), another two (Garu-Tempane and Bawku East districts) were significantly less likely to own ITN compared to Bolgatanga. Although the reason for low ITNs ownership in these two districts may not be readily known, it is on record that around 2013/2014 there was a ban on the use of motorbikes in Bawku Municipality due to an inter-tribal conflict in the area and this affected health care delivery services in Bawku Municipality. Garu-Tempane district is geographically located next to Bawku Municipal and therefore might have also suffered from accessibility challenges emanating from the Bawku conflict. The findings of this study, therefore, could be a pointer to the negative effect of conflicts on the delivery of health services.

Socio-economic status (wealth index) is a very important variable to consider when assessing the effect of health interventions or programs. It is important to know if interventions are reaching the poor as much as the relatively well off in society. In this study, we found an increase in ownership of ITNs with increasing wealth. In contrast to ownership, we found that the richest category was 35% less likely to use ITNs compared to the poorest category. Our findings support those of an early study in Ghana by the Ghana Statistical Service[12]. Previous studies have also documented significant association of ITNs ownership and utilization with wealth index [6,15,25,28]. However, some studies did not find any association of wealth index with ITNs ownership or use [24,27,29]. Among the studies that wealth index was significantly associated with ITNs utilization, while most studies found high wealth index to be associated with high utilization of ITNs and low wealth index to be associated with low ownership and use [6,25,28], one study found lower wealth index to rather be associated with high utilization [15]. This implies that based on the peculiarities of each setting and strategies used in deploying ITNs, the poor and the relatively well-off could benefit disproportionately. It should also be noted that people of high socio-economic status often have access to other methods for preventing man-vector contact and may therefore not use ITNs

even if they have them in their households. A study in Gabon observed that relatively wealthier people who live in houses with door and window screens often believe they are sufficiently protected from mosquito bites and therefore do not make use of ITNs even if they have them in their households[30]. This phenomenon may merit further investigation to ascertain if the use of door and window screens offer adequate protection as that of ITNs.

Study Limitations: As a cross-sectional quantitative study, this study is limited in understanding some of the contextual factors influencing ownership and use of ITNs. These notwithstanding, the study provides useful information to guide malaria control intervention activities in Ghana and similar settings.

Conclusion

Despite the relatively high percentage of ownership and use of ITNs in the study area, this study has revealed gaps and disparities by socio-economic status, occupation, district of residence, location of residence and religious affiliation. It can be inferred from the review of literature that the determinants of ITNs ownership and utilization are not static. Indeed, they are context specific and time specific, a system of continuous monitoring and evaluation is therefore required so that disadvantaged sections of the society can often be targeted. Interventions aimed at mitigating inequalities in distribution and ensuring consistent use of ITNs in rural Ghana and other similar settings should take into consideration the social, economic and demographic factors identified by this study. More specifically individuals of lower socio-economic status should be given more attention.

Author contributions

EWK conceived the idea, did the data analysis and drafted the paper. AAB, JKAW, JFP, SPK, JA, and FSA supervised the collection of the data, data analysis and critically reviewed the paper. All Authors read and approved the final draft.

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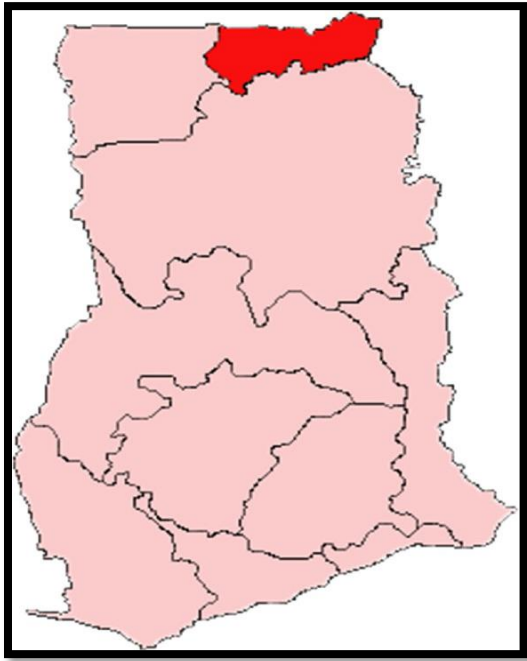
Figure 1 Map of Ghana showing Upper East Region in red.