

Use of insecticide treated nets among women in Ghana: a multilevel modelling of the 2016 malaria indicator survey

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Abstract

Background

Malaria is among the leading causes of morbidity and mortality particularly among women and children in sub-Saharan Africa and remains a public health challenge. Over the years, provision of insecticide mosquito nets (ITNs) for individuals and households have been on the forefront of various organizations. Focus has been on proportion of population with access to ITNs at the expense of usage proportion. This study examined the factors associated with the use of ITNs among women in Ghana.

Methods

This study used a cross-sectional data obtained from the 2016 Ghana Malaria Indicator Survey (GMIS). A sample of 4,267 women aged 15–49 who possessed at least one mosquito net was included in this study. Use of ITNs was the outcome variable. Descriptive statistics and multilevel binary logistic regression were employed. Results were provided in tables with a significance level set at $P < 0.05$.

Results

Out of the 4,267 total sample, more than half (55.9%) were users of ITNs. Women aged 15–24 were less likely (aOR = 0.680 CrI:0.576–0.803) to use ITNs compared to women aged 35 years and above. Women with no education were more likely (aOR = 1.282 CrI:1.047–1.570) to use ITNs compared to women with secondary or higher educational level. Poor women also had significantly higher odds (aOR = 2.005 CrI:1.612–2.495) of using ITNs than similar women who were rich. Women who lived in least disadvantaged communities had higher odds (aOR = 1.358 CrI:1.055–1.748) of using ITNs compared to women in most disadvantaged communities.

Conclusions

Low socio-economic status was a key predictor of ITN usage in Ghana. Having no education, being poor, living in rural areas, chances of getting malaria, coverage of malaria under NHIS and being least socio-economically disadvantaged increased the likelihood of using ITNs. Interventions aimed at improving socio-economic statuses are needed to increase ITN usage in Ghana.

Background

Malaria continues to be among the leading causes of morbidity and mortality particularly among women and children in sub-Saharan Africa. In spite of the attention given to malaria prevention and control and the resources invested into same (2.7 billion dollars in 2018 [1]), malaria infection remains a major public health challenge. Globally, more than three billion people are at risk of malaria. In 2018, there were estimated 228 million cases of malaria resulting in 405,000 deaths with children under five accounting for 67% of deaths worldwide [2](WHO, 2020). Africa carries a disproportionately high share of the global malaria burden. In 2018,

the region was home to 93% of malaria cases and 94% of malaria deaths [2]. Ghana is not spared by this public health menace. Malaria is responsible for approximately 1800 admissions at healthcare facilities and 10 deaths for every 100,000 population in Ghana [3]. In the first quarter of 2020 alone, the country recorded more than a million cases of malaria with 54 deaths [4].

While indoor residual spraying, use of coils and other mechanisms continue to play a major role in malaria prevention and control [5], current policies in many of sub-Saharan Africa emphasize the use of insecticide treated nets (ITNs). In fact, ITNs are one of the most effective methods for preventing malaria, having averted an estimated 68% of malaria cases between 2000 and 2015 [6]. In 2007, the WHO recommended full coverage of ITNs for populations in areas at high risk for malaria transmission [7]. This has led to a massive scaling up of ITN distribution programmes aimed at providing enough nets for all households. These programmes are assessed by the proportion of households owning at least one ITN, and the proportion of people using ITNs. Since 2010, an average of 54% of households in sub-Saharan Africa own at least one ITN, and 33% of the population reported using one the night [8]. In Ghana, the proportion of the population with access to an ITN within their household varies widely by region and wealth quintile [8].

While access to an ITN within the household is a good predictor of ITN use, it is noteworthy that contextual factors could also play a significant role. Researchers have attempted to explore the reasons for ITN non-use while others examined the determinants of ITN use among women or caregivers. The reasons for ITN non-use include discomfort [9], fluidity of sleeping arrangements [10], and little perceived need to use a net when mosquito density is low [11] [9]. Age, education, household wealth [12] [13] [14], household size, distance to health facility, ideational factors [15] [16] [17], knowledge about efficacy of mosquito nets to prevent malaria, source of knowledge of mosquito nets and socioeconomic class [18] [19] are among the factors found to determine mosquito net use.

Since individuals are nested within communities, considering individual factors alone does not provide adequate explanation for ITN use. This notwithstanding, only few studies considered the effects of contextual factors on ITN use. A recent Ghanaian study [20] for instance explored how several factors affect ITN use. However, this study like others, did not consider wider contextual factors like community socio-economic disparity in their analysis. The purpose of this study thus, is to examine the effects of individual and contextual factors on ITN use among women of reproductive age in Ghana.

Methods

Study design

The dataset used in this study is a cross-sectional data obtained from the 2016 Ghana Malaria Indicator Survey (GMIS). It provides information on malaria prevalence and indicators in the country. The sampling frame used for the 2016 GMIS was stratified and is the frame of the 2010 Population and Housing Census (PHC) conducted in Ghana. A two-stage sampling frame was used to select the sample for the 2016 GMIS. Each region was separated into urban and rural areas. In the first stage, 200 Enumeration areas (EAs), including 93 EAs in urban areas and 107 EAs in rural areas, were selected with probability proportional to the EA size and with independent selection in each sampling stratum. The resulting lists of households then served as a sampling frame for the selection of households in the second stage. EAs that were large were segmented and

only one segment was chosen for the survey. In the second stage of selection, a fixed number of 30 households was selected from each cluster to make up a total sample size of 6,000 households and replacements for non-responding households was not allowed. Detailed description of the sampling can be found at <https://dhsprogram.com/pubs/pdf/MIS26/MIS26.pdf> [21].

Data collection

Information from women aged 15 and 49 years who were either permanent residents or visitors present in the households a night preceding the survey was obtained through the administration of questionnaire. There were three types of questionnaires (Household, Woman's and Biomaker) and were written in English and three local Ghanaian languages (Akan, Ewe, and Ga). The questions were programmed into tablet computers and so allowed the use of computer-assisted personal interviewing (CAPI) for the survey. Issues that were captured included background characteristics, malaria prevention, malaria in children, malaria knowledge, among others. More details can be found elsewhere [21].

Outcome variable

This study concentrated on women between ages 15 and 49 years who possessed at least one mosquito net. A question which asked about sleeping under a treated mosquito net in the night preceding the survey was categorized as using ITNs while those who did not sleep under ITNs were categorized as not using mosquito nets. This was coded as a binary variable with a value of 1 and 0.

Independent variables

The variables considered included the following: age, education, household wealth, knowledge about causes of malaria, exposure to malaria messages, knowledge about the efficacy of mosquito nets, knowledge about coverage of malaria under National Insurance Scheme (NHIS), number of household members, place of residence, region and socioeconomic disadvantage. Age was categorized into 15–24, 25–34 and 35+ years. Education was defined as no education, primary and secondary or higher. Household wealth was recoded into poor, middle and rich. Knowledge about causes of malaria was defined as 'Yes' for women who reported that mosquitoes cause malaria and 'No' for those who reported otherwise. Exposure to malaria messages was defined as 'Yes' for those who heard or saw messages about malaria 6 months preceding the survey and 'No' for those who were not exposed to messages of that nature. Knowledge about the efficacy of mosquito nets was measured as 'Yes' for women who agreed that the chances of getting malaria were the same whether mosquito nets were used or not and 'No' for those who either disagreed or claimed that they did not know. Knowledge about coverage of malaria under National Health Insurance Scheme (NHIS) was defined as 'Yes' for those who agreed malaria was covered under NHIS and 'No' for those who disagreed or reported that they did not know. Number of household members was categorized into less than 5 and 5 or more. Socioeconomic status was obtained by applying principal component analysis technique to measure the proportions of individuals who were uneducated and poor within the communities. The resulting values was categorized into tertile 1 (least disadvantaged), tertile 2 and tertile 3 (most disadvantaged). Coding of independent variables were done based on previous works [22] [20].

Statistical analysis

Descriptive statistics

Percentage distribution of all the explanatory variables against the outcome variable were presented in a table. We used Chi-Square test to obtain p-values to indicate the level of significance of each variable.

Modelling approaches/ model fit and specifications

The study adopted the multilevel binary response models to estimate the odds and associated credible intervals of associations with mosquito net usage among women. There were four models in all. The first model had no covariates (Null model) and only showed how the outcome variable reacted. The second model included the independent variables except socioeconomic status (a community level factor). The third model then introduced residence as a random coefficient to allow for urban-rural differentials by communities. Finally, model four then added community socio-economic status to attain the full model. Analysis was done using MLwiN command in Stata version 14.0 and models were fitted using Markov Chain Monte Carlo (MCMC) estimation after using second order penalized quasi-likelihood (PQL2) to obtain sensible starting values for the model parameters [23]. No multicollinearity was identified amongst the covariates. Results were weighted and accounted for complex survey design.

Estimation technique

A two-level women-within- region variance components model was written as:

$$\begin{aligned} \text{Net_use}_{ij} &\sim \text{Bernoulli}(\pi_{ij}) \\ \text{logit}(\pi_{ij}) &= \beta_0 + u_j \\ u_j &\sim N(0, \sigma_u^2) \end{aligned}$$

Where Net_use_{ij} is the binary response for whether a woman i in the region j uses ITNs. β_0 is the intercept for the log-odds of using ITN in the average household. U_j is a household level random effect assumed normally distributed with a zero mean and constant variance σ_u^2 . There was no woman-level residual error appearing in the linear predictor.

The next model adjusted for individual-level factors which included age, education, wealth, knowledge about cause of malaria, exposure to malaria messages, chances of getting malaria, NHIS coverage, number of household members and residence. Age, educational level and wealth status were entered into the model as dummy variables

$$\begin{aligned} \text{use}_{ij} &\sim \text{Bernoulli}(\pi_{ij}) \\ \text{logit}(\pi_{ij}) &= \beta_0 + \beta_1 \text{age1}_{ij} + \beta_2 \text{age2}_{ij} + \beta_3 \text{edu1}_{ij} + \beta_4 \text{edu2}_{ij} + \beta_5 \text{wealth1}_{ij} + \beta_6 \text{wealth2}_{ij} + \beta_7 \text{rural}_{ij} + \beta_8 \text{mcm}_{ij} + \\ &\beta_9 \text{media}_{ij} + \beta_{10} \text{cgm}_{ij} + \beta_{11} \text{nhis}_{ij} + \beta_{12} \text{nhm}_{ij} + u_j \\ u_j &\sim N(0, \sigma_u^2) \end{aligned}$$

The third model presents a random coefficient to allow for urban-rural differentials across regions still adjusting for the same set of predictors as before.

$$\begin{aligned} \text{use}_{ij} &\sim \text{Bernoulli}(\pi_{ij}) \\ \text{logit}(\pi_{ij}) &= \beta_0 + \beta_1 \text{age1}_{ij} + \beta_2 \text{age2}_{ij} + \beta_3 \text{edu1}_{ij} + \beta_4 \text{edu2}_{ij} + \beta_5 \text{wealth1}_{ij} + \beta_6 \text{wealth2}_{ij} + \beta_7 \text{rural}_{ij} + \\ &\beta_8 \text{mcm}_{ij} + \beta_9 \text{media}_{ij} + \beta_{10} \text{cgm}_{ij} + \beta_{11} \text{nhis}_{ij} + \beta_{12} \text{nhm}_{ij} + u_{0k} + u_{5k} \\ \begin{pmatrix} u_{0k} \\ u_{7k} \end{pmatrix} &\sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \square \\ \sigma_{u07} & \sigma_{u7}^2 \end{pmatrix} \right] \end{aligned}$$

The between region variance is now a function of residence in the random effect part of the model.

$$\text{var}(u_{0j} + u_{7j} \text{rural}_{ij}) = \sigma_{u0}^2 + 2\sigma_{u07} \text{rural}_{ij} + \sigma_{u07}^2 \text{rural}_{ij}^2$$

The final model then introduces a community level explanatory variable, socio-economic status, to check whether certain regional-level variations in rural-urban areas may be explained.

$$\begin{aligned} \text{use}_{ij} &\sim \text{Bernoulli}(\pi_{ij}) \\ \text{logit}(\pi_{ij}) &= \beta_0 + \beta_1 \text{age1}_{ij} + \beta_2 \text{age2}_{ij} + \beta_3 \text{edu1}_{ij} + \beta_4 \text{edu2}_{ij} + \beta_5 \text{wealth1}_{ij} + \beta_6 \text{wealth2}_{ij} + \beta_7 \text{rural}_{ij} + \\ &\beta_8 \text{mcm}_{ij} + \beta_9 \text{media}_{ij} + \beta_{10} \text{cgm}_{ij} + \beta_{11} \text{nhis}_{ij} + \beta_{12} \text{nhm}_{ij} + \beta_{13} \text{ses_low}_j + \beta_{14} \text{ses_middle}_j + u_{0k} + u_{\&k} \\ \begin{pmatrix} u_{0k} \\ u_{7k} \end{pmatrix} &\sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \square \\ \sigma_{u07} & \sigma_{u7}^2 \end{pmatrix} \right] \end{aligned}$$

Results

Descriptive analysis

More than half (55.9%) of the respondents were users of ITN. Most of the respondents (60.1%) who used ITNs were aged 25 -34 years. Usage of ITNs was around 70 percent for women who were not educated and the poor. About 57 percent of women who had the opinion that malaria was caused by mosquitos and 54 percent who had exposure to malaria messages made use of ITNs respectively. Those who indicated the chances of getting malaria is not the same whether mosquito net is used or not used mosquito nets the most (56.4%). Most (60.6%) of the women who indicated malaria could not be treated as well as those who knew malaria to be covered under NHIS (58%) made use of mosquito nets. Moreover, close to 60 percent of the women who lived in households of more than five members used ITNs. The highest proportion (66.5%) of women from rural areas, Upper West (66.7%), Upper East (65.8), Northern (65.1%), Volta (59.6) and Brong Ahafo (59.1) made use of ITNs. Majority (71%) of women from the least disadvantaged community used ITN. (Table 1)

Table 1 Use of insecticide treated bed net across the individual and contextual levels of women in Ghana				
Variable	Used treated insecticide mosquito nets			P-value
	No	Yes	Total	
	N(%)	N(%)	N(%)	
Individual level factors	1,883 (44.1)	2,384 (55.9)	4,267 (100)	
Age				<0.001
15-24	765 (50.9)	739 (49.1)	1504 (100)	
25-34	544 (39.9)	818 (60.1)	1362 (100)	
35+	574 (41.0)	827 (59.0)	1401 (100)	
Education				<0.001
No education	333 (29.9)	781 (70.1)	1114 (100)	
Primary	319 (40.6)	466 (59.4)	785 (100)	
Secondary/Higher	1231 (52.0)	1137 (48.0)	2368 (100)	
Household wealth				<0.001
Poor	670 (31.0)	1489 (69.0)	2159 (100)	
Middle	380 (51.1)	364 (48.9)	744 (100)	
Rich	833 (61.1)	531 (38.9)	1364 (100)	
Mosquito cause malaria				0.093
No	330 (47.0)	372 (53.0)	702 (100)	
Yes	1553 (43.6)	2012 (56.4)	3565 (100)	
Exposure to malaria messages				0.002
No	985 (42.0)	1359 (58.0)	2344 (100)	
Yes	898 (46.7)	1025 (53.3)	1923 (100)	
Chances of getting malaria are the same				0.138
No	1545 (43.6)	1997 (56.4)	3542 (100)	
Yes	338 (46.6)	387 (53.4)	725 (100)	
Malaria can be treated				0.157
No	84 (39.4)	129 (60.6)	213 (100)	
Yes	1799 (44.4)	2255 (55.6)	4054 (100)	
Malaria is covered under NHIS				<0.001
No	428 (53.0)	379 (47.0)	807 (100)	

Yes	1455 (42.1)	2005 (58.0)	3460 (100)	
Number of household members				0.002
Less than 5	1079 (46.2)	1255 (53.8)	2334 (100)	
5+	804 (41.6)	1129 (58.4)	1933 (100)	
Community factors				
Residence				<0.001
Urban	1046 (59.2)	722 (40.8)	1768 (100)	
Rural	837 (33.5)	1662 (66.5)	2499 (100)	
Region				<0.001
Western	158 (48.6)	167 (51.4)	325 (100)	
Central	210 (47.7)	230 (52.3)	440 (100)	
Greater Accra	292 (73.9)	103 (26.1)	395 (100)	
Volta	185 (40.4)	273 (59.6)	458 (100)	
Eastern	173 (48.2)	186 (51.8)	359 (100)	
Ashanti	194 (47.2)	217 (52.8)	411 (100)	
Brong Ahafo	172 (41.0)	248 (59.1)	420 (100)	
Northern	183 (34.9)	342 (65.1)	525 (100)	
Upper East	178 (34.2)	342 (65.8)	520 (100)	
Upper West	138 (33.3)	276 (66.7)	414 (100)	
Socioeconomic status				<0.001
Tertile 1 (Most disadvantaged)	834 (58.4)	593 (41.6)	1427 (100)	
Tertile 2	636 (44.9)	782 (55.2)	1418 (100)	
Tertile 3 (Least disadvantaged)	413 (29.0)	1009 (71.0)	1422 (100)	

Measures of association (fixed effects)

Women aged 15-24 were less likely (aOR=0.680 CrI:0.576-0.803) to use ITNs compared to women aged 35 years and above (Table 2). Surprisingly, women with no education were more likely (aOR=1.282 CrI:1.047-1.570) to use ITNs compared to women with secondary or higher educational level. Poor women also had significantly higher odds (aOR=2.005 CrI:1.612-2.495) of using ITNs than similar women who were rich. Women living in rural areas were more likely (aOR=1.660 CrI:1.396-1.973) to use ITNs in comparison to women who lived in urban areas. Women who indicated that malaria was covered under NHIS were more likely (aOR=1.290 CrI:1.099-1.514) to use ITNs compared to women who indicated no NHIS coverage for malaria. Socio-economic status in a community had a significant positive effect, as women who lived in least

disadvantaged communities had higher odds (aOR=1.358 CrI:1.055-1.748) of using ITNs compared to women in most disadvantaged communities.

Measures of association (random effects)

Estimation/ model specification results

Model 0 shows a 0.215 log-odds of using ITN in the average region. This translates into a probability of 0.553. This indicates that almost 55% of the women used ITNs. The between-region variance is estimated to be 0.284. Women's propensity to use ITNs was 0.079. This means that the expected correlation in the propensity to use ITNs between two women from the same region is 0.080. Detailed graphical statistical MCMC diagnostics are shown in appendix. At the second model (Model 1), it was realised that the between-region variance was estimated to be 0.072 compared to 0.284. This suggests that even though all the predictors were level 1, they explained away relatively more variation between regions than within regions. It was also found in model two that there was a greater community-level variation in the probability of using ITNs in rural areas than in urban areas. Since the residual between-community variation decreased in model three for rural areas compared to urban areas, some community-level variation in rural areas is explained by the differences in socio-economic status. The intra-community coefficient indicates that close to 26% of the variable in odds of using ITNs were linked to community level factors.

Table 2: Individual and community factors associated with ITN use by women of reproductive age in Ghana (N=4,267)

Background characteristics	Model 0^a	Model 1^b	Model 2^c	Model 3^d
	OR(95% CrI)	aOR(95% CrI)	aOR(95% CrI)	aOR(95% CrI)
Age				
15-24		0.700*** [0.594,0.827]	0.694*** [0.587,0.822]	0.680*** [0.576,0.803]
25-34		1.141[0.970,1.342]	1.133[0.957,1.341]	1.125[0.954,1.327]
35+		Ref	Ref	Ref
Education				
No education		1.373** [1.131,1.667]	1.364** [1.121,1.659]	1.282* [1.047,1.570]
Primary education		1.166[0.974,1.397]	1.158[0.966,1.389]	1.133[0.947,1.356]
Secondary/Higher		Ref	Ref	Ref
Wealth				
Poor		2.214*** [1.799,2.726]	2.188*** [1.777,2.694]	2.005*** [1.612,2.495]
Middle		1.243* [1.019,1.517]	1.236* [1.017,1.503]	1.193[0.973,1.461]
Rich		Ref	Ref	Ref
Residence				
Urban		Ref	Ref	Ref
Rural		1.744*** [1.492,2.038]	1.727*** [1.465,2.036]	1.660*** [1.396,1.973]
Mosquito causes malaria				
No		Ref	Ref	Ref
Yes		1.152[0.963,1.377]	1.144[0.960,1.363]	1.136[0.947,1.364]
Exposure to mass media				
No		Ref	Ref	Ref
Yes		1.091[0.948,1.254]	1.079[0.940,1.238]	1.077[0.944,1.230]
Chances of getting malaria				

No		Ref	Ref	Ref
Yes		1.213* [1.012,1.453]	1.202* [1.007,1.435]	1.216* [1.018,1.452]
Malaria is covered under NHIS				
No		Ref	Ref	Ref
Yes		1.302** [1.102,1.538]	1.295** [1.092,1.537]	1.290** [1.099,1.514]
Number of Household members				
Less than 5		1.115[0.968,1.284]	1.099[0.901,1.340]	1.107[0.900,1.362]
5+		Ref	Ref	Ref
Socioeconomic disadvantage				
Tertile 1 (most disadvantaged)				Ref
Tertile 2				1.242* [1.043,1.480]
Tertile 3 (least disadvantaged)				1.358* [1.055,1.748]
Random effects				
var(cons)	1.329[0.952,1.853]	1.075[0.948,1.219]	1.024[0.976,1.075]	1.028[0.981,1.076]
cov(cons\rural)			1.014[0.976,1.053]	1.007[0.968,1.047]
var(rural)			1.063[0.965,1.171]	1.058[0.967,1.157]
ICC %	25.94	25.5	20.4	20.7
Model fit statistics				
Bayesian DIC	6277	5378	5375	5372
Exponentiated coefficients; 95% Bayesian credible intervals in brackets				
* p<0.05, ** p<0.01, *** p<0.001				
^a Model 0 is the empty model with no independent variables				
^b Model 1 is adjusted for age, education, wealth, residence, knowledge about causes of malaria, exposure to malaria messages, chances of getting malaria, coverage of malaria under NHIS and number of household members				
^c Model 2 further adjusted for residence as a random coefficient				

Discussion

This study focused on factors associated with the use of ITNs in Ghana and has demonstrated the influence of individual and community factors. Barely 55% of women within the reproductive age group made use of ITNs. This is a little higher than 45.9% and 46.9% reported for pregnant women and non-pregnant women with children under five years respectively [16]. However, higher rates of 60–80% have been reported among other African countries [24] [25] [26] [27]. Previous studies have attributed differences in usage to socio-demographic and cultural beliefs about malaria [24] [28] [29] [30].

It was found that women aged 15–24 were less likely to use ITNs compared to those 35 and above. This finding is similar to Adedokun and Uthman (2020) [22] but contrast reports from Malawi [16] and Ghana [31] [14] where older women were found to be less likely to use ITN compared with their counterparts aged 15–24 years. It could be reasoned that older women are more likely to own ITNs. Furthermore, in an Ethiopian study [18], women aged 26 years and above were about three times more likely to own ITNs compared with those less than 26 years. This could possibly explain why younger women in this study were less likely to use ITNs. The finding also suggests that young women may prove stubborn and not comply to sleeping under ITNs. One other reasoning could be that young women might prefer other means such as using mosquito spray and repellent.

This study reported that those with low education are significantly more likely to use ITN. This may probably be because of the perceived vulnerability which is higher among the poor or those with little or no education. This finding supports the findings of Diema Konlan, et al. (2019) [31] where it was identified that caregivers with increased knowledge on malaria and ITN were less likely to use ITNs and vice versa. They further explain that as caregivers become more educated on risk factors of malaria and significance of ITNs, they tend to practice better environmental hygiene which reduces their utilization of ITNs. Thus, it is likely that community with low income and education as documented in this study may sleep under an ITN once it is available to them. However, this finding did not support an Ethiopian study [32] where higher education was reported to be significantly associated with use of ITN. Differences in the results may be due to the fact that the Ethiopian study was conducted in an urban setting [33].

Similarly, those within the poor wealth category were found to be more likely to use ITNs compared to the rich. This finding corroborates earlier studies in sub-Saharan Africa [34], Ghana [35] and by the Ghana Statistical Service [36]. Contrasting findings however indicated no associations of wealth with ITN usage [37] [38] [39]. However, while other studies [40] [41] indicated higher wealth status as associated with high utilization and low wealth status as associated with low utilization, one study found lower wealth index to rather be associated with high utilization [35]. It could be argued that utilization of ITNs may be high among the poor probably because they are unable to afford more “comfortable” (but expensive) means of malaria prevention, like the usage of mosquito repellents. Koenker and Yukich (2017) [9] identified discomfort (due to heat) as one of the key reasons for ITN non-use among women. Thus, individuals and households who are financially sound resort to other means of malaria prevention rather than using ITN.

Rural residents were found to be more likely to use ITNs in comparison to those at the urban areas. This result is similar to Ricotta, Oppong, Yukich and Briet (2019) [20]; Min, Maung, Oo, Oo, Lin, Thi and Tripathy (2020) [42] and Oresanya, Hoshen and Sofola (2008) [43]. Conversely, a meta-analysis of Demographic Surveys [44] revealed that children in urban households were more likely to use ITNs than those in rural areas. Ricotta et al (2019) [20] postulated that those in urban areas were more exposed to messages through mass media as compared to the rural folks who normally tap messages from health workers. This finding calls for improvement in efforts and emphasizes the need for unique targeting of interventions as well as messaging and education to each setting [20].

Among the respondents, least and moderately disadvantaged women were more likely to use ITNs than most-disadvantaged women. This finding is similar to a study in Malawi where women with high socioeconomic status were more likely to use ITNs than women with low socioeconomic status [16]. The result is also in line with findings from lower middle-income countries where there were poor care-seeking among caregivers of under-five children belonging to the lowest socio-economic status [42] [45] [46] [47]. The results of the present study suggest that women who are most disadvantaged should be prioritized in the mass distribution of ITN as those in this category can hardly afford ITN or the free distribution of the ITN has not reached the right community. In contrast to this finding, a study done in Malawi found no association between wealth, which is a component of socioeconomic status, and ITN usage [48]. Moreover, Adedokun and Uthman (2020) [22] found a contrasting result where the odds of using mosquito nets increased tremendously for women who lived in the most socioeconomically disadvantaged communities.

Surprisingly, the study revealed that those who knew malaria was covered under NHIS were more likely to use ITNs as compared to women who did not know malaria was covered under NHIS. This result may be due to the fact that women who knew malaria was covered under NHIS may also have been exposed to enough information about malaria with its effects, hence, the more likely that they will use ITN [49]. Additionally, the results may be attributed to both perceptions of susceptibility to and severity of malaria which is shown to have a positive association with ITN usage [20] and not merely being covered under NHIS. Also, women who believed that chances of getting malaria was the same with or without the usage of mosquito nets were more likely to use ITNs than those who disagreed. This result is consistent with the work of Adedokun and Uthman (2020) [22] who attributed this outcome to the fact that these women may have found other advantages of using mosquito nets such as prevention of bed bugs and other insects.

Study Strengths And Limitations

The cross-sectional nature of the data set did not allow for provision of information on causality of non-use of ITNs. Since some questions relate to events in the past, there was the possibility for recall bias while conducting the interview with respondents. Aside these limitations, this study made use of a large data set which provided the opportunity for generalization of findings and also to countries with similar characteristics. Information on the role of individual as well as contextual factors in mosquito net use among women in Ghana were provided.

Conclusion

This study concludes that socio-economic status is a key predictor for ITN usage in Ghana. Specifically, having no education, being poor, living in rural areas, chances of getting malaria, coverage of malaria under NHIS and being least socio-economically disadvantaged increased the likelihood of using ITNs. Conversely, low age category decreased the likelihood to use ITNs. Interventions aimed at improving socio-economic statuses are needed to increase ITN usage. Younger age groups should be targeted for community-based health promotion initiatives to educate them on malaria prevention and lifestyle.

Abbreviations

aOR: Adjusted odds ratio; CrI: Credible interval; DHS: Demographic and Health Surveys; DIC: Deviation information criterion; ICC: Intra-cluster correlation; MOR: Median odds ratio

Declarations

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Authors contributions

LKD conceptualized, designed the study and analysed the data. LKD, AB, FOA and AAS were involved in drafting the manuscript. LKD, AB, FOA and AAS critically revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data set used in this study was obtained from the archive of Demographic and Health Surveys (DHS) Program which granted permission for the use of the data. The data set was ethically cleared by Ghana Health Research Ethics Committee of the Federal Ministry of Health (NHREC). The data set is available at https://dhsprogram.com/data/dataset/Ghana_MIS_2016.cfm?flag=0.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interest

The authors declare no competing interests.

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Figures

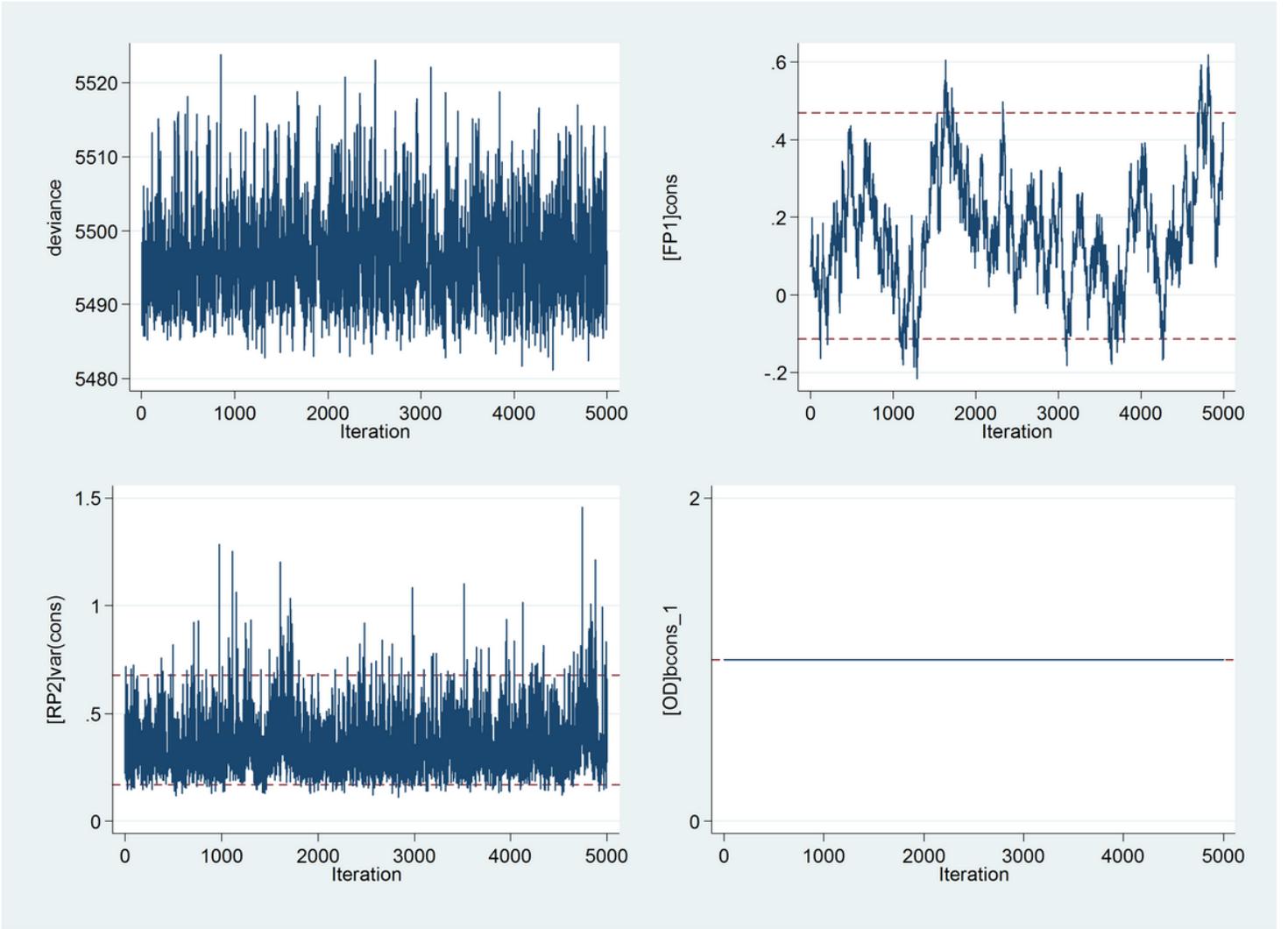


Figure 1

Deviance and parameter chains

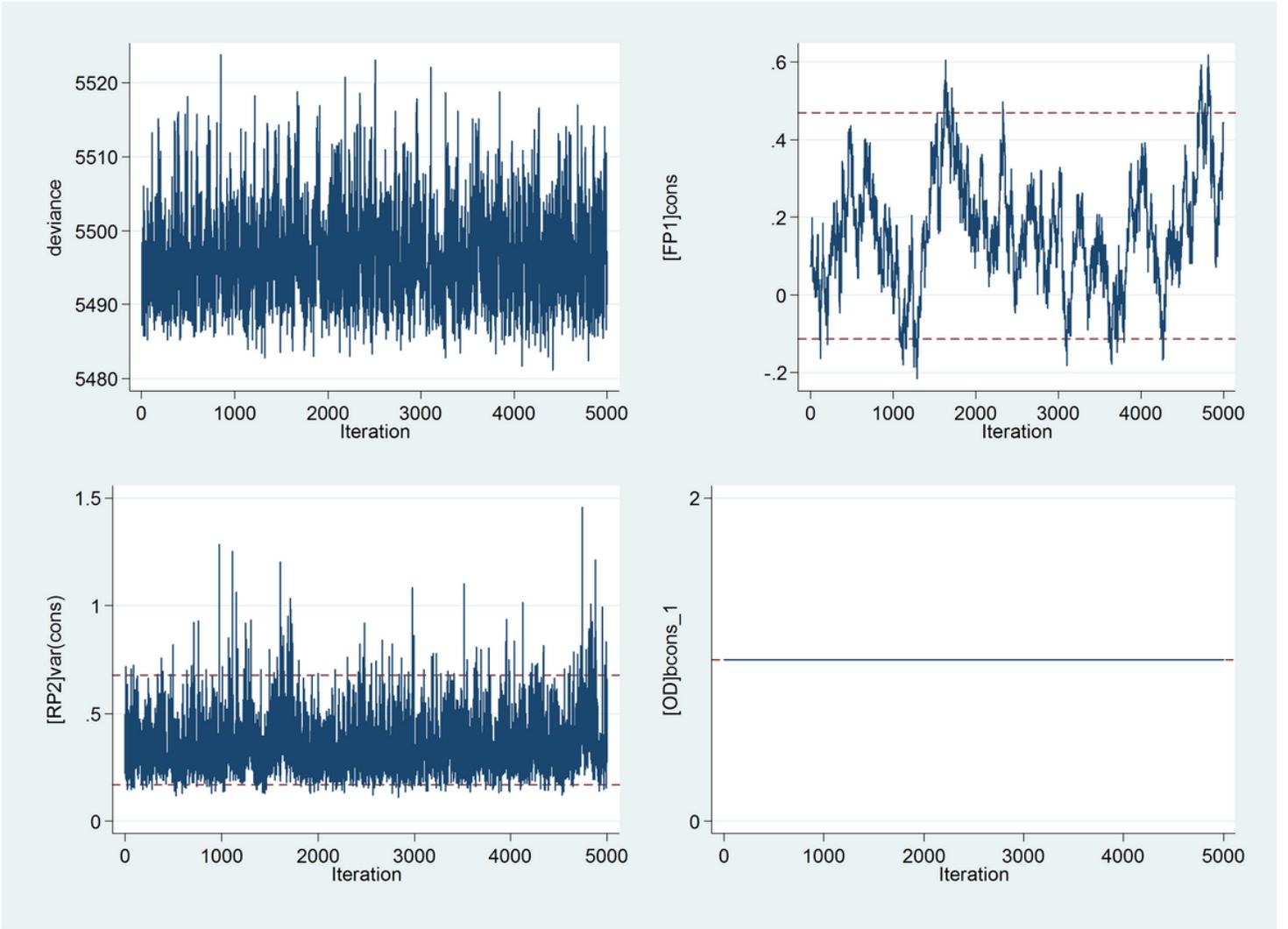


Figure 1

Deviance and parameter chains

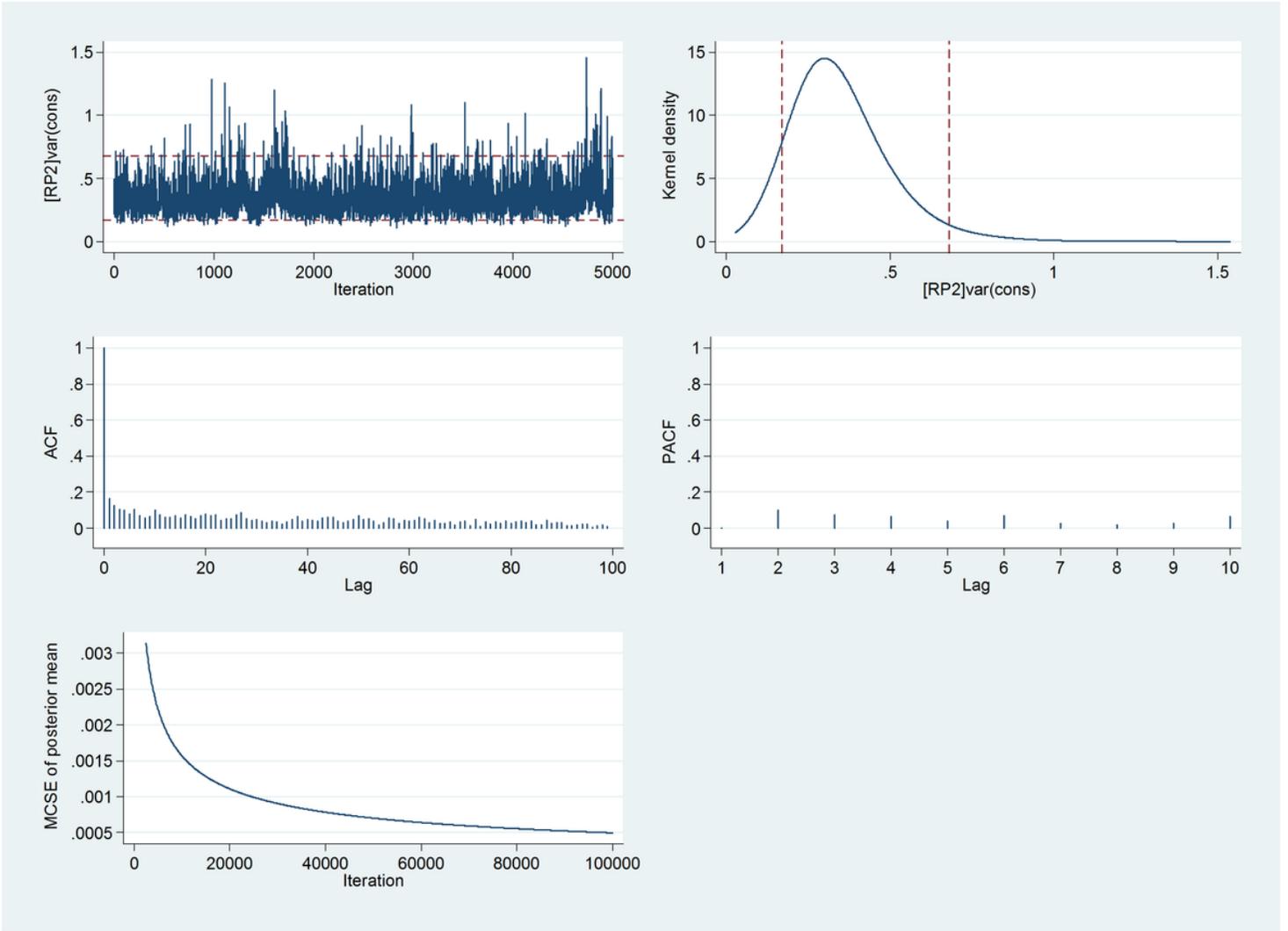


Figure 2

Five-way MCMC graphical diagnostics plot

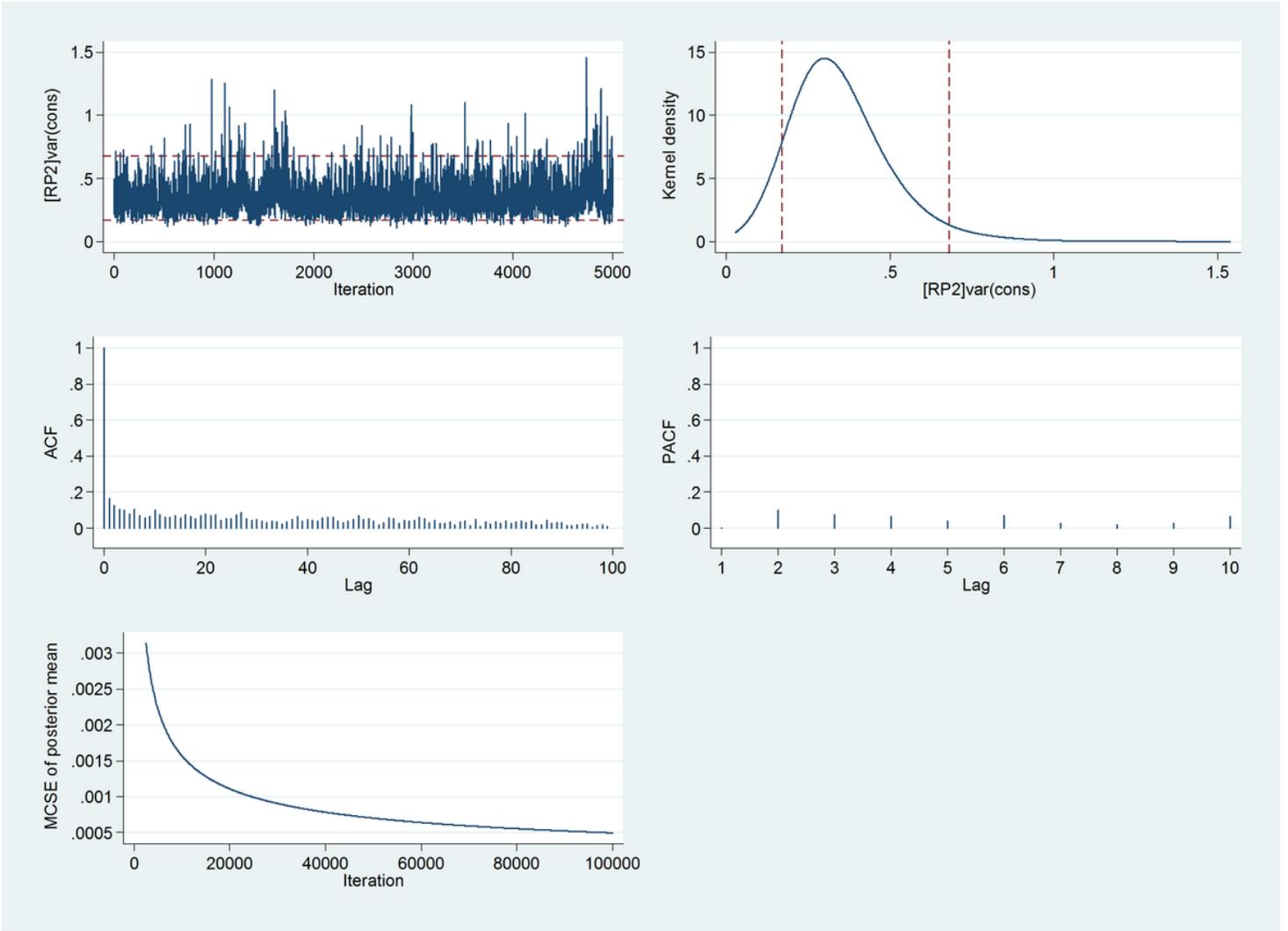


Figure 2

Five-way MCMC graphical diagnostics plot