

Factors Influencing the Use of Insecticide-Treated Nets among Pregnant Women Attending Antenatal Care in the Kintampo North Municipality, Ghana: A Cross-Sectional Study

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Abstract

Background

Malaria in pregnancy remains a leading cause of maternal and neonatal morbidity in sub-Saharan Africa. Insecticide-treated nets (ITNs) are a cornerstone preventive intervention, yet utilization among pregnant women remains suboptimal despite widespread distribution. Understanding the specific knowledge, socio-demographic, health system, and household-level factors that determine whether pregnant women use ITNs consistently is essential for designing effective targeted interventions. This study assessed these factors among pregnant women attending antenatal care (ANC) in the Kintampo North Municipality of the Bono East Region of Ghana.

Methods

A facility-based, descriptive cross-sectional study was conducted among 355 pregnant women attending ANC at three purposively selected health facilities in the Kintampo North Municipality. Participants were recruited consecutively using convenience sampling. Data were collected using a structured, interviewer-administered questionnaire covering knowledge of ITNs, socio-demographic characteristics, health system factors, and household-level factors. Knowledge was classified as good, fair, or poor. ITN use was classified as regular (sleeping under an ITN every or most nights) or irregular. Data were analyzed using Epi Info; chi-square tests assessed associations between independent variables and regular ITN use, with statistical significance set at $p < 0.05$.

Results

The majority of respondents (84.2%) demonstrated good knowledge of ITN use in pregnancy, while regular ITN utilization was reported by 67.6% indicating a significant knowledge-practice gap. A statistically significant association was found between knowledge level and regular ITN use ($\chi^2 = 9.59$, $df = 2$, $p = 0.01$), with regular use highest among women with good knowledge (70.6%) and lowest among those with poor knowledge (20.0%). Among socio-demographic factors, only the number of ANC visits was significantly associated with ITN use ($\chi^2 = 13.71$, $p = 0.001$): women with more than four visits had the highest regular usage (75.2%). No health system factor reached statistical significance, though women rating health worker education as excellent had the highest usage (74.0%) and those reporting consistent ITN supply had 5.0 percentage points higher usage. Among household factors, structural feasibility, having adequate physical space to hang an ITN — was the only significant predictor ($\chi^2 = 4.35$, $p = 0.037$), with 68.7% regular use among women with sufficient space versus 50.0% among those without.

Conclusions

While knowledge of ITN use is high among pregnant women in the Kintampo North Municipality, a substantial knowledge-practice gap persists. ANC frequency and household structural feasibility are the key modifiable

predictors of consistent use. Interventions should prioritize increased ANC attendance, ITN hanging infrastructure support at household level, and sustained supply chain reliability, alongside continued investment in high-quality health worker counselling during ANC visits.

Keywords: *insecticide-treated nets; ITN utilization; pregnant women; antenatal care; malaria prevention; knowledge–practice gap; Ghana; Kintampo North Municipality*

1 Background

Malaria in pregnancy constitutes one of the most significant preventable threats to maternal and neonatal health in sub-Saharan Africa. *Plasmodium falciparum* infection during pregnancy is associated with maternal anaemia, placental malaria, low birth weight, premature delivery, and increased risks of maternal and perinatal mortality (WHO, 2025). In Ghana, malaria accounts for a substantial proportion of ANC attendance, hospital admissions, and pregnancy-related morbidity and mortality, with an estimated 42% of pregnant women experiencing at least one episode of clinical malaria during a given pregnancy (Adu et al., 2020).

Among the core interventions recommended by WHO for malaria prevention in pregnancy, the consistent use of insecticide-treated nets (ITNs) provides both physical barrier protection and insecticidal killing of *Anopheles* mosquitoes, conferring direct protection to the pregnant woman and indirect protection to co-sleeping household members (Unwin et al., 2023; Okumu & Moore, 2021). A systematic review and meta-analysis by Demoze et al. (2024) estimated pooled ITN utilization among pregnant women in East Africa at approximately 57%, with wide variation across countries and settings. In Ghana, the 2022 Demographic and Health Survey reported an ITN use prevalence among pregnant women of 62.3% nationally, substantially below the 80% target established under the WHO Global Technical Strategy for Malaria 2016–2030 (Ghana Statistical Service, 2022).

The Kintampo North Municipality in the Bono East Region is a high-burden malaria setting situated in the forest-savannah transitional ecological zone, which supports year-round mosquito breeding and high perennial transmission intensity. Despite the distribution of ITNs through routine ANC services and periodic mass distribution campaigns, ITN utilization in the municipality has remained suboptimal (Sumaila et al., 2025; Owusu-Agyei et al., 2020). The determinants of this gap have been explored in several Ghanaian studies, which have identified knowledge deficits (Aboagye & Newton, 2023), socio-demographic barriers (Opoku et al., 2025), health system constraints (Asare et al., 2022), and household-level structural factors (Abdul-Manan, 2024) as contributing drivers. However, no study to date has simultaneously examined all four determinant categories within the specific context of the Kintampo North Municipality, leaving programme managers and policymakers without the locally disaggregated, multidimensional evidence needed to design targeted remedial interventions.

This study was conducted to fill that evidence gap by simultaneously assessing knowledge levels and examining socio-demographic, health system, and household-level factors associated with ITN use among pregnant women attending ANC in the Kintampo North Municipality. The findings are intended to inform the design of locally targeted strategies to reduce the knowledge–practice gap and increase consistent ITN use during pregnancy.

2 Methods and Materials

2.1 Study design and setting

A facility-based descriptive cross-sectional study design using a quantitative approach was employed. The study was conducted in the Kintampo North Municipality, Bono East Region, Ghana, a predominantly rural municipality with a 2021 census population of 156,693 situated within the forest-savannah transitional ecological zone, characterized by perennial malaria transmission and high ANC service utilization. Three health facilities with the highest ANC attendance volumes were purposively selected as study sites: Kintampo Municipal Hospital (a public district hospital), Glory Prince of Peace Hospital, and Publix Medical Hospital (both private facilities). Together, these facilities account for the majority of ANC visits in the municipality.

2.2 Study population and eligibility

The study population comprised pregnant women attending ANC at the three selected facilities during the data collection period. Eligible participants were pregnant women aged 18 years and above who had resided in the Kintampo North Municipality for at least six months prior to data collection and who provided written informed consent. Women who were severely ill and unable to participate in an interview, and visitors who did not ordinarily reside in the municipality, were excluded.

2.3 Sample size and sampling

Sample size was calculated using the Cochran (1977) formula: $n = Z^2pq/e^2$, where $Z = 1.96$ (95% confidence level), $p = 0.50$ (assumed ITN use prevalence, selected to maximize sample size), and $e = 0.05$. This yielded a minimum of 384 participants. After applying a finite population correction factor based on total monthly ANC attendance and adding a 10% non-response adjustment, the final required sample size was 355 participants. Proportionate allocation was used to distribute this sample across the three facilities based on their respective monthly ANC attendance volumes obtained from DHIMS-2. Within each facility, eligible pregnant women were recruited consecutively on ANC clinic days until the required facility-level quota was reached.

2.4 Data collection instrument and procedure

Data were collected using a structured, interviewer-administered questionnaire. For participants with adequate literacy, the questionnaire was self-administered with interviewer support available. The questionnaire was organized into five sections: (A) socio-demographic characteristics; (B) knowledge of ITNs and malaria; (C) ITN use status (dependent variable); (D) health system factors; and (E) household-level factors. The questionnaire was pre-tested with 25 pregnant women at a facility outside the study area; minor modifications to question wording and sequencing were made prior to full-scale data collection. Data collection was conducted by trained interviewers over ANC clinic days following completion of participants' routine ANC consultations.

2.5 Measurement of key variables

2.5.1 Knowledge of ITNs

Knowledge was assessed using a composite score derived from six items covering: awareness of ITNs and their purpose; knowledge that mosquitoes transmit malaria; belief that sleeping under an ITN prevents malaria; knowledge of recommended frequency of use (every night); knowledge of proper hanging and use; and prior receipt of ITN education during ANC. Total scores were categorized as: good knowledge (score ≥ 5 out of 6 correct), fair knowledge (score 3–4), and poor knowledge (score ≤ 2).

2.5.2 ITN utilization (dependent variable)

Utilization was assessed through self-reported data on sleeping behaviour under an ITN on the night preceding the interview and on habitual frequency of use. Women who reported sleeping under an ITN every night or most nights were classified as regular users; all others were classified as irregular users.

2.5.3 Data analysis

Data were entered into Microsoft Excel, cleaned, and exported to Epi Info Version 7.2 for statistical analysis. Descriptive statistics; frequencies and proportions were computed for all categorical variables and are presented in tables. Chi-square tests of independence were used to assess the statistical significance of associations between each independent variable and regular ITN use. Statistical significance was defined as $p < 0.05$. No multivariate modelling was performed given the sample size and the exploratory nature of the study.

2.5.4 Ethical considerations

Ethical approval and institutional permission were obtained from the Kintampo North Municipal Health Directorate and the administrations of the three participating health facilities prior to data collection. Written informed consent was obtained from all participants before interview commencement. Participation was entirely voluntary, and participants were informed of their right to withdraw at any time without consequence. All data were anonymized using unique participant codes and stored securely with access restricted to the research team. The study was conducted in accordance with the ethical principles of the Ghana Public Health Act, 2012 (Act 851) and the Declaration of Helsinki.

3 Results

Socio-demographic characteristics of respondents

A total of 355 pregnant women were enrolled. The majority (57.5%) were aged 18–28 years. Most were married (76.6%) and resided in urban areas (89.6%). Basic education was the most common educational level (53.0%), with 20.3% holding secondary education and 7.6% tertiary education. Christianity was the predominant religion (72.1%). With respect to obstetric characteristics, 38.9% were in their first pregnancy, 39.4% had two to three previous pregnancies, and 21.7% had four or more. More than half (53.8%) were in their third trimester, and 42.0% had attended more than four ANC visits during the current pregnancy.

Table 1: Socio-Demographic Characteristics of Respondents (n = 355)

Characteristic	Frequency (n)	Percentage (%)
Age group (years)		
18–28	204	57.5
29–38	106	29.9
≥39	45	12.7
Marital status		
Married	272	76.6
Single / Cohabiting / Other	83	23.4
Educational level		

No formal education / Primary	67	18.9
Basic/JHS	188	53.0
Secondary	72	20.3
Tertiary	27	7.6
Place of residence		
Urban	318	89.6
Rural	37	10.4
Religion		
Christianity	256	72.1
Islam / Other	99	27.9
Number of ANC visits		
1–2	75	21.1
3–4	131	36.9
More than 4	149	42.0
Regular ITN use		
Yes (regular users)	240	67.6
No (irregular users)	115	32.4

Source: Field data, 2026

3.1 Knowledge levels and association with ITN use

The knowledge assessment revealed that 84.2% of respondents had good knowledge of ITN use during pregnancy, 14.4% had fair knowledge, and only 1.4% had poor knowledge (Table 2). Overall regular ITN utilization was 67.6% (n=240). There was a statistically significant association between knowledge level and regular ITN use ($\chi^2 = 9.59$, df = 2, p = 0.01). Regular use was highest among women with good knowledge (70.6%), compared with 50.0% among those with fair knowledge and 20.0% among those with poor knowledge (Table 2).

Table 2: Knowledge Level and Association with Regular ITN Use (n = 355)

Knowledge Level	n (%)	Regular Use n (%)	Irregular Use n (%)	χ^2 / p-value
Good knowledge	299 (84.2%)	211 (70.6%)	88 (29.4%)	$\chi^2=9.59$, p=0.010
Fair knowledge	51 (14.4%)	26 (50.0%)	26 (50.0%)	
Poor knowledge	5 (1.4%)	1 (20.0%)	4 (80.0%)	
Total	355 (100%)	240 (67.6%)	115 (32.4%)	

Source: Field data, 2026

3.2 Socio-demographic factors and ITN use

Among all socio-demographic variables examined age, marital status, educational level, gravidity (number of pregnancies), gestational age, place of residence, religion, and occupation only the number of ANC visits showed a statistically significant association with regular ITN use ($\chi^2 = 13.71$, $df = 2$, $p = 0.001$) (Table 3). Women who had attended more than four ANC visits had the highest regular usage rate at 75.2%, compared with 67.9% among those with three to four visits, and 55.2% among those with one to two visits. No other socio-demographic variable was significantly associated with ITN use in this study population.

Table 3: Association between Socio-Demographic Factors and ITN Usage (n = 355)

**** Statistically significant at $p < 0.05$. Source: Field data, 2026**

3.3 Health system factors and ITN use

None of the health system factors examined reached statistical significance at $p < 0.05$ (Table 4). These factors included receipt of an ITN at ANC, supply chain consistency (whether ITNs were always available at the facility), quality of health worker education on ITNs, distance from home to facility, and whether health workers encouraged ITN use. Notwithstanding the absence of statistical significance, notable directional patterns were observed: women who rated health worker education as excellent had the highest regular use at 74.0%, compared with 63.1% among those who rated it as poor; and women who reported consistent ITN availability at the facility had a regular usage rate approximately five percentage points higher than those who did not.

Table 4: Association between Health System Factors and ITN Usage (n = 355)

Source: Field data, 2026. No variable reached statistical significance at $p < 0.05$.

Household factors and ITN use

Among household-level factors, household size, number of sleeping rooms, structural feasibility (having enough space to hang an ITN), spousal/family encouragement, heat discomfort, cultural beliefs, and ITN ownership only structural feasibility was significantly associated with regular ITN use ($\chi^2 = 4.35$, $df = 1$, $p = 0.037$) (Table 5). Women who reported having adequate space to hang an ITN in their sleeping room had a regular use rate of 68.7%, compared with 50.0% among those without adequate space. No other household factor reached statistical significance, although women who reported spousal or family encouragement had a higher regular use rate (69.1%) compared with those who did not (60.3%).

Table 5: Association between Household-Level Factors and ITN Usage (n = 355)

*** Statistically significant at $p < 0.05$. Source: Field data, 2026.**

4 Discussion

This study examined the knowledge, socio-demographic, health system, and household-level determinants of ITN use among pregnant women attending ANC in the Kintampo North Municipality, providing the first multidimensional assessment of these factors in this high-burden malaria setting. The core findings; high knowledge (84.2%) coexisting with significantly lower regular use (67.6%); ANC frequency and household structural feasibility as the two significant predictors have important theoretical and programmatic implications.

4.1 Knowledge-practice gap

The finding that 84.2% of respondents demonstrated good knowledge of ITN use, while only 67.6% were regular users, confirms a substantial knowledge-practice gap, a phenomenon consistently documented in the sub-Saharan African ITN literature. Aboagye and Newton (2023) reported awareness levels above 90% in an urban Ghanaian sample, with utilization substantially lower than awareness. Dun-Dery et al. (2022), in a mixed-methods study in northern Ghana, similarly documented that knowledge of ITNs was near-universal, yet consistent use remained constrained by practical barriers including heat discomfort, household crowding, and access issues. The statistically significant association observed between knowledge level and regular use ($\chi^2 = 9.59$, $p = 0.01$) with regular use progressively declining from 70.6% among women with good knowledge to 20.0% among those with poor knowledge demonstrates that knowledge does confer a meaningful but insufficient protective effect. This pattern is consistent with the Health Belief Model, in which perceived severity and perceived benefits (both components of knowledge) are necessary but not sufficient for health behaviour adoption: perceived barriers and self-efficacy must also be addressed (Dun-Dery et al., 2022). Interventions that invest only in knowledge-building without simultaneously addressing structural and practical barriers to use will continue to generate this gap.

4.2 ANC frequency as the critical socio-demographic predictor

The finding that ANC visit frequency was the only statistically significant socio-demographic predictor of regular ITN use ($\chi^2 = 13.71$, $p = 0.001$) is consistent with and extends the existing literature. The progressive dose-response pattern observed 55.2% regular use at 1–2 visits, 67.9% at 3–4 visits, and 75.2% at more than four visits reflects the cumulative effects of repeated health worker counselling, reinforced messaging, and multiple ITN receipt opportunities that ANC attendance generates. This finding aligns with the observations of Opoku et al. (2025), who found significant associations between ANC attendance and ITN use in a nationally representative Ghanaian sample, and with Sumaila et al. (2025), who identified ANC attendance as a key enabler of ITN use among pregnant women in the same municipality studied here. The absence of significant associations between ITN use and age, education, marital status, religion, or place of residence diverges from findings in some multi-country studies (Amouzou et al., 2021; Opoku et al., 2025) but is consistent with the observation that in settings where free ITN distribution through ANC is universal and knowledge levels are uniformly high, residual variation in utilisation is explained more by the dose of health system contact and household-level practicalities than by individual socio-demographic characteristics.

4.3 Health system factors: directional trends without significance

No health system variable reached statistical significance in this study, a finding that appears to diverge from a substantial body of literature identifying ANC-based ITN distribution and health worker counselling as strong predictors of utilisation (Asare et al., 2022; Nuñez et al., 2023). Two explanations deserve consideration. First, the high ANC-based ITN receipt rate in this study (81.4% reported receiving an ITN at ANC) may have created a ceiling effect that reduced the statistical discriminating power of health system factors: when nearly all women have been offered an ITN and educated about it, variation in provision quality alone accounts for less utilization variance.

Second, the directional patterns observed higher use among women rating health worker education as excellent (74.0%) versus poor (63.1%), and among women reporting consistent ITN supply (69.2%) versus inconsistent supply (65.3%) are programmatically meaningful even in the absence of statistical significance and are consistent with the findings of Pembe and Mbekenga (2020) and Zurovac and Larson (2021). These patterns suggest that quality improvement in health worker counselling and supply chain reliability remain

important programmatic priorities whose effect may become statistically demonstrable in larger studies with greater statistical power to detect moderate effect sizes.

4.4 *Structural feasibility as the key household predictor*

The finding that having adequate space to hang an ITN was the only statistically significant household-level predictor ($\chi^2 = 4.35$, $p = 0.037$) provides important, actionable evidence that aligns with and extends a nascent but growing literature on structural determinants of ITN use. Abdul-Manan (2024), in a study of pregnant women in Ghana's Middle Belt a context directly comparable to Kintampo North found that difficulty hanging ITNs due to housing structure constraints was a commonly cited barrier. Pinder and Bradley (2020) similarly documented structural housing barriers as significant determinants of ITN use in The Gambia, and Tizifa and Kabaghe (2021) identified structural constraints in Malawi. The absence of significant associations for heat discomfort (despite 40.0% of irregular users citing it as a barrier), spousal encouragement, and cultural beliefs in this study suggests that in the Kintampo North context, the physical infrastructure barrier may be more immediately actionable than the behavioural and social barriers. This has a direct programmatic implication: providing low-cost ITN hanging infrastructure such as rope, string, or hooks alongside ITN distribution at ANC could produce immediate and measurable improvements in consistent use. This intervention would be inexpensive, scalable, and directly aligned with the study's evidence.

Limitations

Several limitations of this study must be acknowledged. First, the cross-sectional design precludes causal inference between the identified predictors and ITN use. Second, self-reported data on sleeping behaviour are subject to social desirability bias respondents may have overreported ITN use, suggesting that the true regular use prevalence may be lower than the 67.6% reported. Third, the study was restricted to three health facilities with high ANC attendance volumes, which may introduce selection bias: women attending high-volume ANC facilities may be more health-seeking and better informed than those who rarely or never attend, potentially overestimating population-level knowledge and underestimating barriers to use. Fourth, no multivariate logistic regression was conducted, precluding estimation of independent predictors after adjusting for confounders. Future studies should address these limitations through the use of larger samples, a mixed-methods design to explore causal mechanisms qualitatively, and multivariate modelling to identify independent predictors and compute adjusted odds ratios.

5 **Conclusions**

This study demonstrates that while knowledge of ITNs is high among pregnant women attending ANC in the Kintampo North Municipality (84.2% good knowledge), a significant knowledge–practice gap persists, with regular use reported by only 67.6% of respondents. Knowledge level, ANC frequency, and household structural feasibility (having adequate space to hang an ITN) are the principal determinants of consistent ITN use in this setting. These findings point to three priority programmatic actions: first, intensifying efforts to increase ANC attendance frequency, given the dose-response relationship between ANC visits and ITN use; second, addressing household structural barriers to ITN hanging through the provision of low-cost hanging infrastructure alongside routine ITN distribution; and third, sustaining and improving the quality of health worker ITN counselling during ANC contacts, given the directional if not statistically significant association between counselling quality and regular use. These interventions, targeted to the specific operational context of the Kintampo North Municipality, have the potential to close the persistent gap between ITN knowledge and consistent practice, and to contribute to the municipality's progress toward the WHO target of 80% ITN use among pregnant women in high-transmission settings.

Abbreviations

ANC: Antenatal care | AOR: Adjusted odds ratio | CHPS: Community-based Health Planning and Services | DHIMS-2: District Health Information Management System Version 2 | GHS: Ghana Health Service | ITN: Insecticide-treated net | LLIN: Long-lasting insecticidal net | WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Permission was obtained from the Kintampo North Municipal Health Directorate and the administrations of the three participating facilities. Written informed consent was obtained from all participants. The study conformed to the principles of the Ghana Public Health Act, 2012 (Act 851) and the Declaration of Helsinki.

Consent for publication

Not applicable. No individual-level identifying data are included in this manuscript.

Availability of data and materials

The datasets generated and analyzed during this study are available from the corresponding author on reasonable request, subject to applicable data governance requirements.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MK conceived and supervised the study, provided intellectual and methodological oversight throughout, and led the development of this manuscript for publication. AED, OJ, PAW, and SAD designed and administered the data collection instrument, conducted fieldwork, collected and entered data, performed the initial analysis, and drafted the original student dissertation. All authors reviewed and approved the final manuscript.

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