

MALARIA CONTROL WITH BED NETS; ASSESSMENT OF CORELATES OF ITS EFFECTIVENESS FOR PREGNANT WOMEN IN KWAEBIBIREM

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Abstract

Objective: This study aimed to investigate correlates of the effectiveness of Insecticide-treated Bed Nets (ITNs) for prevention of malaria through pregnancy till delivery.

Methodology: The hospital-based cross sectional study enrolled 413 Antenatal Care (ANC) attendants at the maternity ward of the Kade government hospital. Differential patterns of use of ITNs among women who had malaria during pregnancy and women who did not have malaria during pregnancy were compared across various variables. Self-reported information by participants were objectively validated from maternal health record books, patient folders and other relevant maternal health registers.

Results: ITNs are an important malaria prevention and control intervention among pregnant women who report using them during pregnancy. The period prevalence of malaria through pregnancy however

remained high among adolescents irrespective of ITN use while tertiary educational background and exposure to Intermittent Preventive Therapy with Sulfadoxine-pyrimethamine (IPTp-SP) reduced risk of malaria in pregnancy irrespective of ITN use.

Conclusion: Malaria morbidity was generally higher among pregnant women who did not use bed nets during pregnancy despite variations by maternal age, area of residence, gestational age, occupation type, marital status, parity, maternal educational background and IPTp-SP status.

Recommendations: Strategies aimed to reduce the period prevalence of malaria during pregnancy should be intensified particularly targeting adolescents. Barriers to sustained universal access to ITNs and IPTp-SP should be eliminated while policies aimed to increase formal education should be prioritized.

Key Words: Malaria in pregnancy, effectiveness, mosquito bed nets.

Introduction

The mutually aggravating condition of malaria in pregnancy constitutes an obstetric, social and medical problem whose solution calls for multidisciplinary and multidimensional ameliorative interventions.¹ Pregnant women and children ≤ 5 years comprise the main risk group for malaria with the two sub populations accounting for an estimated 80% of the disease's mortality in Africa.¹ Malaria's associated perinatal mortality, (largely attributable to infection with *P. falciparum* species),² is an estimated 1500 per day and remains an established predictor of low birth weight in 20-40% of babies born in endemic areas.¹ While placentae of pregnant women may have high parasitemia causing anemia even in the documented absence of peripheral parasitemia, malaria in pregnancy is usually asymptomatic in high transmission settings where levels of acquired individual immunity tend to be high.² Control programs largely aim to reduce the disease's associated morbidity and mortality by attaining a low prevalence that ceases to be a public health problem; this defines 'malaria control', achieved through several treatment and prevention interventions, the choice of which is

determined by the level of transmission.³ Preventive interventions include diagnosis and treatment, the use of Insecticide-treated Bed Nets (ITNs), Intermittent Preventive Treatment during pregnancy (IPTp), Intermittent Preventive Treatment during infancy (IPTi), Indoor Residual Spraying (IRS), larval control and other vector control interventions while efforts to develop effective licensed vaccines are far advanced, currently undergoing pilot implementation in selected sites.³ Comprising the second most common cause of infectious disease-related mortality globally after tuberculosis, malaria during pregnancy accounts for over 10,000 maternal and 200,000 perinatal deaths per year out of an estimated twenty-five million at risk sub population.⁴

Bed nets, among other control and preventive interventions, have been used as physical barriers to prevent bites since the sixth century BC but extensively for malaria in the mid-1980s.⁵ Combinations of insecticidal and irritant effects of the pyrethroids with the physical barrier of the bed net helps reduce vector density, sporozoite rates, malaria parasite prevalence, disease incidence, and mortality when evaluated both in clinical trials and as part of routine public health programs in areas where principal malaria vectors are largely endophagic, (biting indoors), and endophilic, (resting indoors).⁵ ITNs therefore comprise the cornerstone of malaria prevention in Africa.⁵ An estimated 300 million ITNs were distributed in Africa 2010-2012 at a cost of more than US\$1 billion for their

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Conflict of Interest: None Declared

purchase and distribution.⁵ Prevalence of malaria in pregnancy remains high despite broad and continuous distribution of treated bed nets among other interventions particularly targeting pregnant women and children under 5 years. Mean period prevalence of malaria among pregnant women, 2012-2018, accessing care at the Kade district hospital, Kwaebibirem, was 5%. Together with a commensurately high mean perinatal mortality burden of 12 per 1000 births over the same period, these outcomes are of public health concern (despite no currently established correlations between the municipality's maternal malaria prevalence and its perinatal mortality. This study therefore aimed to investigate correlates of the effectiveness of the use of bed nets for the prevention of malaria through pregnancy till delivery in Kwaebibirem, Eastern Ghana.

Methods

This hospital-based cross sectional study, carried out at the Kade government hospital, enrolled a total of 413 participants. The study enrolled women who reported having had malaria at any time during pregnancy and compared them with women who indicated not suffering from malaria at any time during pregnancy; 'malaria at any time during pregnancy' status, reported by participants, was objectively validated with the participants ANC booklets, personal folder and other relevant registers. Malaria at any time during pregnancy was limited to the pregnancy preceding the current delivery for which the client had been admitted to the maternity unit of the hospital. 'Woman' operationally defined all participants i.e. parturients who delivered at any gestational age after 28 completed weeks of gestation, irrespective of maternal age. Participants' self-reported ownership of a bed net was objectively validated from their maternal and child health record booklets indicating a bed net was issued at ANC. This was used as a proxy to objectively validate bed net use among women who reported having nets and using them through pregnancy. Married women comprised those reporting being currently married or cohabiting while single women included the currently unmarried or divorced. Participants were interviewed with a structured questionnaire, pre-tested at the maternity unit of the St. Dominic's Hospital to eliminate ambiguity. Non-ANC attendants were excluded as the study posited that there was no source document to objectively validate their self-reported 'malaria at any time during pregnancy' status, the main outcome of interest. Client folders therefore also comprised key source documents for data abstraction and validation on participants. Urban or rural status of area of residence was defined consistently with specifications of Ghana Statistical Service that define rural areas as towns or communities of less than 5000 population. The sample size was calculated using open epi while data were analyzed with epi info 3.5.4.

Results

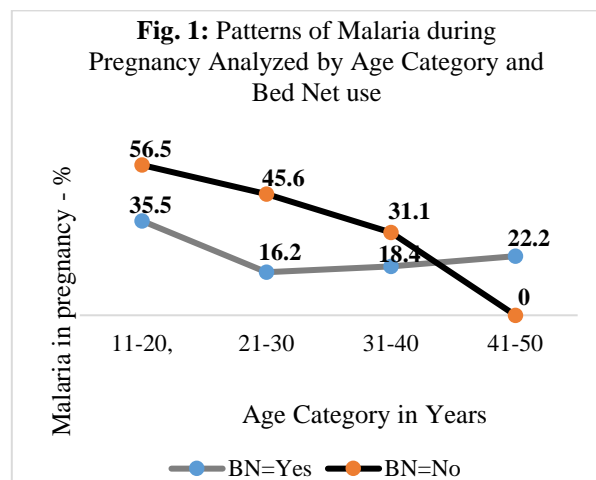
The period prevalence of malaria at any time during pregnancy among women who attended ANC through pregnancy till delivery was 30.8%. The mean age of women who had malaria at any time during pregnancy was 26.3 years; their ages were characterized by high variance of 46.3 and a standard deviation (SD) from the mean age of ± 6.8 . Ages of women who were not diagnosed with malaria at any time during pregnancy varied marginally with a mean age of 28.3 years, variance of 45 and a SD insignificantly different from women who had malaria at any time during pregnancy. The mean age of women who, despite reporting using bed nets, had malaria at any time during pregnancy, was marginally higher than women who had malaria at any time during pregnancy who reported not using bed nets. The mean age of women who did not have malaria at any time during pregnancy who reported using bed nets was insignificantly higher than that of women who reported not using bed nets and had malaria at any time during pregnancy. [Table 1]

Table 1: Age-Specific Measures of Central Tendency for Malaria during Pregnancy

Central Tendency	Malaria During Pregnancy=Yes (%)		Malaria During Pregnancy=No (%)	
	BN=Yes	BN=No	BN=Yes	BN=No
Mean Age	28.2	25.1	28.8	27.1
SD	7.6	5.9	6.5	6.9
Variance	59.0	35.9	42.3	48.1

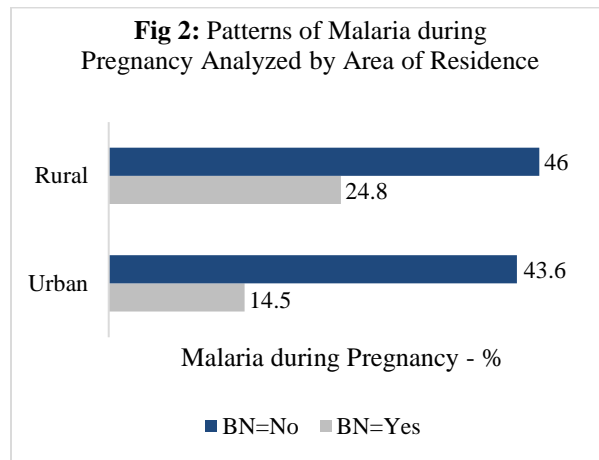
BN=Bed Nets

Women aged 11-12 years recorded the highest period prevalence of malaria through pregnancy irrespective of whether they reported using a bed net or not. While malaria's morbidity burden declined steadily with increasing age among women who reported not using bed nets through pregnancy, it observably plateaued after declining from 35.5% through 16.2% to 22.2% among women who reported using bed nets. [Fig 1]



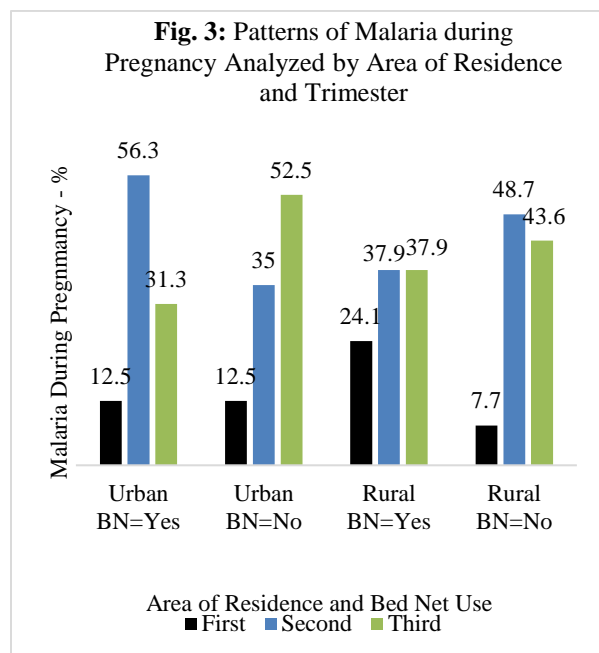
BN=Bed Nets

Women resident in rural communities who reported using bed nets still recorded a higher period prevalence of malaria through pregnancy than women resident in urban communities who also reported using bed nets through pregnancy. [Fig. 2]



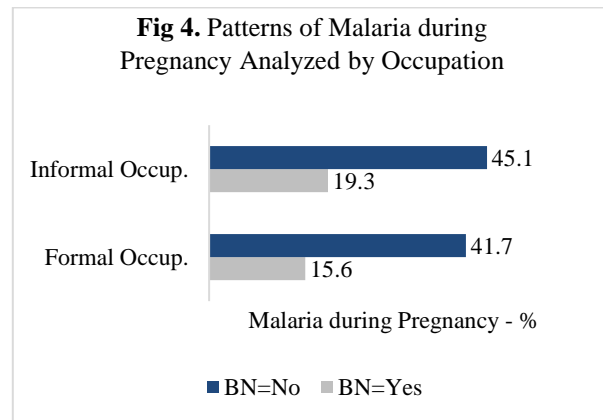
BN=Bed Nets

Further analyses of patterns of distribution of malaria at any time during pregnancy stratified by trimester of occurrence showed that malaria's case burden among urban residents who used bed nets was highest in the second trimester; the morbidity burden among urban residents who reported not using bed nets was notably highest in the third trimester. Among women resident in rural communities who used bed nets, the highest period prevalence occurred in the second and third trimesters while the disease burden among women resident in rural communities who did not use bed nets notably peaked in the second trimester. [Fig. 3]



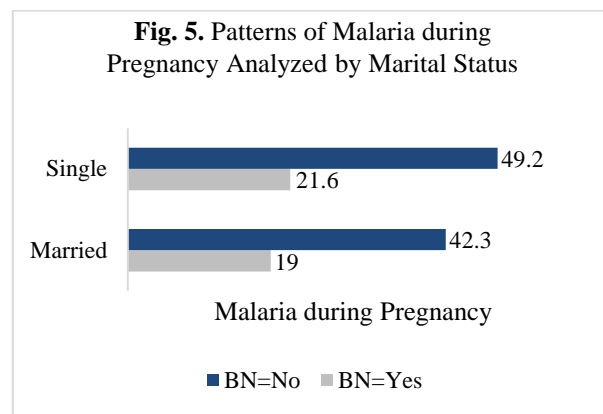
BN=Bed Net

The morbidity burden of malaria at any time during pregnancy was observably higher among women engaged in informal occupations for both groups of women who used bed nets and those who reported not using bed nets. [Fig. 4]



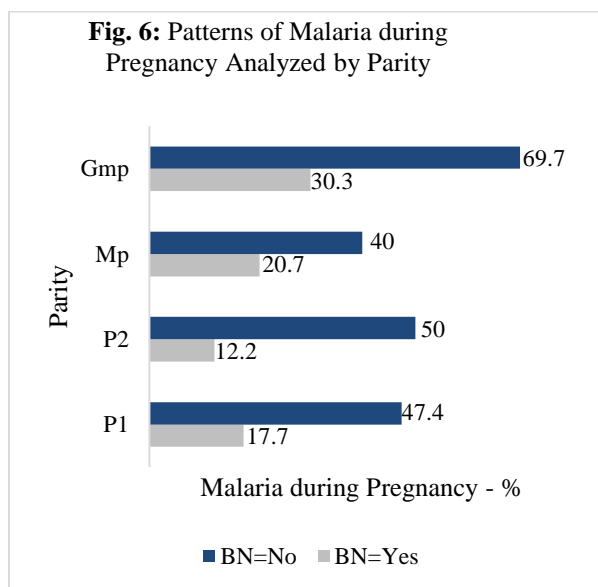
BN=Bed Net

Though the malaria morbidity burden at any time during pregnancy remained comparatively higher among women who reported not using bed nets through pregnancy, analyses by marital status indicated that it was generally higher among single women irrespective of bed net use. [Fig. 5]



BN=Bed Net

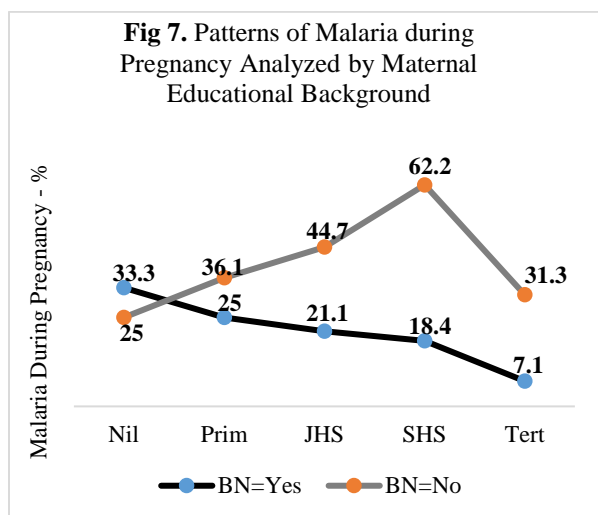
The mean parity of women who had malaria at any time during pregnancy and women who did not have malaria through pregnancy varied insignificantly i.e. 2.73 and 2.71 respectively. Malaria's morbidity burden at any time during pregnancy analyzed by parity further showed a higher period prevalence among women who reported not using bed nets through pregnancy irrespective of the parity. Malaria's morbidity burden among women who reported using bed nets through pregnancy and those who did not, with the exception of multiparous women, showed a rising trend from uniparous through to grand multiparous women. [Fig. 6]



BN=Bed Net, P1=Para 1, P2=Para 2, Mp=Multipara, Gmp=Grandmultipara

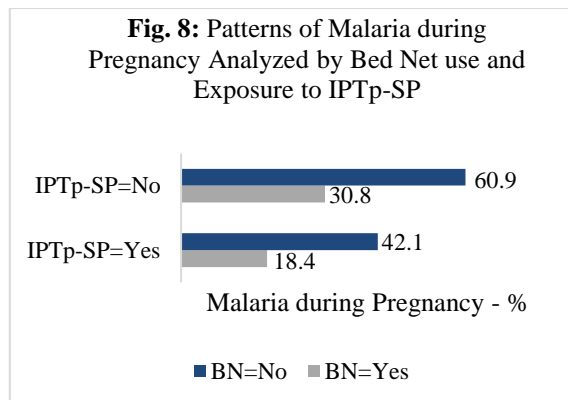
The morbidity burden of malaria at any time during pregnancy analyzed by parity and stratified by trimester showed a consistently higher case burden among women who reported not using bed nets through pregnancy particularly in the third trimester irrespective of parity. Grand multiparous women in the first trimester who reported using bed nets during pregnancy notably did not have malaria. [Table 2.0]

Malaria at any time during pregnancy analyzed by a woman’s highest level of education attained consistently showed that women who reported not using bed nets during pregnancy accounted for a comparatively higher period prevalence of malaria during pregnancy than women who reported using them. Women of tertiary educational background who reported using bed nets through pregnancy observably had the lowest period prevalence of malaria during pregnancy irrespective of bed net use. [Fig. 7]



BN=Bed Net, Nil=No Education, Prim=Primary, JHS=Junior High School, SHS=Senior High School, Tert=Tertiary

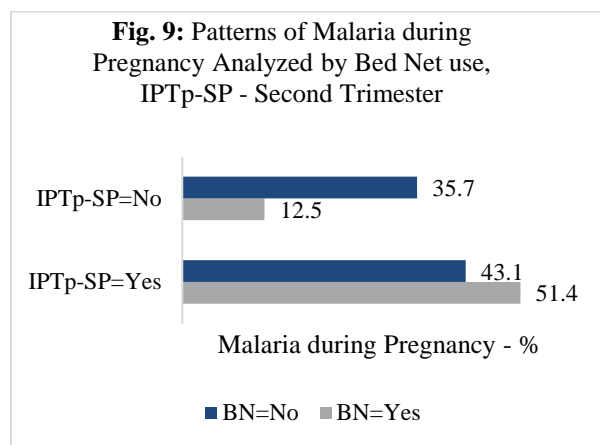
Malaria’s morbidity burden among women who differentially used bed nets through pregnancy analyzed by their exposure to the presumptive and prophylactic treatment of IPTp-SP showed a higher period prevalence of malaria during pregnancy among women who reported not using bed nets, irrespective of exposure to the IPTp-SP. Malaria’s morbidity burden was however notably significantly lower among women who were exposed to IPTp-SP and also reported using bed nets to prevent mosquito bites - an estimated prevalence reduction of about 12.4% (i.e. from 30.8 to 18.4%). [Fig. 8]



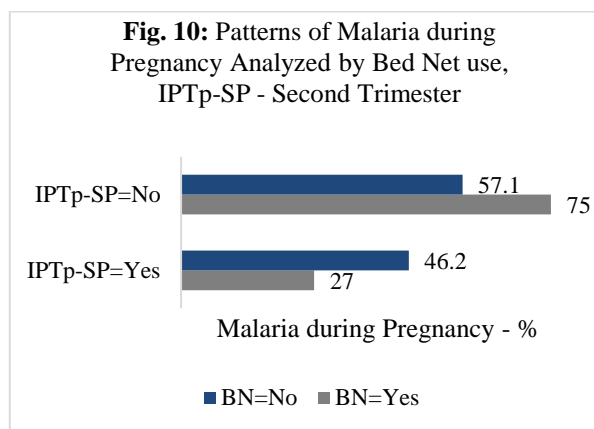
BN=Bed Net

Women who reported owning bed nets were subjectively investigated for use of the nets. Analyses of this variable showed that 19.8% of women who reported owning bed nets had malaria during pregnancy compared with about 44.5% of women who reported not owning bed nets and had malaria at any time during pregnancy. Further subjective investigation of bed net usage and not only ownership still however suggested that malaria’s morbidity burden at any time during pregnancy remained higher among women who reported owning bed nets but were not investigated for sustained usage of the nets through pregnancy i.e. 24.5% and 47.5% respectively.

Women who had malaria at any time during pregnancy were further investigated for patterns of occurrence of malaria by trimester and use of bed nets stratified by exposure to routine IPTp-SP presumptive malaria treatment. This aimed to study malaria’s morbidity burden among women differentially exposed to IPTp-SP and bed nets. An estimated 12.5% of women, not exposed to IPTp-SP in the first trimester, had malaria during pregnancy. IPTp-SP within the policy framework typically starts in the second trimester. At least 51.4% of women who reported using bed nets during pregnancy and were also exposed to IPTp-SP had malaria during that gestational period compared with 43.1% of women who had malaria and reported not using bed nets but were exposed to IPTp-SP during pregnancy. [Fig. 9 and 10]



BN=Bed Net



BN=Bed Net

Table 2. Prevalence of Malaria during Pregnancy Analyzed by Trimester of Gestation and Parity

Parity	Malaria Morbidity by Trimester (%)					
	First		Second		Third	
	BN=Yes	BN=No	BN=Yes	BN=No	BN=Yes	BN=No
Para 1	0.0	3.8	54.5	42.3	45.5	53.8
Para 2	33.3	13.6	33.3	40.9	33.3	45.5
Mp.	17.6	18.2	52.9	40.9	29.4	40.9
Gmp	40.0	0.0	30.0	50.0	30.0	50.0

BN=Bed Net, P1=Para 1, P2=Para 2, Mp=Multipara, Gmp=Grandmultipara

Discussion

Malaria, a mutually aggravating condition in pregnancy comprises an obstetric, social and medical problem whose solution calls for multidisciplinary and multidimensional ameliorative interventions.¹ The period prevalence of malaria during pregnancy of 30% among women who attended ANC remains high as it has established associations with adverse obstetric outcomes e.g. maternal anemia, low birth weight, preterm labor, maternal and perinatal mortality etc. The mean age of women who had confirmed malaria at any time during pregnancy and those who did not varied insignificantly irrespective of differential bed net use between the two groups. The period prevalence of malaria at any time during pregnancy remained highest for the group of women aged 11-20 years irrespective of bed net use. The malaria morbidity burden for women who reported not using bed nets reduced inversely with increasing age and no case was recorded among women of advanced maternal ages i.e. group 41-50 years. The prevalence among women who reported using bed nets during pregnancy was comparably lower through the various age groups ranging between 11 to 50 years. A downward trend was observed among women who did not use bed nets but however slightly increased with increasing age for women aged 21 to 50 years. Maternal age constitutes one of the established maternal factors associated with increased risk of malaria during pregnancy. The higher risk of malaria infection among younger women, especially adolescents, (primigravidae and multigravidae) than older women independent of parity, comprises a finding well established in extant

evidence base.⁶ The comparatively high period prevalence of malaria during pregnancy observed among adolescents was not significantly ameliorable by the use of bed nets as compared with women of older age groups.

The prevalence of malaria during pregnancy remained higher among rural residents than urban residents consistent with extant evidence on distribution patterns of malaria infection during pregnancy.^{7, 8} This therefore implied that bed nets averted more malaria infections among urban residents than rural residents. However, irrespective of this variation in urban-rural malaria infection prevalence, bed nets averted the infection among significantly higher proportions of pregnant women who reported using them at any time during pregnancy than not for both urban and rural residents.⁹ The period prevalence among urban residents who reported using bed nets was observably highest in the second trimester while it was notably highest in the third trimester among urban residents who reported not using bed nets. The disease prevalence was highest in the second and third trimesters among rural residents who reported using bed nets during pregnancy while it remained highest in the second trimester among rural residents who reported not using bed nets. This suggested that the morbidity burden of malaria infection at any time during pregnancy varied insignificantly between urban residents who used bed nets and those who did not.

Women who were engaged in formal occupations recorded a comparatively lower malaria case burden than women engaged in informal occupations. Despite the notable variations in period prevalence of malaria

during pregnancy for women of the two occupation categories, the use of bed nets showed wider variations between women who used them and those who reported not using them. Analyses by occupation, (a proxy for individual socioeconomic status), weakly pointed to the importance of socioeconomic factors in differential patterns of occurrence of malaria at any time during pregnancy. There however currently exists limited evidence on the importance of socioeconomic variables on malaria risk. Interventions aimed to increase the number of health centers in rural communities and improve access to care, improving the economic status and increasing awareness about malaria prevention should therefore remain a priority for malaria control.¹⁰ On the basis of formal occupation, (a proxy measure for individual socioeconomic status), being linked to reduced malaria period prevalence, attainment of objectives of community based interventions seeking to generally improve standards of living, access to healthcare facilities and health awareness may significantly impact malaria control.¹¹ A comprehensively clear understanding of the effects of housing structure, education, occupation, income and wealth on malaria risk can help to better design socioeconomic interventions to control the disease.¹²

Findings suggesting higher malaria period prevalence among single pregnant women than married or cohabiting pregnant women are likely explained by the comparatively higher proportion of younger women (with a therefore higher likelihood to be single) among unmarried women. Established evidence indicates adolescence independently bears higher risk for malaria infection during pregnancy. The mean age of married women was 30 years compared with a mean age of 22 years for women not married and not cohabiting at the time of the study. Findings also indicated that married or cohabiting women marginally used bed nets more than single women. Though malaria's period prevalence remained high among women who did not use bed nets irrespective of parity, its morbidity burden showed a rising trend among the two groups of women who used bed nets and those who did not. Despite the lack of consistent evidence on associations in extant literature between malaria during pregnancy and parity, it remains conceivable that with repeated pregnancies (likely associated with established repeated subclinical malaria infections/parasitemia), multiparous and grand multiparous women should have a declining period prevalence of malaria during pregnancy resulting from acquired partial malaria immunity.^{13, 14} This was not observed in this study and should be prioritized for future research.

The impact of maternal education in prevention of malaria during pregnancy has been emphasized by some studies indicating low maternal educational background was associated with the most significantly increased risk of malaria during pregnancy. Such

evidence indicate that low education independently remains a risk factor for malaria infection during pregnancy.¹⁵ Consistently with findings of extant evidence that have emphasized important associations between malaria during pregnancy and maternal education, an inverse relationship between maternal educational background and malaria during pregnancy was established for both women who reported using bed nets during pregnancy and those who did not. Tertiary educational background remained importantly linked with reduced risk of malaria infection during pregnancy even without the use of bed nets as a sharp drop in malaria morbidity was observed among women of tertiary educational background who reported not using bed nets through pregnancy.

Intermittent preventive therapy with sulphadoxine-pyremethamine, IPTp-SP, remains a policy-prescribed intervention importantly linked with risk reduction of malaria infection during pregnancy, an established association in extant evidence base.²⁰ The period prevalence of malaria during pregnancy for women exposed to IPTp-SP yet reporting not using bed nets through pregnancy remained notably lower than that of women who did not use bed nets through pregnancy and were not exposed to IPTp-SP, the presumptive prophylactic malaria treatment. The precise magnitude of preventive effect i.e. risk difference between exposure to IPTp-SP and the use of bed net through pregnancy should however further be comprehensively investigated in future studies to facilitate establishment of the quality of the statistical relationships between the two i.e. synergistic or complementary using analytic epidemiological studies. Women who reported owning bed nets were subjectively investigated for use of the nets. This was aimed to subjectively investigate the differences between owning a bed net and actually using it. Analyses of this variable showed that 19.8% of women with bed nets had malaria during pregnancy compared with about 44.5% of women without bed nets who had malaria at any time during pregnancy. Further subjective investigation of bed net usage and not only ownership still however suggested that malaria's morbidity burden during pregnancy remained higher among women who reported owning bed nets but were not further investigated for usage of the nets i.e. 24.5% and 47.5% respectively. Future research should prioritize establishment of the risk difference between ownership and usage.

Exposure to IPTp-SP remained importantly linked to reduced risk of malaria during pregnancy. This comprises a second trimester policy directive that prescribes administration of an antimalarial for preventive as well as curative purposes in malaria endemic areas of the world. Women who were exposed to IPTp-SP during pregnancy, irrespective of bed net use, had a comparatively reduced period prevalence of malaria during pregnancy; the morbidity burden of malaria infection during pregnancy observably

remained comparatively lower among women who reported not using bed nets during pregnancy but were exposed to the IPTp-SP malaria prevention and control intervention than women who reported not using bed nets and were further not exposed to IPTp-SP. Differential exposure to IPTp-SP among pregnant women during ANC constitutes a challenge inherent in the prescription criteria more than an issue of differential compliance.

Observations of occurrence of malaria during pregnancy by trimester and exposure to IPTp-SP further suggested that the malaria risk reduction associated with exposure to IPTp-SP was not emphasized in the second trimester as malaria prevalence was observably higher among women who were exposed to IPTp-SP during pregnancy than those who were not. The third trimester contrarily recorded a higher malaria case burden among women who were not exposed to IPTp-SP during pregnancy. The protective effect of IPTp-SP combined with bed nets was therefore more pronounced in the third trimester than second. The first trimester was not reviewed for this variable as IPTp-SP, within the context of its policy framework, typically commences in the second trimester i.e. at about sixteen completed weeks of gestation.

Conclusions

Malaria, a mutually aggravating condition with pregnancy, remains an obstetric, social and medical problem whose solution calls for a multidisciplinary and multidimensional interventions.¹ An estimated 30% of women who attended ANC during pregnancy had malaria during pregnancy. The mean age of women who used bed nets and did not have malaria during pregnancy was marginally higher than that of women who did not use bed nets and had malaria during pregnancy. The highest period prevalence of malaria during pregnancy was observed among women aged 11-20 years irrespective of bed net use. The period prevalence of malaria was higher among rural residents who used bed nets during pregnancy than urban residents who also used bed nets through pregnancy. The malaria morbidity burden among urban residents who used bed nets was highest in the second trimester and remained notably highest in the third trimester among urban residents who did not use bed nets. The highest malaria period prevalence among rural residents who used bed nest was in the second and third trimester while it remained highest in the second trimester among rural residents who did not use bed nets.

Women engaged in informal occupations, irrespective of bed net use, recorded a higher malaria morbidity burden during pregnancy. Women who reported not being married had a comparatively higher malaria morbidity burden during pregnancy irrespective of bed net use. Though the period prevalence of malaria during pregnancy was observably higher among women who reported not

using bed nets irrespective of parity, the disease burden weakly showed a rising trend with increasing parity as grand multiparous women recorded the highest period prevalence. For women who used bed nets, the prevalence of malaria during pregnancy reduced steadily with increasing maternal education while it increased with increasing maternal education for women who did not use bed nets; Tertiary educational background however reduced risk of malaria in pregnancy irrespective of bed net use. Exposure to IPTp-SP remains important for prevention of malaria during pregnancy and its associated adverse outcomes.

Recommendations

Research should consistently prioritize identification of specific factors associated with increased risk of malaria during pregnancy among adolescents, a sub population that independently comprises a high risk group during pregnancy despite the myriad of current preventive interventions. Factors contributing to higher period prevalence of malaria during pregnancy among rural residents and grand multiparous women irrespective of exposure to bed nets should be further investigated together with the influence of socioeconomic factors on risk of malaria infection during pregnancy. Policies aimed to increase literacy in the general population should be prioritized as education has an established broad association with reduced incidence of disease. Strategies aimed to ensure increments of IPTp-SP coverages among pregnant women together with bed net distribution at various service delivery points in various districts in Ghana should be intensified towards enhancement of malaria infection risk reduction. Future research should prioritize investigation of differences in the period prevalence and risk difference of malaria during pregnancy among women who owned bed nets and women who, not only owned bed nets, but were further investigated for usage.

Acknowledgements

I wish to acknowledge the support of the management of Kade Government Hospital and Eastern Regional Director of Health Service.

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