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Effect of using Insecticide Treated Nets [ITNs] on seasonality dynamics of malaria prevalence among expectant mothers

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ABSTRACT

Insecticide-treated nets (ITNs) for personal protection against mosquito bites have proven to be practical, highly effective and cost effective intervention against malaria infection. Despite the report that ITNs have high impact on reduction of vectors of malaria, sporozoite rates, morbidity and mortality in pregnancy, there are known barriers to bed net ownership and use during pregnancy. This study aimed at determining the effect of using insecticide treated nets on seasonality dynamics of malaria prevalence among expectant mothers so as to manage this tropical killer disease. This research work adopted a longitudinal study design and was conducted at Bumula sub-County Hospital of Bungoma County. The sample size was 228 expectant mothers attending antenatal clinic at the hospital. Data on net ownership verses usage, parity, and socio-economic background was collected using a structured questionnaire. Parasitological tests for malaria parasites were carried out using peripheral blood samples obtained from finger pricks of the expectant mothers. Field's stain was used for microscopic determination of malaria parasites. Relationship between net ownership and malaria infection rates was determined using a Chi-square test. A t-test was used to show the difference in infection rates during the rainy and dry season among expectant mothers. There was significantly higher level of long-lasting net ownership in the sampled population ($P< 0.05$). In the study population, 60.5% of expectant mothers possessed nets and had significantly less malaria infection rates than those who did not own nets, ($P < 0.05$). The highest percentage of the mothers acquired bed nets from the antenatal clinic (80.9%). Malaria infection rates were significantly higher during the rainy season than in the dry season ($P < 0.05$). The findings indicated that increased access to insecticide treated nets is required to lower the risk of pregnant women being infected with malaria. The Bungoma county Government should carry out free ITNs distribution campaigns during the rainy season and enhance health education to families within the villages.

Key words:

Insecticide Treated Nets [ITNs], seasonality dynamics, malaria prevalence, expectant mothers.

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Introduction

Sixty out of 400 known species of *Anopheline* mosquitoes have been proved as vectors of human malaria (Coetzee, 2004). *Anopheles gambiae* and *An. funestus* complexes are the principal vectors of malaria in Africa (Coetzee, 2004). *Anopheles gambiae* and *An. arabiensis* are found almost throughout Kenya (Minakawa *et al.*, 2002) where *An. gambiae* complex and *An. funestus* are the major malaria vectors. Malaria is widespread in the tropical and sub-tropical regions of the world, with 107 countries and territories having areas at risk of transmission containing close to 50% of the world`s population (Hay *et al.*, 2004). The global malaria burden is not evenly distributed and sub-Saharan Africa accounts for 90% of global malaria cases (WHO, 2002). Estimates of the global *Plasmodium* morbidity burden have increased in number to 515 million cases, with Africa suffering the vast majority of this fold (Snow *et al.,* 2005).

Malaria arises from an infection by any of the five species of the genus *Plasmodium* namely*; Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale*, *Plasmodium vivax* and *Plasmodium knowlesi (*Snow *et al.,* 2005*)*. Apart from anaemia the parasites cause a variety of adverse consequences that include; accumulation of parasites in the placenta, foetal parasites exposure, congenital infection, infant anaemia, infant morbidity and mortality as well as maternal death (Meshnick, 2007). The parasite is transmitted to humans through a bite of an infected female mosquito of the genus *Anopheles* (WHO, 2014). Malaria is endemic in the Bungoma Referral Hospital of Western Kenya, transmission occurs throughout the year with two seasonal peaks reflecting the rainfall pattern (Ter Kuile *et al*, 2003). The disease is the most diagnosed in outpatient health facilities within the County and the principal cause of death at the County hospital (Bungoma Referral Hospital Health Management Team, 2000).

In Bungoma County, malaria prevalence rate across all ages is upto 75%, and accounts for 39% of outpatients' morbidity and 42% of inpatient morbidity while inpatient mortality of 36% is directly caused by malaria (Bungoma Referral Hospital Health Management Team, 2000). Effects of malaria in pregnancy can be maternal anaemia, stillbirth, low birth weight, or even neonatal death (WHO, 2006). Despite the report that ITNs have high impact on reduction of malaria vector densities, sporozoite rates, morbidity and mortality in expectant mothers, there are known barriers to bed net ownership and use during pregnancy (Opiyo *et al.*, 2007). In line with WHO recommendation for protection of malaria in pregnancy, MoPHS in Kenya adapted the treatment of clinical malaria, use of ITNs and Intermittent Preventive Treatment (IPT) to reduce the burden of malaria in pregnancy (WHO, 2010;

DoMC *et al.*, 2009). The study investigated effects of insecticide treated bed nets on prevalence of malaria among expectant mother.

To date, no studies have addressed the intervention of ITNs on the prevalence of malaria in pregnancy or whether changes in malaria incidence have occurred that might be related to ITNs use among pregnant women as in many areas where malaria is a problem, mosquitoes are found throughout the year with density peaks coinciding with rainy season.

Materials and methods

Study design

The study design was a hospital based longitudinal study, where expectant mothers reporting for ANC were recruited to participate in the study. The research work was conducted during the short rainy season from August – October and dry season November-December 2010.

Study area and population

The study was conducted at the Bumula Sub-County hospital in Bumula Sub-county of Bungoma County (Fig 1.0). The Sub-county covers about 347.7 km^2. It has a population of 178,897 of which about 92,669 are females and 86,228 are males (Government of Kenya National Bureau of Statistics, 2010). The Sub-county receives rainfall which varies between 1200 to 2000mm per annum. It's received in two seasons, from March to June and August - October, Moreover the Sub-county also experiences two dry seasons from January-March and November-December. The annual temperature ranges from 24°C - 31°C, and the average humidity is greater than 80%. The elevation varies between 1100 and 3000 metres above sea level.

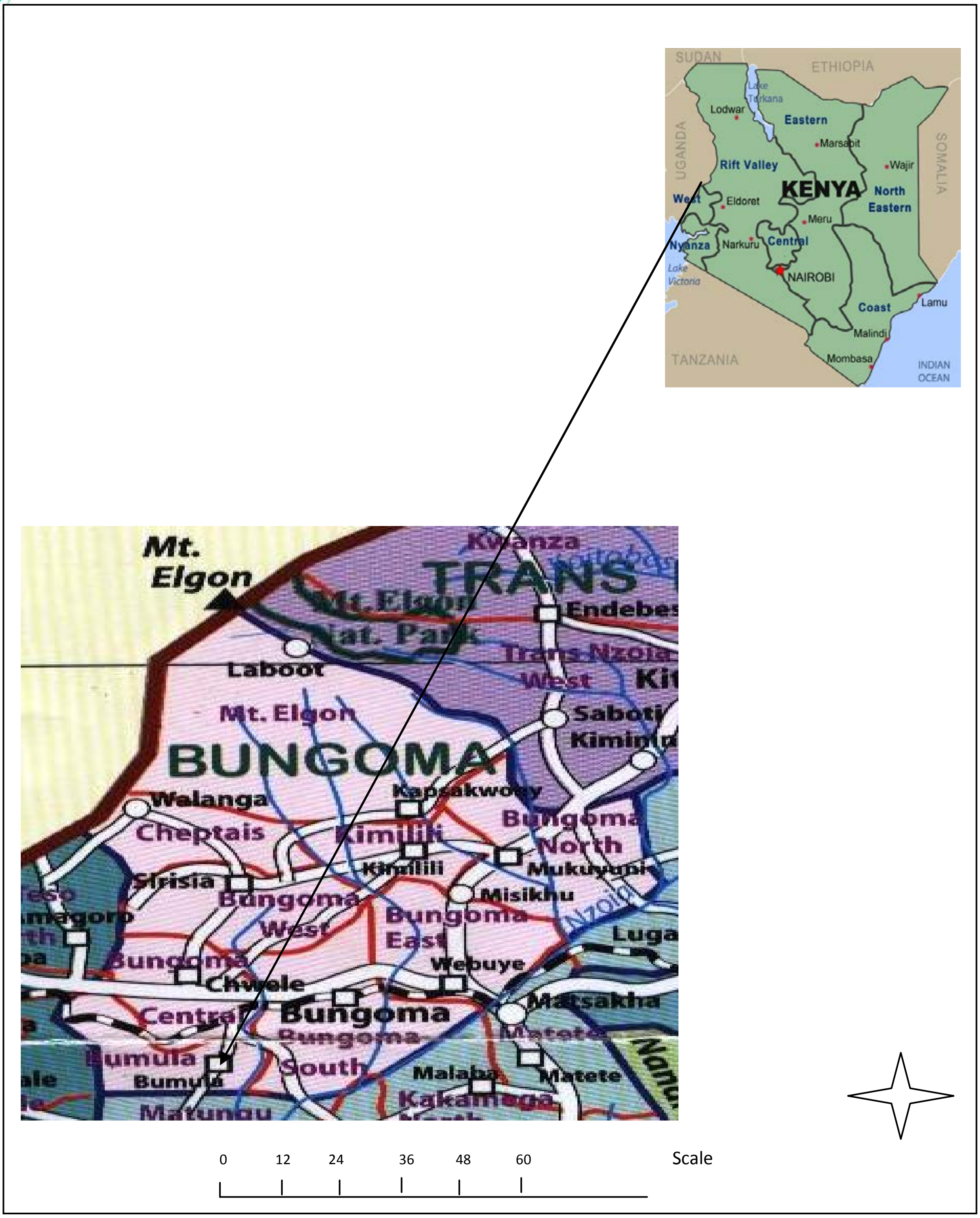

Figure 1.0: A map showing the location of Bumula Division, Bungoma County

Source: National road network, Republic of Kenya (Kenya Roads Board, 2013).

Sample size

The appropriate sample size for a population based cross-sectional study was determined largely by three factors; estimated prevalence of the variable of interest – (prevalence of malaria), the desired level of confidence and the acceptable margin of error. The sample size

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required was calculated according to a formula developed by Cohran (1963) as described by Glenn (2010).

$$n = \frac{Z^2 \text{pq}}{e^2}$$

Where:

n= desired sample size.

Z = standard normal deviate (1.96 for a 95% confidence level).

p = Prevalence of malaria in Bungoma Sub-county 75%.

q = 1-p (proportion in the population that does not have the characteristics being measured).

e= desired level of precision 0.05

$n = 1.96^2 * 0.75 * 0.25 / 0.05^2 \quad = 288$

The study involved 228 a target population of less than 10,000; hence n was adjusted as shown below

$$nf = \frac{n}{1 + \frac{(n-1)}{N}}$$

N = population size of expectant mothers expected to attend Ante-natal care during the study period (Estimated from the past 3 year ANC attendance).

n = desired sample size (when the population is more than 10,000).

nf = desired sample size (when the population is less than 10,000)

= 288/1 + [(288-1)/1100] = 228

Data collection

Expectant mothers in their first, second and subsequent pregnancies were recruited in the study after they signed consent forms. This was done when they came for their monthly antenatal visit at Bumula Sub-county hospital. A number was assigned to each Expectant mothers that was recorded on a prenatal consultation form. After a complete medical examination by ANC nurse, the volunteer's brief demographic information was recorded. The questionnaire was used to determine from the recruited those with ITNs and those without.

Parasitological tests for malaria parasites

Blood was obtained from finger prick by a laboratory technician since parasite concentration is fairly constant in internal and peripheral blood (WHO, 2016; Ohrt *et al*., 2008; Prodhomme, *et al*., 2006). Holding the patient’s left hand palm up, the third finger tip from the thumb was wiped first with a piece of cotton wool lightly soaked in alcohol to remove grease that may spoil the results, thereafter using firm strokes dry the finger with a clean cotton cloth. (Reyburn *et al*, 2007). These strokes also stimulated blood circulation in the tip of the finger. The finger was dried then pierced with sterile lancet and blood allowed to flow freely without squeezing the finger. Thin and thick blood films were prepared immediately upon blood collection on the same slide. Pressure was applied gently to the finger and blood collected in a single small drop, on the middle of the slide. This was for the thin film. further pressure was applied to express more blood which was collected in two or three large drops, on the slide, about 1 cm from the drop intended for the thin film, this was for the thick smear (WHO, 2016; Ohrt *et al*., 2008; Prodhomme, *et al*., 2006).

Field's stain test for thick blood film

Large drops of blood were placed on a microscope slide, and using the edge of another clean slide spread the blood in a circular form with 3-6 movements to make an area of $1cm^2$. The film was air dried, dipped into Field`s stain A for ten seconds after which it was dipped into tap water for three seconds and gently agitated (WHO, 2016). The slide was then dipped in Field`s stain B for 10 seconds, washed gently in running tap water for a few seconds to remove excess stain and drained vertically leaving it to dry. The preparation was examined under light microscope for detection of malaria parasites (Ohrt *et al*., 2008; WHO, 2016).

Rapid Field`s stain test for thin film

The small drop was touched with the spreader and blood allowed to spread along the edge of the spreader (Prodhomme, *et al*., 2006). firmly the spreader was pushed along the slide, keeping it at an angle of 45°. Firmly and in even contact the spreader was pushed along the slide ,making a thin smear. The blood slide was air dried, fixed in 95% methanol for 1 minute and flooded with 1 ml of Field`s stain B diluted 1 in 4 with water. An equal volume of undiluted field stain A was added immediately, mixed well and allowed to stain for 1 minute.

The slide was then rinsed in running tap water to remove excess stain and drained to dry. Examination was carried out using the X100 objective lens of a compound microscope for detection of malaria parasites (WHO, 2016; Ohrt *et al*., 2008; Prodhomme, *et al*., 2006).

Data analysis

All analysis was done using INSTAT 3.36 version (The University of reading, UK 2012). The prevalence of malaria in expectant mothers who used or did not use the ITN was compared by testing the mean difference of infections using T-test, during the rainy and dry seasons. A spearman rank correlation analysis was used to show the relationship between net ownership and malaria parasitaemia during the rainy and dry seasons.

RESULTS

Net ownership by Expectant mothers

A total of 60.5% of the respondents owned nets while 36.8% did not own any net. However, 2.6% of the respondents did not indicate whether they own nets or not.

Table 1 : Percentage Net Ownership Among pregnant women

Count	***Ownership***	***%***
138	Owned net	60.5
83	Did not own net	36.8
7	Non respondent	2.6

A portion of 26.8% of those who owned nets were found to be positive for malaria parasitaemia whereas 28.8% of those who did not own nets tested positive for malaria parasitaemia. The non respondents 17% tested positive for malaria parasitaemia (Figure 2). When correlation between net ownership and malaria infection rate was calculated, it was found to be a positive correlation, which was significant ($P > 0.05$; $r = 0.064$).

Relationship between net ownership and malaria infection

The study established 60.5% of the respondents owned nets. There was a significant association between net ownership and malaria infection ($\chi^2=20.62$; $p < 0.05$). The study recorded 73.2% of those who owned nets testing negative for malaria parasitemia while 26.8% were positive for malaria parasitaemia. Whereas 31.2% of respondents who did not own nets tested positive for malaria parasitaemia. Respondents who owned nets were less likely to get malaria infection.

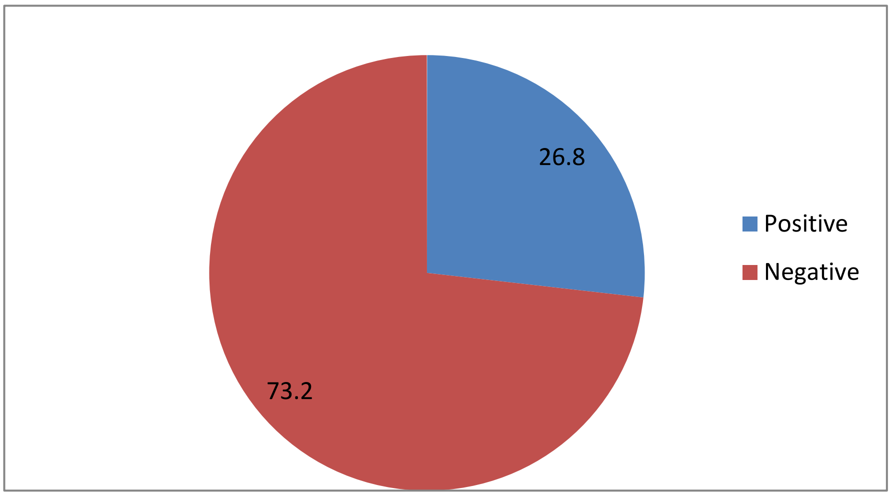

Figure 1.0 : Relationship between net ownership and malaria infection

Prevalence of malaria among Expectant mothers

A total of 57 expectant mothers tested positive for malaria parasites while 168 were negative. The prevalence of malaria among pregnant women was 25%. There was a significant difference between those who tested negative and positive for malaria parasitaemia ($P < 0.001$; $\chi^2 = 186.237$, df = 2;)

Table 2: Prevalence of malaria among pregnant women

Parasitaemia	Frequency	Percentage
Positive	57	25
Negative	168	73.7
P value	0.000	

Differences in malaria infection rates during rainy and dry seasons

The respondents who tested positive for malaria parasitaemia were higher within the rainy season (28.8%) compared to dry season (19.0%). The differences in infection rates during rainy and dry season were significant ($P<0.05$; t=3.67; df =226; Figure 4.14). The expectant mothers were likely to test positive for malaria parasitaemia during the rainy season than the dry season.

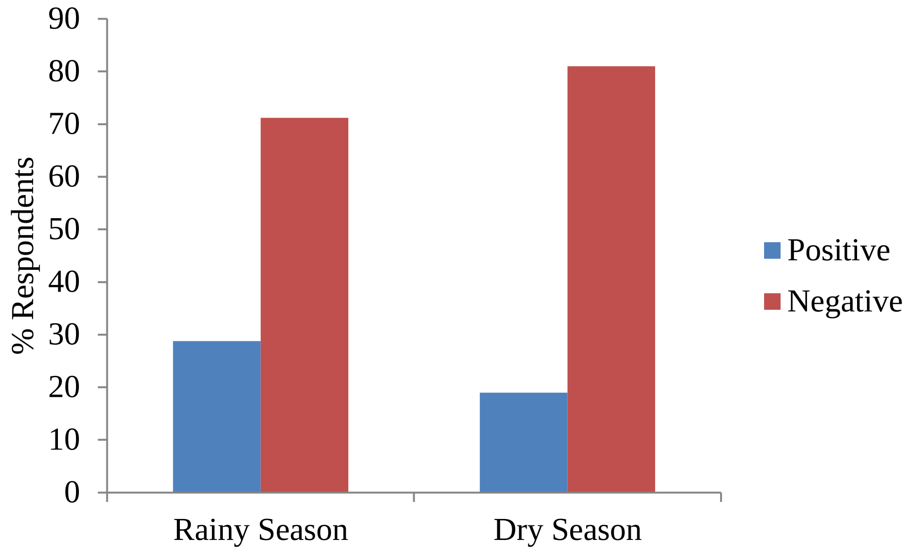

Figure 2: Malaria infections rate during rainy and dry seasons

Discussion

Women who owned nets had less parasitaemia as compared to those who did not have nets hence there were a significant differences in the infection levels between those who possessed nets and those who did not. Net ownership therefore reduced cases of malaria infection in the pregnant women. Studies along the coastal parts of Kenya by O`meara *et al*., (2007) have reported a proportional decline in malaria cases by 63% in Kilifi, 53% in Kwale and 28% in Malindi. O`meara *et al*., (2007) observed that the decline in malaria admissions was as a result of malaria-control efforts in the catchment area. Atieli, *et al*., (2011) too reported reduced infection prevalence for all age groups among net users compared to non-users during the rainy and dry seasons in highlands of Western Kenya.

These study revealed significant mean differences in parasitaemia during the dry and rainy seasons, with higher infection rates during the rainy season. This observation is related to the availability of suitable breeding habitats for mosquitoes during the rainy season. On the other hand the findings by Odongo *et al.* (2005) reported that Parasite density fluctuate according to monthly rainfall pattern, high parasite densities were observed to coincide with peak rainfall pattern of the bimodal annual rain seasons. Malaria prevalence among the expectant mothers was 25%. In Western Kenya, the prevalence of malaria has been reported to be 41% (Kenya Medical Research Institute and US- based Centre for Disease Control, 2013). Hence the prevalence reported in this study is much lower than the general malaria prevalence of the region. This may be related to the impact of reproductive health services they receive at ANC concerning malaria prevention. Van Eijk *et al.*, (2006) reported that 90% of expectant mothers visited the ANC at least once during pregnancy. The reduced malaria prevalence among the expectant mothers might be due to the increased awareness and subsequent use of ITNs, Atieli *et al*., (2011) reported that malaria prevalence in the rainy season was about 30% lower in ITN users than in non-ITN users. This is also supported by a report by Gamble *et al*., (2007), stating that when large numbers of people use LLINs to protect themselves, the burden of malaria can be reduced.

Conclusions

- ✓ Net ownership reduced cases of malaria infection in the pregnant women.
- ✓ There was high prevalence of malaria parasitaemia among pregnant women during the rainy season (28.8%) compared to dry season (19.0%)

Recommendation

- ➢ The County government of Bungoma should take full advantage of devolution of health services to the county by allocating more funds to carry out campaigns to eradicate mosquito breeding grounds during the rainy season. The county government should also endeavor to partner with organizations interested in reproductive health to achieve full ITNs coverage particularly during the rainy season by distributing long-lasting nets through existing ANC units within the county.
- ➢ Vector control methods like indoor residual spraying, window screens, clearing bushes around homesteads should be employed during the dry season for there were cases of malaria infection during the dry season.

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