Master of Public Health

Master international de Santé Publique

Utilisation of bed nets among children under Five years in Tanzania

Exploring the relationship between bed net utilization and Parasitemia test at the national level

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LIST OF ACRONYMS

NMCP …….National Malaria Control Program

NMAC……..National Malaria Advisory Committee

ITNs……..Insecticide treated nets

LLINs……Long lasting insecticide nets

TNVS……Tanzania National Voucher Scheme

CDC……..Center for Disease Control

KEMRI……..Kenya Medical Research Institute

iCCM…….Integrated Community Case Management

CHTs…….Community health teams

ACTs…….Artemisnin Combination Therapy

RDT……..Rapid Diagnostic Test

Alu…….Artemether Lumefantrine

CME……..Continuous Medical Education

ABSTRACT

Background: The Roll Back Malaria Initiative has identified the under fives as one of the high risk groups for malaria and one of the strategies to fight the disease in this age group is the use of bed nets. Despite the massive distribution of bed nets in Tanzania, Malaria prevalence still remains high. **This study explores the relationship between bed net utilization and parasitemia, as an indicator of malaria prevalence, with a particular focus on children under age five at the national level in Tanzania.**

Methods: This paper is based on the 2007/2008 Tanzania Demographic and Health Survey data in which information on bed net ownership and utilization was collected and a parasitemia test done for children under 5 years. The data was examined using both descriptive and multivariate ordinal logistic regression analysis and logistic regression analysis.

Results: In exploring the predictive factors for bed net utilization, parasitemia was not significant at a 0.05 level of significance. The factors that are significant are zone where household is found, the level of information received by the mother, region endemicity, wealth index, number of household members, number of children under 5 in the household. Bed net utilization was also not significant in the predictive factors for parasitemia in children. This surprising result could be explained by several factors: imperfect use, risk perception, quality of data used. The significant factors are anemia level of the child, zone, child had fever two weeks before the survey, current age of child and type of place of residence.

Conclusion: Using a national representative survey and analyzing the data at the individual level, the association between test results for malaria infection and bed net utilization for children under the age of five was found to be insignificant suggesting that the nets are misused

RÉSUMÉ

Contexte: Les enfants de moins de cinq ans constituent la population la plus à risque de faire un paludisme et l'une des stratégies de lutte contre la maladie est l'utilisation de moustiquaires imprégnées. Malgré la diffusion massive de moustiquaires en Tanzanie, la prévalence du paludisme reste encore élevée. En se focalisant sur les enfants de moins de cinq ans à partir de données d'une enquête nationale réalisée en Tanzanie, cette étude explore la relation entre l'utilisation de moustiquaires et le paludisme infection (mesuré par des tests de diagnostic rapide et utilisé comme un indicateur de la prévalence du paludisme).

Méthodes: Cette étude est basée sur l'Enquête Démographique et de Santé (DHS) réalisée en Tanzanie en 2007/2008. Les données d'enquête fournissent des informations sur la propriété et l'utilisation de moustiquaires ainsi que les résultats de tests de diagnostic rapide chez les enfants de moins de 5 ans. Les données ont été analysées en utilisant à la fois une analyse descriptive simple et multiple des régressions logistiques multivariées.

Résultats: Concernant les facteurs prédictifs de l'utilisation de moustiquaires, la présence de parasites chez les enfants le jour du test ne semble pas être un facteur influençant significativement l'utilisation des moustiquaires. Les facteurs ayant un effet significatif sont la zone où se trouvent les ménages, le niveau d'information reçu par la mère, le niveau d'endémicité de la région, l'indice de richesse, le nombre de membres dans le ménage, le nombre d'enfants de moins de 5 ans dans le ménage. Concernant les facteurs prédictifs de la présence de parasites chez les enfants, l'utilisation de moustiquaires ne semblait pas non plus avoir d'influence significative. Ce résultat étonnant pourrait s'expliquer par différents facteurs : utilisation imparfaite, perception du risque, qualité des données utilisées. Les facteurs importants sont le niveau de l'anémie de l'enfant, la fièvre deux semaines avant l'enquête, l'âge actuel de l'enfant et le lieu de résidence.

Conclusion: Au niveau national, la prévalence du paludisme, telle que mesurée dans cette étude, ne semble pas corrélée à l'utilisation de moustiquaires pour les enfants de moins de cinq ans. Réciproquement, l'utilisation de moustiquaires dans le ménage ne semble pas avoir d'effet sur la présence de parasites chez l'enfant ce qui laisse penser que les moustiquaires sont mal utilisées.

1. INTRODUCTION

Malaria remains one of the major threats to public health and economic development in Africa. It is estimated that three million deaths result from malaria throughout the world, with Africa having more than 90% of this burden [1]. Malaria is the leading cause of outpatients, inpatients, and admissions of children less than five years of age at health facilities in Tanzania [2]. The burden of malaria in Tanzania, in particular, remains high. Every year, 14–18 million new malaria cases are reported in Tanzania. The annual incidence rate is 400–500/1,000 people and this number doubles for children less than five years of age. There are 100,000 to 125,000 annual deaths due to malaria (70–80,000 in under-fives) [3].

The United Republic of Tanzania has a population of 37.4 million, approximately 100% of whom live in areas that are at risk of malaria, with endemicity and risk of transmission varying as mapped recently by Mapping Malaria Risk in Africa (MARA).Tanzania has the third largest population at risk of stable malaria in Africa after Nigeria and Democratic Republic of Congo (MARA-lite Software 3.0.0, available from http://www.mara.org.za) (Figure 1). This GIS-based analysis reveals that 75% of the population is subject to stable perennial or stable seasonal malaria transmission; 8% to unstable highly seasonal transmission; and 17% to no malaria transmission in the average year, but still at risk of epidemic malaria.

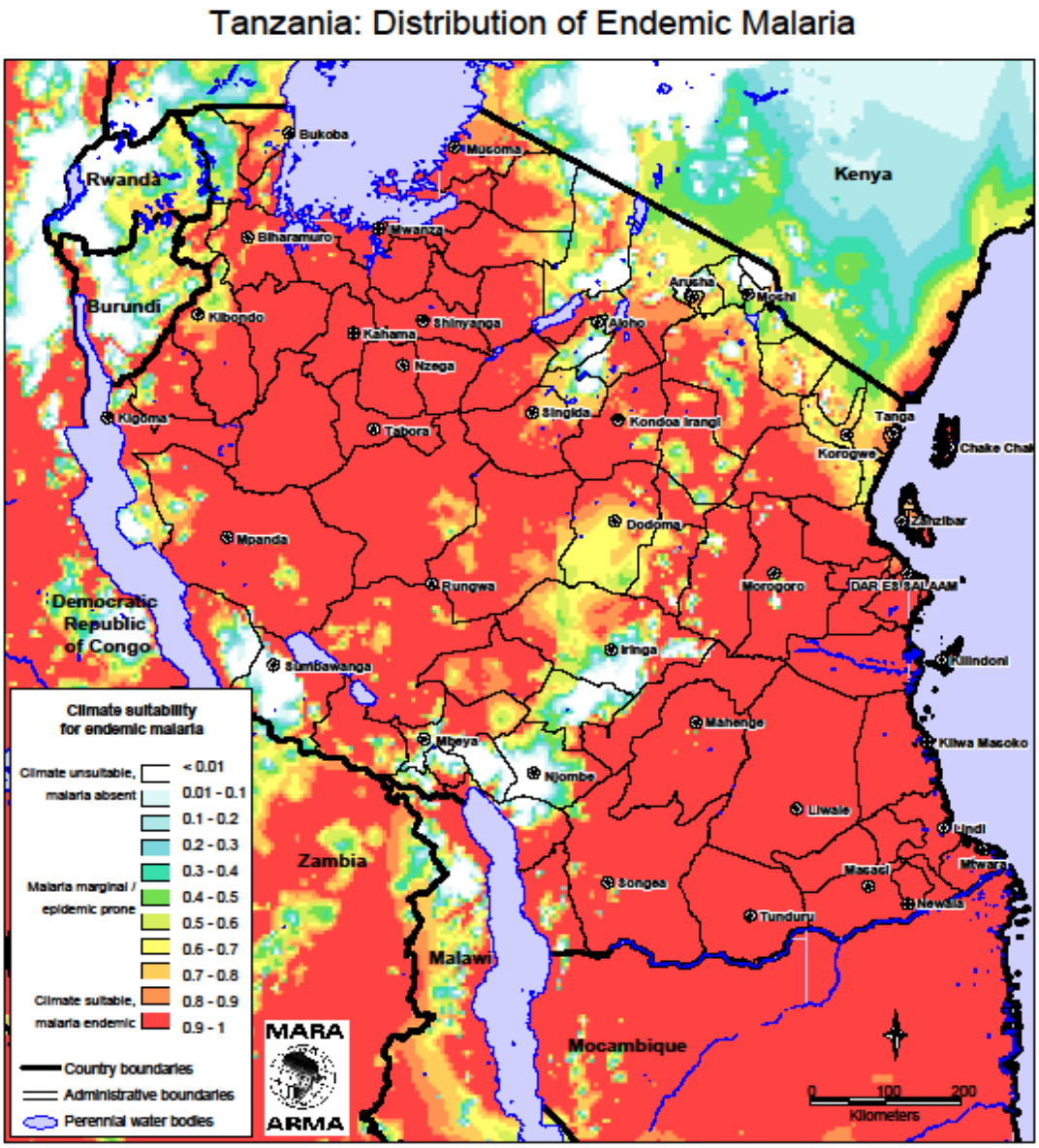
Currently, most of the existing interventions in Tanzania are vertical in nature. The National Malaria Control Program (NMCP) proposes policies and guidelines to the Ministry of Health and Social Welfare through the National Malaria Advisory Committee (NMAC). The NMAC meets annually to review the state of interventions and assess problems resulting from implementation of policies in the previous year. During the review process, different stakeholders are invited, including United Nations agencies, development partners supporting malaria interventions, research and academic institutions, and selected regional and district representatives, to discuss key implementation issues. One problem facing the current control strategies is the limited capacity of the districts to implement and scale-up interventions [3]. Tanzania is currently implementing a policy of decentralization whereby districts are given more powers and resources for decision-making. Such capacity at the district level is limited in terms of quality and quantity of human resources, poor infrastructure, and geographic inaccessibility of some places given the vast landmass area of Tanzania. This implies that the implementation of malaria intervention programs will vary between districts and regions. A critical evaluation of predictive

factors for the success of these interventions with emphasis on inter-region disparities will help in their improvement.

In malaria control programs, a combination of tools is required to work towards eradication. One such tool, which will be the focus in this paper, is use of insecticide-treated nets (ITNs). These nets have been used as a strategy to mitigate against the burden of malaria, as reflected in the government policy through the NMCP strategic plan, and this strategy is one of the most important control pillars. The strategy envisages putting emphasis on children less than five years of age and pregnant women to use treated nets through social marketing because most individuals are aware of the benefits of using ITNs. Implementation on the use of ITNs at the district level for a pilot stage started in 1998. In 2000, a national social marketing program was initiated by the Ministry of Health, non-government organizations, and development partners to develop and test processes for increasing affordable supply, demand, and coverage, thus stimulating the commercial market for ITNs. Through health sector reforms, a sector-wide approach has put additional funding of $0.75 per capita in the heath sector under control of local government councils at the district level to support activities of malaria control interventions, including the use of ITNs at public and private health facilities [4]. Until late 2008, when free distribution of Long lasting insecticide treated nets (LLINs) began in Tanzania, mosquito nets were mainly obtained through the commercial sector. They are sold as ordinary commodities in retail outlets or they are available at a subsidized rate through government health programmes. The same is true for insecticide treatment kits for mosquito nets. The Government health subsidy programme, referred to as the Tanzania National Voucher Scheme (TNVS) or *Hati Punguzo* Programme provides vouchers for all pregnant women and infants who attend health facilities. Vouchers can be exchanged for a mosquito net at designated private outlets (with a small upfront cost). Occasionally, mosquito nets are distributed free of charge to households with children under five through specific health campaigns. Despite all these efforts made, according to Noor et al [5] only 33% of children were sleeping under an ITN in Tanzania. This is why one of the objectives of this study is to understand the reasons for the non-use of these nets.

The predominant malaria species in Tanzania is Plasmodium falciparum. Plasmodium falciparum is the most dangerous of the four species of human malaria (Plasmodium Falciparum, Plasmodium Vivax, Plasmodium Ovale, and Plasmodium Malariae). In areas of

Figure 1: Tanzania distribution of endemic malaria.



This map is a product of the MARA/ARMA collaboration (http://www.mara.org.za). July 2002, Medical Research Council, PO Box 70380, Overport, 4067, Durban, South Africa
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Malaria distribution model: Craig, M.H. et al. 1999. Parasitology Today 15: 105-111.
Topographical data: African Data Sampler, WRI, http://www.igc.org/wri/sdis/maps/ads/ads_idx.htm

constant and high malaria transmission, partial immunity develops within the first four years of life. Parasitemia levels in blood increase steadily up to age four and then become steady up to age ten. They then begin to fall through teenage and adulthood [6]. Many people, including children, may have malaria parasites in their blood without showing any outward signs of infection. Such asymptomatic infection plays an important role in building partial immunity. However, it not only contributes to further transmission of malaria but also take a toll on the health of individuals by contributing to severe anemia [7]. Anemia is a major cause of morbidity and mortality associated with malaria, making prevention and treatment of malaria among children all the more important.

2. LITERATURE REVIEW

Several field trials have evaluated the effectiveness of bed nets as a malaria prevention strategy and have shown that the use of insecticide-impregnated bed nets to minimize human-vector contact reduces the incidence of malaria. Consequently, A meta-analysis of published reports of field trials that measured the incidence of infections was performed to provide a measure of the effectiveness of insecticide-treated bed nets in preventing clinical malaria [8]. Sub-setted analyses were performed on the 10 field trials to calculate pooled incidence rate ratios of infection among the study groups. For the studies comparing insecticide-impregnated bed nets with untreated bed nets, the summary incidence rate ratio for acquiring malarial infections was 0.757. For the studies comparing permethrin-impregnated bed nets with controls without bed nets, the summary incidence rate ratio was 0.497. These data suggest that insecticide-impregnated bed nets are effective in preventing malaria, decreasing the incidence rate ratio by approximately 50% in field trials performed to date.

From research done, the factors predicted in the utilization of bednets have been varying between countries. In a research done in Mbarara district in Uganda, the independent factors that favored bed net use were as follows: 1) age < 30 years, 2) ownership of a television, 3) having mosquito nets in ventilators of the house, 4) being a skilled worker or a professional, or owning a major business, 5) living in a permanent house, 6) believing that bed nets prevent malaria, 7) believing that bed nets are worth their cost, 8) not believing that convulsions cannot be cured by modern medicine, and 9) believing that bed nets are not expensive. The strongest predictors of bed net use are living in a permanent house and agreeing that bed nets are worth

their cost, with adjusted odds ratios of 4.29 (95% confidence interval, 2.76-6.71) and 3.93 (95% confidence interval, 2.5-26.13), respectively [9].

Another study done in Nigeria predicted Education, wealth index, presence of an under-five child in the household, family size, residence, and region by residence were predictive of ownership of any net. The presence of an under-five child in the household, family size, education, presence of health facility in the community, gender of household head, region by residence and wealth index by education predicted ITN ownership. Utilization of any net by children under-five was 11.5% (95% CI, 10.4%–12.6%) and 1.7% (95% CI, 1.3%–2.2%) for ITN. Predictors of use of any net among under-five children were fever in the previous two weeks, presence of health facility in the community, caregiver's education, residence, and wealth index by caregiver's education; while religion, presence of health facility and wealth index by caregiver's education predicted the use of ITN among this group [10].

According to Shane Khan [11], the effects of several other variables are inconsistent; place of residence predicts ITN use consistently only in Tanzania and Uganda where rural residents are less likely than urban residents to use an ITN. In Senegal, household wealth is negatively associated with ITN use among the total household population and among children under age five; wealth is positively associated with use among the household population in Mali and Tanzania and among pregnant women in Mali. In Tanzania, children in the poorest households are least likely to use an ITN. Finally, children who are breastfeeding are not more likely to use an ITN than non-breastfeeding children, with the exception of Mali. Mother’s level of education does not significantly predict ITN use for the child, although the mother’s use of an ITN herself is highly correlated with use by the child. Overall, the study results underscore the need for malaria control programs to take into consideration the number of members in a household when distributing nets and to pay close attention to country-specific conditions when designing and implementing ITN distribution and promotion programs.

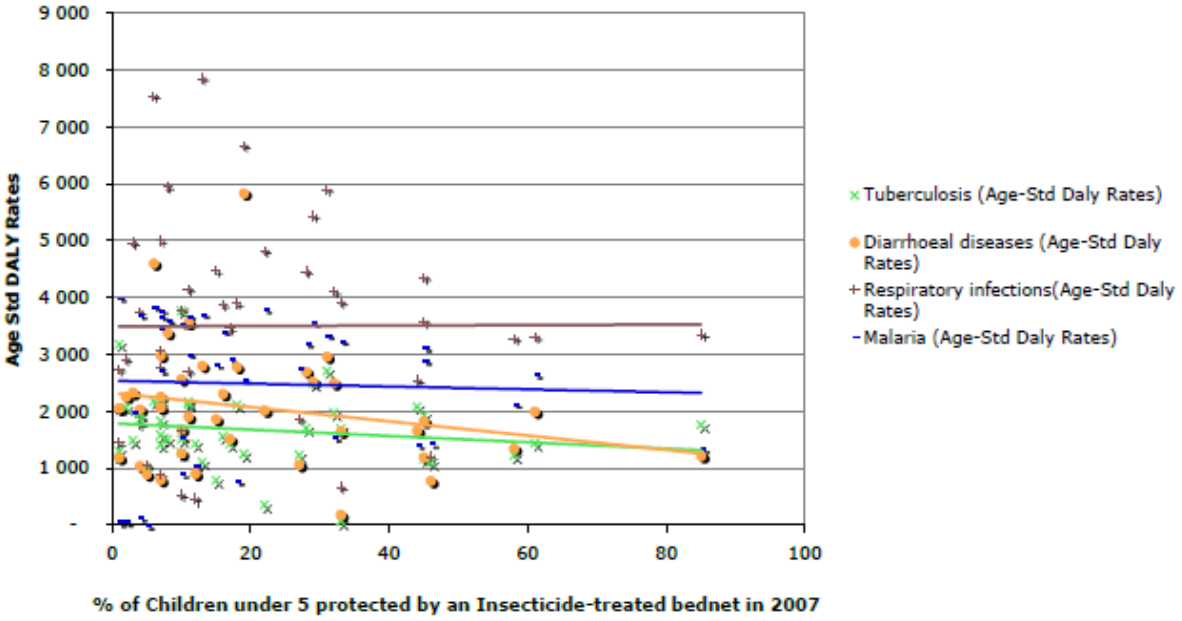
It is often argued that cost-sharing—charging a subsidized, positive price—for a health product is necessary to avoid wasting resources on those who will not use or do not need the product. A field experiment to explore this argument was carried out in Kenya, in which the price at which prenatal clinics could sell long lasting anti-malarial insecticide-treated nets (LLINs) to pregnant women was randomized. There was no evidence found that cost sharing reduces wastage on those that will not use the product: women who received free ITNs are not less likely to use them than those who paid subsidized positive prices. There was also no evidence found that

cost sharing induces selection of women who need the net more: those who pay higher prices appear no sicker than the average prenatal client in the area in terms of measured anemia (an important indicator of malaria). Cost-sharing does, however, considerably dampen demand. It was found that uptake drops by 75 percent when the price of ITNs increases from zero to $0.75 (i.e. from 100 to 87.5 percent subsidy), the price at which ITNs are currently sold to pregnant women in Kenya. The researchers combined their estimates in a cost-effectiveness analysis of ITN prices on child mortality that incorporates both private and social returns to ITN usage. Overall, their results suggest that free distribution of ITNs could save many more lives than cost-sharing programs have achieved so far, and, given the large positive externality associated with widespread usage of ITNs, it would likely do so at a lesser cost per life saved. [12]

The national malaria prevalence rates have depended on the estimated data from the surveillance system. Until recently the only malaria prevalence indicator available in DHS was the prevalence of fevers therefore sentinel surveillance data in Tanzania has had a number of disadvantages. When they exist they are far from being accurate because of deficiencies in the health reporting system and the particularities of malaria. A lot of symptoms, the commonest being fever, are common to other diseases; and immunities built against malaria make it difficult to detect asymptomatic cases. The inclusion of malaria testing in this survey offers the opportunity to better understand the magnitude and pattern of infections among children under five years in Tanzania. The survey results are in turn expected to improve the calibration of the annual sentinel surveillance data, so that trends in malaria infections can be more accurately measured in the intervals between household surveys and other surveys. However, it should also be noted that though the DHS surveys provide an approximate representation of the malaria parasitemia burden, they are only a second best alternative because it would have been better to have well measured surveillance data.

Figure 2 is a scatter plot of the disease burden among children utilizing bed nets at the macro level in Africa. Its source is the DALYs and Noor et al, 2008 paper on national use of bed nets. There is nearly no correlation between the burden of disease of malaria in Africa and the use of bed net. However, the use of bed net is negatively correlated with other diseases of respiratory infection and diarrheal diseases.

Figure 2: Scatter plot of disease burden among children utilizing bed net at the macro level in Africa



The African summit on Roll Back Malaria (Abuja, Nigeria, April 2000) set an ambiguous target for expanding ITN use in Africa- at least 60% coverage of high risk groups by the year 2007, who are the under-fives and pregnant women. In Tanzania, the Abuja target has not yet been achieved. Malaria continues to be a threat and the under fives still pose as a big challenge.

3. STUDY OBJECTIVES AND JUSTIFICATION

The main objective of the study is to explore the relationship between bed net utilization and parasitemia among children under five at the national level in Tanzania. At the regional level, there seems to be an association between endemicity and bed net utilization because programs target the most affected regions. However it should be noted that malaria endemicity and stability varies a lot.

Under this objective the study will explore the factors that influence the use of bed nets, including parasitemia. (This will be analyzed in tables 5 and 7). An important question is

whether or not the use of bed nets is conditioned by the local and individual prevalence of the malaria infection.

The study will also explore the factors that influence parasitemia, including bed net utilization. (This will be analysed in table 6 and 8). The question here is whether the malaria prevalence influences the use of bed nets.

The study will further look at possible confounders in the relationship between bed net use and parasitemia. There can be a number of confounding factors like socio-economic status which bring uncertainty in the causal effect. If there is an effect of these interventions, it can be due to Artemisnin Combination therapy (ACTs) treatment, spraying, or a combination of interventions but not strictly bed net utilization.

The new MIS (Malaria Indicator Survey) DHS (Demographic Health Survey) surveys for the first time allow the exploration of these uncertainties and differences at both the regional and household level. Parasitemia was included as one of the malaria prevalence indicators in the 2007/2008 survey. Two countries in Africa had this indicator; Tanzania and Angola. This study focused on Tanzania because Angola was being studied by another colleague.

In order to complete the practicum, field work was done with Malaria Consortium in Uganda. To date, organizations providing technical assistance to in-country implementing partners are MEASURE DHS, PATH-MACEPA, the Malaria Consortium, CDC, and the Carter Center. After an application for internship to all these organizations, Malaria Consortium, which has an office in Uganda, was positive. The field work sought to understand the different malaria control interventions in practice on ground in a malaria endemic country.

4. METHODS

4.1 THE DATA SET

The study was based on the 2007/2008 Tanzania DHS which was conducted from October 2007 to February 2008. The DHS are nationally representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health and nutrition. Among these, information on malaria was collected. The malaria indicators used were household ownership of bed nets, use of mosquito nets, use of indoor residual spraying of insectsides against mosquitoes, prevalence and prompt treatment of fever, type and timing of anti malarial drugs, prevalence of Anemia and prevalence of malaria infection.

4.2 SAMPLE SIZE AND DESIGN

The sampling frame used for the 2007/2008 survey was developed by the National Bureau of Statistics after the 2002 Population and Housing Census (PHC). The sample excluded nomadic and institutional populations, such as persons staying in hotels, barracks, and prisons. The survey utilised a two-stage stratified sample design. The first stage involved selecting sample points (clusters) consisting of enumeration areas delineated for the 2002 PHC. A total of 475 clusters were selected. The sample was designed to allow estimates of key indicators for each of Tanzania's 26 regions. On the Mainland, 25 sample points were selected in Dares-salaam and 18 in each of the other 20 regions. In Zanzibar, 18 sample points were selected in each of the five regions, for a total of 90 sample points. A household listing operation was undertaken in all the selected areas prior to the fieldwork. From these lists, households to be included in the survey were selected. The second stage of selection involved the systematic sampling of households from these lists. Approximately 16 households were selected from each sampling point in Dares salaam and 18 households per sampling point were selected in other regions. In Zanzibar, approximately 18 households were selected from each sampling point in Unguja, and 36 households were selected in Pemba. A total of 9,144 households selected from 475 sample points throughout Tanzania. In the selected households, interviews were conducted with all women and men aged 15-49. The survey also collected blood samples for anemia and malaria testing among children age 6-59 months whose parent gave consent to testing. The survey had a total of 7502 children.

4.3 QUESTIONNAIRES

Two questionnaires were used: the Household Questionnaire and the Individual Questionnaire. The questionnaires are based on the MIS questionnaires, adapted for the population and health issues relevant to Tanzania. Inputs were solicited from various stakeholders representing government ministries and agencies, nongovernmental organizations, and international partners. After the preparation of the definitive questionnaires in English, questionnaires were translated into Kiswahili.

The Household Questionnaire was used to list all the usual members and visitors of selected households. Some basic information was collected on the characteristics of each person listed, including his or her age, sex, education, and relationship to the head of the household.

The household questionnaire was used to identify women eligible for the individual interview. It also collected information on characteristics of the household dwelling, such as ownership and use of mosquito nets. Furthermore, it was used to record malaria testing results for children age 6-59 months.

The Individual Questionnaire was used to collect information from all women and men age 15-49. These respondents were asked questions on the several topics including background characteristics (education, media exposure, employment, etc.) and other health issues.

Female respondents were asked about their birth history and illnesses of children they gave birth to since January 2002. These questions are used to gauge the prevalence of fever, an important symptom of malaria. They were also asked about ownership and use of bed nets among children.

As part of the survey, all children under the age of five were tested for anemia and malaria. The parents were told the importance of these tests and were asked for consent. The rapid diagnostic test (RDT) used is the Paracheck Pf™ device (Orchid Biomedical, India), which is based on the detection of P. falciparum-specific histidine-rich protein 2 (HRP2 Pf) in blood. The test has relatively high sensitivity and specificity and is deemed appropriate for clinical and epidemiologic assessment of malaria. The paracheck test has been reported to have high sensitivity and specificity. Parents or responsible adults were advised about the malaria test result. If the child tested positive, he or she was provided with a full course of Artemether Lumefantrine (ALu) or Coartem. Children who tested negative but had a fever in the past two weeks were also provided a full course of ALu. Survey field staff explained to the parent or responsible adult that ALu is effective and should rid the child of fever and other symptoms in a few days. Parents/guardians were advised to take the child to a health professional for treatment immediately if, after taking ALu, the child still had high fever, fast or difficult breathing, was not able to drink or breastfeed, and became sicker or did not get better in two days.

4.4 DEFINITION AND ROLE OF VARIABLES INCLUDED IN THE ANALYSIS

Individual child characteristics, those of the parents and the household are likely to determine the use of bed nets and the result of the malaria parasitemia test in children under five years old. The characteristics include their age and sex of the child, the anemia level of the child, whether the child currently has fever or had it in the two weeks before the survey and if they had taken any medication for the fever; those of the parents include their age and sex, level of

education and frequency of listening to a radio and watching TV, which is a measure of their exposure to information on the usefulness of bed nets. The household attributes likely to affect bed net utilization and result of malaria test are type of place of residence, wealth index, whether or not the house had been sprayed in the last 12 months before the survey, endemicity of the household region, zone, distance to the nearest market, distance to nearest health facility, number of bed nets in the household, number of household members and number of children under five.

In this paper, the education level education level has four levels, 1) No education, 2) Primary education, 3) Secondary education, 4) Higher education. Region endemicity was defined using the MARA map. Regions were defined as endemic or marginal. Endemic areas are defined as "areas with significant annual transmission, be it seasonal or perennial". Marginal areas are defined as "areas prone to distinct inter-annual variation, in some years with no transmission taking place at all". This map is a theoretical model based on available long-term climate data. Although it is reasonably accurate, it is not based on actual malaria data and may not reflect the real malaria status. Regions were also regrouped into the different country zones as follows: Central – Dodoma, Singida, Manyara; North – Arusha, Kilimanjaro,Tanga; East – Morogoro, Pwani, Daresalaam; South – Lindi, Mtwara, Ruvuma; Southern highlands – Iringa, Mbeya, Rukwa; West - Tabora, Kigoma; Lake – Kagera, Shinyanga; Zanzibar – Ugunja 1, Ugunja 2, Ugunja 3, Pemba 1, Pemba 2. The wealth index was constructed by DHS using household asset data. The asset information collected in the Household Questionnaire covers information on household ownership of a number of consumer items ranging from a television to a bicycle or car, as well as dwelling characteristics such as source of drinking water, type of sanitation facilities, and type of material used in flooring. Each asset was assigned a weight (factor score) and each household was then assigned a score for each asset, and the scores were summed for each household; individuals were ranked according to the total score of the household in which they resided. The sample was then divided into quintiles from one (Poorest) to five (Richest).

In the model specification, there are two dependent variables; ``child slept under bed net the night before the survey`` and ``result of malaria test``. Child slept under bed net the night before the survey is used as the definition for utilization of bed nets. It is argued that if a child is found to have used the net without prior knowledge of the survey date, then they are likely to be consistent in utilization. Having a bed net in the house, whether the child slept under it or not, is

assumed to be of higher protective value than having no bed net at all because of the insecticide in the net. It is assumed that the level of protection increases with increase in the number of children sleeping under bed nets. Once there is a mosquito net in the household, whether children sleep under it or not is no longer a question of the price rather personal and behavioral factors of both parents, in addition to characteristics of an individual child and the household. This variable is used as a proxy for each child´s protection level.

The study seeks to understand the relationship between parasitemia and bed net utilization. Result of malaria test is used as the definition for presence or absence of parasitemia in children. The result, negative or positive, is assumed to be related to child, parent and household characteristics. Similar characteristics to those affecting bed net utilization are thought to also be a proxy to result of malaria test.

Independent variables were included in the model with guidance from the literature review. Considering the characteristics of a child first, females especially those in rural countries are at a disadvantage when it comes to household resource allocation. The age of a child is another factor that possibly could determine whether a child sleeps under a mosquito net. It has also been proven that parasitemia levels keep rising until the age of five when it becomes stable. Therefore, it is also expected that parasitemia results become more positive with increase in age. Child having fever and anemia is also considered. Fever and anemia are said to be associated with high levels of parasitemia with fever being a major symptom of malaria and anemia being caused by severe malaria. The hypothesis to be tested is that children with fever and anemia are more likely to be positive with parasitemia and therefore will not be found to use a bed net.

Maternal characteristics which will influence whether children sleep under mosquito nets include her education, her age and exposure to the media. All these factors are related to exposure to information and the level of understanding regarding protective measures. Exposure to the media is defined as frequency of listening to radio and watching television. The hypothesis is that if a mother is exposed to knowledge and has a higher understanding, then her children are more likely to sleep under the mosquito net once one is available within the household. Similar characteristics of the husband, such as education and employment are regarded as having the same effect.

The household characteristics considered include sex and age of the household head, wealth of the household, type of residence (urban or rural), number of children under-fives, and whether or not the house was sprayed in the last twelve months prior to the survey. It can be argued that households that were sprayed will tend not to use bed nets and also have lower parasite carrying mosquitoes because of the protection they already have. However on the other hand it can also be argued that sprayed households are more aware of the dangers of malaria and will therefore take further protection measures and utilize bed nets. There is evidence that women are more likely to spend their money on their children than men and, therefore, in households headed by women, children are more likely to sleep under mosquito nets once available.

Household wealth or socioeconomic status is a tricky factor. It is expected that the rich are more likely to own mosquito nets, and, therefore, the proportion of children sleeping under mosquito nets is larger in rich households. However, is it the case when the net is already available in the household? It is proposed and argued that perceived vulnerability is higher among the poor because of the limited options available to them once the child gets sick. So it is likely that children from poorer households are more likely to sleep under a mosquito net once it is available in the household. Additionally, urban households generally have better incomes than rural households and therefore are thought to own mosquito nets, but what of their use among the under-fives? Whether it is also related to more perception of the level of vulnerability in rural areas or the inability for the wealth index to capture incomes levels, is unclear. It is proposed that under-fives in rural households are more likely to use mosquito nets, given that one is available in the household. Factors relating to the area of residence, including zone and region, were also considered. The hypothesis is that regions that have already been defined as endemic have higher parasitemia levels. However whether or not the result of the malaria test is positive because of the already high levels of parasitemia or because of non-utilisation of bednets is still a question.

The bed net utilisation was modelled using the ordinal logit model. The following four-categorical response variable, *U*, for bed net utilisation, was defined as:

$$U = \begin{cases} 0 & \text{No bed net in the household the child is from} \\ 1 & \text{None of the children slept under a bed net} \\ 2 & \text{Some of the children slept under a bed net} \\ 3 & \text{None of the children slept under a bed net} \end{cases}$$

The result of the malaria test was modeled using logistic model and follows a binary response variable ,P, for parasitemia defined as:

$$P = \begin{cases} 0 \ Negative\ result \\ 1 \ \ Positive\ result \end{cases}$$

A child falls under a certain bed net utilization or parasitemia category, depending on a combination of child individual, parent and area characteristics. The category, is modelled as the probability of falling in that category against some reference category, with *U* assumed to arise from a ordinal distribution and P a binomial distribution.

4.5 STATISTICAL ANALYSIS

Utilization of bed nets by children under five and result of malaria parasitemia test were first explored using descriptive statistics. Multivariate analysis was then used to examine differentials in bed net utilization and result of parasitemia test. Where the dependent variable is binary, as in the case of result of malaria test (negative, positive), estimation was by the logit model. Where the dependent variable is ordinal, as in the case of bed net utilization (no bed net, none, some, all), estimation was by the ologit model. Odds ratios were obtained for logit regressions and proportional odds ratios obtained for ordinal logit regressions. Addition of variables in the multivariate analysis was done twice; manually by adding one variable at a time in stata and then using stepwise selection procedure.

5. RESULTS

In table 1, total of 7237 children had results obtained for bed net utilization. Among these 28.8% were from households with no bed nets, 21.3% from households were none of the children under five slept under a bed net, 10.2% of children were from households were some children sleep under bed nets and 39.7% from households were all children under five slept under a bed net.

In table 2, parents for 5600 children gave consent for the malaria test to be done. Among these 87.5% of children were negative while 12.5% were positive.

Table 1: Bed net utilization among children under five in Tanzania

bed net utilisation	Freq.	Percent	Cum.
No bed net	2,086	28.82	28.82
None	1,539	21.27	50.09
Some	738	10.2	60.29
All	2,874	39.71	100
Total	7,237	100	

Table 2: Result of Malaria test among children under five in Tanzania

Result of Malaria test	Freq.	Percent	Cum.
negative	4,900	87.5	87.5
positive	700	12.5	100
Total	5,600	100	

In table 3, the total number of bed nets found in the households was 16913 giving an average number of 1.85 nets per household. The majority of nets were got from shops and health facilities. According to table 4, only 3476 nets (20% of nets) were said to be obtained from the hati Pungozo social marketing program.

Table 3: Table showing the place where the net was got from

	Shop	Street trader	Health facility	Market	Other	Gift	Don´t know	Totals
1	3294	256	3109	292	149	263	65	7428
2	2195	137	2162	148	97	152	62	4953
3	1322	79	1040	65	54	68	44	2672
4	619	38	419	21	19	35	17	1168
5	309	4	96	14	8	10	9	450
6	124	1	43	2	9	4	6	189
7	34	2	13	0	2	0	2	53
Totals	7897	517	6882	542	338	532	205	16913

Figure 3 and 4 show the bed net utilization and result of parasitemia test for children under 5 over zone. The East has the highest percentage of children from households were all children sleep under bed nets but still has 18% of children from households with no bed nets. Zanzibar has the second highest proportion of all children sleeping under bed nets and has the least (only 6%) of children from households with no bed nets. It also has the lowest proportion of negative result of parasitemia. The Lake District, which has a higher number of all proportion children sleeping under bed nets compared to some, none and no bed net, still has a high level of

positive result of parasitemia. In comparison the Central, North and southern highlands have higher percentages of children having no bed nets and yet have relatively low percentages of children having a negative result of the malaria test.

Table 4: Table showing nets obtained under the hati Pungozo social marketing program

	No	Yes	Don´t know	Totals
1	5508	1856	64	7428
2	3851	999	103	4953
3	2223	368	81	2672
4	970	178	20	1168
5	392	49	9	450
6	167	18	4	189
7	43	8	2	53
Totals	13154	3476	283	16913

Figure 3: Bed net utilization for children under five by zone

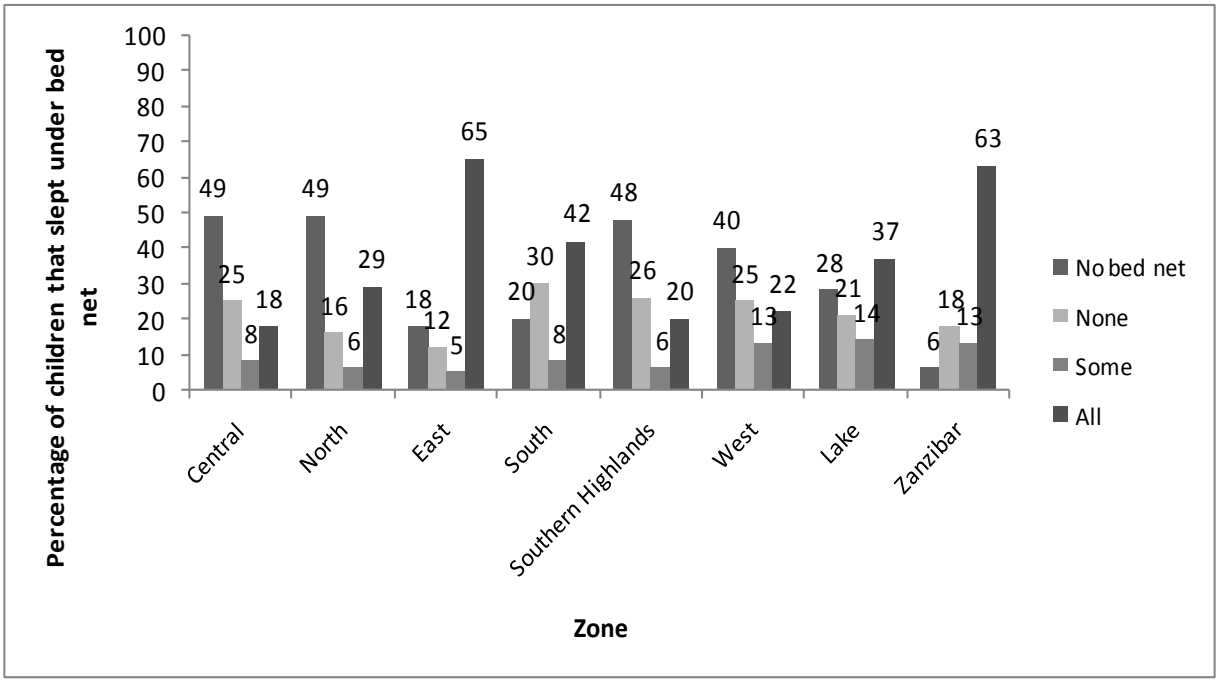
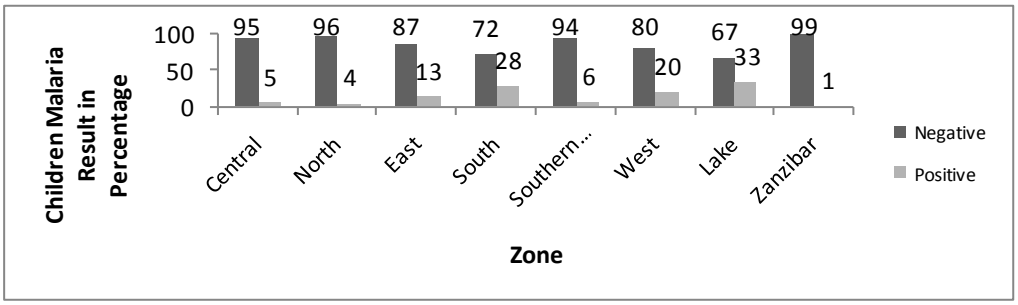


Figure 4: Result of Malaria test for children under five by zone



In table 5 the following factors are significantly associated with utilisation of bed nets at 0.05 level of significance. Type of place of residence, sex of household head, wealth index, highest education level of mother, age group of mother, current age of the child, result of malaria test, anemia level of the child, house sprayed in the last 12 months, region endemicity, frequency of listening to a radio and frequency of watching television.

In table 6 the following are significantly associated with result of the malaria test at 0.05 level of significance. Utilization of bed nets, type of bed net child slept under, no medication taken for fever and convulsion, type of place of residence, wealth index, current age of the child, region endemicity, child had fever two weeks before the survey, child anemia level, house sprayed in the last 12 months prior to the survey, zone and number of bed nets in the household.

When the ordinal logistic regression of the factors with bed net utilization is run in table 7, parasitemia is first found to be significant with an odds ratio of 0.7. However with inclusion of other variables, parasitemia is insignificant with bed net utilization. In table 7, the following variables are stably significant with bed net utilization across all models making them robust: households in the east, west, south, lake and Zanzibar zones, frequency of listening to a radio, region endemicity, sex of the child and wealth index. Compared to the central zone, the odds that a child from East, Zanzibar, Lake, South and West zones will be from a household were all children sleep under a bed net than no bed net on average is 3.5, 5.1, 2.5, 2.8 and 1.6 respectively. The odds that all children from households were the mother frequently listens to a radio are more likely to sleep under a bed net compared to having some, none and no bed net is 1.1 on average. All children from households from regions that have been known to be endemic are on average 1.5 times more likely to sleep under a bed net than have no bed net. As household wealth index increases so does the odds of having all children sleep under bed nets. Number of household members and age of household head are negatively associated however their odds ratios of 0.934 and 0.9993 are borderline and very close to 1.

Table 5: Bivariate Analysis: Variables associated with the utilization of bed nets among the under fives

Background characteristic	Total	Dependent Variable:Percentage of Chidren under 5 slept under bednet the night before the survey					
		None	all children	some children	no bednet	Chi2	P-Value
Type of place of residence							
Urban	1142	12.08	65.15	8.58	14.19	378.91	0.000
Rural	6095	22.99	34.95	10.5	31.57		
Sex of household head							
Male	6101	21.88	40.16	10.23	27.73	24.95	0.000
Female	1136	17.96	37.32	10.04	34.68		
Wealth Index							
Poorest	1492	22.18	21.65	8.31	47.86	881.88	0.000
Poorer	1404	27.14	30.41	8.12	34.33		
Middle	1503	20.49	35.99	12.91	30.61		
Richer	1614	20.14	48.14	11.77	19.95		
Richest	1222	15.88	65.79	9.49	8.84		
Highest education level							
No education	2066	24.15	34.66	9.49	31.7	202.45	0.000
Primary	4492	20.84	38.85	10.13	30.19		
Secondary	637	15.7	60.44	12.4	11.46		
Higher	42	9.52	66.67	19.05	4.76		
Child currently has fever							
No	4680	21.5	41.11	9.53	27.84	5.8965	0.117
Yes	202	19.8	36.63	7.92	35.64		
Age group of mother							
15-19	353	20.96	39.94	8.5	30.59	29.02	0.048
20-24	1703	21.08	40.22	11.45	27.25		
25-29	1880	20.59	40.64	9.26	29.52		
30-34	1480	20.81	39.32	10.88	28.99		
35-39	1135	23	39.56	10.48	26.96		
40-44	500	22	39.8	7	31.2		
45-49	186	21.51	29.03	12.9	36.56		
Current age of child							
0	1468	21.25	38.22	11.78	28.75	35.64	0.000
1	1508	23.54	42.11	10.34	24.01		
2	1330	19.7	40.45	8.95	30.9		
3	1262	20.92	39.7	10.14	29.24		
4	1327	20.87	36.55	10.85	31.73		

Table 5 Continuing… Bivariate Analysis: Variables associated with the utilization of bed nets among the under fives

Background	Total	Dependent Variable:Percentage of Chidren under 5 slept under bednet None	all children	some	no bednet	Chi2	P-Value
Result of Malaria test							
Negative	4892	21.48	40.84	9.46	28.21	35.39	0.000
Positive	700	21.43	30.43	13.43	34.71		
Child had fever in last 2 weeks							
No	5665	21.2	39.1	10.29	29.41	5.53	0.137
Yes	1190	21.93	41.43	10.59	26.05		
Anemia level of child							
Not anemic	1683	22.46	35.23	9.09	33.21	39.29	0.000
Mild	1562	21.57	39.12	9.99	29.32		
Moderate	2253	20.68	42.96	10.21	26.14		
Severe	136	19.12	42.65	14.71	23.53		
House sprayed in last 12 months							
No	5331	22.45	31.7	9.27	36.58	792.25	0.000
Yes	1896	17.88	62.39	12.87	6.86		
Region endemicity							
Marginal	2675	21.98	25.83	6.13	46.06	712.89	0.000
Endemic	4562	20.85	47.87	12.58	18.72		
Frequency of listening to radio							
not at all	2108	28.61	41.56	10.48	19.35	401.69	0.000
ess than once a week	1267	37.88	28.26	12.39	21.47		
atleast once a week	1354	35.89	28.8	11	24.3		
almost everyday	2500	51.92	18.44	8.44	21.2		
Frequency of watching TV							
not at all	5332	22.07	35.54	10.43	31.96	286.05	0.000
ess than once a week	865	20.69	41.97	9.48	27.86		
atleast once a week	525	20.95	52.57	8.38	18.1		
almost everyday	448	12.5	70.31	10.27	6.92		
Zone							
Central	733	49.52	24.56	7.78	18.14	1.50E+03	0.000
North	612	49.35	16.34	5.72	28.59		
East	515	18.06	11.65	4.66	65.63		
South	592.00	20.10	29.56	7.94	42.40		
Southern highlands	769	48.63	26.14	5.59	19.64		
West	1070	39.63	24.58	13.27	22.52		
Lake	1031	28.03	21.05	14.35	36.57		
Zanzibar	1915	6.37	17.91	12.64	63.08		

Table 6: Variables associated with the result of Malaria test among Under Fives

Background characteristics	Totals	Dependent variable: Result of Malaria test			
		Negative	Positive	Chi2	P-value
Children under five slept under a bed net night before survey					
None	1201	87.51	12.49	35.39	0.000
All children	2211	90.37	9.63		
Some children	557	83.12	16.88		
No bednet	1623	85.03	14.97		
Type of bednet child slept under					
Only treated	1896	91.01	14.28	36.06	0.000
Only untreated	586	85.49	14.51		
Nothing taken for fever/Convulsion					
No	912	78.84	21.16	17.57	0.000
Yes,nothing taken	120	61.67	38.33		
Type of place of residence					
Urban	874	94.97	5.03	52.77	0.000
Rural	4726	86.12	13.88		
Sex of household head					
Male	4749	87.37	12.63	0.51	0.473
Female	851	88.25	11.75		
Wealth Index					
Poorest	1166	81.3	18.7	178.25	0.000
Poorer	1101	82.38	17.62		
Middle	1164	85.4	14.6		
Richer	1252	92.89	7.11		
Richest	916	96.83	3.17		
Current age of child					
0	709	93.23	6.77	42.14	0.000
1	1417	89.56	10.44		
2	1216	85.36	14.64		
3	1112	89.69	13.31		
4	1146	84.47	15.53		

Table 6 Continuing…Variables associated with the result of Malaria test among Under Fives

Background characteristics	Totals	Dependent variable: Result of Malaria test			
		Negative	Positive	Chi2	P-value
Region endemicity					
Marginal	2098	88.8	11.2	5.17	0.023
Endemic	3502	86.72	13.28		
Child had fever in last 2 weeks					
No	4542	89.97	10.03	134.41	0.000
Yes	1035	76.81	23.19		
Anemia level					
Not Anemic	1675	93.31	6.69	147.39	0.000
Mild	1547	90.05	9.95		
Moderate	2240	82.37	17.63		
Severe	136	71.32	28.68		
House sprayed in last 12 months					
No	4109	83.57	16.43	225.34	0.000
Yes	1483	98.58	1.42		
Zone					
Central	588	94.9	5.1	718.15	0.000
North	455	95.6	4.4		
East	394	87.31	12.69		
South	462	71.86	28.14		
Southern highlands	610	93.77	6.23		
West	809	80.35	19.65		
Lake	783	66.67	33.33		
Zanzibar	1499	99.2	0.8		
Number of bednets in household					
0	1625	85.05	14.95	70.03	0.000
1	1169	83.75	16.25		
2	1278	87.72	12.28		
3	831	90.97	9.03		
4	398	94.97	5.03		
5	178	96.07	3.93		
6	78	92.31	7.69		
7	28	92.86	7.14		
8	15	100	0		

The results in the stepwise regression in table 9 (in appendix) are similar to those above. Parasitemia is not significant with bed net utilization. The East, South, West, Lake and Zanzibar zones are significant with bed net utilization with odds ratios of 3.8, 2.3, 1.5, 2.2 and 4.7 respectively. Other significant results are frequency of listening to a radio, region endemicity, wealth index, number of household members, current age of the child and age of household head. In addition to these, Number of children under five in the household and distance to the nearest market are also significant.

Table 8 (in appendix) shows the logistic regression analysis for the model of the result of the malaria test. Bed net utilization too is first significantly associated with parasitemia with an odds ratio of 0.8. However this factor becomes insignificant with the addition of other variables. The significant variables across all models are anemia level of the child, households from the south, west and the lake zones, child had fever two weeks before the survey and current age of the child. The chance that a child with anemia has a positive Parasitemia test is about two times more than that without anemia. Compared to the central zone there's a higher chance for a child to have positive test for Parasitemia by about 5.2 in the South, 5.4 in the West and 7.8 in the lake zone. A child that had fever two weeks before the survey is 2.4 times more likely to have a positive test than a negative one. As the age of the child increases to 5, the chance that the child has a positive test is 1.4 times higher than negative. Type of place of residence is also significant with children in the rural areas more likely to test positive for parasitemia.

Table 10 (in appendix) is the stepwise ordinal logistic regression for the parasitemia result of malaria test. The results are similar to those from table 8 above. Bed net utilization is insignificant with parasitemia. Anemia, child had fever two weeks before the survey and zones in the South, West and Lake district are significant with similar odds ratios as those reported above. In addition to these, children in the east are 2 times more likely to have positive parasitemia results than those in the central while those in Zanzibar are 0.06 times less likely. Children from richest households 0.3 times less likely to have positive results than those in poorest households and those from rural areas are 2 times more likely to have positive results than those in urban areas.

6. DISCUSSION AND CONCLUSION

In assessing the relationship between bed net utilization and parasitemia, the factors assessing bed net utilization were explored. It was expected that a positive result of malaria test would have a positive influence on the use of bed nets. On the contrary, parasitemia is not significant with bed net utilization at the national level with an individual data set. This confirms what was reported in the graph in figure 2. Having parasitemia or not does not have an influence on bed net use.

The limitation is whether or not the result of the malaria test used is a representation of the parasitemia levels in the country. The timing of the test make it difficult as a child that is tested negative might turn positive a few hours later. It should also be noted that the sensitivity of the para check test used is higher in endemic regions than in marginal regions.

Also the parasitemia result used in the study is for both asymptomatic and symptomatic cases. It should always be noted that people may have parasitemia and yet not have malaria. The variable child had fever 2 weeks before the survey, which is one of the clinical symptoms for malaria, is significant. The debate is whether all asymptomatic cases should be treated or just those that are confirmed with clinical cases. If all asymptomatic cases are treated, this can be very expensive and wasteful. On the other hand non-treated asymptomatic cases might turn severe.

In exploring the factors that influence parasitemia, it was also expected that the increase in bed net use would have a negative influence on parasitemia. On the contrary this was not significant. The use of bed nets does not influence the result of the parasitemia test at the national level. This however does not mean that bed nets are not efficient because their efficiency has been proved in literature. However there are some biases in this relationship.
There are many sources of none utilization of bed nets which were not recorded in the survey. One of these can be the bed time. Many children go to bed very late after being bitten by mosquitoes.
The indicator used for bed net utilization, child slept under bed net last night, does not effectively represent bed net use. A better indicator would be to have a daily all year record of child bed net utilization.

The influence of bed nets on parasitemia can also be biased by the adaptation of mosquitoes which may change their biting times to during the day if all children are using bed nets.

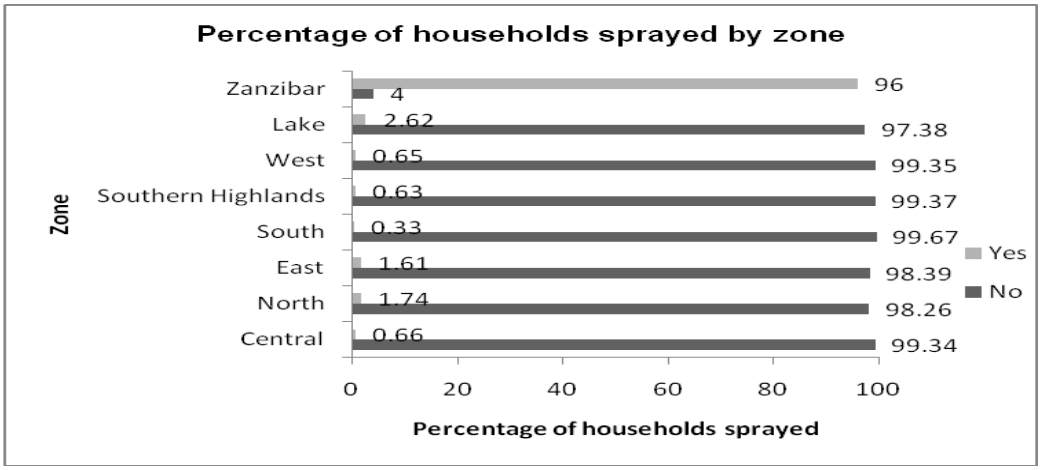
Other malaria interventions may confound this relationship too. These can be spraying or use of ACTs. Spraying was insignificant in this study. This could be because only the Zanzibar zone had high levels of spraying (see figure 6). ACTs were not included in the model. Only a small percentage of children had been found to have used the recommended ACTs. Also massive stock outs of ACTs are reported in malaria prone countries with some countries having up to 6 months of stock outs.

There is a bi-directional relationship between the use of bed nets and parasitemia which makes it difficult to make a conclusion on the causal factor. However the best statistical method for analyzing this data to be able to treat the bi-directional relationship would have been to use simultaneous estimation and instrumental variable analysis but given the limited time period, this was beyond my statistical knowledge.
More accurate results would have been realized if multi-level analysis was used to take into account the multi-level nature of the data but again this was not possible.

The zones that were not significant with bed net utilization were also not significant with parasitemia. This means that the bed net interventions are not targeting the zones that do not need them. Although households in the south, west and lake districts were positively associated with bed net utilization, they were also found to have more children with a positive malaria result. There should be a scale up in interventions on bed net utilization in these zones. Zanzibar and the East are regions that have been successful in the intervention of bed nets. This can be seen with high positive association with bed net utilization and yet insignificant with parasitemia. The situation in Zanzibar might be explained by an integration of interventions. As seen in the table below had 96% of all households sprayed. But however this is still questionable because the East zone had high levels of bed net utilization, low levels of parasitemia and only had 1.6% of houses sprayed.

Indeed the question on whether or not IRS is effective and its comparison with other interventions is still being debated. There is still very little evidence to support it. A review was done to seek to find data that would enable the effectiveness of IRS to be quantified. The reviewers concluded, however, that insufficient research has so far been conducted to allow estimates to be made [13].

Figure 5: Graph showing the percentage of households sprayed by Zone



It is also interesting to note that region-endemicity which is significant with bed net utilization is not significant with parasitemia. This could be as a result of the varying nature of malaria endemicity in Tanzania. Regions that were endemic could now be marginal and vice versa. This can be attributed to the change in climatology, topography and vector related factors [14]. Therefore the intervention of bed nets could have target the regions that were endemic but the prevalence has since changed making eradication of malaria even more difficult.

7. RECOMMENDATIONS

Even if the relationship between parasitemia and bed net utilization is not significant in the study, I recommend that DHS should continue to include parasitemia in the surveys because it is a proxy to the malaria prevalence in the country.

The population should be taught and given more information on the importance and proper use of bed nets. The radio as an effective means of information flow should be used.

Interventions should continue to match malaria region endemicity but these need to be mapped regularly to match with the transmission variations so that interventions can be targeted to match the malaria prevalence in the country. At the moment interventions of bed nets be improved in the South, West and Lake Zones.

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APPENDIX

APPENDIX 1: VARIOUS TABLES USED IN THE STUDY.

Table 7: Ordinal Logistic regression for bed net utilization of children under five and predictive factors at the individual level

	Dependent variable: Child under five slept under a bed net the night before the survey								
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Parasitemia	0.712***	0.728***	0.812***	0.795***	0.816**	0.842**	0.90	0.91	0.91
	(0.05)	(0.05)	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
No. Of children under 5		0.925***	0.954**	0.953**	0.953**	0.964*	0.98	0.99	0.99
		(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Zone(Reference:Central)									
North			1.22	1.20	1.219*	1.19	1.06	1.01	1.03
			(0.15)	(0.15)	(0.15)	(0.14)	(0.13)	(0.12)	(0.13)
East			6.765***	6.515***	6.560***	6.483***	5.540***	5.000***	5.052***
			(0.88)	(0.86)	(0.87)	(0.86)	(0.74)	(0.67)	(0.68)
South			3.328***	3.204***	3.226***	3.191***	3.059***	2.948***	2.976***
			(0.39)	(0.38)	(0.38)	(0.38)	(0.36)	(0.35)	(0.36)
Southern highlands			1.05	1.04	1.05	1.06	1.06	1.06	1.06
			(0.11)	(0.11)	(0.11)	(0.12)	(0.12)	(0.12)	(0.12)
West			1.760***	1.706***	1.716***	1.772***	1.702***	1.648***	1.653***
			(0.18)	(0.18)	(0.18)	(0.19)	(0.18)	(0.17)	(0.18)
Lake			2.885***	2.808***	2.826***	2.780***	2.668***	2.587***	2.613***
			(0.30)	(0.30)	(0.30)	(0.30)	(0.28)	(0.28)	(0.28)
Zanzibar			8.587***	8.324***	8.459***	8.794***	8.184***	7.961***	8.014***
			(0.81)	(0.80)	(0.81)	(0.88)	(0.82)	(0.80)	(0.81)
anemia level				1.062**	1.04	1.04	1.04	1.04	1.05
				(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Sex of child					0.952**	0.954**	0.952**	0.952**	0.952**
					(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Highest education level(Reference:No education)									
Primary						1.512***	1.344***	1.297***	1.302***
						(0.09)	(0.08)	(0.08)	(0.08)
Secondary						1.800***	1.509***	1.288**	1.291**
						(0.20)	(0.17)	(0.15)	(0.15)
Higher						3.526***	2.454**	1.86	1.92
						(1.39)	(0.97)	(0.74)	(0.77)
Frequency of listening to radio							1.275***	1.248***	1.241***
							(0.03)	(0.03)	(0.03)
Frequency of watching television								1.190***	1.195***
								(0.04)	(0.04)
Sex of household head									0.846**
									(0.06)
Constant									
cut 1	0.391***	0.330***	0.91	1.00	0.87	1.240*	1.615***	1.610***	1.324*
	(0.01)	(0.02)	(0.08)	(0.10)	(0.10)	(0.15)	(0.21)	(0.21)	(0.20)
cut 2	0.98	0.823***	2.628***	2.897***	2.526***	3.641***	4.839***	4.832***	3.976***
	(0.03)	(0.04)	(0.23)	(0.29)	(0.29)	(0.46)	(0.63)	(0.63)	(0.62)
cut3	1.466***	1.238***	4.217***	4.650***	4.055***	5.873***	7.851***	7.833***	6.446***
	(0.04)	(0.06)	(0.38)	(0.48)	(0.47)	(0.75)	(1.03)	(1.03)	(1.01)
Observations	5592.00	5592.00	5592.00	5590.00	5590.00	5590.00	5584.00	5536.00	5536.00
r2_p	0.00	0.00	0.07	0.08	0.08	0.08	0.09	0.09	0.09

Standard error in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7 Continuing… Logistic regression for bed net utilization of children under five and predictive factors at the individual level

	Dependent Variable: Child under five slept under a bed net the night before the survey							
VARIABLES	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
Parasitemia	0.9100	0.9720	0.9690	0.9710	0.9780	0.9530	0.9550	0.9580
	(0.0754)	(0.0809)	(0.0810)	(0.0812)	(0.0820)	(0.0809)	(0.0810)	(0.0812)
No. Of children under 5	0.9750	0.9920	1.156***	1.128***	1.130***	1.128***	1.127***	1.134***
	(0.0197)	(0.0202)	(0.0318)	(0.0322)	(0.0323)	(0.0324)	(0.0324)	(0.0328)
Zone(Reference: Central)								
North	1.1560	0.9770	0.9920	1.0050	1.0110	1.0010	0.9880	0.9870
	(0.1450)	(0.1240)	(0.1260)	(0.1280)	(0.1290)	(0.1280)	(0.1270)	(0.1260)
East	4.529***	3.670***	3.657***	3.672***	3.650***	3.604***	3.581***	3.563***
	(0.6220)	(0.5110)	(0.5110)	(0.5130)	(0.5110)	(0.5060)	(0.5030)	(0.5000)
South	2.369***	2.499***	2.375***	2.320***	2.295***	2.270***	2.288***	2.263***
	(0.3110)	(0.3310)	(0.3160)	(0.3100)	(0.3060)	(0.3040)	(0.3060)	(0.3030)
Southern highlands	1.1870	1.0380	1.0360	1.0070	1.0110	1.0030	1.0190	1.0200
	(0.1350)	(0.1190)	(0.1190)	(0.1160)	(0.1170)	(0.1160)	(0.1190)	(0.1190)
West	1.478***	1.464***	1.561***	1.543***	1.549***	1.548***	1.552***	1.548***
	(0.1610)	(0.1610)	(0.1730)	(0.1710)	(0.1720)	(0.1730)	(0.1730)	(0.1730)
Lake	2.310***	2.218***	2.289***	2.240***	2.209***	2.178***	2.199***	2.199***
	(0.2570)	(0.2490)	(0.2580)	(0.2530)	(0.2500)	(0.2470)	(0.2500)	(0.2500)
Zanzibar	6.421***	5.179***	5.128***	5.069***	3.762***	3.796***	3.876***	3.755***
	(0.7300)	(0.6040)	(0.6000)	(0.5940)	(0.8630)	(0.8750)	(0.8950)	(0.8690)
anemia level	1.0410	1.0420	1.0430	1.0430	1.0410	1.0410	1.0410	1.0400
	(0.0331)	(0.0334)	(0.0336)	(0.0336)	(0.0336)	(0.0337)	(0.0337)	(0.0337)
Sex of child	0.952**	0.949**	0.949**	0.948**	0.948***	0.953**	0.953**	0.953**
	(0.0194)	(0.0195)	(0.0196)	(0.0196)	(0.0196)	(0.0199)	(0.0199)	(0.0199)
Mothers education level (Reference:No education)								
Primary	1.299***	1.136**	1.137**	1.136**	1.135**	1.134**	1.129*	1.121*
	(0.0792)	(0.0708)	(0.0710)	(0.0710)	(0.0710)	(0.0711)	(0.0709)	(0.0705)
Secondary	1.281**	0.8900	0.9020	0.9000	0.8960	0.8990	0.8900	0.8870
	(0.1460)	(0.1050)	(0.1070)	(0.1070)	(0.1060)	(0.1070)	(0.1060)	(0.1060)
Higher	1.9110	1.1340	1.0740	1.0790	1.0680	0.9890	0.9730	0.9680
	(0.7680)	(0.4550)	(0.4360)	(0.4390)	(0.4320)	(0.4020)	(0.3950)	(0.3930)
Freq. of listening to radio	1.244***	1.163***	1.159***	1.155***	1.153***	1.153***	1.151***	1.151***
	(0.0280)	(0.0272)	(0.0271)	(0.0271)	(0.0271)	(0.0271)	(0.0271)	(0.0271)
Freq. of watching TV	1.184***	1.0260	1.0510	1.0510	1.0510	1.0470	1.0450	1.0460
	(0.0417)	(0.0394)	(0.0406)	(0.0407)	(0.0407)	(0.0407)	(0.0406)	(0.0406)
Sex of household head	0.843**	0.8940	0.876*	0.884*	0.882*	0.879*	0.881*	0.884*
	(0.0617)	(0.0660)	(0.0648)	(0.0655)	(0.0654)	(0.0653)	(0.0654)	(0.0657)
region_endemicity	1.404***	1.423***	1.541***	1.561***	1.590***	1.593***	1.577***	1.589***
	(0.1150)	(0.1170)	(0.1280)	(0.1300)	(0.1330)	(0.1340)	(0.1330)	(0.1340)
Wealth Index (Reference:Poorest)								
Poorer		1.503***	1.548***	1.536***	1.552***	1.543***	1.537***	1.537***
		(0.1230)	(0.1270)	(0.1260)	(0.1270)	(0.1270)	(0.1270)	(0.1270)
Middle		1.852***	1.921***	1.924***	1.944***	1.924***	1.908***	1.891***
		(0.1520)	(0.1580)	(0.1590)	(0.1610)	(0.1590)	(0.1580)	(0.1570)
Richer		2.337***	2.486***	2.463***	2.471***	2.462***	2.413***	2.381***
		(0.2020)	(0.2160)	(0.2140)	(0.2150)	(0.2150)	(0.2130)	(0.2100)
Richest		4.352***	4.566***	4.512***	4.535***	4.515***	4.381***	4.284***
		(0.4860)	(0.5120)	(0.5060)	(0.5090)	(0.5080)	(0.5010)	(0.4920)
No of household members			0.923***	0.937***	0.936***	0.936***	0.935***	0.935***
			(0.0089)	(0.0100)	(0.0100)	(0.0100)	(0.0100)	(0.0100)
Age of household head				0.993***	0.993***	0.993***	0.993***	0.993***
				(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
House sprayed in last 12 months					1.3620	1.3420	1.3430	1.3520
					(0.2740)	(0.2720)	(0.2720)	(0.2740)
Child had fever in last 2 weeks						1.1180	1.1200	1.125*
						(0.0773)	(0.0775)	(0.0779)
Distance to nearest market							1.0810	1.0860
							(0.0559)	(0.0562)
Distance to nearest health facility								0.995**
								(0.0025)
Constant								
cut 1	1.429**	1.993***	1.640***	1.2800	1.2720	1.2780	1.523*	1.515*
	(0.2210)	(0.3200)	(0.2670)	(0.2300)	(0.2290)	(0.2310)	(0.3270)	(0.3260)
cut 2	4.308***	6.229***	5.166***	4.039***	4.026***	4.043***	4.823***	4.802***
	(0.6750)	(1.0120)	(0.8490)	(0.7320)	(0.7310)	(0.7370)	(1.0450)	(1.0410)
cut3	6.989***	10.24***	8.548***	6.690***	6.675***	6.678***	7.970***	7.939***
	(1.1010)	(1.6750)	(1.4130)	(1.2180)	(1.2170)	(1.2230)	(1.7330)	(1.7280)
Observations	5536	5535	5535	5530	5522	5499	5499	5499
r2_p	0.0922	0.1060	0.1110	0.1120	0.1120	0.1120	0.1120	0.1130

standard erros in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 8: Logistic regression of Parasitemia results for children under five and predictive factors at the individual level

	Dependent variable: Result of Parasitemia test					
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Bed net utilization	0.865***	0.834***	0.873***	0.914**	0.917**	0.761
	(0.0277)	(0.0272)	(0.0291)	(0.0334)	(0.0336)	(0.157)
Anemia		1.820***	1.829***	1.633***	1.647***	1.786***
		(0.0916)	(0.0925)	(0.0872)	(0.0883)	(0.159)
Zone						
North				0.690	0.653	1.289
				(0.207)	(0.199)	(0.816)
East				2.283***	2.272***	2.911*
				(0.571)	(0.569)	(1.618)
South				6.177***	6.140***	6.839***
				(1.431)	(1.424)	(3.814)
Southern highlands				1.071	1.069	1.585
				(0.274)	(0.273)	(0.985)
West				3.640***	3.557***	7.195***
				(0.780)	(0.763)	(3.874)
Lake				8.050***	8.023***	9.184***
				(1.691)	(1.691)	(4.913)
Zanzibar				0.142***	0.150***	0.285
				(0.0509)	(0.0793)	(0.286)
Region endemicity				0.886	0.884	0.789
				(0.0998)	(0.101)	(0.149)
House sprayed in last 12 months					0.937	0.406
					(0.368)	(0.319)
Bed net type						1.034
						(0.160)
Constant	0.178***	0.0472***	0.00286***	0.0248***	0.0243***	0.0267***
	(0.0109)	(0.00636)	(0.00208)	(0.00546)	(0.00537)	(0.0214)
Observations	5592	5590	5590	5590	5582	2481
r2_p	0.00492	0.0414	0.0592	0.200	0.201	0.239

Standard error in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

Table 8 Continuing…… Logistic regression of Parasitemia results for children under five and predictive factors at the individual level

	Dependent variable: Result of Parasitemia test				
VARIABLES	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**
Bed net utilization	0.775	0.680*	0.753	0.816	0.797
	(0.163)	(0.146)	(0.163)	(0.179)	(0.175)
Anemia	1.724***	2.030***	2.056***	2.067***	2.075***
	(0.155)	(0.195)	(0.200)	(0.203)	(0.205)
Zone(Refence: Central)					
North	1.158	1.013	1.247	1.243	1.254
	(0.736)	(0.649)	(0.805)	(0.807)	(0.814)
East	2.621*	2.393	2.784*	2.751*	2.916*
	(1.465)	(1.345)	(1.577)	(1.561)	(1.657)
South	6.556***	6.071***	5.379***	4.422***	4.690***
	(3.679)	(3.429)	(3.060)	(2.518)	(2.675)
Southern highlands	1.537	1.502	1.660	1.558	1.614
	(0.958)	(0.944)	(1.051)	(0.990)	(1.025)
West	7.290***	6.613***	5.967***	5.170***	5.446***
	(3.944)	(3.603)	(3.271)	(2.839)	(2.993)
Lake	8.620***	7.913***	6.927***	6.633***	7.061***
	(4.635)	(4.286)	(3.774)	(3.609)	(3.848)
Zanzibar	0.267	0.211	0.171*	0.149*	0.170*
	(0.269)	(0.213)	(0.181)	(0.159)	(0.181)
Region endemicity	0.786	0.782	0.901	0.978	1.010
	(0.151)	(0.153)	(0.179)	(0.198)	(0.206)
House sprayed in last 12 months	0.451	0.474	0.488	0.541	0.554
	(0.354)	(0.372)	(0.409)	(0.459)	(0.464)
Bed net type	0.993	1.034	1.093	1.188	1.170
	(0.156)	(0.165)	(0.176)	(0.194)	(0.192)
Child had fever in last 2 weeks	2.201***	2.490***	2.560***	2.508***	2.527***
	(0.348)	(0.405)	(0.424)	(0.419)	(0.423)
Current age of child		1.410***	1.417***	1.418***	1.427***
		(0.0864)	(0.0876)	(0.0882)	(0.0892)
Type of place of residence			3.288***	1.861**	1.903**
			(0.763)	(0.511)	(0.523)
Wealth index					
Poorer				1.370	1.472
				(0.324)	(0.353)
Middle				1.108	1.194
				(0.255)	(0.280)
Richer				0.914	1.028
				(0.230)	(0.267)
Richest				0.371***	0.431**
				(0.129)	(0.153)
No. Of nets in household					0.863**
					(0.0643)
Constant	0.0238***	0.0119***	0.000896***	0.00209***	0.00246***
	(0.0192)	(0.00988)	(0.000876)	(0.00215)	(0.00254)
Observations	2474	2474	2474	2473	2473
r2_p	0.253	0.273	0.292	0.303	0.305

Standard error in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 9: Stepwise regression for bed net utilization of children under five

Ordered logistic regression — Number of obs = 5499; LR chi2(16) = 1576.06; Prob > chi2 = 0.0000; Log likelihood = -6275.6154; Pseudo R2 = 0.1116

Bed net utilisation	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Zone						
Zanzibar	4.689611	0.5025701	14.42	0.000	3.801162	5.785718
East	3.858464	0.4863555	10.71	0.000	3.013849	4.93978
South	2.318387	0.2825937	6.9	0.000	1.825706	2.944021
Lake	2.216301	0.2115175	8.34	0.000	1.838199	2.672176
West	1.571993	0.1496929	4.75	0.000	1.304353	1.894551
Wealth Index						
Richest	2.367271	0.2049608	9.95	0.000	1.997791	2.805084
Richer	1.863752	0.1537534	7.55	0.000	1.585502	2.190834
Middle	1.519784	0.1243173	5.12	0.000	1.294656	1.784061
Poorer	1.138653	0.0659711	2.24	0.025	1.016424	1.275582
Region						
Endemicity	1.583958	0.1278906	5.7	0.000	1.352125	1.855542
Frequency of listening to a radio	1.163038	0.0265449	6.62	0.000	1.112157	1.216246
Age of household head	0.9928628	0.0022421	-3.17	0.002	0.9884781	0.997267
No. Of household members	0.938424	0.0100062	-5.96	0.000	0.9190157	0.958242
No. Of children under five in household	1.134088	0.0323178	4.42	0.000	1.072482	1.199232
Distance to nearest market	0.9968249	0.0009602	-3.3	0.001	0.9949447	0.998709
Current age of child	0.9406165	0.0184613	-3.12	0.002	0.9051202	0.977505
/cut1	0.1885939	0.1338194			-0.073687	0.450875
/cut2	1.336788	0.1357833			1.070658	1.602918
/cut3	1.836687	0.1366446			1.568868	2.104505

Table 10: Stepwise regression of Result of Malaria test

```
Logistic regression                                 Number of obs   =       2473
                                                    LR chi2(10)     =     487.35
                                                    Prob > chi2     =     0.0000
Log likelihood = -572.70459                         Pseudo R2       =     0.2985
```

Result of Malaria test	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
Zone						
(Refrence:Central)						
Lake	4.993848	1.336436	6.01	0.000	2.95556	8.437831
West	4.039917	1.137852	4.96	0.000	2.326107	7.016415
South	3.38855	0.9959159	4.15	0.000	1.904761	6.028196
East	2.036374	0.6434048	2.25	0.024	1.096265	3.782683
Zanzibar	0.0633311	0.0321645	-5.43	0.000	0.0234051	0.171366
Anemia	2.052296	0.199378	7.4	0.000	1.696473	2.482752
Wealth Index						
(Reference: Poorest)						
Richest	0.3519009	0.1039288	-3.54	0.000	0.1972561	0.627784
Child had fever 2 weeks before survey	2.548237	0.4229595	5.64	0.000	1.840587	3.527957
Current age of child	1.403853	0.0862334	5.52	0.000	1.244617	1.583463
Type of place of residence	1.950226	0.5212689	2.5	0.012	1.154969	3.29306

APPENDIX 2: PRACTICUM EXPERIENCE WITH MALARIA CONSORTIUM UGANDA

As part of my practicum I did a 3 months practicum with Malaria Consortium (MC) in Uganda (March-May 2010). During this time I worked in the following two main areas in addition to other duties: the health system strengthening project and the Integrated Community Case Management (iCCM).

The MC health system strengthening project operates in five different African countries: Uganda, Ethiopia, Zambia and Mozambique and Tanzania. I was involved in the following activities:

1. Looking at the different Malaria interventions in specifically Uganda and Tanzania.
   In both countries the interventions are vertical in nature. The main

   - Case management: This includes ensuring the availability of recommended antimalarial drugs at all times at the health care facilities, quick and effective treatment of malaria, effective monitoring of antimalarial drug resistance, and development and implementation of epidemic preparedness plans in malaria epidemic-prone districts. The recommended antimalarial drug in both countries is ACTs (artemisnin combination therapy).
   - Intermittent preventive treatment during pregnancy
   - Vector control: This includes the use of ITNs and indoor residual spraying. The ITN policy in both countries has been massive coverage of children under five and pregnant women. However this year the policy is changing in Uganda and is being scaled out to provide a mosquito net for every sleeping position in each household with funding from the global fund. Some districts have already been covered and the goal is to cover the entire country in the next two years. The nets are being distributed free to all households. It will be interesting to watch the changes in the prevalence rates as bed nets are scaled out.

     IRS is still a big debate in both countries. In Uganda since 2006 only 6 out of 81 districts have been sprayed. In 2008, spraying was stopped after environmentalists

put up a case in the high court against it. In 2009 susceptibility testing was carried out in some other districts and the results are being studied by Ministry if Health. The case is still ongoing and now with the constitutional court.

On the other hand, IRS in Tanzania seems to have been accepted as a good intervention. Trials were carried out in Zanzibar and it is said that a lot of the reduction in the prevalence rate is attributed to spraying. Plans are under way to scale up IRS to other regions in Tanzania.

In addition to these major policies, there is IEC (information education communication) and operational research.

2. Participation in Continuous Medical Education (CMEs) in Hoima district.

   I was part of the team that carried out CMEs in Hoima regional hospital. It was attended by 32 health workers from the Hoima regional referral hospital. These included Pharmacists, malaria focal person, nurses, laboratory assistants and technicians, clinical officers. The topic handled was management of severe malaria in especially children and pregnant women. Bed side teaching, with case studies of inpatient with severe malaria, was also done.

3. Clinical audits in Kibaale district, specifically assigned to Kakindo health center IV.
   A clinical audit was done at Kakindo health center where the center was scored against set out guidelines. Kakindo health center scored about 30%. A feedback session with staff of the center was done and recommendations were agreed upon.

4. Assessment of Health Management Information System (HMIS) activities.
   I wrote concept paper for the assessment was written. The assessments are still being done.
   While doing the assessments it was noted that data from especially hard to reach areas in Uganda is none existent. I wrote a proposal "**Using mobile codes and camera phones installed with a bar code reader, GPRS and GSM for data collection, drug supply and chain management, patient identification, management of patient referrals and supervision of community health workers."** This proposal has been submitted.

5. Planning and drug supply and chain management meetings in four districts namely; Masindi, Buliisa, Kiboga and Hoima districts.

   Two weeks of planning meetings and trainining in drug supply and chain management were carried out in the districts. The main problem identified by the districts was massive stock outs of ACTs. Sometimes these stock outs can last upto 6 months.

I also worked on the iCCM program in Uganda. The challenge of malaria in children is two-fold: How to reach children in need of preventive and curative malaria services and how to provide these services in an efficient and effective manner. iCCM uses community health teams(CHTs) to provide services to children especially those in hard to reach areas. The CHTs are village volunteers who are given basic training in the management of malaria. The training covers symptoms of malaria, diagnosis using RDTs, and treatment using ACTs. The idea is that it is easier and cheaper for the children to get to the community health worker than it is for them to get to the health facility. Usually by the time the children get to the health facility it is often too late to avert death. Although the CHTs are volunteers, they are given a motivation package. My main role was to carry out a cost effectiveness analysis of the program. If this program is found to be cost effective, it will be scaled out to other districts in Uganda and to other countries. I started the piloting of the costing. MC has offered me a job as a health economist. I will be working to complete the cost effectiveness of iCCM after my graduation at EHESP. (See letter from MC attached below)

During my internship with Malaria Consortium, I have been able to understand the different malaria intervention programmes in Uganda. I have also seen the work done by Malaria Consortium in helping the districts with data collection and analysis and hence making an influence in policy adjustment. I can therefore say that my internship objectives have been met. The additional activities I was involved in have helped boost the potential in me. Working on the iCCM costing has helped me realize what I can achieve with my two degrees of Economics and Public Health and given me a clearer picture of my career developments.

I would like to thank Malaria Consortium for giving me such a rich internship experience and trusting me to do all that I have done in the last three months. I would also like to thank all the staff for the support they have given me during this time. I look forward to working with Malaria Consortium at my next job.

malaria **consortium**

disease control, better health

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26 May 2009

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Re: Internship with Malaria Consortium from 1st March to 31st May 2010

It has been a pleasure to host Ms Stella Settumba and the team here is glad that we gave her the opportunity to intern with us. She commenced her attachment with us on 1st March 2010 and since then has been actively involved in several of our projects. Her main focus has been to work with our health systems strengthening team which is handling areas such as medicine supply management, quality of care improvements using clinical audits, and external quality assurance especially in malaria case management. Attached is a detailed report of the work that she has undertaken during her placement with us.

An important piece of work that Ms Settumba has been involved in is to help pilot a costing tool for a two-country programme on Integrated Community Case Management of Common Childhood Diseases funded by the Bill and Melinda Gates Foundation. This gave us the chance to appreciate the competencies that Stella has in this area and her keenness. Based on the quality of her work we have discussed with her the possibility of her taking up an opportunity with us on this project. We therefore hope that these discussions will be fruitful and that she can join Malaria Consortium upon her return after completing the International Masters in Public Health at Ecole des hautes étude en Santé Publique (EHESP).

Finally, we will be keen to explore with you areas of collaboration given that this placement has progressed smoothly.

Yours sincerely,

Dr James Tibenderana
Director Case Management
Malaria Consortium