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A Review of the Literature on Insecticide Treated Bed Net Use, Anaemia and Malaria Parasitaemia in Under Five Children

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Abstract: Insecticide Treated bed Net (ITN) is considered to be the most efficacious of all currently feasible interventions for malaria control in Africa. However, lack of data on its use in under five children has made it difficult to keep tract of its efficacy in this population. This study was aimed at pooling published data from parts of Africa and Asia with the hope of providing an overview of the use of ITNs and its efficacy in children under five years of age. Literature search was carried out Pubmed, Pubmedcentral, MEDLINE, and Cochrane library for all published articles between 1991 and 2015 using search strings such as under five children, ITN, malaria parasitaemia, anaemia, protective efficacy, ownership and use, pattern of deployment and types of ITN. Based on specific criteria, 30 studies were included. Few countries have met the ITN coverage target of 80% including Nigeria, with coverage rates ranging from about 69% to 75%. ITN use in under five children has been shown to reduce the prevalence of malaria and anaemia in areas unstable malaria transmission to a variable degree. ITN possession does not always translate to usage and consistent use is required for effective malaria control.

Keywords: ITN, Malaria, Anaemia, Under Five Children, Africa

1. Introduction

Insecticide treated bed nets are now a major intervention for malaria control. They are a form of personal protection that has been shown to reduce the incidence of malaria, severe disease and death due to malaria in endemic regions. In community wide trials in several African settings, ITNs have been shown to reduce the death of children under five years from all causes of under five deaths by about 20% [1,2].

Insecticide Treated bed Nets (ITNs) have emerged as an efficacious and cost effective malaria control strategy and are a key technical element to the Roll Back Malaria strategy [3]. It reduces mortality and morbidity in children less than five years of age in sub-Saharan Africa [3]. They have been shown to reduce the number of malaria episodes by as much as 50% and childhood mortality by 20% [4]. Duc, showed that as net treatment programme in Vietnam built up during the 1990s, so that more than 10 million people were provided for, the national malaria incidence declined remarkably and malaria deaths dropped almost to zero during the period [5].

Untreated bed nets form a protective physical barrier around people sleeping under them. However, mosquitoes can feed on people through the nets, and nets with even a few small holes provide little, if any, protection. Applying an insecticide greatly improves the protective effect of bed nets. The insecticides used for treating bed nets kill mosquitoes, as well as other insects. The insecticides also repel mosquitoes, reducing the number that enter the house and attempt to feed on people inside. In addition, if high community coverage is achieved, the numbers of mosquitoes, as well as their length of life will be reduced. With this, all members of the community are protected, regardless of whether or not they are using a bed net. To achieve these effects, high community coverage is required.

2. Types of Insecticide Treated Bed Net

There are several types of nets available. They vary by size, material and/or treatment. Most nets are made of polyester but nets are also available in cotton, polyethylene, or polypropylene [6]. Only pyrethroid insecticides are approved for use on ITNs [7]. These insecticides have been shown to pose very low health risks to humans and other mammals, but are highly toxic to insects and knock them down, even at very low doses. ITNs are dip-treated using the synthetic pyrethroid insecticide such as permethrin or deltamethrin [8]. Pyrethroids do not rapidly break down unless washed or exposed to sunlight [1]. The great importance of pyrethroid deposit on the net arises because the body odour of sleepers attracts human seeking (anthropoliphic) mosquitoes to make contact with the net so that many are killed. Thus, with widespread use of treated nets, their mortality will be so high that one would expect a reduction in mean mosquito age and hence a major reduction in the population of mosquitoes [7].

Previously, nets had to be retreated every 6-12 months and more frequently if the nets were washed. They had to be replaced or retreated after six washes. Retreatment was done by simply dipping them in a mixture of water and insecticide and allowing them to dry in a shade. The need for frequent retreatment was a major barrier to widespread use of ITNs in malaria endemic countries [8]. Additional cost and lack of understanding of its importance also resulted in low retreatment rates in most African countries [1]. More recently, several companies have developed Long Lasting Insecticide treated Nets (LLINs) that maintain effective levels for at least three years. There are three types of LLINs - polyester netting which has insecticide bound to the external surface of the netting using a resin, polyethylene which has insecticide incorporated into the fibre and polypropylene which also has insecticide incorporated into the fibre. All types can be washed at least 20 times, but physical durability will vary [8]. Long Lasting Insecticide treated Nets have now replaced ITNs in most countries. These nets have been associated with sharp decreases in malaria in countries where malaria programmes have achieved high LLIN coverage. The WHO now recommends that LLINs be distributed to and used by all people in malarious areas, not just to the most vulnerable groups [1].

In April 2000, African Heads of States met in Abuja where they set among other targets in the Roll Back Malaria programme, a 60% use of ITN among the high risk groups by year 2005. A target that was subsequently raised to 80% by 2010 [2]. Few countries have however met this target and under-five ITN coverage in Africa is currently only 3% with rates in Nigeria reflecting these regional figures [9]. As earlier mentioned, a new global guideline on the use of ITN by all members of the community has been issued by the WHO [10, 11]. The WHO now recommends that LLINs be distributed to and used by all people (universal coverage) in malaria endemic areas and not just the most vulnerable groups (under-fives and pregnant women) [2].

Several studies have shown that malarial parasitaemia is positively correlated with anaemia and that parasitaemia is the primary cause of anaemia in very young children in Africa [12]. Malarial infection is the norm in high transmission areas. Consequently, anaemia is common in young children. Hopes for controlling malaria and malarial anaemia have recently been revitalised by the demonstration that nets treated with insecticide can reduce malarial morbidity and mortality [12].

3. How to Deploy an ITN

For effectiveness, it is important that the netting does not have holes or gaps large enough to allow insects to enter. Because an insect can bite a person through the net, the net must not rest directly on the skin. Mosquito nets can be hung over beds, from the ceiling or a frame, built into tents [13]. When hung over beds, rectangular nets provide more room for sleeping without the danger of net coming in contact with the skin, at which point mosquitoes may bite through untreated net [14]. The net is said to be properly used when the corners of the rectangular ITN are attached to the eaves and walls of the room, with the net lowered during sleeping time and tucked under the sleeping mattress or mat, or made to touch the ground all around. This ensures maximum contact between the host seeking mosquitoes and the insecticide treated net, and minimises the contact between the mosquitoes and potentially infective hosts. This is referred to as adherence [14].

4. Methodology

This was a review of published scientific literature on the use of Insecticide treated bed nets in Africa, South-East Asia and other parts of the world between 1991 and 2015. Literature search was performed on PUBMED/MEDLINE, PUBMED central, Cochrane library for all articles using search strings or key words such as under five children, ITN, malaria parasitaemia, anaemia, protective efficacy, ownership and use, pattern of deployment and types of ITN. The reference list of articles were also checked for other articles that were not detected by the bibliographic search. In general, only studies based on ownership and use of insecticide treated bed net, its effect on malaria parasitaemia, anaemia, its protective efficacy and nutritional status of the children were included. Studies involving older children were also included so that comparisons could be made.

A total of 30 articles were reviewed. Three studies [1, 12, 15] were done across several East and West African countries including Madagascar. Most of the studies were carried out in East Africa: 5 in Tanzania [3, 7, 16-18] and 4 in Western Kenya [11, 14, 19, 20]. Three studies were done in West Africa; 2 in Nigeria [4, 21] and 1 from Ghana [9]. The studies [5, 22-26] from outside Africa were mostly from Asia with 2 articles coming from 2 regions of the same country [25]. One study was from the republic of Vanuatu, located east of Australia and west of Fiji [27].

The studies from East Africa involved mostly children under five years while the others also included older children.

5. Results

A summary of randomised controlled trials showed an average protective effect of about 50% on mild malaria episodes in areas where the rate of malaria transmission was stable. Moreover, protective effects were shown on the prevalence of malaria parasitaemia and on overall mortality. A modest improvement in packed cell volume and weight gain was also observed in children sleeping under nets [12].

6. ITN Ownership and Use

Focus group discussions carried out in Afghanistan [22] among men and women from ITN owning and non-owning households, over a five- year period, to explore coverage and usage of ITN, showed that 69% of the respondents owned ITNs. These were mostly purchased and most of them did not use the nets. Insecticide Treated bed Net was mainly used during the high transmission period to control mosquito nuisance. Only 38% of the respondents wanted to use ITN for prevention of malaria and cost was one of the primary reasons for not having an ITN. This was shown to be true in a study carried out in Bangladesh by Syed *et al*., [23] where, despite having a poor knowledge of the importance of ITN in malaria prevention, ITN possession and use increased with 70% of the members of the households sleeping under an ITN after bed nets were distributed free of charge. Knowledge about ITN hanging and malaria increased in the first year after the nets were distributed, but failed to remain high in the second year of the study. This may have been as a result of poor knowledge on the importance of ITN in malaria prevention.

Insecticide treated bed net use has also been shown to be driven by the need to promote healthy life and eliminate malaria. This was shown in a study carried out in Vanuatu, [27] an area where malaria has almost been eliminated. The most cited benefit for ITN use was the prevention of malaria, followed by protection from mosquito bite. ITN ownership was high with 1.99 ITNs present per household and 71.9% of respondents sleeping under an ITN the night before the survey. Also, unlike in the previous study above, in this study, all the respondents had correct knowledge about malaria. This was probably why they continued to sleep under the nets in spite of minimal malaria transmission rate.

The number of persons per ITN has also been shown to have an impact on its beneficial effect. This is seen in the study [24] carried out to determine if sleeping overnight in a farming hut was a risk factor for malaria infection in a setting with ITNs, in rural Laos in East Asia. ITNs were obtained from free distribution and this increased the number of children sleeping in an ITN from 13% to 74.6%. This study showed that there was no association between malaria infection and sleeping in the farm hut overnight, because the children used ITNs when sleeping. These children were older children and usually slept under an ITN. Sleeping under ITNs in the farm huts at night prevented the children from having malaria episodes but when the nets were shared with more than 5 people, they came down with more malaria episodes.

7. ITN Use, Malaria Parasitaemia and Anaemia

Insecticide treated bed nets have been shown to reduce the prevalence of malaria and anaemia in areas of unstable malaria transmission although to a variable degree. This is seen in the study by Lin *et al.,* [25] on the promotion of insecticide treated mosquito net in Myanmar, South East Asia. It was found that health promotion messages given by village midwives increased bed net usage to over 60% and that treatment of nets caused a reduction in malaria cases. The finding of Smithuis *et al.,* [26] was however different in many respects. Their study was conducted in Western Myanmar to determine the effect of ITN on the incidence and prevalence of malaria in children below 10 years. A baseline study was carried out before ITNs were given to the villages mapped out as intervention villages. The control villages received ITNs after the study. Baseline anaemia and malnutrition were similar in both villages. After ITNs were distributed, the children were followed up for weight, height, and haemoglobin and malaria parasitaemia estimation. They found out that more children in the control villages came down with malaria twice within the study period. Insecticide treated bed net use was not found to reduce malaria significantly. Overall, they concluded that there was no significant benefit evident for ITN deployment. The reason given for this was the early evening and strong preference for outdoor biting of most malaria vectors in the area, which meant that bites occurred before the nets were used and so there was no protection from the nets.

Njau *et al.,* [15], in their cross sectional survey across three sub-Saharan African countries, Tanzania, Uganda and Angola, explored the impact of free ITN distribution, on ITN ownership and malaria infection rates. It was shown that Angolan children from wealthier households were less likely to be parasitaemic than the poorest households. Free distribution of nets achieved a coverage of 52% with 41% of under five children sleeping under an ITN in Angola. This was higher than the two other countries. The prevalence of malaria was highest in Uganda and lowest in Tanzania. The reason for this was the fact that household ownership of at least one ITN was highest in Tanzania (68%), while it was 61% and 33% in Uganda and Angola, respectively. Angolan children were less likely to be parasitaemic because 41% of them were sleeping under ITNs.

Several other studies [15-20] have shown that ITNs cause a reduction in malaria parasitaemia and anaemia in under-five children especially when used properly. In their Western Kenyan study, Terkuile *et al.,* [19], conducted three cross sectional surveys to assess the impact of ITNs on morbidity in 1,890 children less than 3 years old. They found that the children in all the villages were comparable in terms of malaria episodes and anaemia, before the ITNs were distributed. The picture was however different after the ITNs were distributed. Children in the intervention villages had less clinical malaria, had moderately severe anaemia and parasitaemia. They also had less pruritic body rash, presumably from reduced insect bites. This was similar to the finding of a Tanzanian study by Abdulla *et al.,* [16], whose objective was to assess the impact of a social marketing programme for distributing ITNs on malaria parasitaemia and anaemia in 748 children, less than 2 years old. As ITN ownership increased, from 10% before the programme to 61% after the programme, the mean haemoglobin level in these children increased from 80g/dl to 89g/dl. Overall the prevalence of anaemia decreased from 49% to 26%. Also, there was a decline in malaria parasitaemia from a base line of 63% to 38% in the two- year period of the survey.

Another western Kenyan study by Penelope *et al.,* [20] carried out among children 1 to 59 months old, showed the implication of proper deployment of ITNs. Child deaths were monitored over a two-year period by bi-annual household census. Overall, 1,722 deaths occurred in children with 56.4% of these deaths occurring in children in the control villages; where no nets were given initially, but was given to them after the trial. In the villages where nets were given, the death rate was 45.4%. Eight lives were saved per year for every 1000 children, aged 1-59 months. The haemoglobin level of children in the intervention villages improved, as well as their growth. Deaths were excluded if a child died on or before the first day of the study, was stillborn, died within 28 days of birth or died within 30 days of migration into the study area. Similarly, Schellenberg *et al.,* [17] assessed the coverage and effect on child survival of a large social marketing programme for insecticide treated nets in two rural districts in Tanzania, using a case control approach. Cases, were deaths in children between 1 month and 4 years. Four controls were chosen for each case. Although the methodology was different from the study by Penelope *et al*., [20], their findings were not so different. The results showed that ITNs were associated with a 27% increase in survival. Overall, it was found that ITNs prevented 1 in 20 deaths. The fact that Schellenberg *et al.,* [17] excluded children from 49 months to 59 months may have accounted for the slight difference in both studies.

A different trend was observed in a Zambian study [28] carried out in an area with near universal ITN coverage. Among all the children less than 5 years old, 81.8% slept in a house possessing more than one ITN, and 68% of them slept under an ITN. Overall parasite prevalence was 9.7%. This prevalence is very low when compared to other studies [15, 19]. This may be due to the fact that more under-five children slept under an ITN. Malaria parasite prevalence was 9.7% in the first year of the study and 12.6% in the second year of the study. There was thus an increase in the parasite prevalence instead of a decrease. Although this increase was not much, it was different from the findings from the other studies where malaria parasite prevalence decreased in the subsequent surveys after ITN was distributed. The reason given for this paradoxical finding was that chronic malaria parasite infection is a significant risk factor for severe malaria in children 6-59 months even though they live in an area with high ITN coverage. Overall, the prevalence of severe anaemia among children aged 6-59 months over both study years was 6.9%. The prevalence of severe anaemia was lower in the first study year than in the second. The reason given for this reversal in trend was that even in an area of high ITN coverage, chronic malaria parasite infection remains a significant risk factor for severe anaemia in children 6-59 months. This therefore calls for an integrated management approach of malaria control.

8. Protective Efficacy of ITN

When the protective efficacy of ITN was considered, most of the studies [16, 20] showed similar results. In the Western Kenyan study by Penelope *et al.,* [20] the protective efficacy of ITN was 23% in infants and 7% in children 12-59 months. Also, the protective efficacy was higher in the first year of the study, but reduced in the second year. The reason given for this was the late re-treatment of the nets beyond 6 months. In the Tanzanian study by Abdulla *et al.,* [16] ITN had a protective efficacy of 62% on the prevalence of parasitaemia and 62% on anaemia. This was higher than the prevalence in the Western Kenyan study by Penelope *et al.,* [20]. The differences may well be explained by the differences in the ages of the children in both studies. The Tanzanian study involved children less than two years old, who are more susceptible to malarial anaemia [16].

The Zambian study [28] failed to detect a significant protective efficacy of sleeping under an ITN the previous night, against malaria parasite infection or severe malaria prevalence among all children less than five years old. Their finding was different from that in other studies, despite the fact that the study area had a high ITN coverage, because chronic malaria parasite infection remains a significant risk factor for anaemia in under five children.

A Cochrane review by Lengeler [29] aimed at assessing the impact of ITN or insecticide treated curtains on mortality, malarial illness, malarial anaemia and spleen rates showed that ITN provided 17% protective efficacy compared to no nets and 23% protective efficacy compared to untreated nets. Insecticide Treated bed Net reduced the incidence of uncomplicated malaria in areas of stable malaria by 50% compared with no nets and 39% compared to untreated nets. In areas of unstable malaria, ITN reduced the incidence by 62%. Could this mean that ITN is more effective in areas with unstable malaria where immunity is low? When compared with no nets and in areas of stable malaria, ITN also had an impact on severe malaria (45% protective efficacy), and prevalence of anaemia (13% protective efficacy). There was an improvement in the average haemoglobin level in children by 1.7%.

Insecticide Treated bed Net use has been shown to have seasonal variation as shown in Ghana [9], Tanzania [18], and

Kenya [14]. In Ghana, there was a 20% decrease in the use of ITN in the dry season, probably as a result of heat experienced during this period, and also because of decreased population of mosquitoes.

Alaii et al., [14] in their western Kenyan study on the factors that affect ITN use, showed that excessive heat was often cited as the reason for not deploying a child's ITN, while the most important reason for non-adherence was disruption of sleeping arrangement, where a child will be temporarily displaced from his sleeping space for a number of reasons like absence of the mother, or a relative needs to sleep in the child's space. Other factors noted were fear of suffocation because of the strong smell of the chemical in new nets, fear of infertility, among many others. These may have been responsible for the findings of another western Kenyan trial where pre-treated bed nets, nails and twines were distributed free of charge to those residing in intervention households. They were also shown how to use these nets. Despite all these, a spot check done a month later in 1,104 randomly selected households, showed that half of the ITNs were not being used.

A southern Nigerian study[21] done in a semi-urban community, showed that out of 268 ITNs bought by households visited, only 18.28% of the nets were found to be properly deployed and 53.06% of the nets were occupied by under-five children that slept with their parents on the bed.

Thus, ITN possession does not always translate to use and consistent use is required for effective malaria control.

9. Methods of Detection of Malaria Parasites

Detection of malaria parasite can be done by peripheral blood smear and rapid diagnostic test [30]. More recently, modern techniques utilizing antigen tests or polymerase chain reaction (PCR) have been discovered. Thick films allows screening of a larger volume of blood and are about eleven times more sensitive than thin film. Picking up low levels of infection is thus easier. The parasite is more distorted and so distinguishing the species is difficult unlike in thin film which helps confirm parasite species. Ideally, blood should be collected when the patient's temperature is just rising. Thick film is done by placing a drop of blood on a clean slide and then stirred with the edge of another slide until it is impossible to see news print through it. Staining is done with Giemsa stain for about 30 minutes after which the slide is gently washed for about 30 seconds and allowed to dry. Examination of the slide is done using an oil immersion or high dry lens to determine if the parasites are present. To make a thin film, the blood is spread with a spreader, allowed to dry, fixed by dipping it into methyl alcohol and then stained. Examination under the microscope is done in a similar manner.

Malaria antigen detection tests are immunochromatographic tests that are done using venous blood and takes about 5 to 20 minutes to be completed. These tests are used where the laboratory technician is not experienced in malaria diagnosis. Results are read usually as the presence or absence of coloured stripes on the dipstick. They are suitable for use in the field. One disadvantage is that the tests are qualitative and not quantitative.

10. Conclusion

Despite high ownership rates in some countries, ITN use is low especially because of lack of knowledge on the importance of its use for malaria control. Its use is also found to have a seasonal variation. The protective efficacy of ITN is inversely related to the number of persons sleeping under the net. ITNs reduce the prevalence of malaria and anaemia in areas of stable and unstable malaria transmission, though to a variable degree. It also prevents deaths especially in under five children. ITN has a protective efficacy against malaria and anaemia when compared with no nets especially in young children and this seemed higher in areas with unstable malaria transmission. There is indeed the need for an integrated management approach for malaria control with ongoing education on the use of ITN to cause behaviour modification.

References

[1] Vanden J, Thwing J, Wolkon A, Kulkarni AM, Manga A, Erskine M, et al. Assessing bed net use and non- use after long lasting insecticide net distribution: a simple framework to guide programmatic strategies. *Malar* J 2010; 9: 133-42.

[2] Roll Back Malaria. RBM Global Strategic Plan Geneva: Roll Back Malaria Partnership, 2005. http://www.rollbackmalaria.org/gmap/1-2.html. (Accessed 2/12/12).

[3] Hanson K, Merchant T, Nathan R, Mponda H, Jones C, Bruce J, et al. Household ownership and use of insecticide treated nets among target groups after implementation of a national voucher programme in the United Republic of Tanzania. *Br Med J* 2009; 339: 2434-44.

[4] Edelu BO, Ikefuna AN, Emodi JI, Adimora GN. Awareness and use of insecticide treated bed nets among children attending outpatient clinic at UNTH, Enugu- the need for anz effective mobilization process. *Afr Health Sci* 2010; 10: 117-9.

[5] DucHinh T. Use of insecticide impregnated bed nets for malaria control in Vietnam. http://www.Mekong.malaria.org/mcis/mmf6/mmf6.15htm. (Accessed 1/5/14).

[6] World Health Organisation: Annex VII: Procedure for treating Mosquito nets and curtains (PDF) 2009.

[7] Cutis CF, Jana-Kana B, Maxwell CA. Insecticide treated nets: Impacts on vector populations and relevance of initial intensity of transmission pyrethroid resistance. *J vector Borne Dis* 2003; 40:1-8.

[8] Maseum H, Shar R, Schroeder K, Daars A, Singer P. Africa's largest Long Lasting Insecticide treated net producer. Lessons from A to Z textiles. *BMC International Health and Human Right* 2010; 10:1472-77.

[9] Binka FN, Adongo P. Acceptability and use of ITN in Northern Ghana. *Trop Med Int Health* 1999; 5:499-501.

[10] Child health and community Health systems. http:// www.unicef.org. / health/_index_malaria.html. Accessed 2/12/12.

[11] Gimnig JE, Vulule JM, Lo TQ, Kamau L, Kolkzac MS, Philips-Howard PA, et al. Impact of permethrin-treated bed net on entomologic indices in an area of intense year round malaria transmission. *Am J Trop Med Hyg* 2003; 68: 16-22.

[12] Baume AC, Marin CM. Gains in awareness, ownership and use of insecticide treated nets in Nigeria, Senegal, Uganda, and Zambia. *Malar J* 2008; 2: 153-63.

[13] 'Insecticide Treated Bed nets'. Centres for Disease Control and Prevention. http://www.cdc.gov/malaria/malaria_worldwide. (Accessed 1/5/14).

[14] Allai JA, Hawley WA, Kolczak MS, TerKuile FO, Gimnig JE, Vulule JM, et al. Factors affecting use of permethrin treated bed nets during a randomised control trial in western Kenya. *Am J Trop Med Hyg* 2003; 68: 137-41.

[15] Njau JD, Stephenson R, Menon M, Kachur SP, McFarland DA. Exploring the impact of targeted distribution of free bed nets on house-holds bed net ownership, socio-economic disparities and childhood malaria infection rates: analysis of national malaria survey data from three sub-saharan Africa countries. *Malar J* 2013; 1: 245-50.

[16] Abdulla S, Armstrong J, Nathan R, Mukasa O, Merchant T, Smith T, et al. Impact on malaria morbidity, of a programme supplying insecticide treated net in children aged 2years in Tanzania; a community cross sectional study. *BMJ* 2001; 322: 270-4.

[17] Schellenberg JR, Abdulla S, Nathan R, Mukasa O, Mechany TJ, Kikumbih N, et al. Effect of a large scale social marketing of ITN on child survival in rural Tanzania. *Lancet* 2001; 327: 1241-47.

[18] Winch PJ, Makembo AM, Kamazuma SR. Seasonal variations in the perceived risk of malaria: implications for the promotion on insecticide impregnated bed nets. *Soc Sci Med* 1994; 39: 63-75.

[19] Terkuile OT, Terlouw JD, Philip-Howard PA, Hawley WA, Friedman J, Kolkzac MS, et al. Impact of permethrin treated bed nets on malaria and all-cause morbidity in young children in an area if intense, perennial malaria transmission in western Kenya. *Am J Trop Med Hyg* 2003; 68: 100-7.

[20] Penelope AP, Bernard LW, Kolcsak MS, HighTower AW, Terkuile OF, Allai JA, et al. Efficacy of permethrin treated nets in the prevention of mortality in young children in an area high of perennial malaria transmission in western Kenya. *Am J Trop Med Hyg* 2003; 68: 23-9.

[21] Ordinioha B. The use of insecticide –treated bed net in a semi urban community in south-south, Nigeria. *Nig J Trop Med* 2007; 16: 223-26.

[22] Howard N, Shafi A, Jones C, Rowland M. Malaria control under the Taliban regime: Insecticide treated net purchasing, coverage, and usage among men and women in Eastern Afghanistan. *Malar J* 2010; 9:7-11.

[23] Syed A, Hossain S, Mohammed KM, Sanjit R. Free distribution of insecticide treated bed nets improves possession and preferential use by households and is equitable: findings from 2 cross-sectional surveys in thirteen endemic districts in Bangladesh. *Malar J* 2011;10:357-61.

[24] Daisuke N, Laimanivong S, Kobayashi J, Chidavonsa K, Kano S, Vanisaveth V, et al. Is staying overnight in a farming hut a risk factor for malaria infection in a setting with insecticide treated bed nets in rural Laos? *Malar J* 2010; 9: 372-5.

[25] Lin K, Aung S, Lwin S, Min H, Aye NN, Webber R, et al. Promotion of insecticide treated mosquito nets in Myanmar. *South East Asian J Trop Med Publ Health* 2000; 31: 444-7.

[26] Smithuis F, Kyaw M, OhnPhe U, Vander BI, Katterman N, Rogers C, et al. The effect of Insecticide treated nets on the incidence and prevalence of malaria in children in an area of unstable seasonal transmission in Western Myanmar. *Malar J* 2013; 12: 363-6.

[27] Watanabe N, Kaneko A, Yamar S, Leodoro H, Taleo G, Takeo T, et al. Determinants of the use of insecticide treated bed nets on Islands of pre and post malaria elimination: an application of the Health Belief Model in Vanuatu. *Malar J* 2014; 13: 441-46.

[28] Eisele TP, Muller JM, Moonga HB, Hamainza B, Hutchinson P, Keating J, et al. Malaria infection and anaemia prevalence in Zambia's Luangwa district: an area of near- universal insecticide treated mosquito net coverage. *Am J Trop Med Hyg* 2011; 84: 152-7.

[29] Lengeler C. Insecticide treated bed nets and curtains for preventing malaria. *Cochrane Data of Syst Rev* 2000; 2:CD000363.

[30] Diagnosis of Malaria.http://en.m.wikipedia.org/wiki/diagnosis of malaria. (Accessed online 1/5/14).