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THE EFFECTIVENESS OF INSECTICIDE TREATED MOSQUITO NETS AS A SINGLE VECTOR CONTROL MEASURE AGAINST MALARIA IN ONMBA-ASHA COMMUNITY NAKA, GWER-WEST LGA BENUE STATE, NIGERIA

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Abstract

The use of Insecticide Treated mosquito Net (ITN) has been the major preventive measure against Malaria for a long time now but Malaria is still a serious public health challenge. This study investigated the effectiveness of ITN and the use of indoor residual spray (IRS) of insecticide Novan (Nashik) when used as a single vector control measure against Malaria. A total of 402 human subjects were screened using standard microscopy, out of which 302 (75.1%) were infected with plasmodium species while 100 (24.9%) were not infected. The 100 uninfected subjects were then divided into 2 groups with one group having their homes sprayed with Novan insecticide while the other group was given ITNs. After 8 months of observations, 40 subjects (80%) from those who used Novan had Malaria while 46 subjects (92%) who used ITN had Malaria.

KEYWORDS:
Malaria, Effectiveness, Insecticide, Treated Mosquito Net, Vector.

The higher percentage of Malaria infection observed among ITN users was attributed to factors such as outdoor resting at night for long periods before going to bed, wrong or non- usage of the nets during heat periods etc. Although results have shown that Novan insecticide is more effective than ITN, statistical analysis (Chi-square; df=21, p>0.05) showed that there was no significant difference between the effectiveness of Novan insecticide and ITN when used as a single vector control measure against Malaria. These findings may be useful in providing information concerning ITN in evaluating appropriate vector control measures against Malaria. The public health and epidemiological implications of the findings is the use of these two vector controls measures simultaneously.

INTRODUCTION

The use of Insecticide Treated mosquito Net (ITN) has been the major preventive measure against Malaria for a long time now beginning from the days when it was just ordinary nets to the recent Long-Lasting nets. These nets have proven to be quite effective, but Malaria is still a serious global public health challenge. This is an indicator that something may be wrong with this prevention approach. Malaria is a life-threatening disease caused by parasites that are transmitted through the bites of female Anopheles mosquitoes (WHO, 2015). **According to the Federal Ministry of Health (FMOH) and the Roll Back Malaria (RBM) reports of 2005, there are at least four (4) identified species of this parasite that infect humans namely, *P. faciparum, P. ovale, P. vivax and P. malariae. P. knowlesi* which has just been discovered to infect humans has only demonstrated in Malaysia.** According to the World Health Organization (WHO), about half of the global population is at risk of malaria (WHO, 2016). However, the greatest percentage of the global

burden of malaria is disproportionately carried by sub-Saharan Africa with 90% of cases and 92% of malaria deaths, thus making malaria a serious public health threat and a huge epidemiological burden to Africa (WHO, 2016). According to the National Malaria Control Program (NMCP), malaria is endemic in Nigeria as 97% of the population live in high malaria risk areas (NMCP, 2014).

Further evidence has also shown that Nigeria carries a significant proportion (25%) of the burden in Africa with an estimated 110 million clinically diagnosed cases per year and about 110,000 malaria related deaths in 2015 (WHO, 2016; Federal Ministry of Health (FMOH, 2009). It is also responsible for 60% of all outpatient attendance and 30% of all hospital admissions (Ezire et al., 2015). The principal strategies for malaria prevention include vector control which reduces mosquito bites through the use of insecticide treated bed nets (ITNs) and indoor residual spray (WHO, 2015; Olatunbosun et al., 2014) with vector control being the principal method to prevent and reduce the transmission of malaria (WHO, 2017). Indoor residual spray has been found to be effective for 3 to 6 months depending on the nature of surface sprayed and insecticide combination (WHO, 2017). To attain its full potential, at least 85% of structures in the target area need to be covered and there may be the need for multiple sprays (FMOH, 2009). However, evidence has shown that only 2 percent of households surveyed by the National Populations Commission in 2013 have been sprayed in the previous 12 months (NPC, 2014). Most of the IRS is carried out by state governments or by organizations supported through government programs while the rest is carried out by non-governmental organizations (NPC, 2014).

Unless something very drastic is done to tame the tide of Malaria, it is not likely for the proportion of burden to reduce in Africa because of the constant trend toward deteriorating

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

health systems, wars, growing drug and insecticide resistance and global warming among other challenges overwhelm current efforts to reduce the disease impact.

Purpose of the study

The main purpose of this study is to investigate whether there is a difference between the use of Novan Insecticide (IRS) and the use of Insecticide-Treated Mosquito nets (ITNs) when used singly as vector control measures against mosquito bites.

Research Questions

1. **Does the effective use of IRS of Novan insecticide totally eliminate mosquito bites?**
2. **Does the effective use of ITNs totally eliminate mosquito bites?**

Research Design

Chi-square statistical method was adopted for this study. It aims at investigating whether there is a difference between the use of Novan Insecticide (IRS) and the use of Insecticide-Treated Mosquito nets (ITNs) when used singly as vector control measures against mosquito bites.

MATERIALS AND METHODS

Study Area

This Research was conducted in Onmba-Asha Community in Naka Gwer-West Local Government Area of Benue State. The analysis was carried out in the microbiology laboratory of Father Matthias Healthcare Centre Onmba-Asha. The choice of the study area was for the following reasons:

1. The records from microbiology department of the Father Matthias Healthcare Centre, Naka have shown a high prevalence of Malaria among the indigenes in the previous years,
2. The water dam which is the main source of water in the entire Naka is located in Onmba-Asha Community. All year-round people are involved in one activity or the other around the

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

swampy banks either fetching water, cultivating their farms or making bricks. Sometimes the inhabitants come to only water their crops or hand around and discuss at night. This dam surrounded with its human activities and damp and humid environment provide a good breeding and feeding site for mosquitoes,

3. The student carrying out the research was a staff with Mt. La Salle College, Naka. This made it easy for monitoring of activities and collection of samples from subjects early in the morning and late in the evening.

The inhabitants of Onmba-Asha are a mixture of farmers, civil servants, brick makers and traders, while their neighbors are predominantly farmers with little or no formal education. The weather in Naka is cool with a temperature range of 23°C-31°C and a rainfall in the range of 150-180mm. The map of the study area is shown below:

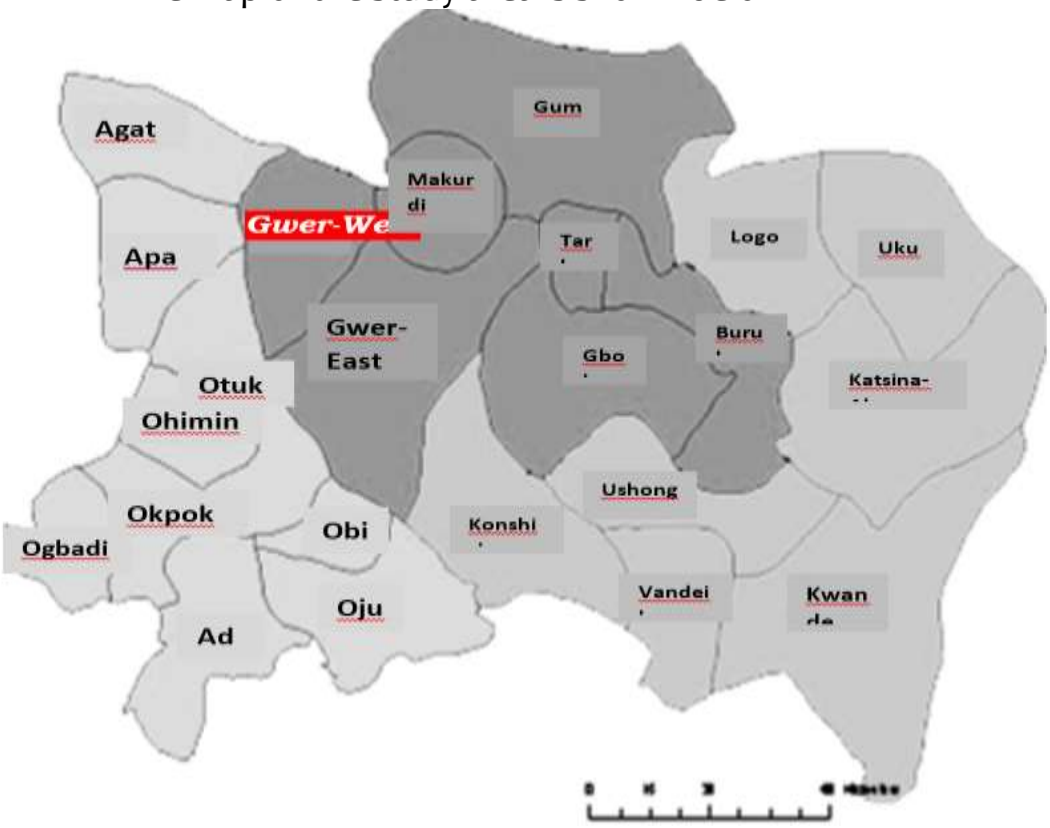

Figure 1: Map of Benue State showing Gwer-West Local Government https://en.wikipedia.org/wiki/Benue state

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

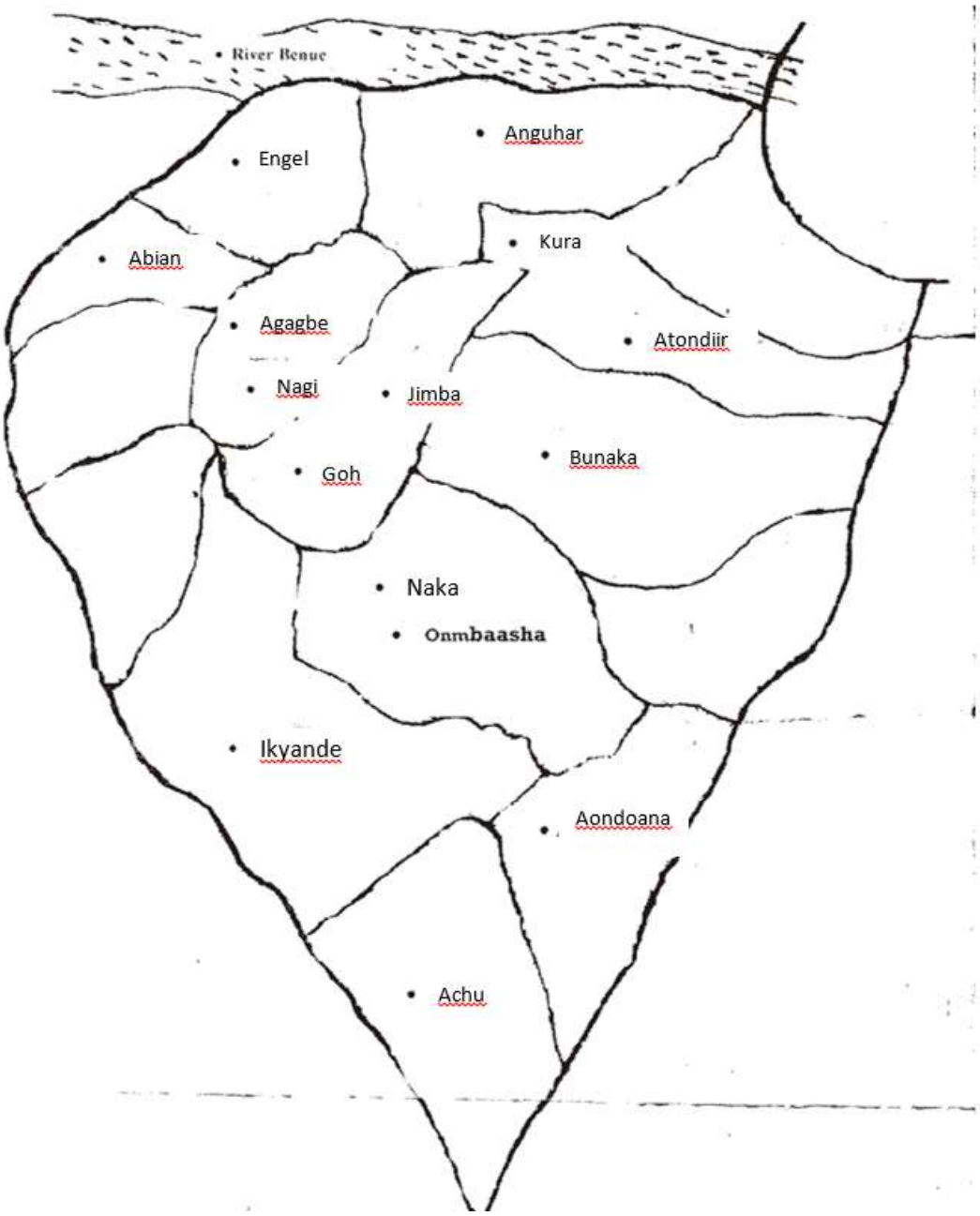

Figure 2: Map of Gwer-West Local Government Area, showing Onmba-Asha Community https://en.wikipedia.org/wiki/Gwer_West

Collection of Samples

Collection of blood samples was done twice daily; early in the morning between 6:00 am and 7:00 am before work and in the evening at about

5:00pm and 6:30pm before retirement since this is the time to find people home. Informed consent was taken from all subjects before collection of blood.

The name, age and sex of subjects were recorded in an exercise book to avoid confusion and enable easy location and identification of the subjects later during net distribution and Novan application.

RESULT AND DISCUSSION

Results

The present study showed the effectiveness of Insecticide-Treated Mosquito Nets (ITN) and the use of indoor residual spray (IRS) of insecticide Novan (Nashik) when used as a single vector control measure against Malaria. A total of 402 human subjects were screened using standard microscopy, out of which 302 (75.1%) were infected with plasmodium species while 100 (24.9%) were not infected. The 100 uninfected subjects were then divided into 2 groups with one group having their homes sprayed with Novan insecticide (IRS) while the other group was given ITNs. After 8 months of observations, 40 subjects (80%) from those who used Novan had Malaria while 46 subjects (92%) who used ITN had Malaria. The higher percentage of Malaria infection observed among ITN users was attributed to factors such as outdoor resting at night for long periods before going to bed, wrong or non- usage of the nets during heat periods etc. Although results have shown that Novan insecticide is more effective than ITN, statistical analysis (Chi-square; df=21, $p>0.05$) showed that there was no significant difference between the effectiveness of Novan insecticide and ITN.

Details of the result are shown in the following tables:

In unit 1 where Novan insecticides was the treatment, the following malaria cases were recorded.

Table 1: Overall prevalence of malaria among age classes in unit 1

Age group (yrs.)	Months and number of infected								
	March	*May*	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Total*
10-20	3	3	2	4	3	3	2	1	21
20-30	1	2	2	1	2	1	2	0	11
30-40	1	0	0	0	0	1	0	0	2
40-50	0	1	2	0	1	1	1	0	6
Total	**5**	**6**	**6**	**5**	**6**	**6**	**5**	**1**	**40**

(χ^2 test, p>0.05)

In Table 1, it was observed that out of a total of 50 non-infected subjects who used Novan, 40 (80%) of them developed malaria at the end of 8 months.

Table 2: Percentage prevalence of malaria among age classes in unit 1

Age group (yrs.)	**No. Examined**	**No. Infected**	**Percentage infection (%)**
10 – 20	23	21	**52.5**
20 – 30	15	11	**27.5**
30 – 40	5	2	**5.0**
40 – 50	7	6	**15.0**
Total	**50**	**40**	**100**

(χ^2 test, p>0.05)

Table 2 shows the percentage infection of malaria in all the age groups. The age group with the highest malaria infection is 10-20 years with 52.5% followed by age group 20-30 with 27.59% while 40-50 years had 15.0% infection and age group 30-40 years had the smallest percentage infection of 5.

Table 3: Overall prevalence of malaria among age classes in unit 2.

Age group (yrs)	**Months**								
	March	May	June	July	Aug	Sept	Oct	Nov	Total
10 – 20	3	2	5	3	6	5	4	0	28
20 – 30	2	2	1	1	1	1	1	0	9
30 -40	1	2	0	1	0	1	1	0	6
40 – 50	1	0	0	2	0	0	0	0	3
Total	7	6	6	7	7	7	6	0	46

(χ^2 test, $p>0.05$)

Here, it shows that 46 out the 50 non-infected subjects (i.e., 92% of 50) developed malaria within 8 months among those that used ITNs.

Table: 4. Prevalence of malaria among age classes in unit 2.

Age class (yrs.)	**No. examined**	**No. infected**	**Percentage infection (%)**
10 – 20	29	28	60.9
20 – 30	10	9	19.6
30 – 40	6	6	13.0
40 – 50	5	3	6.5
Total	**50**	**46**	**100**

(χ^2 test, $p>0.05$)

Table 4 gives a percentage infection of malaria among those that used ITN. It reveals that age class 10-20 years had the highest percentage malaria infection of 60.9% while 20-30 years had 19.6%. The age class of 30-40 years had 13.0% while 40-50 had the smallest infection of 6.5%. However, statistically there are no significant differences between the infected age classes. (χ^2 test, $p > 0.05$)

INTERNATIONAL JOURNAL – MBP
VOL. 17 NO.3 SEP-2021 ISSN: 1999-5650

Discussion

Anopheles mosquitoes are most active at two times: just before dawn and right after darkness sets in fitting the times when man wakes early in the morning and relaxes late before retiring to bed. At these times of the day, the control of outdoor mosquitoes is important to provide protection against mosquito bites (www.mosquitomagnet.com). It is to this end that this project investigates the effectiveness of Novan insecticide (IRS) and Insecticides-Treated Mosquito Nets (ITN) when used as single vector control tools/measures against mosquito bites. The study revealed that out of the 50 persons who used or applied Novan insecticide in their houses (IRS), 40(80%) of them had malaria while 46 (92%) out of the 50 persons that used ITN as vector control tools had malaria at the end of the study period. Chi-square analysis showed that there is no significant difference between the use of Novan Insecticide (IRS) and ITN when used as single vector control measures.

The direct interpretation of this result is that the use of ITN as a single vector control tool against mosquito bites is as effective as the use of Novan Insecticide (IRS). This result confirms the work of Fredrick (2013) that spraying of chemicals (IRS) is a supplement of ITN in the prevention of mosquito bites. A comparison of the number of persons that had malaria in unit 1 and unit 2 at the end of the study period showed that a total of 40 persons out of the 50 that used IRS had malaria while 46 had malaria out of the 50 persons that used ITN. This result agrees with the research carried out by Annie (2009) which showed that IRS is more suitable than ITN in the prevention of mosquito bites. No doubt the use of ITN and IRS has proved to be the most effective malaria vector control tools today (Yakob, 2010). It is worthy of note at this juncture that no matter how effective a single malaria vector control measure may be, it has its shortcomings when

used singly or as a stand-alone strategy against malaria control (Eliningaya, 2012).

The efficacy of IRS of any chemical depends on a number of factors. These include:

a) **Temperature of the environment to be sprayed:** The work of Katey (2014) showed that temperature has the potential to affect the toxicity of chemicals used for IRS and suggested that for any chemical to be effectively used for IRS, the environmental temperature must suit the operational conditions of such a chemical.
b) **The chemical used:** Pesticides are toxic to humans to some degree (Annie, 2009) and care has to be taken not to cause harm to non-target organisms.
c) **The method of Spray:** The operational principles of the chemicals are a very important factor for consideration. Some chemicals work by contact, others are non-contact spatial repellants while others are just toxic (John, 2007). The result would be very poor if a chemical whose operation is by contact is only applied at the corners of the room using the syringe. There is also the issue of insecticide resistance by the vectors. It is in consideration of this fact that chemicals like pyrethroid that are the active agents in ITNs are not used for IRS.

The higher level of malaria cases among ITN users compared to IRS may have been due to the following factors:

1. **Late retirement to bed:** People who do not retire early to bed but prefer to relax outdoors or out of bed may be bitten. This agrees with the research of Fredrick (2013) which stated that mosquitoes have changed from Endophilic and Endophagic to Exophagic nature.
2. **Improper Usage:** Nets can only serve the purpose of preventing contact between man and mosquito if they are used properly

when the mosquitoes are in the environment thus entry into the nets by mosquitoes is prevented. Any misuse or openings on the net would admit mosquitoes, thus failing to prevent mosquito bites.

It must be clearly understood that a single bite from a plasmodium infected mosquito would result to malaria and therefore the use of ITN must be consistent where the Malaria causing mosquitoes are present, to be effective*.

CONCLUSION

The findings from this study shows that the effectiveness of ITN as a single vector control measure against malaria is not significantly different from the use of IRS (Novan insecticide) when it is used as a single vector control measure (i.e., the only preventive measure) against malaria. The insecticide treated bed nets can only provide protection from Mosquito bites only when one is in the net and that is basically when one is sleeping. But what about when he is awake and out of the net? On the other hand, the use of IRS of Novan as a single vector control measure is only effective in protecting one from mosquito bites when one is indoors. But life is not spent indoors. The limitations of these two preventive measures when used as a single vector preventive measure against Malaria is that they are only effective INDOORS. And since Mosquito bites do not occur only when man is asleep at night or indoors alone, it is therefore better to use the measures that prevent mosquito bites even when one is outdoors*.

Recommendations

One of the targets set by heads of state of 44 malaria endemic African countries stated that, "80% of the people at risk from malaria are protected by locally appropriate vector control methods such as ITNs, IRS & Environmental and Biological measures". The government

should therefore advocate for an **integrated vector management technique (IVM)** comprising of at least two vector control measures such as ITN, IRS and Environmental management instead of only one vector control tool. This technique **(IVM)** would prevent mosquito bites in bed, indoors as well as outdoors.

REFERENCES

Adebayo et. al. (2015) Knowledge of Malaria prevention among Pregnant women & female
care givers of under five children in southwest Nigeria. Free PMC article.

African Union Commission universal access to HIV/AIDS, tuberculosis, and malaria services by a United Africa by 2010: malariacontrol: success in sight (ES), 2006; 11-12 (www.abuja.auatmsummit **2006.net).**

African Union Commission, Universal Access to HIV/AIDS, Tuberculosis and Malaria Services by a United Africa by 2010: malaria control: success in sight (ES), 2010; 13-17. (www.abuja-auatmsummit2006.net**).**

African Union Commission, Universal Access to HIV/AIDs, Tuberculosis and Malaria Services by a United Africa by 2010. (E2-E6) **Concept Paper (E2), 2006; 4. (www. Abuja-auatm summit 2006.net.) 21.**

African Union Commission, Universal Access to HIV/AIDS, Tuberculosis and malaria services by a united Africa by 2010: socio-cultural determinants and impact (E6), 2008;5. (www.abuja – auatmsummit2006.net).

Annie, H.,Anton, C. H., Golsum T.,Angela, E. M. & Joseph L D
(2009) Tracking spending on malaria by source in 106 countries, 2000-16: an economic modelling study April 2019.The Lancet Infectious Diseases 19(7):703-716
DOI:10.1016/S1473-3099(19)30165-3

Awuapila, N. Msen (2007). Towards the total eradication of Anopheles Mosquito in the West African sub-region, a concept paper presentation at the meeting of Malaria Eradication in Africa (MEIA). A Non-Governmental Organization (NGO) based in Abuja, January 2007.

Baume, C.A. and & Marin M.C., (2008). Gains in Awareness, Ownership and Use of ITN in Nigeria, Senegal, Uganda & Zambia. Malaria Journal, 2008, 7:153, doi: 10.1186/1475-2875-7-153

BBC News World Edition of Wednesday 21 September 2005. Doi: 09/22/2005 10: 41: 07pm (Electronic Version; January 18th, 2013)

Chigozie, U.J. (2008) Evaluation of Maternal Malaria at Childbirth Using Rapid Diagnostic Test & Its Relationship with Weight & Fetal Hemoglobin Levels in

Nigeria. The Journal of Gynecology & Obstetrics, 2008, Volume 10 No-1 Doi:10.5580/13el.

Eliningaya, J. K., Stephen M., Aneth M. M., Shandala M., Humphrey D. M., Araceli Q. A., &

Jonathan R. M., (2012). Protective efficacy of menthol propylene glycol carbonate compared to N, N-Diethyl-methylbenzamide against mosquito bites in Northern Tanzania, NY USA, Parasites and Vectors 2012, 5: 189 Doi: 10.1186/1756-3305-5-189.

Ezire.et.al., (2015) Determination of use of ITN among pregnant women in Nigeria. International Journal of women's Health. Published online 2015 June 26.doi:10.2147/IJWH.577807,7:655-661

Federal Ministry of Health (FMOH) & Roll Back Malaria Progress & Impact Series. National Malaria Control Programme, September 2009.

Felix, S. O., (2005) Malaria Scourge: The Facts, the Lies and the Politics Vanguard 26th July 2005. www.gamji.com/article.5000/news.

Fredrick, G. K., Anne M. A., John B. K., & Ambrose W. O., (2013). Bitting Patterns and

Seasonality of *Anopheles gambriae* sensu lato and *Anopheles funestus* mosquitoes in Kamuli District, Uganda; Parasites and Vectors 2013, 6: 340 doi; 10. 1186/1756-3305-6-340 2013.

George, B, K., (2013). National Malaria Strategic Plan: 2005/6-2010/11 Africa. Fighting Malaria; Uganda, 2013.

Global Funds to Fight Aids, Tuberculosis and Malaria (GFATM) Information sheet, 2006.

https://en.wikipedia.org/wiki/Benue state

https://en.wikipedia.org/wiki/Gwer_West

John, P.G., Nicole, L. A., Theeraphap C., Wannapa, S., Kamal, C., Michael, R. S. & Donald, R. R. (2007) A new Classification system for the Actions of IRS chemicals Traditionally Used for Malaria Control

Katey, D.G., Krijn P.P., Andrew F.R.& Matthew B.T. (2014). Environmental Temperatures Significantly Change the Impact of Insecticides Measured using WHOPES protocol Malaria Journal Volume:13, Article 350

National Population Commission Nigeria (NPC) ICF International. Nigeria National Malaria Indicator Survey Abuja. ICF Macro; 2014 (Google Scholar)

National Malaria Control Programme (NMCP)., (2014) Nigerian National Malaria Operations
Plan 2014

Neil, A.C., Biology (3rd Ed). Benjamin/Cummings, California 1993.

Nigerian National Malaria Operation Plan, 2014. www.pmi.gov/../nigerian-mop-FY13.pdf

Nigerian Demographic & Health Survey (2011) Federal Ministry of Health (FMOH) Abuja

Offoboche, M. (2004). Eradicating Malaria by the Use of DDT, 2004; 3 (Electronic global press
Abuja).

Offoboche, M. (2007) Eradicating Malaria by The Use Of DDT, (Electronic global press
Abuja), 3, 6 and 7, 2007

Offoboche, M. (2009) Update on The Debate on The Eradication of Malaria African CSOs Meeting on DDT Report/Final Report PAN Africa. April 8th, 2009, Unpublished.

Olatunbosun et.al., (2014) Prevalence of Anemia among pregnant women at Booking in the University of Uyo Teaching Hospital, Uyo, Nigeria. BioMed Research International Vol. 2014, Article ID 849080, http//dx.doi.org/10.1155/2014/849080

Omolade, O. Okwa (2012): The Current Trend in Integrated Prevention and Control of Malaria.
A Case Study of Some Nigerian Communities. Department of Zoology and Environmental Biology, University of Lagos, 2012.

Papiya, G. M. & Sumit M. (2007): Prevention and Treatment of Malaria in Nigeria: Differential & Determinants from a spatial view; 2007.

Philippa A. W, Natacha Protopopoff, Alexandra Wright, Zuhura Kivaju, Robinson Tigererwa,
Franklin W. Mosha, William Kisinza, Mark Rowland, Immo Klein-Schmidt, (2014) Indoor Residual Spraying in Combination with ITN Compared to ITN alone for protection against Malaria: A Cluster Randomized Trial in Tanzania. Published April 15, 2014, DOI, 10.1371/Journal.pmed.1001630.

Sabina Awule (Verbal Interview). Microbiology Laboratory, Father Matthias Healthcare Unit, Naka, Gwer-West 2008.

This day Newspaper 14/01/06; 10. Vol. 11, No. 4193(Electronic Version, January 18th, 2013).

Thomas C. Nchinda (1998) Re-Emerging Disease in Africa. World Health Organization Headquarters
Geneva, Switzerland, 1989.

William K. Verbal Communication, Gwer-East, February 2, 2012.

Winifred Ogbebo (2013): Nigeria: Where are the Insecticide-Treated Mosquito nets?
Presented at: All Africa My Africa Travel blog. Africa an Integrated Regional Information Network, Nairobi 30th September 2013.

World Health Organization Records, 2006
World Health Organization Records, 2010
World Health Organization Records, 2012

World Hunger and Poverty, Facts and Statistics, 2013

World Health Organization Records, 2015

World Health Organization Records, 2016
World Health Organization Records, 2017
World Hunger Education Services, P.O. Box 29056 Washington, D. C. 20017, 2013
(www.worldhunger.org/articles).
www.abuja-auatmsmmit2006.net, 2006.
www.abuja-auatmsummit2006.net,2008.
www.malariapolicycenter.org/malaria
www.med-chem.com/pages/lab-procedure
www.mosquitomagnet.com
www.sunitafe.edu.au
www.theglobalfund.org.2006,
www.theglobalfund.org.2008,
www.who-int\malaria,2006 - 2008
www.who-int\malaria2010 - 2014
www.wikipedia.org\wiki\mosquito.net
www.worldhunger.org/articles/learn
www.worldwatchinstitute.org (Annual Reports, 2013)
Yakob L., Dunning R., Yan G. (2010) Indoor Residual Spray & ITN for malaria control:
Theoretical Synergisms & Antagonisms. J.R. Soc. Interface 2011 Jun 6; 8(59): 799-806. Doi:10.1098/rsif. 2010. 0537.Epub 2010 Nov., 17.