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Human Induced Environmental Factors and Mosquito Breeding in Enugu Urban-Nigeria

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Abstract: - This study examined the relationship between the human-induced environmental factors and mosquito breeding, in Enugu Urban. It identified the environmental factors that favor breeding of mosquito. Two hundred and seventy questionnaire were distributed within the 18 prominent communities of Enugu urban. Data collected were presented in tables while Pearson correlation was used in hypothesis testing. Results obtained showed that there is a significant relationship between human induced environmental factors in Enugu urban and malaria vector breeding. The human induced environmental factors favor malaria transmission. The study recommends environmental manipulation and modification through vegetation clearing, proper waste management and filling of potholes, ditches and health education of inhabitants among others.

Keywords: - *Human induced environmental factors; mosquito breeding; malaria; environmental manipulation.*

I. INTRODUCTION

[1]observed that malaria is a tropical disease caused by the presence of parasitic protozoa of the genus Plasmodium within the red blood cells and is transmitted by infected female mosquitoes of the genus Anopheles. [2]in his own contribution said that malaria is a disease that causes chills, fever and sweating and is transmitted by the bite of female Anopheles mosquitoes, which have previously bitten infected person.

The history of malaria predates humanity, as this ancient disease evolved before human [3]. Malaria is a widespread and potentially lethal infectious disease. It has afflicted people for much of human history, and has affected human settlement patterns. The prevention and treatment of the disease have been investigated in science and medicine for hundreds of years and since the discovery of the parasites which cause it, attention has focused on its biology. These studies have continued up to the present day, since no effective vaccine has yet been developed and many of the older anti – malaria drugs are losing effectiveness as the parasites evolves high levels of drug resistance. As malaria remains a major public health problem, causing deaths of millions in Africa, we are left with proper environmental management as an option to compliment the malaria treatments in order to reduce the burden of malaria in the present generation.

Science has proved that environmental factors influence distribution of diseases in human population. In order words environmental factors influences diseases distribution in any locality. These environmental factors may be natural or human-induced. The human-induced factors results from either omission or commission by man. Examples are refuse dumps, potholes, abandoned ditches and overgrown bushes within residential areas etc. According to [4] several studies have shown that malaria infection like many other diseases is influenced by environmental factors. Furthermore [5] said that generally there must be environmental factors due to human activities resulting from either omission or commission by man within locality, that work together with natural factors to provide a favorable environment for the propagation of vector of malaria -the mosquito. This implies that left for natural factors they cannot influence malaria alone without other human-induced environmental factors that actually provide the breeding sites of mosquito that transmits malaria disease.

In April 2000 African leaders from 44 malaria endemic countries met in Abuja, Nigeria for the African summit on malaria. One of the outcomes of the summit is advocacy on intervention through environmental management. They are of the view that environmental factors both natural and human-induced which favor breeding of the insect that transmits malaria should be identified and managed in every country. They opined

that prevention and control of malaria will be purely based on identification of critical environmental factors which favor the breeding of the insect that transmits malaria and intervention through proper environmental management. Enugu State including Enugu Urban has its own human induced environmental characteristics that influence the disease distribution in the area. The extent these environmental factors influence malaria prevalence in Enugu Urban needs to be investigated for appropriate intervention. The financial loss due to malaria annually in Africa is estimated to be about 132 billion naira for treatment cost, loss of man hours etc., yet malaria is a preventable disease [6].

II. THE STUDY AREA.

Enugu State is one of the states in southeastern Nigeria. Its capital is Enugu. The state was created in 1991 from the old Anambra State. Enugu state is located within latitude 6^0.00'N and 7^0.00'N and longitude 7^0.00'E and 7^0.45'E. The state is called the Coal City State because of the discovery of coal in a commercial quantity in Enugu Urban in 1909. Enugu was then the capital of East Central State of Nigeria. Some of the important towns in the State are Enugu Urban, Oji, Udi and Nsukka Urban.

The state shares borders with Abia State and Imo State to the south, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest and Anambra State to the west. Enugu State is made up of 17 local government areas. These include Igbo Eze North, Igbo Eze South, Udenu, Nssuka, Isi Uzo, UzoUwani, Igbo Etiti, Udi, Enugu East, Enugu North, Enugu South, Ezeagu, Nkanu West, Nkanu East, Oji-River, Awgu and Aninri local government areas.

Enugu Urban which is the study area is made up of Enugu East, Enugu North, and Enugu South (figure 1.). Enugu Urban is also located within latitude 6.24^{0}N and 6.30^{0}N and longitude 7.27^{0}E and 7.32^{0}E. It is an hour's drive from Onitsha, one of the biggest commercial cities in Africa and 2 hours drive from Aba, another very large commercial city, both of which are trading centers in Nigeria.

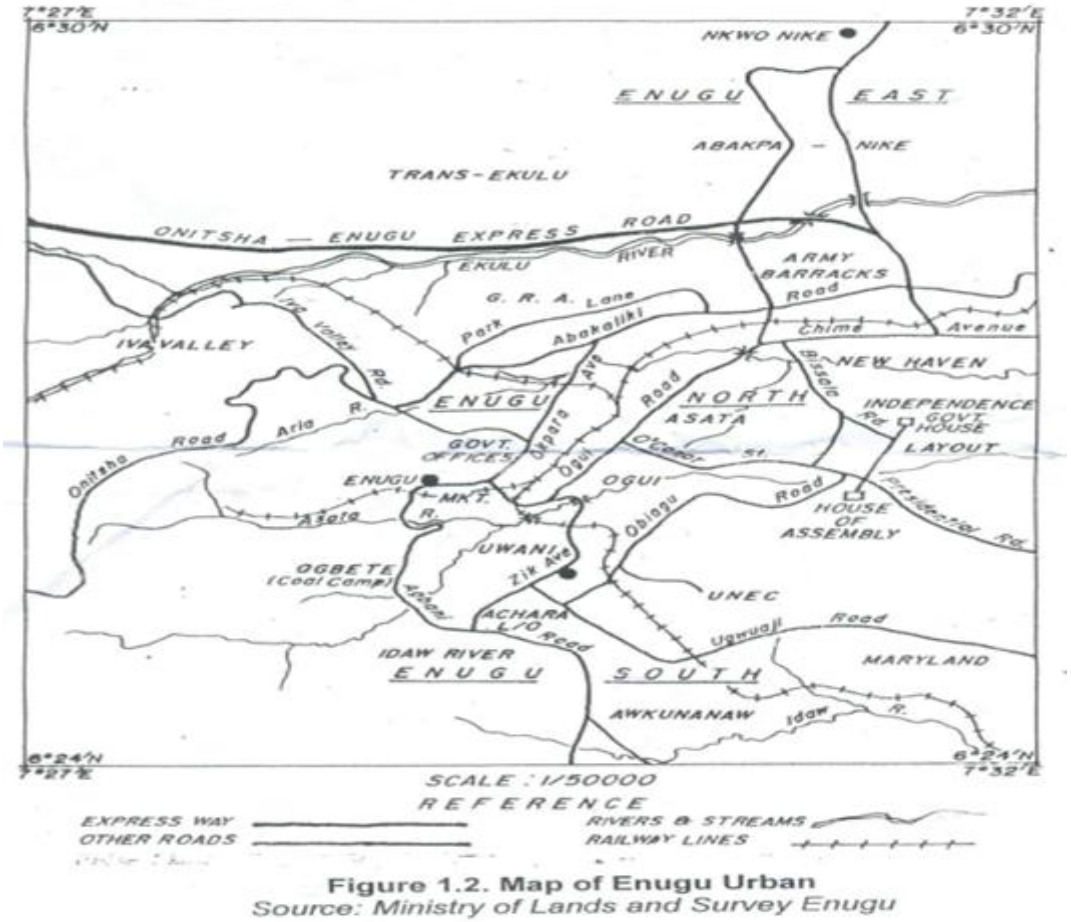

Figure 1.2. Map of Enugu Urban
Source: Ministry of Lands and Survey Enugu

Figure 1. Map of Enugu Urban
Source: Ministry of Lands and Survey, Enugu (2010)

Enugu Urban shares boundary with Igbo Etiti and Isi-Uzo Local Governments in the north, Udi local Governments in the west, Nkanu West Local Government in the south and part of Nkanu East Local Government Area in the east. There are 18 prominent residential areas in the Urban. These are Abakpa, Trans-Ekulu, Nike, GRA, Ogui, Asata, New Heaven, Obiagu, Ogbete, Iva valley, Independence Layout, Achara Layout, Ugwuaji, Maryland, Awkunanaw, Uwani, Agbani, and Coal Camp. Enugu Urban is the most developed urban area in Enugu state.

The study area falls within the humid tropical rain forest belt of Southeastern Nigeria. It has two seasons, the raining season and the dry season. The rainy season which is characterized by heavy thunderstorms lasts from April to October with the South Westerly moisture accompanied by air mass moving northwards into the city. The turbulent runoff result in leaching, sheet erosion and eventually gullies [8]. The mean temperature varies from about 20.30ºC to about 32.16ºC in the dry season and rainy season respectively, [8]. During the dry season the humidity is lower than in the rainy season. Temperature is most often high during the day and low during the night. This results in high evaporation rate during the day. Harmattan which occurs between the months of November and February is always accompanied by poor visibility mostly at night and early in the morning.

The rivers and streams which flow from the Udi hills dissect the study area into several sections. Thus there are rivers such as Ekulu, Idaw, Asata and Nyaba Rivers which separates Enugu South from Nkanu East. These rivers have many tributaries; the study area is generally marked by low land, slopping towards Enugu South Local Government Area and the Southern part of Enugu East Local Government Area. The elevations are between 182.88 meters and 219.45 meters above the sea level. Below is a table showing the population of each local government area that make up the study area. This is based on the figure of [9].

Table 1: Enugu Urban Local Government Areas Population

LOCAL GOVERNMENT AREA	MALES	FEMALES	TOTAL
Enugu East	131, 214	145, 905	277, 119
Enugu North	118, 895	123, 245	242, 050
Enugu South	93, 758	104, 274	198, 032
Total	343, 867	373, 424	717, 201

Source: National population commission (2006).

Enugu Urban is the educational, commercial, industrial and administrative base of Enugu State. The biggest market within the Urban is located within Enugu North Local Government Area; Ogbete Main Market. There are some other prominent markets such as Kenyeta market in Enugu South, Abakpa Market in Enugu East including New Market situated also in Enugu North. As the administrative center of the State, a reasonable percentage of the inhabitants are civil servants. They work in various Government establishments and offices.

III. CONCEPTUAL FRAMEWORK: SYSTEMS THEORY.

This work is based on system theory. A system may be defined as structured set of objects or attributes, where these objects and attributes consist of components or blocks that has connections drawn between them, is interrelated with one another and operate together by way of some driving process, [8]. The concept of the system is very useful in providing a means of understanding complex relationship between environmental factors that favour the breeding of mosquitoes and the longevity of malaria parasites and the transmission of malaria to man by the mosquitoes.

If the impact of environmental factors on malaria is to be understood, the entire cause-effect chain must be described and analyzed comprehensibly. The system approach seems to be the only approach which adequately reflects the complexity of the interrelationship between the environmental factors and mosquito and human population. The system not only explains the component of the various subsystems but also the interactions and processes between them, rather than focusing on each subsystem in isolation. The system approach can help to foster understanding of the relationship between environmental factors and malaria risks. Fig. 2 is a model showing the relationship between the environmental factors, mosquito system and human population.

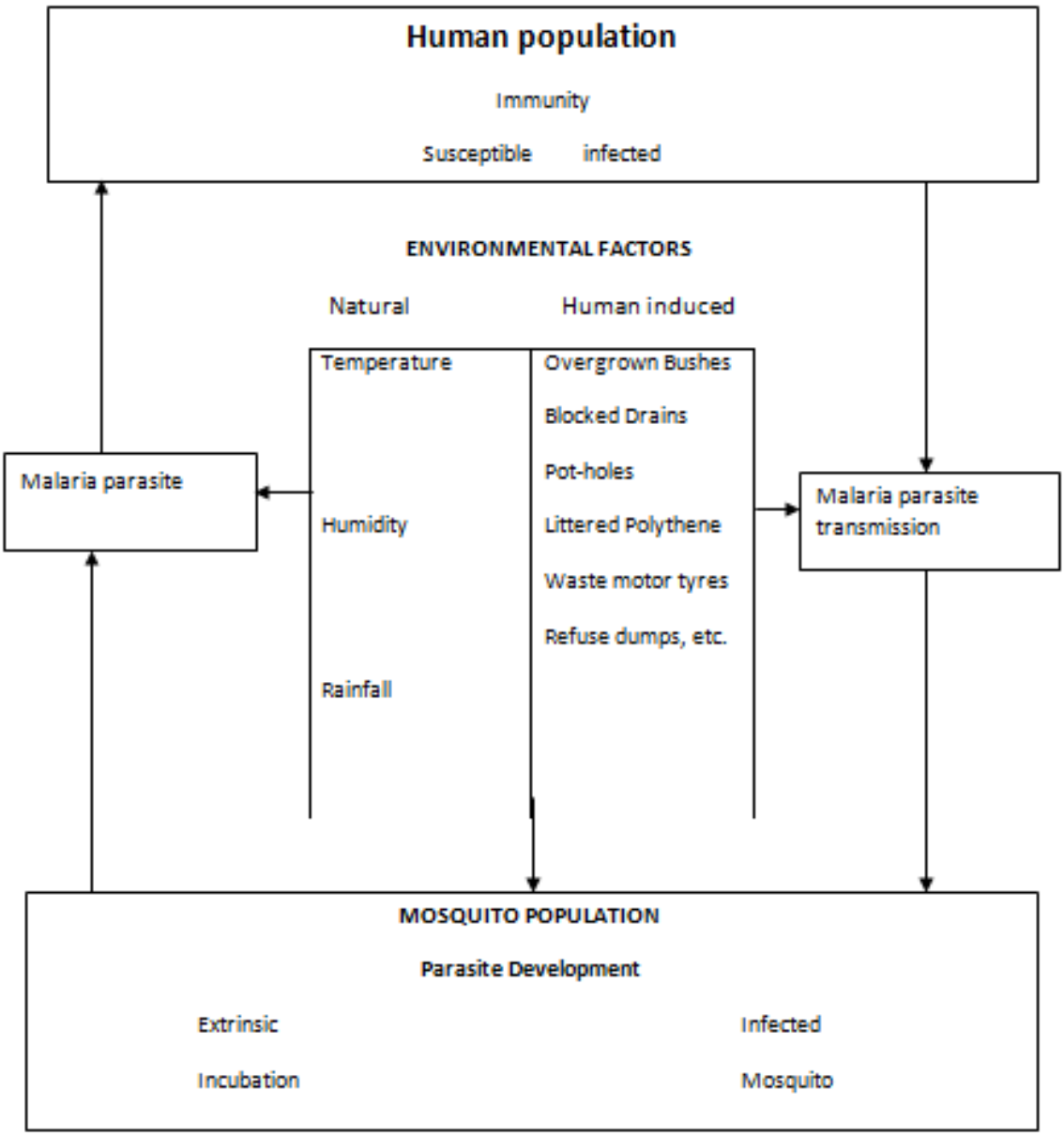

Figure 2: Malaria life cycle model (modified from [10])

The model to assess the effect of environmental factors on malaria consists of several linked modules (i.e. subsystems): the environmental factors (natural and human-induced), the malaria system (divided into a human subsystem and a mosquito subsystem), and thus impact. The system is linked in a manner such that the output of one system serves as input of the next.

Rainfall may play a crucial role in malaria epidemiology because it provides the medium for the aquatic stage of the mosquito life cycle. It may prove beneficial to mosquito breeding if moderate, but, if excessive it may flush out the mosquito larvae [10]. But it should be noted that even if the rain is moderate mosquito cannot breed without presence of environmental factors such as potholes, bushes, blocked drains, littered polythene materials and other receptacles that can hold water after rain. This means that a well-drained area cannot support mosquito breeding even if the rain is moderate. This research concentrates on the impact of human-induced environmental factors as a component of the integrated system of malaria life cycle on malaria vector breeding in the Urban.

The human population system is divided into three categories of the epidemiological model: susceptible, infected and immune .The rate at which people become infected depends on the basic reproduction rate, which changes with environmental conditions.

IV. RESEARCH METHOD

Data on human-induced environmental factors that favour malaria vector breeding were sourced from the inhabitants of Enugu Urban through administration of questionnaire. Data was collected on:
(a) blocked drainages (b) bushes around residents (c) pot hole that can hold water (d) waste motor tires (e) presence of junks (e.g. Abandoned vehicles) (f) presence of heaps of refuse (g) Presence of littered empty water sachets/ other receptacles that may hold water after rain. (h) presence of swimming pools, ponds/ other water bodies (i) abandoned ditches.
In this research, 270 questionnairewere distributed within the 18 prominent communities of the Urban. In each of the communities, 15 questionnaires were distributed. To ensure proper and wide coverage in obtaining information relating to the human-induced environmental factors, streets within the residential areas of the communities were randomly selected for data collection. This was achieved by using the table of random samples. The streets were numbered and using the table the needed streets were selected. In each of the street selected, one literate adult person in every 20th household was given the questionnaire to answer. Data from the responses of the respondents was presented using statistical table.
To determine if there is significant relationship between the human-induced environmental factors in Enugu Urban and mosquito breeding in the Urban, the hypotheses was tested using Pearson correlation.

V. RESULTS

The Table below summarizes the responses of the inhabitants of Enugu Urban in relation to whether the environmental factors are found very close to their residences.

Table 2: Summary of the Responses Relating to Human Induced Environmental Factors

Source: Authors field work (2009).

s/n	Items	Strongly agree	Agree	Disagree	Strongly disagree	undecided	Total
1.	Overgrown bushes	50	100	105	15	0	270
2.	Blocked drains	30	130	90	10	10	270
3.	Refuse dumps	60	120	80	8	2	270
4.	Pot holes	52	98	50	60	10	270
5.	Waste motor tyres	40	97	90	40	3	270
6.	Water bodies (Swimming pool, stream, and ponds).	15	25	150	80	0	270
7.	Abandoned vehicles	20	75	105	70	0	270
8.	Empty water sachets/receptacles that can hold water	170	50	40	10	0	270
9.	Abandoned	25	25	50	165	5	270
10.	The above human induced environmental conditions you indicated to be close to your resident provide breeding sites for mosquitoes.	190	50	18	9	3	270

The number that strongly agree on the item that empty water sachets/ receptacles that can hold water are found very close to their residence is the highest (170 respondents out 270) among all other items of measurement. Also on the side of strongly disagree, abandoned ditches has a total of 165 respondents out of 270 respondents. However, on the item of question 10 which measured whether the human-induced environmental factors are mosquito breeding sites in the area of study, 190 out of 270 respondents strongly agreed that they are mosquito breeding sites.

Table 3. Descriptive Statistics

	Mean	Std. Deviation	N
O.B	54.0000	47.88006	5
B.D	54.0000	53.66563	5
R.D	54.0000	49.71921	5
P.H	54.0000	31.33688	5
W.M.T	54.0000	39.17269	5
W.B	54.0000	61.58328	5
A.V	54.0000	42.92435	5
E.W.S/R	54.0000	68.04410	5
A.D	54.0000	64.07027	5
MB	54.0000	78.15689	5

In table3 OB = Overgrown Bushes, BD = Blocked Drains, RD = Refuse Dumps, PH = Pot Holes, WMT = Waste Motor Tires, WB = Water Bodies (pond, stream, swimming pool), AV = Abandoned Vehicles, EWS/R = Empty Water Sachets/ Receptacles that can hold water after rain, AD = Abandoned Ditches, MB = Mosquito Breeding.

The correlation table below shows significant relationship that exists between items.

CORRELATIONS											
		OB	BD	RD	PH	WMT	WB	AV	LEWS	AD	MB
OB	Pearson Correlation	1	.926*	.939*	0.661	.956*	0.476	0.729	0.251	-0.253	0.13
	Sig. (2-tailed)		0.024	0.018	0.224	0.011	0.417	0.162	0.684	0.681	0.835
	N	5	5	5	5	5	5	5	5	5	5
BD	Pearson Correlation	.926*	1	.948*	0.731	.923*	0.259	0.642	0.049	-0.318	-0.038
	Sig. (2-tailed)	0.024		0.014	0.16	0.025	0.674	0.242	0.937	0.601	0.951
	N	5	5	5	5	5	5	5	5	5	5
RD	Pearson Correlation	.939*	.948*	1	0.77	.897*	0.16	0.537	0.362	-0.373	0.279
	Sig. (2-tailed)	0.018	0.014		0.128	0.039	0.797	0.351	0.549	0.537	0.649
	N	5	5	5	5	5	5	5	5	5	5
PH	Pearson Correlation	0.661	0.731	0.77	1	0.802	0.123	0.606	0.206	0.202	0.17
	Sig. (2-tailed)	0.224	0.16	0.128		0.103	0.844	0.279	0.739	0.745	0.784
	N	5	5	5	5	5	5	5	5	5	5
WMT	Pearson Correlation	.956*	.923*	.897*	0.802	1	0.533	0.854	0.1	-0.004	-0.012
	Sig. (2-tailed)	0.011	0.025	0.039	0.103		0.355	0.065	0.872	0.995	0.985
	N	5	5	5	5	5	5	5	5	5	5
WB	Pearson Correlation	0.476	0.259	0.16	0.123	0.533	1	0.846	-0.237	0.451	-0.367
	Sig. (2-tailed)	0.417	0.674	0.797	0.844	0.355		0.071	0.701	0.446	0.544
	N	5	5	5	5	5	5	5	5	5	5
AV	Pearson Correlation	0.729	0.642	0.537	0.606	0.854	0.846	1	-0.217	0.418	-0.336
	Sig. (2-tailed)	0.162	0.242	0.351	0.279	0.065	0.071		0.726	0.484	0.58
	N	5	5	5	5	5	5	5	5	5	5
EWS/R	Pearson Correlation	0.251	0.049	0.362	0.206	0.1	-0.237	-0.217	1	-0.311	.989**
	Sig. (2-tailed)	0.684	0.937	0.549	0.739	0.872	0.701	0.726		0.61	0.001
	N	5	5	5	5	5	5	5	5	5	5
AD	Pearson Correlation	-0.253	-0.318	-0.373	0.202	-0.004	0.451	0.418	-0.311	1	-0.309
	Sig. (2-tailed)	0.681	0.601	0.537	0.745	0.995	0.446	0.484	0.61		0.613
	N	5	5	5	5	5	5	5	5	5	5
MB	Pearson Correlation	0.13	-0.038	0.279	0.17	0.012	-0.367	-0.336	.989**	-0.309	1
	Sig. (2-tailed)	0.835	0.951	0.649	0.784	0.985	0.544	0.58	0.001	0.613	
	N	5	5	5	5	5	5	5	5	5	5

*. Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level(2-tailed)

Value more than or equal to 0.5, shows strong positive relationship, and less than 0.5 signifies weak positive relationship between the variables. Equally values less than -0.5 implies strong negative relationship while values more than or equal to -0.5 implies weak negative relationship.

MB and E.W.S/R has the strongest positive relationship with Pearson correlation coefficient value of 0.989 followed by RD, PH, and OB with a value of 0.130

MB and W.M.T has the strongest negative relationship of -0.012 followed by BD, AD, AV, and WB with the value of -0.367

Human-Induced environmental such as overgrown bushes, blocked drains, refuse dumps, potholes, waste motor tires, abandoned vehicles, empty water sachets and receptacles that can hold water after rain, all provide sites for mosquito breeding in Enugu Urban. The empty water sachets/ and receptacles that can hold water after rain has the strongest positive relationship with mosquito breeding, followed by refuse dumps, pot holes and overgrown bushes. On the other hand, waste motor tires and mosquito breeding has the strongest negative relationship in Enugu Urban, followed by blocked drains, abandoned ditches, abandoned vehicles, and water bodies (ponds, streams, swimming pools)

VI. RECOMMENDATIONS

Recommendations are focused on legislation, environmental manipulation, environmental modification, and health education of the inhabitants of Enugu Urban.

1. Legislation on empty water sachets and receptacles that can hold water after rain. The legislation should be centered on the storage, movement and disposal of this receptacles and empty water sachets. Hawkers are to move about with small waste bins to collect immediately empty water sachets into the bin and later disposed properly or sent for recycling. Other receptacles such as empty cocoanut shells, empty tins, broken plastic containers e.t.c should not be allowed to be littered in the environment.
2. Filling of potholes, low lying areas and ditches to remove potential mosquito breeding sites in Enugu urban. These are particularly important if situated close to human habitation.
3. Proper solid waste management is recommended. Refuse should not be allowed to dump for a long time before taken to final disposal sites.
4. Attention should be given to proper refuse management as an environmental management approach to malaria control and not only as a way of beatifying the streets.
5. Since the environment support mosquito breeding mostly in rainy season a special campaign for clean environment in respect of proper waste disposed, clearing of bushed, filling of potholes etc. should be organized to alert the inhabitants of Enugu urban of the danger ahead. Jingles in televisions and radios are also necessary.
6. Vegetation clearing is also recommended to remove resting places and outdoor sheltering of mosquito. Also clearing of overgrown bushes close to residents increase water evaporation and thereby contribute to a reduction in breeding sites of mosquito.
7. Introduction of larvivorus fishes to ponds and swimming pools as predators of mosquito's larvae using edible fish can turn environmental management into a more profitable method of malaria control. For example Gambeson species.
8. Introduction of larvicides into non-drinkable water bodies both large and small to kill mosquito larvae is necessary.
9. The Enugu State Waste Management Agency should rise to this challenge of waste management in other to ensure a drastic reduction in malaria prevalence in Enugu urban.
10. Mosquito scouts should also be trained to join had with other professional bodies like environmental managers and environmental health officers to ensure good planning, organizations and motioning of activities for the modification and manipulation of environment with a view to preventing or minimizing mosquito propagation.
11. Other methods that may be employed to reduce man – vector contact in Enugu Urban include screening of houses, sleeping under mosquito nets, and public education.

VII. CONCLUSION

This research considered environmental factors that affect malaria vector breeding in Enugu Urban. The findings of the study proved that human induced environmental factors such as blocked drains, pot holes, empty water sachets, receptacles that can hold water after rain and many more are breeding sites of mosquito in Enugu Urban. Among these, empty water sachets/ receptacles that can hold water after rain contributes most to mosquito breeding in the Urban. The research also proved that rainfall and human- induced environmental factors work hand in hand to affect malaria vector breeding in the Urban Area.

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