AN INVESTIGATION ON INCIDENCE AND MORTALITY RATE OF REPORTED CASES OF MALARIA IN ANAMBRA STATE

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ABSTRACT

This study assessed the incidence and mortality of reported cases of malaria in Anambra State using mission owned hospitals as a case. Two mission hospitals randomly selected were Saint Charles Borromeo hospital Onitsha and Iyi-Enu hospital Ogidi. The data collected is for the period of thirteen years (2001-2013) .The statistical tools employed in this study were two- way Analysis of Variance, Multiple comparison test, Test for equality of proportions,Runs test and Trend analysis. The result of the estimated mortality rate revealed that Anambra State experienced higher mortality in the year 2002 and lower mortality in the year 2011. The runs test conducted found the presence of trend for both incidence and mortality. Also, trend analysis was conducted using least square method, and the result revealed that the rate of change for incidence of malaria in Anambra State is 4.50 while that of mortality is -7.69. Findings from the analysis showed that the mean incidence of malaria in Anambra State does not differ significantly across the years under study while the mean incidence of malaria in Anambra State differs significantly across the age groups. It was also found that the mean malaria mortality in Anambra State is equal across the years indicating that it does not differ significantly. The result further revealed that the mean malaria mortality in Anambra State shows no equality across the age groups. The incidence and mortality with regards to malaria was found to be equal between males and females in Anambra State. In addition, it was found that the proportion of the incidence of malaria is not equal across age groups and the proportion of malaria mortality is equally not equal across age groups in Anambra State.

Key words: Mission owed hospitals, Two Way Analysis of Variance, Multiple comparison test, Runs test, Trend analysis.

1. INTRODUCTION

Malaria is a life-threatening blood disease caused by a parasite that is transmitted to human by the female Anopheles Mosquito. Malaria is mosquito infectious disease of humans and other animals caused by parasitic protozoan (a type of unicellular micro-organism) of the plasmodium.

By the end of 18th century, scientists found out that malaria is transmitted from person-to-person through the bite of the female mosquito, which needs blood for her eggs. Malaria is common in tropical and subtropical regions because of rainfall, warm temperature and stagnant waters provide an environment ideal for mosquito larvae.

According to World Health Organization (WHO) 2000, approximately 40% of the total global populations are at risk of malaria infection. The impact of malaria in human existence, the world over, becomes more damaging as a result of high morbidity and mortality experience in different parts of the globe especially the developing countries like Nigeria.

Malaria accounts for an estimated two to three million deaths annually and is also responsible for untold morbidity in approximately 300 to 500 million people annually. Susceptible groups are children and adult who have host or never acquired immunity (*Smith et al, 2002*).

According to World Health Organization (WHO), Center for Disease Control and Prevention (CDCP), Roll Back Malaria Partnership (RBM), (2010), 3.3 billion people-half the world's population are at risk of Malaria; one million people die each year from malaria. Also in Africa, 91% of all malaria death cases occur in Sub-Sahara Africa, 1 in 5 children deaths are caused by malaria, 10,000 pregnant women and 200,000 infants die from malaria every year.

Government, organizations and individual all over the world have made frantic efforts, not only to prevent but also to eradicate malaria since its discovery.

These efforts can be seen in the introduction of treated bed nets, vector control and works of World Health Organization (WHO), Roll Back Malaria (RBM), National Malaria Control Program (NM CP) and many other health organizations.

Despite all these wars waged against malaria and even though so many research has been done on malaria over the years past, its incidence and mortality rate increase on daily basis in many developing countries like Nigeria. This shows that there is a basic lack of high quality epidemiological data on the incidence and mortality rate of malaria in many endemic areas.

This study will serve as an eye opener to the people of Anambra State of Nigeria and the world in general as it is geared towards giving a detailed overview of incidence and mortality rate of malaria from the available figure**s.**

2. REVIEW OF RELATED LITERATURE

Opera (2001) carried out a study on Effect of Malaria during Pregnancy on Infant Mortality in Abia State, Nigeria between 1993 and 1999". Using Chi-Square test for independence, the result showed that malaria during pregnancy increased neonatal mortality by lowering birth weight. Baird, et al (2002) conducted a research on the seasonal malaria attack rates in infants and young children in Northern Ghana from 1996 to 1997. Using Fisher's exact test and Chi-Square test of independence, the result showed that the mean parasitemia count at the time of re-infection in the dry season roughly equaled that in the wet season.

Durueke (2005) carried out a research on the incidence, management and bionomic of malaria in children under five years of age in parts of Isiala Mbano LGA, Imo State, from November 2004 to August 2005. Using a Chi-Square test for proportion, the result revealed that the incidence of malaria in the studied area was inversely proportional to the socio-economic level and decreased with improvement in standard of living. Korenromp et al (2007) carried out a study on Forecasting Malaria Incidence Based on Monthly Case Reports and Environmental Factors in KaruziBurudi, from 1997 to 2003". Using time series analysis, the result revealed that the exploration of the incidence of malaria, precipitation, vegetation from 1997 to 2003 showed no clear trend, and suggests a seasonal dependency in the series with a 6 – month period for the incidence and a 12 – month period for rainfall, temperature and vegetation. Gerritsen et al (2008) carried out an analysis on malaria incidence in Limpopo Province South Africa from 1998 to 2007, using Chi – Square test of independence and time series analysis, the result showed that out of 58768 cases of malaria reported including 628 deaths, the mean incidence of malaria was 124.5 per 100,000 persons and the mean mortality rate was 1.1% per season. Also, there was a decreasing trend in the incidence over time and the mean incidence in males was

higher than the females. Finally, the result revealed the incidence inmalaria peaked at the age of 35 to 39 years, decreased with age from 40 years and is lowest in 0 – 14 years old. The fixed case fatality rate (CFR) increased with increasing age.

Adebola and Okereke (2007) conducted a study on Increasing Burden of Childhood Severe Malaria in A Nigerian Tertiary Hospital: Implication for Control, Between January2000 and December 2005". Using Logistic Regression, the result showed that severe malaria constituted an important cause of hospital admission among Nigerian children especially those aged below 5 years. The result revealed that there was significant increase in the proportion of cases of severe malaria from 2000 to 2005.

Nwankwo and Okafor (2009) carried out a research on the Effectiveness of Insecticide Treated Bed Nets (ITNs) in malaria prevention among children aged 6 (six) months to 5 (five) years in UmungwaObowo L.G.A., Imo State of Nigeria between June and September 2006. From the 100 children selected and randomly assigned either treated bed nets or traditional bed nets and using a Chi – Square test of independence, the result revealed that there was a significant difference in the malaria morbidity situation among the two groups. That is to say, morbidity due to malaria was high in children that used traditional bed nets than the other group. Yeshiwodim et al (2009) carried out a research on spatial analysis of malaria incidence at the village level in areas with unstable transmission in Ethiopia from September, 2002 to August, 2006. Applying the method of Poisson regression analysis, the result showed the presence of significant spartio-temporal variation and also showed a decrease in the incidence of malaria with increasing age. The conclusion was that incidence of malaria varies according to gender and age, with males age 5 and above showing a statistically high incidence. Greenwood et al. (2009) carried out a research on the evolution of malaria mortality and morbidity after the emergence of chloroquine resistance in rural area of the Gambia, West Africa between1992 to 2004. Applying the method of Univariate Logistic Regression and Time Series Analysis, the result revealed that mortality attributable to malaria did not continue to increase dramatically, in spite of the growing resistance to chloroquineas first – line treatment, until 2003. The result also showed that malaria morbidity and mortality followed parallel trends and rather fluctuated according to rainfall. Ayeni (2011) conducted a research titled "Malaria Morbidity in Akure South West, Nigeria: A Temporal Observation in Climate Change Scenario, from 2000 to 2008". Applying the method of Time Series Analysis, the result revealed that malaria morbidity was generally low before 2004 and that the reported cases of malaria increased from 43,533 in 2004 to about 62,121 cases in 2008. From the result also, malaria index revealed an increase of 0.005 annually between 2000 and 2008.

3. MATERIALS AND METHODOLOGY

The data for this research work were collected from medical departments of Saint Charles Borromeo Hospital Onitsha and Iyi Enu Hospital Ogidi in Anambra State. The data is secondary; consist of number of patients treated of malaria and the number of patients that died from malaria together with their gender and ages from 2001 to 2013. The methods adopted for the analysis were Two-way Analysis of Variance, Multiple comparison test, Test for equality of proportions, Mortality rate, Runs test and Trend Analysis.

3.1 TWO-WAY ANALYSIS OF VARIANCE

There are mainly two different ways of analyzing two-factor experiments. They depend on whether the variables are independent or whether they interact i.e. the case where the variables or treatments are not dependent. To test for interaction of the treatments, more than one observation has to be included in each cell of two-way analysis data table (i.e. replication). If there are no interactions of treatments, the two-way ANOVA is called randomized block design. The two-way ANOVA without interaction is used in this study.

Two -Way ANOVA without Interaction

The model for two-way analysis of variance without interaction is given as:

$X_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$ (1)

i= 1,2,…,a

j= 1,2,…,b

Where:

μ = the grand mean.

α_i = the ith treatment effect.

β_j = the jth block effect.

e_{ij} = the random error associated with X_{ij}

$\sum_{i=1}^{a} \alpha_i = 0$ (2)

$\sum_{j=1}^{b} \beta_j = 0$ (3)

Partitioning the Sum of Squares

$C = \frac{X_{..}^2}{ab} = \frac{1}{ab}\left(\sum_{i=1}^{a}\sum_{j=1}^{b} X_{ij}^2\right)$ (Correction term)

$SS_T = C_{ij} - C$, where $C_{ij} = \sum_{i=1}^{a}\sum_{j=1}^{b} X_{ij}^2$

$SS_\alpha = C_i - C$, where $C_i = \frac{1}{b}\sum_{i=1}^{a} X_{i.}^2$

$SS_\beta = C_j - C$, where $C_j = \frac{1}{a}\sum_{i=1}^{a} X_{.j}^2$

$\mathbf{SS_E = C_{ij} - C_i - C_j = SS_T} - SS_\alpha - SS_\beta$

The Test Hypotheses

Three null and alternative hypotheses to be tested are that:

i. H_0^1: $\alpha_i = 0$ (the treatments are all equal to zero)
   H_1^1: $\alpha_i \neq 0$ (at least one of the α_i's is different)

ii. H_0^2: $\beta_j = 0$ (the block effects are all equal to zero)
   H_1^2: $\beta_j \neq 0$ (at least one of the β_j's is different)

The Test Statistic

The test statistic for two-way ANOVA without interaction is given by:

$$F_{treatment} = \frac{MStrt}{MSE} \quad (4)$$

$$F_{block} = \frac{MSblock}{MSE} \quad (5)$$

Table 1: ANOVA Table

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F*
Treatment	a - 1	SS_{trt}	$\frac{SS_{trt}}{a-1}$	$\frac{MS_{trt}}{MS_E}$
Block	b – 1	SS_{block}	$\frac{SS_{block}}{b-1}$	$\frac{MS_{block}}{MS_E}$
Error	(a – 1)(b – 1)	SS_{error}	$\frac{SS_{error}}{(a-1)(b-1)}$	
Total	(ab) – 1	SST		

The Decision Rule

If $F_{trt} \geq F\alpha$, (a-1), (a – 1)(b – 1), H_0 is to be rejected, otherwise fail to reject H_o

If $F_{block} \geq F\alpha$, (b-1), (a – 1)(b – 1), H_0 is to be rejected, otherwise fail to reject H_o

3.2 TEST FOR EQUALITY OF TWO POPULATION PROPORTION

According to Nwobi (2003), test for equality of two population proportion is a test used to find out whether two proportions from two populations are equal or one of the proportions is less or more than the other.

The Test Hypotheses

The null and alternative hypotheses to be tested are:

H_0: $P_1 = P_2$ or $P_1 - P_2 = 0$ (the two population proportions are equal)
H_1^1: $P_1 \neq P_2$ or $P_1 - P_2 \neq 0$ (the two population proportions are not equal)
or
H_1^2: $P_1 > P_2$ or $P_1 - P_2 > 0$ (the first proportion is greater than the second)
Or
H_1^3: $P_1 < P_2$ or $P_1 - P_2 < 0$ (the first proportion is less than the second)

The Test Statistic

The test statistic is the Z_{cal} which is given by;

$$Z_{cal} = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{n_1} + \frac{P_2(1-P_2)}{n_2}}} \quad (5)$$

Where P_1 and P_2 are the proportion of the first and second population respectively, and n_1 and n_2 are the number of observation in the first and second population, respectively.

Decision Rule

H_0 is to be rejected if $| Z_{cal} | > Z_{tab}$, otherwise fail to reject H_0.

3.3 MORTALITY RATE

According to Nwogu and Iwueze (2009), mortality rate is a measure of the deaths (in general, or due to a specific cause) in some population, scaled to the size of that population, per unit time. Mortality rate is typically expressed in units of deaths per 1000 individuals per year. Mortality rate is given by the formula.

$$MR = \frac{Numberofdeathsofaspecificyear}{Thenumberofpeopleinthepopulation} X \frac{1000}{1}$$

$$= \frac{\partial i}{Pi} X \ \frac{1000}{1} \qquad (6)$$

Bartlett's Test

According to Nduka and Nwobi (2003), the Bartlett's test is one of the methods of testing for constant variance. The Bartlett's test statistic is given by:

$$B = \frac{K}{1+L} \qquad (7)$$

Where

$$L = \frac{1}{3(a-1)}\left[\sum_{i=1}^{a}\frac{1}{ni-1} - \frac{1}{\sum_{i=1}^{a}(ni-1)}\right] \qquad (8)$$

$$K = \sum_{i=1}^{a}(ni-1)loge[T_A] - \sum_{i=1}^{a}(ni-1)loge(S_i^2) \qquad (9)$$

$$T_A = \frac{1}{\sum_{i=1}^{a}(ni-1)}\sum_{i=1}^{a}(ni-1)S_i^2 \qquad (10)$$

Where

$$S_i^2 = \sum_{i=1}^{ni}\frac{(X_{ij}-\overline{Xi.})}{ni-1} \qquad (11)$$

Under the null hypothesis of constant variance the statistic in (7) follows Chi-square distribution with a – 1degrees of freedom. The null hypothesis of constant variance is rejected if the calculated value of B in (7) exceeds its chi-square tabulated of significance and a – 1 degrees of freedom.

RUNS TEST (Test for the Presence of Trend)

The Runs test is used for testing for the trend in this study. Definition: According to Nwobi and Nduka (2003), a run can be defined as a succession of identical symbol, which are followed and preceded by different symbols or by no symbols at all.

The Test Hypothesis

The hypothesis tested is:

H_0: the sequence follows a random process (there is no trend)
H_1: the sequence does not follow a random process (there is presence of trend)

The Test Statistic

The test statistic is given by:

$$Z = \frac{R - \mu_r}{\delta_r} \qquad (12)$$

Where μ_r= the mean of the runs given by the formula

$$\mu_r = 1 + \frac{2n_1n_2}{n_1+n_2} \qquad (13)$$

and δ_r^2 = the variance of the runs given by the formula

$$\delta_r^2 = \frac{2n_1\,n_2\,(2n_1n_2-n_1-n_2)}{(n_1+n_2)^2\,(n_1+n_2-1)} \qquad (14)$$

and

R = the total number of runs.
n_1 and n_2 = the number of positive and negative runs respectively.
Decision Rule**:** H_0 is to be rejected if $|Z_{cal}| > Z_{tab}$, otherwise fail to reject H_0.

3.4 TREND ANALYSIS

A trend is fitted after established its presence in the series.

Definition: According to Iwueze (2006), a trend or secular trend is defined as long-term changes in the mean and it refers to the general direction in which the graph of the time series appears to be going over a long term interval of time. Trend may be upward (growth) or downwards (decline). There are different methods of estimating trend, example the Least Squares method. According to Murray and Larry (1998), least square method is used to find the equation of an appropriate trend line (curve) and probably test for its adequacy. From this equation, the trend values (T_t) is computed.

The linear trend line is given as;

$$T_t = a + bt \tag{15}$$

Where;

T_t is the trend values

b is the slope and it is estimated as;

$$\hat{b} = \frac{n\sum Tt - \sum T \sum t}{n\sum t^2 - (\sum t)^2} \tag{16}$$

a is the intercept and it is estimated as;

$$\hat{a} = \overline{T - \hat{b}\bar{t}} \tag{17}$$

t is the time (period)

4. DATA ANALYSIS AND RESULTS

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Table 4 .1: Computation of Bartlett's Test for Homogeneity of Variance

s\n	S_i^2	$\log_e S_i^2$	$(n_i-1)\ S_i^2$	$(n_i-1)\ \log_e S_i^2$
1	16884	9.7341	84420	48.6705
2	18262.7	9.8126	91313.5	49.063
3	17744.27	9.7838	88721.33	48.919
4	16700.17	9.7232	83500.83	48.616
5	6797.47	8.8243	33987.33	44.1215
6	7074.17	8.8642	35370.83	44.321
7	18113.07	9.8044	90565.33	49.0219
8	19712.8	9.8890	98564	49.4451
9	19261.37	9.8659	96306.83	49.3293
10	22439.47	10.0186	112197.33	50.0929
11	14595.47	9.5885	72977.33	47.9423
12	18076.17	9.8023	90380.83	49.0118
13	14298.67	9.5679	71493.33	47.8396
Total			1049798.8	626.3939

Hypothesis testing

H_0: $\sigma_i^2 = 0$, i = 1,2,3,…,13

H_1: $\sigma_i^2 \neq 0$ for at least one i's.

Using equation (10)

$T_A = \frac{1049798.8}{65} = 16150.7508$

Using equation (9) we have

$K = 65\log_e^{16150.7508} - 626.3939 = 3.4380$

Using equation (8)

L $= \frac{1}{3(13-1)}\left[2.6 - \frac{1}{65}\right] = 0.0718$

Using equation (7)

B $= \frac{3.4380}{1+0.0718} = 3.2077$

$X^2_{(a-1),0.05} = X^2_{(12),0.05} = 21.00$

Testing For Equality Between The Means Of The Years And The Means Of The Age Groups Of The Reported Cases Of Malaria In Anambra State

The null and alternative hypotheses are of the form:

H_0^1: $\beta_{2001} = \beta_{2002} = \ldots = \beta_{2013}$ (the incidence of malaria is equal across the years)

H_0^2: $\alpha_{(0\text{-}14)} = \alpha_{(15\text{-}29)} = \ldots = \alpha_{(75+)}$ (the incidence of malaria is equal across the age groups)

H_1^1: $\beta_{2001} \neq \beta_{2002} \neq \ldots \neq \beta_{2013}$ (at least one of the years is different)

H_1^2: $\alpha_{(0\text{-}14)} \neq \alpha_{(15\text{-}29)} \neq \ldots \neq \alpha_{(75+)}$ (at least one of the age group is different)

Table 4.2: Two-way Analysis of Variance for Reported incidence of malaria

Source	DF	SS	MS	F	P-VALUE
YEAR	12	28128	2344	1.89	0.054443
AGE	5	975229	195046	156.92	4.13E-33
Error	60	74570	1243		
Total	77	1077927			

From the result of the analysis displayed in Table 4.2, it was found that year did not contribute to the effect since the F-value of 1.89 and a corresponding p-value of 0.054 accepted the null hypothesis. This indicated that the mean incidence of malaria in Anambra State does not differ significantly across the observed years. The result further revealed that for variable Age with F-ratio of 156.92 and a p-value of 0.00 shows strong evidence that the mean incidence of malaria in Anambra State differs significantly across the age groups.

Testing For Equality Between The Means Of The Years And The Means Of The Age Groups Of Malaria Mortality In Anambra State

The null and alternative hypotheses are of the form:

H_0^1: $\beta_{2001} = \beta_{2002} = \ldots = \beta_{2013}$ (malaria mortality is equal across the years)

H_0^2: $\alpha_{(0\text{-}14)} = \alpha_{(15\text{-}29)} = \ldots = \alpha_{(75+)}$ (the malaria mortality is equal across the age groups)

H_1^1: $\beta_{2001} \neq \beta_{2002} \neq \ldots \neq \beta_{2013}$ (at least one of the years is different)

H_1^2: $\alpha_{(0\text{-}14)} \neq \alpha_{(15\text{-}29)} \neq \ldots \neq \alpha_{(75+)}$ (at least one of the age group different)

Table 4.3:Two-way Analysis of Variance for mortality

Source	DF	SS	MS	F	P-VALUE
YEAR	12	150.21	12.52	1.53	0.140538
AGE	5	1422.10	284.42	34.64	1.75E-16
Error	60	492.56	8.21		
Total	77	2064.87			

In Table 4.3, the result of the analysis showed that the mean malaria mortality in Anambra State is equal across the observed years since an F-value of 1.53 and a corresponding p-value of 0.14 authenticated the acceptance of null hypothesis. The result also showed that variable Age with F-ratio of 34.64 and p-value of 0.00 confirms the rejection of null hypothesis. This expresses strong evidence that the mean malaria mortality in Anambra State is not equal across the age groups.

Tests for Equality of Two Population Proportion for the Incidence of Malaria in Anambra State

The hypothesis tested

H_0: $P_{males} = P_{females}$ (the incidence of malaria are equal for both sex)

H_1^1: $P_{males} \neq P_{females}$ (the incidence of malaria are not equal for both sex)

Table 4.4: Incidence of malaria with gender

GENDER	0 – 14	15 -29	30 – 44	45 – 59	60 – 74	75+	Total
MALE	2699	1823	1096	1076	770	461	7925
FEMALE	2665	1642	1204	1239	722	436	7908
TOTAL	5364	3465	2300	2315	1492	897	15833

$P_{males} = \frac{n_{males}}{N} = \frac{7925}{15833} = 0.5005$

$P_{females} = \frac{n_{females}}{N} = \frac{7908}{15833} = 0.4995$

The test statistic using equation (5) now becomes

$$Z_{cal} = \frac{0.5005 - 0.4995}{\sqrt{\frac{0.5005(1-0.5005)}{7925} + \frac{0.4995(1-0.4995)}{7908}}} = 0.1259$$

CRITICAL VALUE

$Z_{tab} = Z_{1-\alpha/2} = Z_{1-0.05/2} = Z_{0.975} = 1.96$

DECISION

Since Z_{cal} (=0.1259) < Z_{tab} (=1.96), H_0 being accepted shows that the incidence is equal for both sex

For Malaria Mortality in Anambra State

Hypothesis tested

H_0: $P_{males} = P_{females}$ (malaria mortality are equal for both sex)

H_1^1: $P_{males} \neq P_{females}$ (malaria mortality are not equal for both sex)

Table 4.5: Malaria mortality

GENDER	0 - 14	15 -29	30 - 44	45 – 59	60 – 74	75+	Total
MALE	136	69	67	67	47	40	426
FEMALE	122	52	64	68	62	44	412
TOTAL	258	121	131	135	109	84	838

$P_{males} = \frac{n_{males}}{N} = \frac{426}{838} = 0.508$

$P_{\text{females}} = \frac{n_{females}}{N} = \frac{412}{838} = 0.492$

The test statistic using equation (5) now becomes

$$Z_{cal} = \frac{0.508 - 0.492}{\sqrt{\frac{0.508(1-0.508)}{426} + \frac{0.492(1-0.492)}{412}}} = 0.468$$

CRITICAL VALUE

$Z_{tab} = Z_{1-\alpha/2} = Z_{1-0.05/2} = Z_{0.975} = 1.96$

DECISION

Since Z_{cal} (=0.468) < Z_{tab} (=1.96), Null hypothesis is accepted indicating that malaria mortality are equal for both sex.

Test for Equality of More Than Two Population Proportions for the Incidence of Malaria

The test hypothesis is of the form:

H_0: $P_{(0-14)} = P_{(15-29)} = \ldots = P_{(75+)}$ (the proportion of the incidence of malaria are equal across the age groups)

H_1: $P_{(0-14)} \neq P_{(15-29)} \neq \ldots \neq P_{(75+)}$ (the proportion of the incidence of malaria are not equal across the age groups)

Table 4.6: Sample Proportions for age groups and X^2_{cal} on Incidence of malaria

Age Group	Observed Q_i	Proportion $P_0=\frac{Q_i}{N}$	% Proportion	Expected e_i	P_e	$\%P_e$	$(P_0-P_e)^2/P_e$
0-14	5364	0.3388	33.88	2638.3333	0.1667	16.67	17.7675
15-29	3465	0.2189	21.89	2638.3333	0.1667	16.67	1.6346
39-44	2300	0.1453	14.53	2638.3333	0.1667	16.67	0.2747
45-54	2315	0.1462	14.62	2638.3333	0.1667	16.67	0.2521
55-64	1492	0.0942	9.42	2638.3333	0.1667	16.67	3.1705
75+	897	0.0567	5.67	2638.3333	0.1667	16.67	7.2586
Total	15833			15833			30.358

$\text{Expected} e_i = \frac{\text{Total of observed}}{\text{number of age groups}}$

$Pe_i = \frac{e_i}{\text{Total observed}}$

The test statistic using equation below now becomes:

$X^2_{cal} = \sum_{i=1}^{n} \frac{(P_0 - P_e)^2}{P_e} = 30.358$

CRITICAL VALUE

$X^2_{tab} = X^2_{1-\alpha},(n-1) = X^2_{1-0.05},(6-1)$

$X^2_{0.95},5 = 11.10$

DECISION

Since X^2_{cal} (30.358) > X^2_{cal} = (11.10), H_0 is therefore rejected in favor of H_I.

For Malaria Mortality

The test hypothesis is of the form:

H_0: $P_{(0-14)} = P_{(15-29)} = \ldots = P_{(75+)}$ (the proportion of malaria mortality are equal across the age groups)

H_1: $P_{(0-14)} \neq P_{(15-29)} \neq \ldots \neq P_{(75+)}$ (the proportion of malaria mortality are not equal across the age groups)

Table 4.7: Sample proportions for age groups and the X^2_{cal} on Malaria Mortality

Age group	Observed Q_i	Proportion $P_0=\frac{Q_i}{N}$	% proportion	Expected e_i	P_e	$\%P_e$	$(P_0-P_e)^2/P_e$
0-14	258	0.3079	30.79	139.667	0.1667	16.67	11.9601
15-29	121	0.1444	14.44	139.667	0.1667	16.67	0.2983
39-44	131	0.1563	15.63	139.667	0.1667	16.67	0.0649
45-54	135	0.1611	16.11	139.667	0.1667	16.67	0.0188
55-64	109	0.1301	13.01	139.667	0.1667	16.67	0.8036
75+	84	0.1002	10.02	139.667	0.1667	16.67	2.6528
Total	838			838			15.7985

Expected $e_i = \frac{\text{Total of observed}}{\text{number of age groups}}$

$Pe_i = \frac{e_i}{\text{Total observed}}$

The test statistic using equation below now becomes:

$X^2_{cal} = \sum_{i=1}^{n} \frac{(P_0 - P_e)^2}{P_e} = 15.7985$

CRITICAL VALUE

$X^2_{tab} = X^2_{1-\alpha},(n-1) = X^2_{1-0.05},(6-1)$

$X^2_{0.95},5 = 11.10$

DECISION

Since X^2_{cal} (15.7985) > X^2_{cal} = (11.10), H_0 is therefore rejected in favor of H_I.

From the result, the proportion of malaria mortality in Anambra State is not equal across age groups. Implies there is significant difference on malaria mortality across age groups

Table 4.8: The mortality rate of the reported cases of malaria.

Year	Reported Cases	Malaria Mortality	Mortality Rate
2001	1392	61	$43.83^0/_{00}$
2002	1149	79	$68.76^0/_{00}$
2003	1276	64	$50.16^0/_{00}$
2004	1171	53	$45.26^0/_{00}$
2005	988	62	$62.75^0/_{00}$
2006	1019	67	$65.75^0/_{00}$
2007	1198	66	$55.09^0/_{00}$
2008	1284	63	$49.07^0/_{00}$
2009	1277	73	$57.17^0/_{00}$
2010	1370	59	$43.07^0/_{00}$
2011	1198	50	$41.74^0/_{00}$
2012	1279	79	$61.77^0/_{00}$
2013	1232	62	$50.32^0/_{00}$

These results above imply that out of every 1000 persons reported cases of Malaria in Anambra State in 2001, approximately 44 persons died of the disease (Malaria). Also for 2002, about 69 persons died of the disease, etc. Hence from table 4.8, it is shown that the highest number of persons that died of Malaria

was recorded in 2002, while the lowest persons that died of malaria were recorded in 2011. This is an indication that the disease is in control.

4.1 TESTING FOR TREND IN THE INCIDENCE OF MALARIA IN ANAMBRA STATE

H_0: The incidence of malaria in Anambra State is randomly distributed (there is no trend)
H_1: The incidence of malaria in Anambra State is not randomly distributed (there is presence of trend)

The mean of the runs, μ_r is obtained using (Equation 21) as:

$$\mu_r = 1 + \frac{2(32)(46)}{32+46} = 38.7436$$

The variance of the runs, δ_r^2 is also computed using (Equation 22) as:

$$\delta_r^2 = \frac{2(32)(46)[2(32)(46)-32-46]}{(32+46)^2\ ((32+46-1)} = 18.0108$$

$\delta_r = \sqrt{\delta_r^2} = 4.2439$

Thus the test statistic using (Equation 20) now becomes:

$$Z = \frac{8-38.7438}{4.2439} = -7.2442$$

CRITICAL VALUE

$Z_{tab} = Z_{\alpha/2} = Z_{0.05/2} = Z_{0.025} = 1.96$

DECISION

Since $|Z_{cal}|$ (= 7.2442) > Z_{tab} (= 1.96), Null hypothesis is rejected showing there is presence of trend in incidence of malaria in Anambra state.

4.2 TESTING FOR TREND IN MALARIA MORTALITY IN ANAMBRA STATE

H_0: Malaria in Anambra State is randomly distributed (there is no trend)
H_1: Malaria in Anambra State is not randomly distributed (there is presence of trend)

The mean of the runs, μ_r is obtained using (13) as:

$$\mu_r = 1 + \frac{2(31)(47)}{31+47} = 38.539$$

The variance of the runs, δ_r^2 is also computed using (14) as:

$$\delta_r^2 = \frac{2(31)(47)[2(31)(47)-31-47]}{(31+47)^2\ ((31+47-1)} = 17.6407$$

$\delta_r = \sqrt{17.6407} = 4.2001$

Thus the test statistic using (Equation 12) now becomes:

$$Z = \frac{18-38.539}{4.2001} = -4.8473$$

CRITICAL VALUE

$Z_{tab} = Z_{\alpha/2} = Z_{0.05/2} = Z_{0.025} = 1.96$

DECISION

Since $|Z_{cal}|$ (= 4.8473) > Z_{tab} (= 1.96), H_0 is rejected confirming that there is presence of trend in morality cases of malaria in Anambra State.

4.3. TREND ANALYSIS FOR REPORTED CASES AND MORTALITY OF MALARIA IN ANAMBRA STATE

The data for reported cases and mortality of malaria in Anambra State exhibit an upward and downward movement over the years under study. Using the computer software (Minitab version 11.0), the equation (16), (17) and (18) gives the trend line for reported case as;

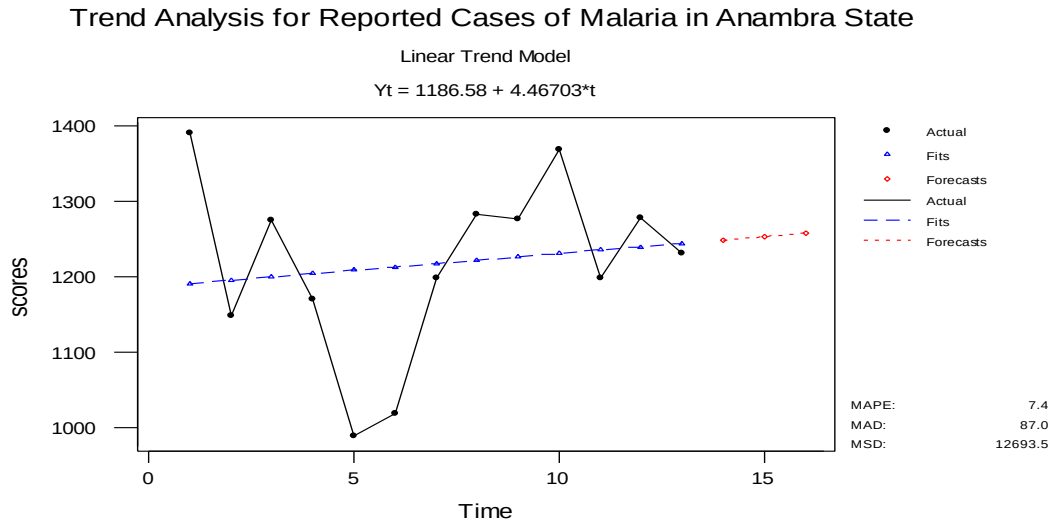

Figure 1: Trend Analysis for reported cases of Malaria in Anambra State

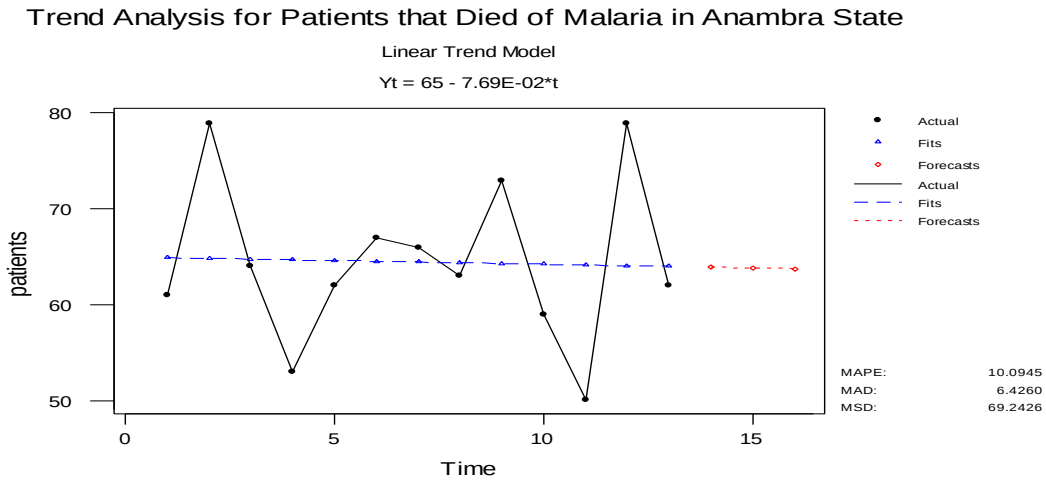

Figure 2: Trend Analysis for patients that Died of Malaria in Anambra State

$T_t = 1186.46 + 4.49451*t$ (19)

$T_t = 65 - 7.69E\text{-}02*t$ (20)

The equation (19) and (20) represent the trend models for reported cases of malaria and mortality in Anambra State respectively. Also, three years prediction was made base on time and the trend line for reported cases of malaria which exhibited an upward movement, while that of mortality do not show any increase non decrease over the period under study.

5. CONCLUSION

This study centered on the incidence and mortality rate of reported cases of malaria in Anambra state Nigeria using mission owned hospitals as a case. Two hospitals were randomly selected out of several recognized hospitals in the State. The two hospitals selected randomly have really unveiled to us the real picture of the cases of mortality and treated cases of malaria in Anambra State, Nigeria. Data were collected based on the treated and mortality cases of malaria patients, according to their ages and years of occurrence. The statistical techniques used in the study are valid, since it satisfies the assumptions behind them. Thus, findings from the analysis in this study revealed the following conclusions:

The mean incidence of malaria in Anambra State does not differ significantly across the years under study.
The mean incidence of malaria in Anambra State differs significantly across the age groups. The mean malaria mortality in Anambra State is equal across the years. That is to say that it does not differ significantly. The mean malaria mortality in Anambra State is not equal across the age groups. It implies that it differs significantly.
The incidence of malaria is equal between males and females in Anambra State.
Malaria mortality in Anambra State is also equal between males and females.
The proportion of the incidence of malaria is not equal across age groups in Anambra State.
The proportion of malaria mortality shows no equality across age groups in Anambra State.

Sequel to the findings from this study the following recommendations were made:
There should be proper attention to the sick, especially for those requiring urgent attention instead of the bureaucratic procedures often adopted in the hospitals.
Drugs for treatment and prevention of malaria should be tested to ensure that they satisfy the roll-back malaria needs of the vast majority of the people at all levels of health drugs for which quality certification can be readily obtained from local institutions, from the country of origin or through the auspices of the World Health Organization.

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