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Modelling Malaria Case Counts at General Hospital Toto: A Chi-Square and Poisson Regression Approach

YAHAYA MUHAMMAD MUSA[1], SAIDU R.Y[2], AUDI N. I.[3]
[1, 2, 3]*Department of Statistics and Data Analytics, Nasarawa State University, Keffi.*

Abstract- ***In sub-Sahara Africa, malaria continue to be a serious public health concern, with Nigeria accounting for a sizable share of cases and fatalities worldwide. The study examined secondary hospital records of malaria patients who ever seen at General Hospital Toto between 2010 and 2024. To ascertain the temporal trend, demographic traits and prevalence pattern. To investigate the relationship between malaria cases and demographic factors (gender and age group) and to determine annual trends, Descriptive statistics, Chi-square and Poisson regression model were utilized. Analysis was done on 749 cases of malaria. Nearly 58.7% of cases included men, while 41.3% involved women. children aged 0–9 years had lowest prevalence (5.9%). Whereas adult aged 20–39 years' account for more than half (50.8%) of all the reported cases. There was no statistically significant association between malaria cases and gender (p = 0.258) or age group (p = 0.412), according to chi-square analysis. with an estimated 3% annual increases (p = 0.04) Poisson regression revealed a statistically significant increase trend in malaria incidence over time. the result point ta an increasing malaria burden at Toto general hospital, with young and middle-aged persons being disproportionately affected. To lower the spread of malaria and enhance health outcomes, more preventative measures, enhanced diagnostic capabilities and ongoing surveillance are required.***

Index Terms- ***Malaria, Prevalence, Demographic Characteristics, Poisson Regression, Chi-Square***

I. INTRODUCTION

The infectious disease malaria is spread by the bites of female anopheles mosquitoes carrying protozoan parasites of the species plasmodium. Fever, exhaustion, Nausea and Headaches are frequent symptoms of human malaria, which usually manifest 10 to 15 days after infection (*Dahalan et al., 2019).* Malaria can caused jaundice, convulsion, coma, and even extreme cases (*Basu & Sahi, 2017). Human can contract six different species of plasmodium with* P. falciparum and P. vivax accounting for the majority of infections globally (WHO,2023).

In 2022, there were an anticipated 249 million malaria infections and 608,000 facilities worldwide, with sub-Sahara African accounting for almost 95% of cases (WHO, 2023). Nigeria continue to be one of the highest-burden nations, making a substantial contribution to the morbidity and death of malaria worldwide. environmental socioeconomic and health system factors contribute to the persistence of malaria transmission despite the availability of effective preventive and treatment strategies (*Clark* et al., 2008).

clinical suspicion and laboratory confirmation using microscopy, quick diagnostic tests or molecular techniques provide the foundation for the diagnosis malaria. (Rawat et al., 2021). According to The world health organization, any feverish patient in an endemic location should be suspected of having malaria, which should then be verified by parasitological testing *(*Dormont et al., 2021). insecticide-treated nets, indoor residual spraying, chemoprophylaxis and more recently RTS, S and R21 vaccination are examples of preventive measures (WHO, 2022).

Malaria continues to be a major reason for hospital admission and patients visits in Nasarawa state and throughout Nigeria. However, there is limited current hospital-based data regarding the temporal pattern and demographic distribution of malaria in various content. Systematic analysis of malaria record is required to direct local control initiatives at general hospital Toto, a significant referral site in the Toto local government. The purpose of this study is to:

1. Find out how often malaria is among patients who have reported to General Hospital Toto

2. Analyze the demographic of General Hospital malaria patients.
3. Analyze the demographics of General Hospital malaria patients

Previous studies have documented substantial variation in malaria burden by geography, age and socioeconomic status, some of which include;

In order to clarify the connection between albumin level and the severity of malaria, Suruda et al. (2024) carried out a thorough systematic review and meta-analysis. To find research looking at albumin level in malaria patients, a thorough literature search was carried out across several databases, including Embase, Scopus, PubMed, MEDLINE, Ovid, and Google Scholar, The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to. A random-effects model was used to pool the data, and I^2 statistics were used to evaluate heterogeneity. malaria patients had significant lower albumin levels than non-malaria controls, according to meta-analysis of 28 studies ($P < 0.001$), standardized mean differences [SMD] = −2.23, 95% CI − 3.25 to − 1.20, I^2: 98%, random effects model, 28 studies).

In 2024, Shilanthi and Rajita analyze cases of severe imported malaria. infection. by the Anti Malaria Campaign (AMC) of Sri Lanka`s national malaria database provided information on imported malaria cases that were recorded in the country between 2013 and 2023. The general characteristics and their health-seeking behavior of patient with severe malaria, as defined by the World Health Organization, were examined in case data and compare to those patients with uncomplicated malaria. the last three cases of severe malaria in 2023 are described in detail. Over the course of 11 years (2013–2023), 532 cases of malaria were reported; 46 (8.6%) of these cases had severe malaria, of which 45 were caused by Plasmodium falciparum and one Plasmodium vivax.

Lianyu and zhionyu 2024, looked into what influences malaria patients' treatment delays and how they seek medical attention. Bivariate and multivariable regression model were used to examined the medical records of 494 patients who had been diagnosed with malaria from six distinct malaria-endemic areas in China. The path taken by malaria victims seeking medical attention were shown using a Sankey diagram. Patients and physician delays were used to classify all therapy delays. 81.6%, of patients delayed seeking treatment for malaria, with patients accounting for 28.4% of these delayed and clinicians for 34.8%. One day was the median interval between the beginning of symptoms and the first medical consultation. The median interval between the first medical consultation and the definite diagnosis was two days.
In order to synthesize various ascorbic and level in malaria patients with varying degree of malaria severity and Plasmodium species, Manas et al., 2023 conducted a systematic review. The PROSPERO database (CRD42023394849). To find research on ascorbic acid and malaria, a thorough search of PubMed, Embase, MEDLINE, Ovid, Scopus, and Google Scholar was carried out. The random-effects model was used to compute the pooled standardized mean difference (Cohen's d) with 95% confidence intervals (CIs). Thirty papers were included for syntheses out of 1480 publications that were found through database searches. According to the meta-analysis, individual with malaria had lower ascorbic acid level than either uninfected controls or those without malaria ($p < 0.01$, Cohen's $d = -3.71$, 95% CI = −4.44 to −2.98, $I^2 = 98.87\%$, 30 studies).

II. MATERIALS AND METHODS

2.1 Research design

This study examines malaria cases that have been recorded at General Hospital Toto. Descriptive statistics, Chi square and Poisson regression model were applied to the data in order to accomplish the study`s goal. Data on malaria cases from General Hospital Toto`s administrative records were used in the study

2.2 Method of Data Collection

administrative records of General Hospital Toto, provided the secondary data used in this study. The dataset includes annual reports of malaria cases at General Hospital Toto from 2010 to 2024.

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2.3 Model Specification

2.3.1 Chi-square

The chi-squared test (χ^2 test) is a statistical hypothesis test used in this content to investigate the association or independence between instances of Malaria and certain categorical characteristics like Sex (male / female) and Age group. In particular, Pearson's chi-squared test. Is valid when the test statistic is chi-squared distributed under the null hypothesis. It is provided by:

$$X^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad \text{---------- (1)}$$

Where

O_{ij} = Actual number of malaria patients in category i

and j

E_{ij} = Number of malaria cases expected if malaria is

independent of the factors

r = Number of rows

c = Number of columns

The computed X^2 is compare with the critical value

using degree of freedom given as:

$$Df = (r-1)(c-1) \quad \text{---------- (2)}$$

Model Assumptions

1. Each observation is independent of the other
2. Data must be from random sampling
3. No significant outliers in the data
4. Expected frequency in each cell of the contingency table are at least 5
5. No empty cell in the contingency table with zero observation

2.3.2 Poisson Regression Model

a generalized linear model (GLM) called Poisson regression model is used to analyze count data in which the dependent variable is the frequency of an occurrence. Malaria cases counts are modeled in this content using the Poisson Regression model because the counts happen over time.

The Poisson regression model assumes that the response variable *Y* follows a Poisson distribution:

$$Y_i \sim \text{Poisson}(\lambda_i)$$

Where:

Y_i = number of malaria cases in time period *i*

λ_i = expected number of cases in time period *i*

The probability of observing y cases given predictors X is given by:

$$P(Y_i = y_i|X_i) = \frac{e^{-\lambda_i}\lambda_i{}^{y_i}}{y_i!} \quad \text{------- (3)}$$

The model for Poisson regression is described as:

$$log\lambda_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \cdots + \beta_p X_{ip}$$

---------- (4)

where:

λ_i= expected number of malaria case in a given

period or group

β_0 = intercept (log of expected malaria case when all

predictors are zero).

$\beta_0, \beta_1, \ldots \beta_p$ = regression coefficients (Effect of

predictors on malaria case).

X_{i1}, X_{i2}, ….X_{ip} = predictor variables (Age group,

sex).

To statistically model malaria cases and their corresponding years using Poisson regression model, it will be as thus:

$$\log(Malaria\ cases = \beta_0 + \beta_1(year) + e_i$$

(5)

Model Assumptions

1. The dependent variable *Y* must be a non-negative integer (0, 1, 2, ...).
2. The counts follow a Poisson distribution where:

$$P(Y = y) = \frac{e^{-\lambda}\lambda^y}{y!} \quad \text{---------- (6)}$$

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Where

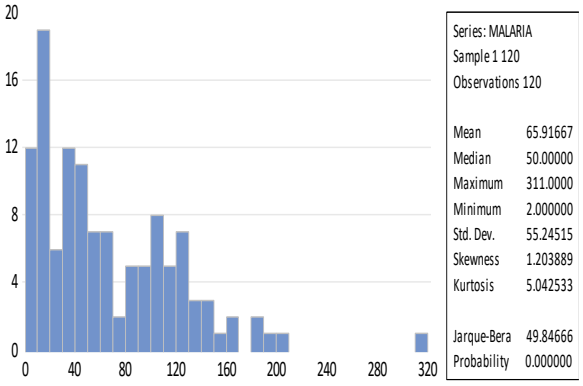
λ = expected count (mean and variance = λ).

3. The mean and variance of Y are equal $(E(Y) = Var(Y) = \lambda)$

4. The log of the expected count is a linear combination of predictors.

III. ANALYSIS AND RESULTS

Descriptive statistics



The Jarque-Bera normality test and descriptive statistics of the residuals of the malaria cases that were reported are displayed in Fig. 3.1 above. According to the figure general hospital Toto reported 66 malaria cases on average each year. The variable is not normally distributed according to Jargue-Bera finding (p-value=0.0001<0.05).

Table 3.1: Contingency table for observed frequencies (Male and Female)

Year	male	Female	Total
2010	33	16	49
2011	39	33	72
2012	27	18	45
2013	19	10	29
2014	32	15	47
2015	20	17	37
2016	16	10	26
2017	35	29	64
2018	20	12	32
2019	28	24	52
2020	35	15	40
2021	56	33	89
2022	42	35	57
2023	38	22	60
2024	53	20	73
Total	440	309	749

Table 3.2: Contingency table for observed frequencies (Age-group)

Year	Age-group							
	0-9	10-19	20-29	30-39	40-49	50-59	60+	Total
2010	0	6	10	15	6	5	7	49
2011	2	9	12	20	11	8	10	72
2012	5	7	8	13	8	4	2	45
2013	0	4	9	7	3	2	4	29
2014	3	7	7	13	9	3	4	47
2015	2	4	10	12	2	5	0	37
2016	1	4	9	8	1	2	1	26
2017	3	6	12	25	6	8	6	64
2018	2	1	4	11	6	5	3	32
2019	2	2	20	9	4	7	8	52
2020	3	2	10	11	5	5	3	40
2021	5	3	18	21	17	15	10	89
2022	8	5	12	9	10	9	7	57
2023	3	7	15	10	7	8	10	60
2024	5	3	9	21	12	10	13	73
Total	44	70	175	205	107	103	88	749

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Table 3.3. Malaria prevalence for Gender and Age-Group

Variable	Frequency (N= 749)	Percent (%)
Age group in years		
0 – 9	44	5.9
10 – 19	70	9.3
20 – 29	175	23.4
30-39	205	27.4
40-49	107	14.3
50-59	103	13.6
60 above	88	11.7
Gender		
Male	440	58.7
Female	309	41.3

Males accounted for almost 60% of cases, according to the above table. Adults between the ages of 20 and 39 accounted for 50.8% of all malaria cases, indicating higher exposure, while children between the ages of 0 and 9 had the fewest reported cases, possibly as a result of protective measures like bed nets and vaccinations.

Table 3.4: Chi-square output for gender

Gender	Value	F-statistic	Probability
Male	440		0.0004
Females	309		0.0000
Chi-Square		165.00	0.258

Interpretation
the chi-square results for gender are displayed in table 3.4. above, show. The findings show that gender and malaria cases do not significantly associate (p value = 0.258>0.05)

Table 4.5: Chi-square output Age-Group

Age-Group	Value	F-statistic	Probability
0-9	44		
10-19	70		
20-29	175		
30-39	205		
40-49	107		
50-59	103		
60 above	88		
Chi-square		107	0.412

Interpretation
the chi-square result for the Age-group is displayed in table 3.5. The findings show that Age-Group and malaria case do not significantly correlate (p value = 0.412>0.05)

Table 3.6 Poisson regression output

```
. poisson totalmalariacases year

Iteration 0:   log likelihood = -80.402183
Iteration 1:   log likelihood = -80.402183

Poisson regression                              Number of obs     =         15
                                                LR chi2(1)        =      11.74
                                                Prob > chi2       =     0.0006
Log likelihood = -80.402183                     Pseudo R2         =     0.0680

------------------------------------------------------------------------------
totalmalari~s |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
         year |   .0286083   .0083688     3.42   0.001     .0122059    .0450108
        _cons |  -53.76973   16.88427    -3.18   0.001    -86.8623    -20.67717
------------------------------------------------------------------------------
```

Interpretation
The results of the Poisson regression are displayed in table 3.6. above. The model is shown as follows in the output:

"$Malaria\ cases = -53.769 + 0.0286(year) + e_i$"

According to this model, there is a statistically significant (p-value = 0.04 < 0.05) rise in malaria cases of 3% for every extra year. Indicating that, the incidence of malaria at General Hospital Toto is on the rise (2010–2024).

REFERENCES

[1] Basu S, Sahi PK (July 2017). "Malaria: An Update". Indian Journal of Pediatrics. 84 (7): 521–

528. doi:10.1007/s12098-017-2332-2. PMID 28357581. S2CID 11461451

[2] Clark TD, Greenhouse B, Njama-Meya D, Nzarubara B, Maiteki-Sebuguzi C, Staedke SG, Seto E, Kamya MR, Rosenthal PJ, Dorsey G. Factors determining the heterogeneity of malaria incidence in children in Kampala, Uganda. J Infect Dis. 2008;198:393–400. doi: 10.1086/589778.

[3] Dahalan FA, Churcher TS, Windbichler N, Lawniczak MK (November 2019). "The male mosquito contribution towards malaria transmission: Mating influences the Anopheles female midgut transcriptome and increases female susceptibility to human malaria parasites". PLOSPathogens. 15 (11):e1008063. doi:10.1371/journal.ppat.1008063. PMC 6837289. PMID 31697788

[4] Dormont L, Mulatier M, Carrasco D, Cohuet A (May 2021). "Mosquito Attractants". Journal of Chemical Ecology. 47 (4–5): 351–393. Bibcode:2021JCEco..47..351D. doi:10.1007/s10886-021-01261-2. PMID 33725235.

[5] Lianyu and Zhionyu 2024: factors influencing treatment delays among malaria patients and their health-seeking behavior. Malaria journal. Vol 23 (3) 60-73 2024

[6] Manas K., htAongart M., and and Nsoh G., A., 2023: Malaria Is Associated with Diminished Levels of Ascorbic Acid: A Systematic Review and Meta-Analysis Antioxid. Redox Signal. 40, (12) 460–469.

[7] Rawat A, Roy M, Jyoti A, Kaushik S, Verma K, Srivastava VK (August 2021). "Cysteine proteases: Battling pathogenic parasitic protozoans with omnipresent enzymes". Microbiological Research. 249: 126784. doi:10.1016/j.micres.2021.126784. PMID 33989978. S2CID 234597200

[8] Shilanthi & Rajita 2024: An epimiological analysis of severe imported malaria infectionas in Sri Lanka. Malaria journals, vol 23 (7) 180-195 2024

[9] WHO (2023). World Malaria Report 2023. Switzerland: World Health Organization. ISBN 978-92-4-008617-3. Archived from the original on 2024-07-18. Retrieved 2024-07-22.

[10] World Health Organization. "Global Technical Strategy for Malaria 2016-2030" (PDF). Archived (PDF) from the original on 2024-02-22. Retrieved 2024-02-19.

[11] WHO. World malaria report 2022 (2022). https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022. Accessed 19 November 2023