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# Statistical Analysis on Diagnosed Cases of Malaria and Typhoid Fever in Enugu-Nigeria

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## Abstract

*This paper is a study on the diagnosed cases of Malaria and Typhoid using binary logistic regression, odds ratio, chi-square and traditional time series analysis. Malaria and typhoid are some of the most common fever-causing illnesses in developing countries. Malaria is caused by the Plasmodium parasites, transmitted through the bites of infected female Anopheles mosquitoes. Typhoid fever, on the other hand, is caused by the bacterium Salmonella Typhi transmitted through contaminated food and water. These illnesses typically present with flu-like symptoms such as fever, body aches, headaches, and fatigue. Malaria and typhoid disproportionately affect vulnerable populations such as children, pregnant women, and those living in impoverished areas with limited access to healthcare. Misdiagnosis and mismanagement can lead to severe complications such as cerebral malaria, kidney failure, and intestinal perforation in the case of typhoid. A sample of two hundred and forty-nine patients in Enugu was taken and data obtained were analysed using binary logistic regression. The data obtained are presented in tables and bar charts. The odds ratio, relative risk, chi-square statistic for test of independence of Malaria and Typhoid, trend are calculated.*

***Keywords—*** Endocarditis, Pyamia, Immunoglobulim G (IgG), Immunoglobulim M (IgM), Pyrogen, Septicemia, Salmonella typhi, Serologic assay, Widal test

## 1 Introduction

Fever (also known as pyrexia) is a human body temperature that is above the normal range of $36^oC - 37^oC$ (98-1000F). Fever is a sign rather than a disease; when a doctor has confirmed that there is an elevated body temperature, certain diagnostic tests maybe ordered, depending on other signs and symptoms that exist. These tests may include blood test, urine test, x-rays and other imaging scans.

Malaria and typhoid are some of the most common cause of febrile illnesses in developing countries. Malaria is caused by the Plasmodium parasites, transmitted through the bites of infected female Anopheles mosquitoes. Typhoid fever, on the other hand, is caused by the bacterium Salmonella Typhi, transmitted through contaminated food and water or close contact with infected samples or a person carrying the salmonella bacteria. These illnesses typically present with flu-like symptoms such as fever, body aches, headaches, and fatigue etc. Malaria and typhoid affect vulnerable populations such as infants, children under 5 years, pregnant women,people living with HIV or AIDS and those living in areas with limited access to healthcare and good water supply. Misdiagnosis and insufficient/ lack of treatment can lead to severe complications such as cerebral malaria, kidney failure, and intestinal perforation in the case of typhoid.

Prompt and accurate diagnosis through clinical diagnosis,laboratory testing, followed by appropriate treatment with anti-malarial drugs or antibiotics, is crucial in reducing morbidity and mortality associated with these diseases. Preventive measures such as avoiding mosquito bites through use of insecticide treated nets, good environmental sanitation and practicing food and water safety, use of malaria prophylaxis can also significantly reduce the incidence of malaria and typhoid. Despite the availability of effective prevention and treatment options, malaria and typhoid fever continue to pose a significant health burden in many developing countries, highlighting the need for continued investment in public health infrastructure and education.

Malaria is a life-threatening disease that is typically transmitted through the bites of an infected female Anopheles mosquito. Once the parasites are inside the body, they migrate to the blood streams and begin to infect red blood cells. In Africa, malaria is estimated to result in losses of 12billions US dollars a year due to increase healthcare costs and negative effects on tourism, World Health Organization (W.H.O), (2012).

The first symptom of malaria will surface which is known as fever. The fever moves in cycles as the parasite destroy one group of blood cell after another. Cerebral malaria is the most dreaded complication of this malaria infection, and is unique to plasmodium falciparum. Cerebral malaria is caused due to damage of endothelium of the vessels by parasitic sequestration and leakage which results in low oxygen level in the brain(hypoxia), Newman [1]. Moreover, malaria is typically diagnosed by the microscopic examination of blood using blood films or with antigen-based rapid diagnostic test. The risk of the disease can be reduced by preventing mosquito bites through the use of mosquito nets and insect repellents, or with mosquito control measures such as spraying insecticides and draining standing water. Despite the need, no effective vaccine exists, although efforts to develop one or more are ongoing. The recommended treatment for uncomplicated malaria is an artemisinin-based combination therapy(ACT) that include artemether-lumefantrine while effective treatment of complicated malaria is with quinine.

Typhoid fever, also known as enteric fever, is a potentially fatal multi-systemic illness. It is caused majorly by salmonella enterica serotype typhi and minorly by S.enterica serotypes paratypi A,B,C which grows in the intestines and blood. The protean manifestation of typhoid fever makes this disease a time diagnostic challenge. The classical symptoms include: fever, malaise, diffuse abdominal pain and constipation. Salmonella typhi has been a major human pathogen for thousands of years, thriving in conditions of poor sanitation, crowding and social chaos. The name salmonella typhi is derived from the Ancient Greek Typhos, an ethereal smoke or cloud that has believed to cause disease and long lasting neuropsychiatric complications. The widal test was developed in 1896 and named after Georges Fernand Widal, who introduced it as a presumptive serological test for enteric fever whereby bacteria causing typhoid fever are mixed with a serum containing specific antibodies obtained from an infected individual. The widal test is unreliable but is widely used in developing countries because of its low cost. Chloramphemcol was the original drug of choice for many years, but has been replaced by other effective antibiotics like Azithromycin The bacterial genus salmonella are highly contagious; the organism can be transferred from person to person; directly via saliva, fecal/oral spread and indirect contact like using contaminated eating utensils, eating food or drinking water contaminated with the feces of an infected person. In addition, a number of salmonella species can be transmitted from animals like snakes, turtles, chicken, cats and dogs. Malaria and typhoid fever remain the disease of major public health importance and cause of morbidity and mortality in tropical Africa and developing countries as well. Both febrile illnesses are common in many countries of the world where the prevailing environmental conditions of humid climate, poor sanitary habits, poverty and ignorance exist. These two diseases have been associated with poverty and under development.There is a popular belief that both typhoid fever and malaria are “Endemics” and quite prevalent. Individuals, who fail to respond to the first and second line of malaria treatment usually, suspect typhoid fever. Typhoid fever is a fever mainly associated with low-economic status and poor hygiene, with human beings being the only known natural hosts and reservoir of infection, Bhan et al [2]. Bhutta [3] noted that there are approximately 21.5 million infections and 200,000 deaths from typhoid fever globally each year. Graham et al [4] concluded that the prevalence of different pathogen found in sick children presenting to heath facilities in Africa has increased on the profile of non-typhoidal salmonella infections. Omoya [5] noted that salmonella typhi is a human restricted parasite, this chronic carrier become the crucial reservoir, which can persist for decade. Buckle et al [6] opined that the study of typhi is associated with a large outbreak and a carrier at the genome level which provides new insight into the pathogenesis of the pathogen. An association between malaria and typhoid fever was first described in the medical literature in the middle of the 19th century, which was named typho malaria fever by the United States Army, Johan [7]. In the last 20 years, the relationship between malaria and salmonellae has been confirmed by additional studies from Africa that largely describe a higher incidence of non-typhoidal salmonella bacteraemia among patients with malaria parasitaemia, Ammah et al [8]. Mweu and English [9] noted that cross-reactions of typhomalarial fever can occur as a consequence of latent and post-infectious diseases prevalent in this followings: Tuberculosis, pneumonia, amoebiasis and chronic active hepatitis. In some places, there appears to be more typhoid fever cases in area of drug resistant, malaria and a cross-reaction between malaria parasites and salmonella antigens may cause false positive widal agglutination test, Mbuh et al [10]. Heggenhougen et al [11] malaria and other infectious diseases can be studied from a biological, ecological or socio-cultural point of view. Historically, malaria was not confirmed to “tropical” climates. It disappeared from the United States and northern Europe largely as a result of changes in human behavior, and only a small part of the decline was the result of direct primary health intervention, Brown [12].

Pruss-Ustun [13] concluded that typhoid fever remains a significant health burden, especially in low and middle income countries. However, malaria has been recognized as the second most universal disease treated at clinic and one of the most major contributors to infant mortality, Skarbinski [14]. Nwaneri et al [15] showed that most children (76.6%) with suspected malaria received home-based management before presenting to the hospital; and concluded that majority of the under-fives received inappropriate home-based treatment of malaria. Wanzira et al [16] concluded that increasing malaria parasite prevalence among children less than five years is still related to increasing age and severity of anemia even in the context of decreasing malaria prevalence. Anyanwu et al [17] explained that income level and type of settlement, as structural factors, affect the decision on where to seek malaria treatment and whether or not a malaria diagnostic test will be used prior to treatment. Thus, one of the dangers of using mixed anti-malaria drugs can offers a safe route for the sales of explored and fake anti-malaria drugs. Killeen [18] concluded that improved housing has the potential to reduced malaria transmission nearly as much as insecticidal bed nets, with potential additional benefits such as control of other mosquito-borne illnesses and overall improvements in well beings. Ferrao et al [19] , in a study, stated that the average malaria mortality by gender was 44.9% for females and 35.1% for males with the total of 944malaria death cases which was registered in china. Zomorrodi and Attia [20] stated that it is important to educate health care worker about thermometry, the pathophysiology of fever, the distribution between hyperthermia and fever, and safe evidence-based treatment strategies. Thus, informed practitioner will in turn be better equipped to educate patients. Gasem et al [21] recommended that improvement of the living conditions, better hygiene, regular inspection of the street food vendors and health education aimed at hygienic food handling is needed to achieve a decrease in the incidence of typhoid fever. Snehanshu et al [22] in the research, the result was subjected to chi-square test to determine if the relationships between the malaria parasite infection and salmonella typhi are actually significant and the result indicated that 36 (18%) of the total population were positive for malaria parasites. This further indicated that 17 (47.22%) out of 36 malaria positive samples, were also positive for salmonella typhi infections using widal agglutination test. Pradhan [23] concluded that a proper protocol is required to diagnose and treat the co-infection. Malaria and typhoid co-infection remain a threat to many people in many developing countries, like India, Pakistan e.t.c. Ekesiobi et al [24] explained that malaria and typhoid fever are distinguishable regarding their clinical signs and symptoms and there are some overlaps in their pathology, plasmodium and salmonella are not of all same phylum, cannot share antigens nor have same method of transmission. Orok et al [25] explained that the incidence of typhoid fever and malaria co-infection could be reduced to minimal if diagnose of typhoid fever by cultural method is emphasized in our clinical hospital laboratories. This will also improve patient management by cutting down cost of treatment and eliminate other risks associated with misuse of antibiotic. Anyanwu et al [17] concluded that socio-economic factors are major variables in determining behaviors and practices in malaria treatment. Most of the anti-malarial drug use behaviors that can promote resistance. Birhanie et al [26] in a study concluded that malaria was the most prevalent disease among febrile patients. There was a substantial result discrepancy among widal test and blood culture for the diagnosis of typhoid fever. Poor hand washing habit was significantly associated with typhoid fever. Ndip et al [27] opined that the circulation of infections of different etiologies with similar differential clinical diagnosis and their implication in disease course remain a major concern especially in developing tropical countries where factors (such as vectors and poverty) that enhance their spread abound. Ukibe et al [28] concluded that malaria and its co-infection with typhoid are responsible for most of the adverse pregnancy outcome in the study area and recommended that the use of insecticide treated bed nets (ITNs), environmental sanitation and provision of basic amenities including portable water will go a long way to reverse this trend. Whitty et al [29] pointed out that the symptoms and signs of malaria are non-specific and overlap with many other common infection. Prothero [30] explained that morbidity and mortality resulting from malaria have considerable economic effects. The effects of malaria are greatest among the poorest people who face direct economic costs (reduced income, lost productivity, expenses for treatment) and social costs affecting household behavior (demographic, educational). Orish et al [31] in a study, pointed out that age-specific discrepancy in decreasing malaria prevalence observed is consistent with several studies that showed peak malaria prevalence with morbidity and mortality in younger children, especially those younger than one year of age in areas of high malaria transmission. Maltha et al [32] opined that the relative proportions of severe malaria and invasion bacterial infections in febrile and/or severally ill children differed dramatically according to the seasons as well as the bacterial pathogens isolated, with a peak of severe malaria during the rainy season and a relative increase of invasion bacterial injections (mainly due to National Testing Service (NTS)) shortly thereafter.

Other interesting publications by the lead author include ( [33], [34], [35], [36], [37], [38], [39], [40] and [41]).

The rest of this paper is organized as follows; in section two, the methods of data analysis are presented. In section three, we analyse and discuss the results. The concluding remark is in section four.

## 2 Methodology

Binary logistic regression is a statistical technique used to model the relationship between a binary response variable and a numerical (or categorical) predictor variable. If we let $\pi(y) = 1; (x_1, x_2, ..., x_p) = \pi(\underline{x})$ represent the probability of "success" or the outcome of interest, for a given set of $p$ independent variables, then the logit model can be written as

$$logit\left[\pi(\underline{x})\right] = \ln\left(\frac{\pi(x)}{1-\pi(\underline{x})}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \tag{1}$$

$$\pi(\underline{x}) = \frac{e^{\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_p x_p}}{1+e^{\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_p x_p}} = \frac{1}{1+e^{-(\alpha+\beta_1 x_1+\beta_2 x_2+...+\beta_p x_p)}} \tag{2}$$

Suppose that the $i^{th}$ independent variables $x_i$ has $k_i$ levels. The $k_i - 1$ dummy variables will be denoted as $D_{ij}$ and the coefficients for these dummy variables will be denoted as $B_{ij}; i = 1, 2, ..., p; j = 1, 2, ..., k_i - 1$. Thus the logit for a model with $p$ variables and the $i^{th}$ variable being discrete would be

$$\hat{y} = \beta_0 + \beta_1 x_1 + ... + \sum_{j=1}^{k_i-1} \beta_{ij} D_{ij} + \beta_p x_p \tag{3}$$

where

- $\hat{y}$ represent Typhoid fever
- $\beta_0$ is the intercept
- $x_1$ represents gender
- $x_2$ is the age

- $D_{ij}$ represent levels of Malaria parasite

To test the significance of the coefficients involves formulation and testing of a statistical hypothesis to determine whether the independent variables in the model are significantly related to the outcome variable. Thus, the likelihood ratio test is to be used for hypothesis testing purposes.

$$D = -2\sum\left[y_i\ln\left(\frac{\hat{\pi}_i}{y_i}\right)+(1-y_i)\ln\left(\frac{1-\hat{\pi}_i}{1-y_i}\right)\right] \tag{4}$$

The confidence interval estimators for the slope and intercept are based on their respective Wald tests. The endpoints of a $100(1-\alpha)$ % CI for the slope coefficient are $\beta_1 \pm Z_{1-\frac{\alpha}{2}}\hat{SE}(\beta_1)$ and for the intercept $\beta_0 \pm Z_{1-\frac{\alpha}{2}}\hat{SE}(\beta_0)$

O'connel [42] posited that to examine the impact on the odds of an independent variable, the first step is to construct the odds ratio (OR). Odds ratio is a measure of association between event A and event B in a given population, that is, OR is the ratio of odds of A to odds of B. Meanwhile, the odds of an event is defined as the ratio of the likelihood (or frequency) of its occurrence to the likelihood (or frequency) of its nonoccurrence. Thus, odds ratio is written as;

$$OR = \frac{odds(A)}{odds(B)} \tag{5}$$

The odds ratio (OR) compares these two odds and provides a measure of the association. Statistical significance of an OR is typically assessed by testing the significance of the regression coefficient. Either use a Wald test or likelihood ratio test. Alternatively, Zaiontz C. (2015) stated that the odds ratio between two data elements in the sample is defined as follows

$$OR_{x_ix_j} = \frac{odds(x_{i1},...,x_{ik})}{odds(x_{j1},...,x_{jk})} = \frac{e^{b_0+\sum_{m=1}^{k} b_m x_{im}}}{e^{b_0+\sum_{m=1}^{k} b_m x_{jm}}} = e^{\sum_{m=1}^{k} b_j(x_{im}-x_{jm})} \tag{6}$$

A Risk is an exposure of an individual that increases the likelihood of developing a disease or damage or injury etc. Chittaranjan [43] explained that relative risk of an event is the likelihood of its occurrence after exposure to a risk variable as compared with the likelihood of its occurrence in the control. Therefore, the Relative Risk (RR) of contracting an infection is given as

$$RR = \frac{OR}{(1-p_0)+(p_0\times OR)} = \frac{Risk\quad of\quad events\quad in\quad the\quad treatment\quad group}{Risk\quad of\quad events\quad in\quad the\quad control\quad group} \tag{7}$$

where

- $OR = \frac{\frac{p_0}{1-p_1}}{\frac{p_0}{1-p_0}} = \frac{p_1}{p_0}$
- $p_0$ is the incidence of the outcome of interest in the non-exposed.
- $p_1$ is the incidence of the outcome of interest in the exposed group

The Chi-square test of independence is used to determine if there is a significant relationship between two or more nominal (or categorical) variables. The expected cell frequency is given by

$$E_{ij} = \frac{X_{i.}X_{.j}}{n} = \frac{(row\quad total)\times(column\quad total)}{sample\quad size}$$

The hypothesis is;
$H_0$ : there is no significant difference between the categorical variables
$H_1$ : there is a significant difference between the categorical variables. The test statistic for testing the independence hypothesis is

$$\chi^2 = \frac{\sum_{j=1}^{c}\sum_{i=1}^{r}\left(X_{ij}-E(X_{ij})\right)^2}{E(X_{ij})} \tag{8}$$

Which has approximately a $\chi^2$ distribution with $v=(r-1)(c-1)$ degrees of freedom; where $r$ is the number of rows and $c$ is the number of columns in the contingency table. Decision rule states that the null hypothesis is rejected if

- $\chi^2 > \chi_v^2$ using the rejection region approach.
- $p-value < \alpha$ where $p-value = P(\chi_v^2 > \chi)$ using the $p-value$ approach.

The trend is the component of a time series that represents variations of low frequency in a time series, the high and medium frequency fluctuations having been filtered out. The least square method is a method used in fitting trend line to a time series. The linear trend equation is given as

$$\hat{Y}_t = \hat{\alpha} + \hat{\beta}t \tag{9}$$

where

- $\hat{Y}_t$ the estimated trend line value for a given time period ($t$)
- $\hat{\alpha}$ is the trend line value when $t = 0$
- $\hat{\beta}$ is the gradient or slope of the trend line.
- $t$ is the time unit

## 3 Analysis and Discussion of Results

The data set in table 1 below represent diagnosed cases of Malaria and Typhoid fever among 275 patients at the Caritas University Medical Centre Enugu, Nigeria over a selected period of time. The complete data set is available on request from the authors.

**Table 1:** Diagnosed cases of Malaria and Typhoid fever

| s/n | sex | age | mild infection | moderation infection | severe infection | Salmonella typhi | Month/Year |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 16 | 1 | 0 | 0 | negative | September |
| 2 | 0 | 21 | 0 | 1 | 0 | positive | September |
| 3 | 0 | 26 | 0 | 1 | 0 | positive | September |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 273 | 0 | 19 | 0 | 0 | 1 | - | February |
| 274 | 0 | 18 | 0 | 1 | 0 | - | February |
| 275 | 1 | 27 | 0 | 1 | 0 | Negative | March |

Tables ( 2- 6) are the contingency tables extracted from the complete table of table 1.

**Table 2:** Distribution of Malaria Infection by Gender

| Gender | Malaria | | | Total |
|---|---|---|---|---|
| | Mild Infection | Moderate Infection | Severe Infection | |
| Male | 36 | 32 | 38 | 106 |
| Female | 56 | 47 | 40 | 143 |
| Total | 92 | 79 | 78 | 239 |

**Table 3:** Distribution of Malaria Infection by Age

| Age | Malaria | | | Total |
|---|---|---|---|---|
| | Mild Infection | Moderate Infection | Severe Infection | |
| $< 18$ | 8 | 2 | 4 | 14 |
| $\geq 18$ | 84 | 77 | 74 | 235 |
| Total | 92 | 79 | 78 | 249 |

**Table 4:** Distribution of Typhoid Fever by Gender

| Gender | Typhoid Fever | | Total |
|---|---|---|---|
| | Positive | Negative | |
| Male | 33 | 71 | 104 |
| Female | 50 | 85 | 135 |
| Total | 83 | 156 | 249 |

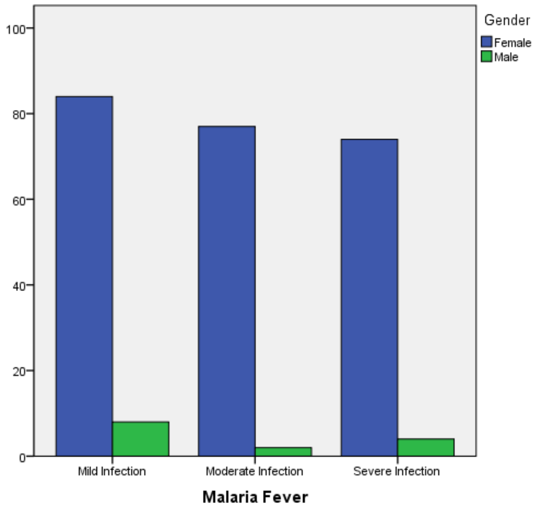
**Table 5:** Distribution of Typhoid Fever by Age

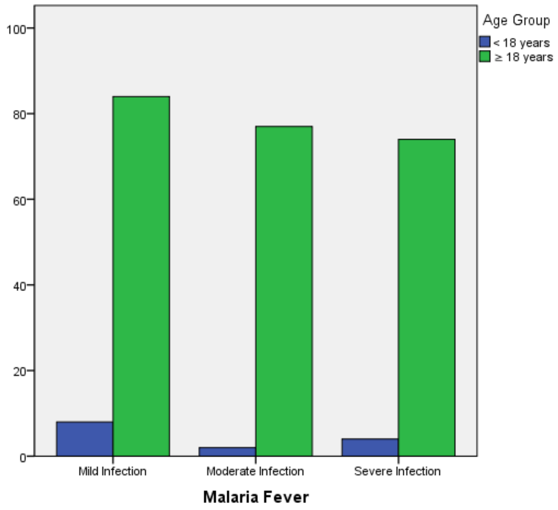
| Age | Typhoid Fever | | Total |
|---|---|---|---|
| | Positive | Negative | |
| $< 18$ | 2 | 11 | 13 |
| $\geq 18$ | 145 | 81 | 226 |
| Total | 147 | 92 | 239 |

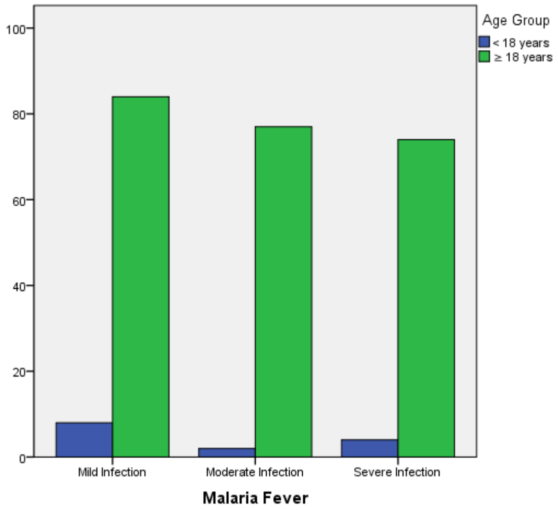
**Table 6:** Distribution of Typhoid Fever and Malaria Infections

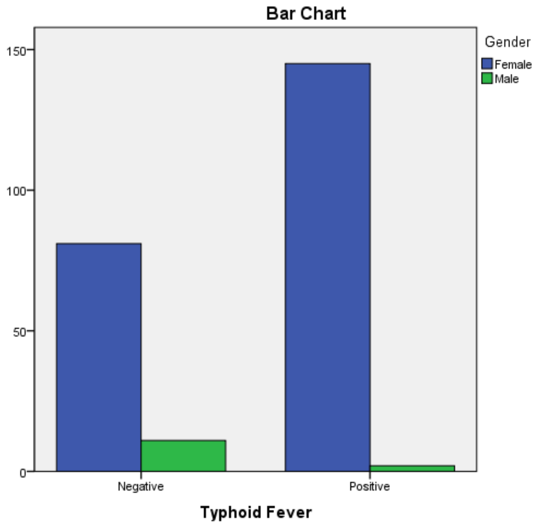
| Typhoid Fever | Malaria | | | Total |
|---|---|---|---|---|
| | Mild Infection | Moderate Infection | Severe Infection | |
| Positive | 17 | 26 | 31 | 74 |
| Negative | 57 | 43 | 39 | 139 |
| Total | 74 | 69 | 70 | 213 |

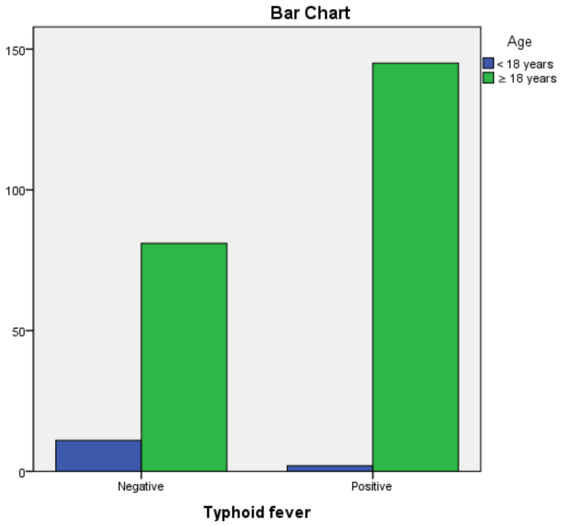
The bar charts are to enable descriptive insight of the contingency tables.

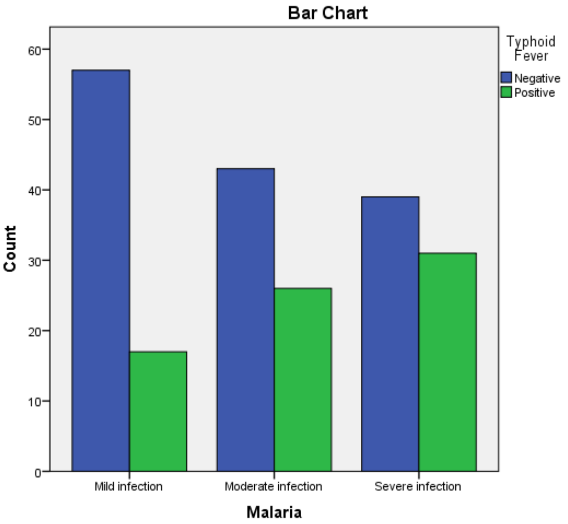












The dummy variables logistic regression model for typhoid fever was estimated in three models due to the two dummy variables that occurred in the levels of malaria

$$\hat{y} = -2.443 + 0.429 \times gender_{(1)} + 0.029 \times age_{(1)} + 1.005 \times mild-infection_{(1)} + 0.315 \times moderate-infection_{(1)} \quad \text{(Model I)}$$

The male patients are 65.15% more likely to be infected by typhoid fever than the female and those 18 years and older are also 97.2 % more likely to be infected.

$$\hat{y} = -1.758 + 0.439 \times gender_{(1)} + 0.029 \times age_{(1)} + 0.665 \times mild-infection_{(1)} - 0.370 \times severe-infection_{(1)} \quad \text{(Model II)}$$

From the result, mild infection as compared to moderate infection increases the incidence of typhoid fever but severe infection does not and both of them are statistically not significant. The male patients are 64.5% more likely to be infected by typhoid fever than the female and those 18 years and older are also more likely to be infected by 97.2%.

$$\hat{y} = -1.482 + 0.441 \times gender_{(1)} + 0.028 \times age_{(1)} - 0.982 \times severe-infection_{(1)} - 0.625 \times moderate-infection_{(1)} \quad \text{(Model III)}$$

From the result, both moderate and severe infections as compared to mild infection decrease the incidence of typhoid fever; meanwhile severe infection is statistically significant but moderate infection is not. The male patients are 64.4% more likely to be infected by typhoid fever than the female and those 18 years and older are also 97.2% more likely to be infected than those below 18 years.

The $R^2 = 88\%$; this is the proportion of total variability in Typhoid fever that is accounted for by the independent variables namely gender, age and malaria infection (mild, moderate and severe). This indicates that the model is good. The confident interval for the coefficients gender is $(0.846, 2.847)$, for age is $(0.935, 1.132)$, for mild infection is $(0.234, 11.058)$, for moderate infection is $(0.128, 5.269)$ and for severe infection is $(0.089, 3.701)$.

The Chi-square test results show that there is a significant association between Typhoid fever and gender, and also for Typhoid fever and age since $p-value < 0.05$. The test also shows that there is no significant association between malaria and gender, also for malaria and age since $p-value > 0.05$. The result from the test also shows that there is a significant association between Malaria and Typhoid since $p-value < 0.05$.

The analysis using odds ratio resulted thus: For every 100 persons suffering from malaria fever (mild infection), there are approximately 64 males less likely to be infected, also for every 100 persons suffering from malaria fever (severe infection), there are approximately 5 males less likely to be infected.

The risk of being infected by Typhoid fever is less likely in males than in females, that is, the males are 79% free from being infected by Typhoid fever. The risk of having Typhoid fever is more likely in patients aged 18 or above by 89.84% than in patients less than 18 years

The trend line from the time series analysis for the incidence of common fevers monthly is

$$\left.\begin{aligned} \hat{y}_t &= 2.985 + 0.028 \times Malaria \\ \hat{y}_t &= 1.697 - 0.094 \times Typhoid \end{aligned}\right\} \quad (10)$$

There is a significant association between Typhoid fever and gender, and also for Typhoid fever and age. Also, there is no significant association between Malaria and gender, and Malaria and age. In addition, there is a significant association between malaria and Typhoid fever. More so, male patients are less likely to be infected with malaria fever (both for mild, moderate and severe infection) than the females. Furthermore, the risk of being infected by Typhoid fever is less likely in males than in females; and the risk of having Typhoid fever is more likely in patients aged 18 or more than in patients less than 18 years. Finally, the time series analysis showed that the incidence of malaria and typhoid fever in relation to month has a linear relationship. Based on the results from data analysis, malaria (mild, moderate and severe infection) affects typhoid fever positively in addition to age and gender; but malaria is actually independent of age and gender.

# 4 Conclusion

This work considers the occurrence of common fevers in school environment. All the independent variables in the model are significant except the moderate infection. For the dummy variable logistic regression: mild and moderate infections as compared to severe infection increases the incidence of typhoid fever though mild infection has more effect; also mild infection as compared to moderate infection increases the incidence of typhoid fever but severe infection does not; and moderate infection as compared to mild infection increases the incidence of typhoid fever but severe infection does not. Also male patients are more likely to be infected by typhoid fever than the female and those 18 years and older are also more likely to be infected. There is a significant association between Typhoid fever and gender, and also for Typhoid fever and age. Also, there is no significant association between Malaria and gender, and Malaria and age. In addition, there is a significant association between malaria and Typhoid fever. This means that there are likelihood that Malaria patients have typhoid fever. More so, male patients are less likely to be infected with malaria fever (both for mild, moderate and severe infection) than the females. Furthermore, the risk of being infected by Typhoid fever is less likely in males than in females; and the risk of having Typhoid fever is more likely in patients aged 18 or more than in patients less than 18 years. Finally, the time series analysis showed that the incidence of malaria and typhoid fever in relation to month has a linear relationship.

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