



## Malaria Attributable Fraction and some of its Predisposing Factors

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### Abstract

*Malaria parasites occur in endemic areas such as the detection of parasites in a blood film from a febrile individual does not necessarily indicate clinical malaria, the fraction that has malaria symptoms and is attributable to malaria has been a major concern especially when symptomatic patients presume that they have malaria before confirming from laboratory test. The aim of the study is to determine the proportion of the patients that actually has malaria among the symptomatic patients. The objectives are to determine the predisposing factors that will tell us if a patient has malaria before laboratory test and a model that is clinically interpretable to describe the relationship between an outcome (malaria or no malaria) and a set of independent variables. As a result of high rate of malaria cases, there is a need to conduct research on factors influencing malaria. Logistic regression was used to analyse the secondary data collected from University of Ilorin Clinic from 1<sup>st</sup> January, 2015 to 30<sup>th</sup> June, 2015. The attributable fraction for malaria was 49.2% and 50.8% was attributable to other diseases though they have identical symptoms. Males are 2.899 times likely to have malaria than females even after controlling for genotype. Patients of AA are 4.212 times likely to have malaria than the SS patients, patients of AS are 3.991 times likely to have malaria than the SS patients.*

**Keywords:** *Malaria; parasites; febrile; clinical; attributable fraction.*

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### 1.0 INTRODUCTION

Attributable fraction is the fraction that has the diseases. Malaria is caused by infection with protozoan that belongs to the genus Plasmodium transmitted by female Anopheles species mosquitoes. High malaria transmission occurs majorly in Africa south of the Sahara, where *P.falciparum* predominates and causes an estimated 90% of the deaths attributable to

malaria worldwide. High transmission also occurs in other areas of the world (e.g. Papua New Guinea), however, not all endemic areas in Africa south of the Sahara are characterized by high rates of transmission. In 1999, it was estimated that there were some 261 million cases of malaria in areas with high transmission (WHO). Microscopic diagnosis, the established method for laboratory confirmation of malaria,

presents technical and personnel requirements that often cannot be met, particularly facilities at the periphery of the health care system. Delays in the provision of the microscopy results to the clinician means that decisions on treatment can be taken without the benefit of the results. In this study, an attempt was made to know the fraction of the patients that complained about malaria and actually have malaria. Malaria is an intermittent and remittent fever which invades the red blood cells and can be transmitted by mosquitoes in many tropical and subtropical regions.

**2.0 MATERIALS AND METHODS**

**2.1 Data Collection and Modelling**

The secondary data were collected from University of Ilorin Clinic from 1<sup>st</sup> January, 2015 to 30<sup>th</sup> June, 2015 and was limited to patients that complained about malaria in which their blood samples were collected and tested in the laboratory at the University Clinic from 1<sup>st</sup>

**2.3 Confidence Bound for the Attributable Fraction for Malaria**

The 95% confidence bound attributable to malaria is defined as

$$AF \pm Z_{1-\alpha/2} se(AF)$$

$$AF \pm Z_{1-\alpha/2} \sqrt{\frac{AF(1 - AF)}{n}}$$

$$0.492 \pm 1.96 \sqrt{\frac{0.492(1-0.492)}{199}}$$

$$0.492 \pm 0.0354$$

$$(0.4566, 0.5274)$$

**Interpretation:** We were 95% confident that the attributable fraction for malaria lies between 45.66% and 52.74%.

**3.0 RESULTS**

The Nagelkerke R Square was 22.3% and showed a moderately strong relationship between the predictors and the prediction. The table 2 also showed that the males have a higher chance of having malaria than their female's

January, 2014 to 30<sup>th</sup> June, 2015. Binary logistic regression was used to model the data, confidence bound was computed for the attributable fraction due to malaria, the Chi-Square test of independence was used to check if the categorical variables that would be included in the model were significant while independent t-test was also used to check if the continuous variables were significant. The variables that were significant were included in the binary logistic regression analysis.

**2.2 Participants and Procedures**

The majority of the patients were undergraduate students of the University of Ilorin, Ilorin Nigeria. The data used were restricted to patients who presumed that they have malaria and requested for malaria treatment. Consequently, the patients were tested in the laboratory to know the actual sickness.

counterpart. The attributable fraction for malaria was 49.2% with 95% confidence interval of 45.66% to 53.74%. The patients with genotype AA were 4.212 times likely to have malaria than patients with SS.

Binary Logistic Regression

Table 1. Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
	239.334 <sup>a</sup>	0.168	0.223

The analysis also showed that 16.8% of the variation of patients who had any disease was explained by the logistic model, there were other factors influencing whether the patients would have malaria or related diseases with similar symptoms.

Table 2. Variables in the Equation

	B	S.E.	Wald	Df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
							Lower	Upper
Step 1 <sup>a</sup> gender(1)	1.064	0.316	11.346	1	0.001	2.899	1.560	5.385
Genotype			19.656	2	0.000			
Genotype(1)	1.384	1.445	.918	1	0.338	3.991	0.235	67.740
Genotype(2)	1.438	0.325	19.551	1	0.000	4.212	2.227	7.966
Constant	-1.384	0.296	21.925	1	0.000	.251		

a. Variable(s) entered on step 1: gender, Genotype.

The effect of gender (1) which represented male was significant and positive. The odds ratio showed that males were 2.899 times likely to have malaria than females even after controlling for genotype. The overall association between the outcome and genotype remains highly significant, as indicated by the overall Wald statistic of 19.655. The genotype (2) which was AA genotype was a significant predictor of the outcome.

### 3.1 Participants Characteristics

The majority of the patients were females, singles and genotype AA. Most of the patient’s symptoms were attributed to high fever while the least symptoms were attributed to diarrhea. Majority of the patients complained about malaria because of the symptoms they exhibited.

### 3.2 Descriptive Statistics

In this study, 5% of the patients were below 16 years, 61.3% were between 16 years to 30 years and 33.3% were above 30 years. About 44.2% of the patients were males and 55.8% were females. 65.8% of the patients were single, 33.2% of the patients were married and 1% was widow or widower. 1% of patients was SS, 59.3% were AA and 39.7% were AS. The attributable fraction for malaria was 49.2%, the attributable fraction for measles was 14.6%, the attributable fraction for typhoid fever was 17.6%, the attributable fraction for cholera was 8.5%, the attributable fraction for tuberculosis was 4% and the attributable fraction for other diseases was 6%.

### 3.3 Binary Logistic Regression

Assumptions of Logistic Regression:

- It does not assume a linear relationship between dependent and independent variables.
- The dependent variable must be a dichotomy (2 categories)
- The independent variables need not be interval, normally distributed, nor linearly related, nor of equal variance within each group.
- The categories must be mutually exclusive and exhaustive.
- The larger samples are needed than for linear regression since the maximum likelihood coefficients are large sample estimates.

The logistic regression is  $\text{logit}(p) =$

$$\log \left[ \frac{p}{1-p} \right]$$

Where p ranges from 0 to 1.

Logit(p) scale ranges from  $-\infty$  to  $+\infty$  and is symmetrical around the logit of 0.5 which is zero.

The form of the logistic regression is

$$\text{Logit} [p(x)] = \log \left[ \left( \frac{p(x)}{1-p(x)} \right) \right] = a + b_1x_1 + b_2x_2 + b_3x_3 + \dots$$

This equation looks like a linear regression but is different and a logistic regression finds a best fitting equation just like linear regression. Logistic regression uses a maximum likelihood which maximizes the probability of getting the observed the fitted regression coefficients. A

consequence of this is that the goodness of fit and overall significant statistics used in the logistic regression is different from those used in linear regression.

P can be calculated with the formula

$$p = \frac{\exp(a + b_1x_1 + b_2x_2 + b_3x_3 + \dots)}{1 + \exp(a + b_1x_1 + b_2x_2 + b_3x_3 + \dots)}$$

Where p = probability that a case is in a particular category.

Exp = the base of natural logarithm

a=the constant of the equation

b=the coefficient of the predictor variable.

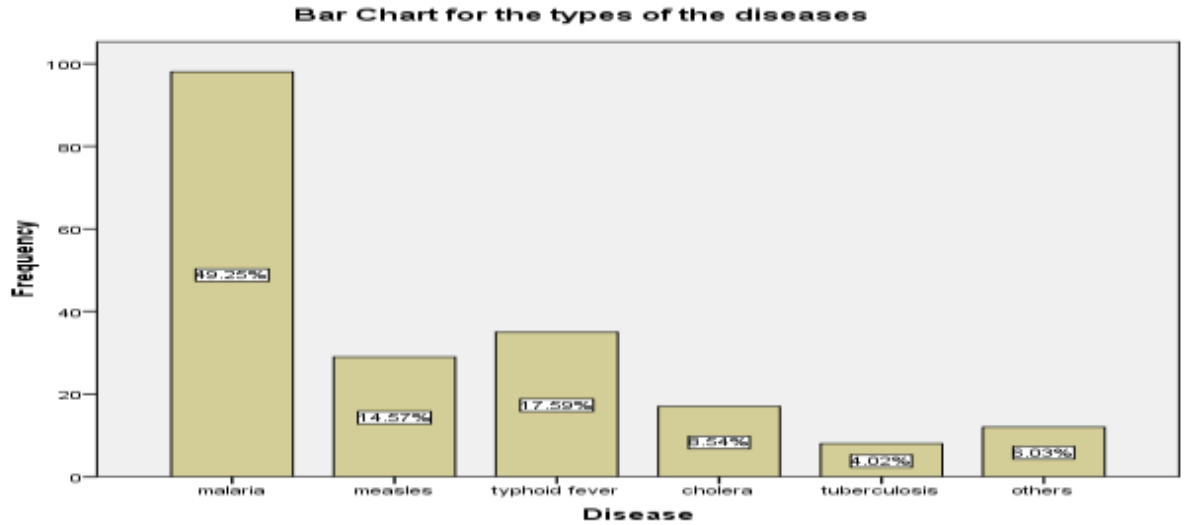


Figure 1: Bar Chart for the types of diseases.

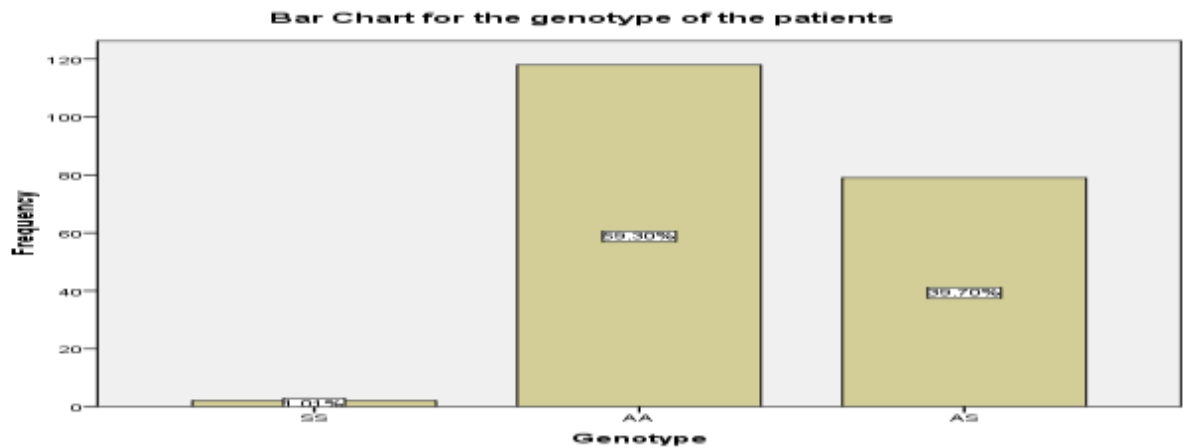


Figure 2: Bar Chart for the genotype of the patients.

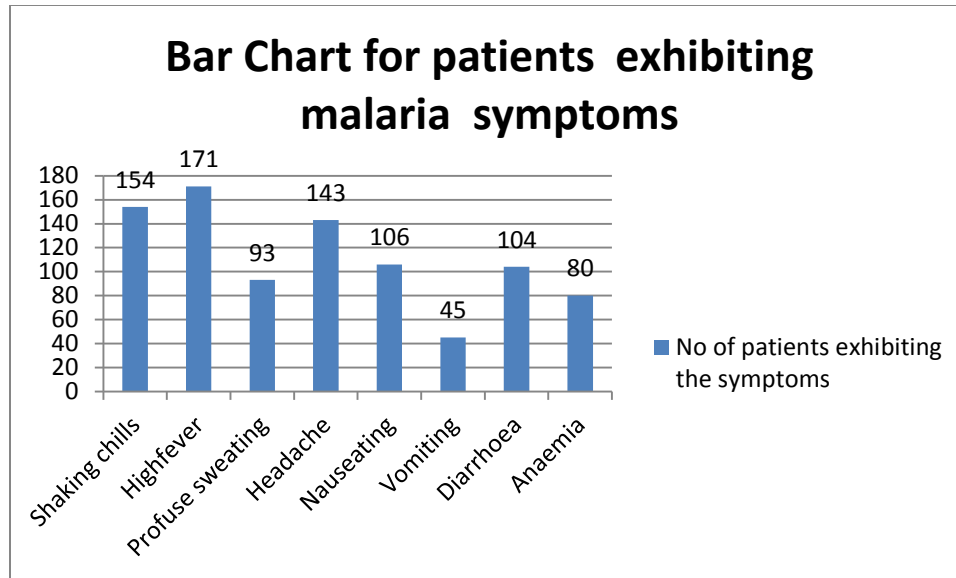


Figure 3: Bar Chart for patients exhibiting malaria symptoms.

#### 4.0 DISCUSSION

In this study, the proportion of malaria cases attributable to malaria was 49.2% (95% CI 45.66% - 52.74%), which represented the proportion of febrile cases that would have been eliminated if malaria infections were eliminated in the study area. Similarly, the results of this study revealed other cases not attributable to malaria in the study area. The attributable fraction for measles was 14.6%, the attributable fraction for typhoid fever was 17.6%, the attributable fraction for cholera was 8.5%, the attributable fraction for tuberculosis was 4% and the attributable fraction for other diseases was 6%. The patients with genotype AA were 4.212 times likely to have malaria than patients with SS. The genotype (1) which represented AS was not a significant predictor of the outcome because as the Wald statistic approaches 0, the p-value approaches 1, which will make the p-value not to be significant. This indicated that there was no significant relationship between the outcome and genotype AS. The odds ratio for patients with genotype AS showed that they were 3.991 times likely to have malaria than patients with SS but was not a good predictor of the outcome because of the p-value. The 95% confidence interval for genotype (1) includes 1, hence, the odds ratio was not statistically significant.

#### 4.1 Strength and Limitations

The predisposing factors can tell us if a patient had malaria before a laboratory test were studied. This study was limited to patients that complained about malaria in which their blood samples were collected and tested in the laboratory at the University of Ilorin Clinic from 1<sup>st</sup> January, 2014 to 30<sup>th</sup> June, 2015.

#### 5.0 CONCLUSIONS

AND

#### RECOMMENDATIONS

##### 5.1 Conclusions

Majority of the patients complained about high fever and 49.2% were attributable to malaria. Gender and genotype were significant in predicting malaria. Age was not significant and the average age of the patients was 26 years. The white blood cell that is protecting the body against infectious diseases was not significant. The packed cell volume, neutrophil and lymphocyte were not significant because they were highly correlated with white blood cell. Males are 2.899 times likely to have malaria than females even after controlling for genotype. Patients of AA are 4.212 times likely to have malaria than the SS patients. The symptoms were not used in predicting if a patient had malaria because all the symptoms were highly correlated. Patients of AS are 3.991 times likely to have malaria than SS patients.

##### 5.2 Recommendations

1. Males should go for malaria test regularly because they are prone to malaria parasites.
2. Patients with AA genotype should go for malaria test more often because they are more likely to have malaria.
3. Males should be encouraged to always have mosquitoes' nets in their bags, so that they can use the nets whenever they travel. Because males travel a lot due to the nature of their jobs 14.and are

## 7.0 REFERENCES

- Altman, D.G. (1991). *Practical Statistics for Medical Research*. Chapman and Hall, London.
- Alvan, R.F. (2002). *Principles of Medical Statistics*. Chapman and Hall/ CRC, Washington, D.C.
- Anderson, B. (1990). *Methodological Errors in Medical Research*. Blackwell, Oxford, United Kingdom.
- Chap, T.L. (2003). *Introductory Biostatistics*. John Willey and Sons, Inc., Hoboken, New Jersey.
- David, G.K. & Mitchel, K. (2003). *Logistic Regression a Self-Learning Text*, (3<sup>rd</sup> Edition). John Wiley and Sons, Hoboken, New Jersey.
- David, W.H., Stanley, L. & Rodney X.S. (2013). *Applied Logistic Regression*. (3<sup>rd</sup> Edition). John Wiley and Sons, Inc., Hoboken, New Jersey.
- Everitt, B.S. (2005). *The Cambridge Dictionary of Statistics*. (3<sup>rd</sup> Edition). Cambridge

exposed to malaria parasites during the process.

4. Females and Males should reside in an area that is clean and free from malaria parasites abode.

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University Press, United Kingdom.

Harris, M. & Taylor, G. (2003). *Medical Statistics Made Easy*, Martin Dunitz, an imprint of the Taylor & Francis Group, United Kingdom.

John, M.L. (2001). *Biostatistical Methods the Assessment of Relative Risks*. John Wiley and Sons, Hoboken, New Jersey.

Matthews, J.N.S. (2006). *An Introduction to Randomized Clinical Trials* (2<sup>nd</sup> Edition). Chapman and Hall, London.

Nancy, L.G. (2004). *Advances in Clinical Trials Biostatistics*. Marcel Dekker Inc., London.

SPSS Inc. Released 2008. *SPSS Statistics for Windows Version 18.0* Chicago SPSS incorporated.

WHO/ USAID. (1999). *New Perspective Malaria Diagnosis Report of a joint Informal Consultation*, Geneva, 25-27 October, 1999.