

Assessment of the choice of malaria diagnostic methods among household heads of the Nkwen village in Bamenda-3 municipality

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Abstract

Malaria remains a major threat to life in Bamenda in particular and Cameroon in general. Despite numerous and relatively affordable malaria diagnostic and treatment methods, accurate choice of diagnosis remains a major challenge to the inhabitants of the almost 14,285 households in the Nkwen village of the Bamenda 3 municipality. This study was designed to investigate the key determinants of the choice of malaria diagnostic methods (demand side analysis) in the Nkwen village of the Bamenda 3 municipality. A purposive and randomized sampling method was employed to recruit of 560 household's heads from the 46 quarters of the Nkwen village. The Multinomial Logistic Regression Model and Chi-Square analysis were used to analyze the collected data. The findings reveal that gender, marital status, educational level, income, household size, age, religion and health insurance policy contribute to the choice of malaria diagnostic methods in the study area. Therefore, the integration of socio-economic factors into malaria control policies will feasibly contribute to malaria decrease in the study area.

Key Words: Malaria; Malaria Diagnosis, Health Care Services, Multinomial Logistic Model.

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Introduction

Malaria remains a global health problem especially in the WHO African Region. According to the most recent World malaria report, there were 228 million cases of malaria in 2018 compared to 231 million cases in 2017, resulting to an estimated 405000 and 416000 malaria deaths in 2018 and 2017 respectively (Nlinwe and Ateh 2020). Prompt malaria diagnosis constitutes a key element in malaria control strategy because it results in reduced complications and deaths from malaria (Oo et al. 2019). When malaria is properly diagnosed, non-malaria febrile illnesses will be accurately treated guided by test results (Shillcutt et al. 2008). In fact, it was estimated that approximately 100,000 lives can be possibly save in a year, if malaria is accurately diagnosed (Hawkes and Kain 2007). The initial signs and symptoms of malaria which are variable and generally not well defined includes headache, abdominal pain, weakness, fever, vomiting, diarrhea, dizziness, myalgia, nausea and chills (Tangpukdee et al. 2009). Despite these obvious signs and symptoms, malaria confirmatory laboratory diagnosis remain an immediate need because clinical diagnosis alone (physical examinations, signs and symptoms), can be highly interrupted by infections with other tropical diseases (Tangpukdee et al. 2009). Rather than giving presumptive treatment, the WHO advised that only established malaria cases be treated, so as to effectively fight malaria (Ruizendaal et al. 2014). Although patients may sometimes be enthusiastic about being tested for malaria before treatment (Chandler et al. 2008; Bamiselu et al. 2016), other factors were found to delay early seeking for appropriate malaria diagnosis and treatment; level of education, socio-economic status of the family, type of marriage/marital status, age and parity (Chukwuocha et al. 2014). Therefore this study was designed to investigate the determinants of the choice and association of types of malaria diagnostic methods in the Bamenda health area of Cameroon.

Materials and Methods

This study was carried out in Nkwen, one of the two villages of Bamenda 3 municipality. Nkwen village has about 14,285 households with 46 quarters (Mbang 2018). In each quarter 5% of the total households were randomly selected giving an estimated number of 714 targeted households. A total of 560 targeted household heads actually participated in the study giving a compliance rate of 78.43%. The Bamenda 3 municipality is one of the three municipalities in Bamenda, which are all administratively covered by the Bamenda city council. Bamenda is the chief town of the North West region of Cameroon. Cameroon has ten regions. The study period was for seven months, from October 2018 to May 2019.

Data were analyzed with the use of descriptive statistics (Tables and Charts) and the Multinomial Logistic regression Model (MLM). The Multinomial Logistic Regression Model relies on the fundamental assumption that the error term in estimating τ_{ij} is independent of the error term in estimating τ_{ik} . This implies that the error term in estimating the choice probability of individual i alternative j is independent of the error term in estimating the choice probability of individual for alternative k ($k \neq j$). To model the choice of malaria diagnostic methods, three diagnostic choices were used in the study: diagnosis by signs and symptoms, clinical examination and laboratory examination (Williams 2006; Kakkilaya 2003; Murray et al. 2008). These variables were treated as nominal scale categories so that the effect should be gotten across the individual categories. To see how this can be done, let Y_{ij}
 $= 1$, if the individual chooses alternative ($j = 1$ or 2)
 $= 3$, otherwise (since 3 is the base category)
 Further, let $\tau_{ij} = \Pr(Y_{ij}=1)$ where \Pr stands for probability. Therefore, $\tau_{i1}, \tau_{i2}, \tau_{i3}$ represent the probabilities that individual i chooses alternative 1, 2, or 3, respectively – that is alternatives of diagnosis by signs and symptoms, diagnosis by clinical examination, and diagnosis by laboratory examination. If these are the only alternatives an

individual faces, then, obviously,
 $\tau_{i1} + \tau_{i2} + \tau_{i3} = 1$

This is because the sum of the probabilities of mutually exclusive and exhaustive events must be 1. τ_{ij} will be called response probabilities. This means that in our example, if we determine any two probabilities, the third one is determined automatically. In other words, there is no need to estimate the three probabilities independently. Now, what are the factors or variables that determine the probability of choosing a particular option? In the choice of malaria diagnosis model, information on the variables includes: Gender of respondent (GEN) = 1 if male, 0 otherwise; Marital status of respondent (MS) = 1 if married, 0 otherwise; Educational level of respondent (EDU) = 1 if no education, 2 if primary, 3 if secondary, 4 if university undergraduate 5 if university post graduate; Income of respondent (Y) = less than 30,000(1) 31,000-50,000(2) 51,000-100,000(3)101,000-150,000(4), 151,000-250,000(5), 251,000-350,000(6), 351,000-500,000(7), above 500,000(8); Number of people living in each household (NLH) = 1 for 0-3, 2 for 4-6, 3 for 7-9 and 4 for 10+; Age of respondent (Ag) = 1 if Less than 20years, 2 if 21-40years, 3 if 41-60years, and 4 if above 61years; Place of residence (PoR)=1 for urban, 0 otherwise; Religion of respondent (ReG)=1 for Christian, 0 otherwise; Health insurance policy (HIP)=1 insured, 0 otherwise; Cost of diagnosis (C)= less than or equal to 1000(1), 1,00-2000(2), 2001-3000(3), 3001-4000(4), Above 4000(5) (3). Generalizing the bivariate logistic regression model, we can write the multinomial logit model (MLM) as:

$$\tau_{ij} = \frac{e^{\alpha_j + \beta_j X_i}}{\sum_{j=1}^3 e^{\alpha_j + \beta_j X_i}}$$

Where X_i represent the explanatory variables. Notice that we have put the subscript j on the intercept and the slope coefficients to remind us that the values of these coefficients can differ

from choice to choice. In other words, the three probabilities estimated may have different coefficients for the regressors. In effect, we are estimating three regressions. As we noted before, we cannot estimate all the three probabilities independently. The common practice in MLM is to choose one category or choice as the base, reference or comparison category and set its coefficient values to zero. So if we choose the third category (laboratory test) and set $\alpha_1 = 0$ and $\beta_1 = 0$ we obtain the estimates of the probabilities for the two other choices. We then find out the impact of a unit change in the value of a regressor on the choice probability, holding all other regressors values constant. That is, we find out $\frac{\partial \tau_{ij}}{\partial X_{ik}}$ which is the partial derivative of τ_{ij} with respect to the kth explanatory variable. This is known as the marginal effect interpretation which is adopted in this paper.

Results

The findings presented on table 4.1 represents the summary of descriptive statistics. The results justify the homogeneity of the findings.

Table 1: Summary of Descriptive Statistics

	MDM	Gen	MS	EDU	Y	NLH	Ag	PoR	ReG	GenHH	HIP	C
Mean	1.288	.456	.364	.948	2.476	2.32	1.98	.248	.956	.696	.104	2.772
Std. Dev.	.864	.498	.482	.222	1.999	.944	.603	.432	.205	.460	.306	1.089
Maximum	2	1	1	1	8	4	4	1	1	1	1	5
Minimum	0	0	0	0	1	1	1	0	0	0	0	1
Skewness	-.590	.177	.565	-4.036	1.084	.440	.665	1.167	-4.446	-.852	2.595	.330
Kurtosis	1.599	1.031	1.319	17.285	2.939	2.317	5.013	2.362	20.773	1.726	7.731	2.776
Observations	560	560	560	560	560	560	560	560	560	500	560	560

Source: Compiled by Authors Using Stata Version 12.0

The findings presented on table 4.2 represents pairwise correlation matrix results. The results show that the correlation coefficients for the leading diagonals is 1.0000, with the rest less than 1. This indicates that each variable is perfectly collinear to itself and therefore justifies the reliability of the results because no variable is strongly correlated with the other, except with itself.

Table 2: Correlation Matrix Table

	MDM	Gen	MS	EDU	Y	NLH	Ag	PoR	ReG	GenHH	HIP	C
MDM	1.0000											
Gen	0.0155	1.0000										
MS	0.1665	0.0501	1.0000									
EDU	-0.0367	-0.1473	0.0649	1.0000								
Y	-0.0563	0.2323	0.2569	-0.0164	1.0000							
NLH	-0.0567	0.0811	0.0078	0.0222	-0.1085	1.0000						
Ag	0.2954	0.0304	0.2733	-0.0675	0.2438	0.0816	1.0000					
PoR	-0.0521	-0.0980	-0.0687	-0.1158	0.1136	0.0801	-0.0424	1.0000				
ReG	0.0264	-0.0385	0.0812	0.4768	-0.2517	0.0728	-0.2012	-0.2381	1.0000			
GenHH	-0.1119	0.1861	0.3373	0.0802	-0.0167	0.0675	-0.1517	-0.1642	0.3246	1.0000		
HIP	-0.1213	-0.0225	-0.0943	0.0798	0.1026	-0.1573	-0.1191	0.1381	-0.2464	-0.0027	1.0000	
C	-0.0451	0.1660	-0.0325	0.0337	0.0684	0.1724	0.0357	-0.1861	0.1881	0.0533	-0.1333	1.0000

Source: Compiled by Author Using Stata Version 12.0

The findings presented on table 4.3 are the Multinomial Logistic Regression Model (MLM) with robust standard errors to take care of the problem of heteroscedasticity. Comparing the choice between signs and symptoms with laboratory tests (base outcome), the coefficient of gender is negative showing that males are 16.11% less likely ($P < 0001$) to prefer signs and symptoms over laboratory test for malaria diagnosis, compared to females. The males are also 16.08% more likely ($P < 0001$) to prefer clinical diagnosis over laboratory test, as compared to females. The coefficient of marital status is negative for both results showing that marriage decreases the likelihood of preferring signs and symptoms by 13.04% in favor of laboratory test ($P < 0001$). An increase in the level of education of a household head will decrease the likelihood for them to prefer signs and symptoms and clinical examination over laboratory test by 20.87% ($P < 0001$) and 21.51% ($P < 005$), respectively. The results also show that an increase in income will decrease the likelihood ($P < 0001$) to diagnose malaria using only signs and symptoms and clinical examination by 50.59% and 15.86% respectively.

An increase in the number of people living in each household will increase the likelihood ($P < 0001$) to diagnose malaria through signs and symptoms and clinical examination over laboratory test, by 75.15% and 71.24% respectively. Increase in age will decrease ($P < 0001$) the likelihood to diagnose malaria via signs and symptoms only, in favor of laboratory test by 28.64%. Christians are 32.73% less likely ($P < 005$) to prefer signs and symptoms over laboratory examination, as compared to non-Christians. People who are covered by health insurance policy are 8.17% less likely ($P < 005$) to prefer clinical diagnosis in favor of laboratory examination. The results are generally 99 percent reliable for policy prescriptions.

Table 3: Multinomial Logistic Regression Results with laboratory tests as the base outcome

Variable	Signs and Symptoms		Clinical Diagnosis	
	Coefficient (Robust Std. Err)	Marginal Effects (Robust Std. Err)	Coefficient (Robust Std. Err)	Marginal Effects (Robust Std. Err)
Gen	-.7776957*** (.2633367)	-.1610894*** (.04079)	1.000014*** (.3148446)	.160812*** (.03749)
MS	-.9192191*** (.2986136)	-.1303514*** (.04322)	-.5287262* (.2924936)	-.038744 (.034)
EDU	2.100195* (1.103174)	.208705*** (.04002)	-.9277837* (.4855517)	-.2151145** (.10759)
Y	.2885841*** (.0699367)	.0505966*** (.01158)	-.0486472 (.0762922)	-.0158626 (.00968)
NLH	.3529664*** (.1248397)	.0751457*** (.0206)	-.4597349** (.1835441)	-.0712405*** (.02097)
Ag	-1.683849*** (.2467968)	-.2864079*** (.04136)	.0177631 (.2550349)	.0580925* (.03022)
PoR	-.3417252 (.3786267)	-.091848* (.04954)	1.046623*** (.2951627)	.1764048*** (.0512)
ReG	-1.475669** (.6886361)	-.3272787** (.16401)	.0374301 (.7008586)	.0666862 (.06006)
GenHH	.8485977*** (.2932226)	.1108907*** (.04012)	.7787873** (.3136899)	.0694558** (.03384)
HIP	.4575331 (.3390314)	.1068053 (.06532)	-.6519105 (.5110818)	-.081711** (.04037)
C	.1726773 (.1300878)	.0303605 (.02206)	-.0316888 (.1582284)	-.0098258 (.02021)
Constant	-.6876589 (1.134485)	—	-.7566995 (1.022544)	—
Number of obs				500
Wald chi2(24)				150.82
Prob> chi2				0.0000
Pseudo R2				0.5689

Source: Compiled by Author Using Stata Version 12.0 Note: *(**) (***) => The null hypothesis is rejected at 10% (5%) (1%) level of significance Note: Laboratory Test =>Based Category.

The results presented on table 4.4 shows that the value of the Pearson Chi-Square stands at 5.816, which is greater than its asymptotic value and significant at 10 percent level of significance. Therefore malaria diagnostic method is likely (coefficient of the likelihood ratio; 6.079 ($P < 0.005$)) associated with its prevalence, with a linear-by-linear association between the two variables.

Table 4: Chi-Square Tests of Association between Malaria Diagnostic Method and Malaria Prevalence

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.816a	2	.055
Likelihood Ratio	6.079	2	.048
Linear-by-Linear Association	4.715	1	.030
N of Valid Cases	484		

Source: Compiled by Author Using SPSS Version 20.0

From the findings presented on table 4.5 above, the coefficients of Cramer’s V, Contingency and Phi stands at .610, .709 and .610 respectively, significant at 10 percent level of statistical significance. All coefficients are greater than 0.50, indicating that there is a strong 90 percent confident association between malaria diagnostic method and the prevalence of malaria. The coefficients for Pearson’s R, and Spearman Correlation stand at .599 and .503 respectively. The coefficients are significant at the 5 percent level of significance. There is therefore a strong relationship between malaria diagnostic method and the prevalence of malaria.

Table 5: Symmetric Measures of Association between Malaria Diagnostic Method and Malaria Prevalence

Symmetric Measures					
		Value	Asymp. Std. Errora	Approx. Tb	Approx. Sig.
Nominal by Nominal	Phi	.610			.055
	Cramer's V	.610			.055
	Contingency Coefficient	.709			.055
Interval by Interval	Pearson's R	.599	.041	2.180	.030c
Ordinal by Ordinal	Spearman Correlation	.503	.042	2.271	.024c
N of Valid Cases		484			

Source: Compiled by Author Using SPSS Version 20.0

Discussion

According to the above findings, household heads in the following categories were significantly prone to malaria diagnosis using laboratory tests (RDT/microcopy): Males; decrease house hold size; Christian; insured; married, older, increase educational level and increase income. In line with findings from (Yaya et al. 2017), malaria prevention practices among women is low. In order to improve the attitude towards proper malaria diagnosis, rigorous behavioral communication involvement of especially young female household heads is encouraged. Since being single and young also predisposes the household heads to inaccurate malaria diagnostic methods. Increase in educational level and increase knowledge should be encouraged by the provision of free/subsidized education. Education creates awareness, hence increasing the likelihood to comply with

recommended practice of accurate malaria diagnosis and control in general (Munisi et al. 2019). Family planning and reduction in family size could possibly control malaria by improving the standard of living in households. Reduce household size will reduce the cost on healthcare, hence encouraging compliance to best practice of malaria laboratory diagnosis. In line with previous findings, improvement in the standard of living in households significantly impacts malaria control (Sharma et al. 2015).

Therefore, socio economic measures aimed at encouraging gender equality, promoting education, encouragement of family planning should be fostered. Furthermore, poverty reduction strategies such as encouragement of entrepreneurial activities that will increase income levels, in addition to reduction in the cost of malaria diagnosis are all strongly recommended. Encouragement of more people to under-take

health insurance policy will also ensure accurate malaria diagnosis. In conclusion, to effectively improve on the outcome of malaria control efforts in the study area, the integration of these socio-economic factors is highly recommended.

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