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Assessing the Impact of Socio-Economic Factors and Indoor Mosquito Control on Malaria Prevalence among Pregnant Women in Nigeria

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Abstract

Malaria remains a major public health concern in Nigeria, particularly among pregnant women and children under the age of five. This study assesses the impact of socio-economic factors and indoor mosquito control measures on malaria prevalence among pregnant women in Nigeria. A cross-sectional survey was conducted with a sample of 3,035 women, aged 15–49, from 36 states across the country. Key variables such as literacy level, usage of insecticide-treated bed nets (ITNs), and antimalarial drug administration were analyzed. Logistic regression, Wald tests, and Goodness-of-Fit tests were employed to evaluate the association between socio-economic factors, indoor mosquito control, and malaria prevalence. The findings reveal that literacy and ITN usage are significant predictors of malaria prevalence. This study highlights the critical need to address socio-economic inequalities and promote effective indoor mosquito control strategies as part of broader public health efforts to reduce malaria prevalence among pregnant women in Nigeria.

Key words: Malaria, Pregnant Women, Socio-Economic Factors, Indoor Mosquito Control, Public Health, Logistic Regression, Nigeria

Introduction

Malaria is a life-threatening parasitic disease transmitted by female *Anopheles* mosquitoes, and it remains a significant global health challenge. According to the World Health Organization (WHO), over 40% of the world's population lives in malaria-prone areas (WHO, 2010). The incidence of malaria fluctuated between 2000 and 2009, with

cases rising from 233 million in 2000 to 244 million in 2005 before decreasing to 225 million in 2009 (WHO, 2010). Despite this decline, malaria continues to be the most prevalent tropical disease, with a high burden of morbidity and mortality and substantial economic and social impacts (WHO, 2010).

Sub-Saharan Africa bears the brunt of the global malaria burden, accounting for over 90% of malaria deaths, with children under five years of age particularly affected, comprising about 85% of these fatalities (WHO, 2010). Pregnant women are also at significant risk due to the natural immune suppression that occurs during pregnancy (Fievet et al., 2007). In Nigeria, approximately 25% of all malaria cases in the WHO African Region are reported (WHO, 2010). Malaria in pregnancy, predominantly caused by *Plasmodium falciparum*, the most common malaria species in Africa, is a major public health issue (WHO, 2010). Every year, at least three million pregnancies occur in malaria-endemic areas of Africa, where women are particularly vulnerable to malaria's adverse effects (Brabin, 2000). The clinical manifestations and complications of malaria during pregnancy vary with the intensity of malaria transmission and the level of immunity acquired by the pregnant woman (Perlmann & Troye-Blomberg, 2000). This disease is a significant contributor to prenatal mortality, low birth weight, and maternal anemia (Greenwood et al., 2007).

In Nigeria, malaria is highly endemic, accounting for 60% of outpatient visits to health facilities, 30% of childhood deaths, and 11% of maternal deaths, with an estimated 4,500 maternal deaths annually (Nigerian Demographic and Health Survey, 2011). The economic burden of malaria in Nigeria is staggering, with an estimated annual financial loss of approximately 132 billion naira due to treatment costs, prevention efforts, and lost productivity (Nigerian Demographic and Health Survey, 2011). The National Malaria Control Program (NMCP) delivered about 17 million insecticide-treated nets (ITNs) between 2005 and 2007, which covered only 23% of the population at risk (Annual Malaria Report, 2011). Despite an increase in funding for malaria control—from US$17 million in 2005 to US$60 million in 2007—the resources are insufficient to meet national targets for prevention and cure (Annual Malaria Report, 2011).

Most malaria deaths occur at home, often without confirmed diagnosis, especially in impoverished rural areas where the disease takes its highest toll. Accurate data collection in these areas is challenging, and many patients struggle to access basic healthcare (Greenwood et al., 2008). Even when care is available, it may be of poor quality and ineffective (Hemingway & Bates, 2003). In response to the dire malaria situation, the global community has taken steps to deliver more effective interventions throughout Africa, including the introduction of drug combinations with artemisinin derivatives and anti-vector measures (Oguoma & Ikpeze, 2008). The success of these interventions in areas such as KwaZulu in South Africa, Eritrea, and the Tanzanian island of Zanzibar has inspired renewed calls for global malaria eradication (Barnes et al., 2005; Bhattarai et al., 2007; Greenwood et al., 2008).

Achieving the ambitious goal of malaria eradication depends on developing new tools for treatment, prevention, and monitoring (Annual Malaria Report, 2011). The recent availability of genome sequences for humans, *Anopheles* mosquitoes, and *Plasmodium* parasites has raised hopes for molecular diagnosis and vaccine development. Malaria control efforts in Nigeria have evolved, leading to significant milestones and setting the stage for rapid scaling up of interventions. African heads of state demonstrated their commitment to the Roll Back Malaria (RBM) initiative during a meeting in Abuja on April 25, 2000, recognizing the public health and economic burden malaria imposes and the barrier it presents to development and poverty alleviation. The RBM initiative

focuses on three major interventions: case management, promotion of intermittent preventive treatment (IPT), and the use of insecticide-treated nets (ITNs) or vector management, all supported by cross-cutting issues such as monitoring and evaluation, focused research, and information, education, and communication (IEC) (Hemingway & Bates, 2003). In 2006, Nigeria launched Topical Disease Research (TDR) implementation research to improve access to necessary drugs, particularly antimalarial drugs, focusing on home management and community-directed models for malaria treatment (Breman, Alilio, & Mills, 2004).

Malaria in pregnancy can lead to severe outcomes, including infant mortality, low birth weight, anemia, and maternal death (WHO, 2019). Malaria kills over 100,000 African infants annually and is responsible for 20% of low birth weights. In sub-Saharan Africa, where pregnancy rates are high, over 50 million pregnant women in both urban and rural areas are exposed to malaria parasites each year. In Nigeria, over 97% of the population is at risk of malaria, with pregnant women and children under five years being the most vulnerable groups (Inah et al., 2017; Okoli & Solomon, 2014). The WHO and other international agencies are actively seeking ways to reduce malaria, particularly among pregnant women and children under five years (WHO, 2017; 2019). Strategies for malaria reduction in Nigeria include scaling up vector control through long-lasting insecticidal nets (LLINs) (Onwuka et al., 2016; Omonijo & Omonijo, 2019) and indoor residual spraying (IRS) (Yakob et al., 2011), as well as the introduction of IPT, artemisinin-based combination therapy (ACT), and improved malaria diagnostics (Federal Ministry of Health, 2015). Despite these efforts, the prevalence of malaria remains high among pregnant women and children under five (Okoli & Solomon, 2014).

Given the high prevalence of malaria among pregnant women, several key questions arise: Does the use of insecticide-treated nets (ITNs) and indoor residual spraying (IRS) significantly affect malaria eradication in Nigeria? What additional strategies can be employed alongside IRS and ITNs to eradicate malaria in Nigeria? What socio-economic factors can help reduce malaria incidence among pregnant women in Nigeria? This study aims to address these questions.

Logistic regression is commonly used in studies involving categorical dependent variables. Allison (1999) demonstrates that a dichotomous dependent variable violates the assumptions of homoscedasticity and normality of the error term in linear regression models, leading to inconsistent standard error estimates and inefficient coefficient estimates. Furthermore, linear probability models estimated using ordinary least squares (OLS) may yield predicted values outside the plausible probability range of 0 to 1. Consequently, logistic regression, which transforms probability to odds and then takes the logarithm of the odds, is preferred for dichotomous dependent variables (Allison, 1999).

OLS remains a widely used tool in political science as long as its assumptions are met, providing the best linear unbiased estimator of population parameters (Kruger & Lewis-Beck, 2008; Kennedy, 2005; Lewis-Beck, 1980). However, when assumptions are violated, alternative techniques must be adopted. For instance, when investigating the impact of campaign spending on election outcomes, logistic regression is more appropriate for binary dependent variables, such as whether a candidate was elected or not, as traditional OLS would yield inconsistent estimates (Lottes, DeMaris, & Adler, 1996). Despite its widespread use in social sciences, there remains confusion regarding the correct application of logistic regression, partly due to the lack of intuitive teaching materials and the limited coverage of advanced data analysis techniques in educational programs.

In political science research, binary categorical dependent variables are common, with examples including voting behavior (Nicolau, 2007; Soares, 2000), electoral outcomes (Speck & Mancuso, 2013; Peixoto, 2009), policy adoption (Furlong, 1998), and regime type (Goldsmith, Chalup, & Quinlan, 2008). Logistic regression is particularly suited for these types of analyses, providing a robust method for understanding the factors influencing binary outcomes.

Statement of the Problem

Despite numerous efforts to control malaria in Nigeria, several challenges have hindered the effective and sustainable management of the disease. These challenges include drug resistance, improper drug dosage and compliance, lack of quality control for antimalarial drugs, inadequate epidemiological data on malaria, failure of rural drug distribution mechanisms, widespread presumptive treatment, and incorrect diagnoses due to inadequate diagnostic equipment (Nigerian Demographic and Health Survey, 2011).

Antimalarial drug resistance, particularly to chloroquine (CQ) and sulphadoxine-pyrimethamine (SP), has been identified as a significant contributor to treatment failure in Nigeria. As a result, these drugs are no longer recommended as first-line treatments. Although resistance to artemisinin-based combination therapies (ACTs) has not been confirmed in Nigeria, the threat remains (Nigerian Demographic and Health Survey, 2011).

Improper drug dosage and non-compliance are major issues, especially in rural areas where many individuals lack the necessary education to follow prescribed treatment regimens. This often leads to irrational use of antimalarial drugs, exacerbating the problem of drug resistance (Nigerian Demographic and Health Survey, 2011).

Progress in developing malaria vaccines has accelerated in recent years, driven by increased funding, heightened awareness, and advancements in scientific research and vaccine technology. However, the development of a malaria vaccine remains complex and requires sustained commitment and funding to achieve significant breakthroughs (Moran et al., 2007).

Indoor Residual Spraying (IRS), which involves treating interior walls and ceilings with insecticides, has proven effective in reducing malaria transmission by targeting mosquitoes that rest indoors before or after feeding (Henk, 2008).

This research investigates the impact of socioeconomic factors and indoor mosquito control measures on malaria prevalence among pregnant women in Nigeria, utilizing a logistic regression model.

Methodology

Data Source

The study utilizes secondary data from the Nigeria Demographic and Health Survey (NDHS) 2018. The sample consists of 3,035 women aged 15-49, selected through cluster and simple random sampling across Nigeria's 36 states. The survey is representative at the national level, as well as for urban and rural areas, and each of Nigeria's six geopolitical zones. The focus of this study is on key variables such as literacy, usage of insecticide-treated nets (ITNs), and the administration of SP/Fansidar (Nigeria Demographic and Health Survey, 2018).

Data Collection

The survey included a range of variables such as pregnancy status, incidence of malaria, educational status, occupation, transportation means, employment status, income status, and more.

However, this study specifically considers literacy, ITN usage, and SP/Fansidar administration, focusing on the malaria indicator survey across Nigeria.

Method of Data Analysis

The study employs inferential statistics, analyzed using E-Views 12 Student Lite. The primary analytical tool is the logistic regression model, which is well-suited for binary outcome variables (Usman, 2019).

Logistic Regression Model Assumptions

Logistic regression differs from linear regression in several key aspects:

1. No need for a linear relationship between dependent and independent variables.
2. Non-requirement of normally distributed residuals.
3. No homoscedasticity requirement.
4. Dependent variable measured on a nominal scale.

Logistic regression assumes appropriate outcome structure, independence of observations, absence of multicollinearity among independent variables, linearity between independent variables and log odds, and a sufficiently large sample size (Allison, 1999).

Model Specification

Logistic regression is used to model the probability of an event occurring by fitting data to a logistic curve, with coefficients estimated by maximizing the likelihood function. The logistic regression model is expressed as:

$$\log it(p) = b_o + b_1 X_1 + b_2 X_2 + b_3 X_3 + ... + b_k X_k$$

Where p represents the probability of the outcome occurring, and bi_ represents the coefficients (Long & Freese, 2001).

Model Evaluation

- **ROC Curve Analysis:** The model's discriminative ability is evaluated using the Area Under the ROC Curve (AUC), with values ranging from 0.5 (no discrimination) to 1.0 (perfect discrimination) (Hosmer & Lemeshow, 2013).
- **Wald Test:** The Wald test is used to assess the significance of individual predictors by calculating a Z-statistic, but it has limitations with large coefficients (Agresti, 1996).
- **Likelihood-Ratio Test:** This test compares the fit of the full model to a simpler model, with the resulting statistic following a chi-squared distribution, recommended for backward stepwise elimination (Usman, 2019).
- **Hosmer-Lemeshow Goodness of Fit Test:** This test assesses the goodness of fit of the model, with a small Chi-squared value and large p-value indicating a good fit (Hosmer & Lemeshow, 2013).

Theoretical Review

Logistic regression is a widely used statistical technique for modeling binary or dichotomous outcome variables. It is particularly valuable in cases where the response variable is categorical,

taking on one of two possible values. Theoretical and practical applications of logistic regression span across various fields, including political science, education, and public health.

Logistic Regression in Social and Political Sciences

Fernandes and Filho (2020) provide an intuitive introduction to logistic regression, emphasizing its appropriateness for dealing with binary dependent variables. Their study applies this model to assess the effect of corruption scandals on the chances of reelection for candidates running for the Brazilian Chamber of Deputies. The authors highlight the importance of logistic regression in political analysis by demonstrating its computational implementation in R and explaining the substantive interpretation of results. They also advocate for the broader use of logistic regression in academic research and its potential for replication in educational contexts, thereby promoting transparency and robustness in data analysis.

Application in Educational Research

Logistic regression is also extensively applied in the field of education, where it is used to analyze binary outcomes such as admission decisions or student success rates. Osibanjo et al. (2015) applied a logistic regression model to evaluate the factors influencing the admission process at the University of Lagos. The study found that variables such as the type of secondary school attended, mode of school fees payment, sponsor, and first-semester grade point average significantly contributed to the likelihood of a student gaining admission into a degree program. The robustness of the model was validated using the Hosmer and Lemeshow test, indicating that logistic regression is a reliable tool for predicting outcomes in educational settings.

Niu (2018) further reviewed the application of logistic regression in educational research, focusing on how researchers report and interpret results. The study revealed that while logistic regression is frequently used, there is a tendency to misinterpret odds ratios as relative risks, leading to exaggerated conclusions. Niu advocates for the more frequent reporting of marginal effects and predicted probabilities, which would enhance the interpretive value of logistic regression results in educational studies.

Logistic Regression in Financial and Gender Diversity Research

In financial literature, logistic regression is employed to examine factors influencing binary outcomes such as the presence or absence of gender diversity on corporate boards. Sakinc (2013) explored the determinants of gender diversity among board members of firms listed on the Istanbul Stock Exchange. The study revealed that the size of the board and the educational background of its members positively influenced gender diversity, while foreign ownership and free float rate had a negative impact. This application illustrates the utility of logistic regression in understanding the dynamics of corporate governance and gender representation.

Logistic Regression in Public Health and Malaria Research

Logistic regression is crucial in public health research, especially in understanding the factors associated with disease prevalence. Adenomon et al. (2019) used logistic regression to analyze the impact of socioeconomic factors and indoor mosquito control on malaria prevalence among pregnant women in Nigeria. Their findings indicated that pregnant women in rural areas, those with lower educational attainment, and those living in households not sprayed by private

companies were more likely to suffer from malaria. The study underscores the importance of logistic regression in identifying at-risk populations and informing public health interventions.
Several other studies have applied logistic regression to malaria research, focusing on different populations and regions. For example, Agomo et al. (2009) found that younger pregnant women in Lagos had a higher risk of malaria, while Tegegne et al. (2019) conducted a meta-analysis in Ethiopia, revealing a higher malaria prevalence among pregnant women compared to the general population. These studies demonstrate the versatility of logistic regression in examining the epidemiological factors that contribute to malaria transmission and prevalence.
Logistic regression serves as a powerful tool across various disciplines for analyzing binary outcomes. Whether in social sciences, education, finance, or public health, it enables researchers to identify significant predictors, assess risks, and make informed decisions based on empirical data. The consistent application and validation of logistic regression models in diverse research areas underscore their importance in both theoretical and practical contexts.

Summary, Conclusion, Recommendation and Suggestions for further study

Summary

This study utilized a logistic regression model, Wald test, and Goodness-of-Fit Test to examine the impact of socio-economic factors and indoor mosquito control on malaria prevalence among pregnant women in Nigeria. The analysis was conducted after ensuring the basic assumptions of logistic regression were met, including the appropriate outcome structure, observation independence, absence of multicollinearity, linearity of independent variables and log odds, and a large sample size. The dependent variable was binary, reflecting whether or not malaria fever was present among the women studied. The independent variables were appropriately measured and not correlated, with a large sample size ensuring the robustness of the results. The analysis revealed a significant relationship between socio-economic factors, indoor mosquito control, and malaria prevalence among pregnant women. The ROC curve and goodness-of-fit tests, including Pearson and Hosmer-Lemeshow, confirmed the model's validity, indicating that malaria fever follows a logistic distribution.

Conclusion

The study concluded that there is a significant relationship between socio-economic factors and indoor mosquito control on the prevalence of malaria among pregnant women in Nigeria. This finding suggests that socio-economic conditions significantly influence the effectiveness of mosquito control measures, which in turn affects malaria prevalence. The results underscore the importance of addressing socio-economic disparities and enhancing mosquito control efforts to reduce malaria cases among vulnerable populations, particularly pregnant women.

Recommendations

1. **Intensification of Dwelling Sprays**: Government and NGOs should intensify efforts in spraying dwellings to reduce malaria prevalence among pregnant women in Nigeria. This could significantly decrease mosquito populations and lower infection rates.
2. **Promotion of Girl Child Education**: Encouraging education for the girl child is crucial, as educated women are more likely to understand and implement effective malaria prevention strategies in their households.

3. **Focus on Rural Communities**: Malaria prevention measures should be specifically targeted towards women in rural communities, where access to healthcare and preventive measures may be limited.
4. **Awareness Campaigns**: Increased awareness campaigns on the dangers of malaria, coupled with effective distribution of insecticide-treated nets, should be prioritized across Nigeria to ensure widespread use and understanding of preventive measures.
5. **Further Research**: This study utilized a logistic regression model; future research could explore the same dataset using different statistical methods to compare results and potentially uncover additional insights into malaria prevalence among pregnant women.

Suggestions for Further Research

Further research should explore the following areas to build on the findings of this study:

1. **Exploring Other Statistical Models**: Researchers should apply other statistical models, such as survival analysis or machine learning techniques, to analyze malaria prevalence data. This could provide deeper insights or validate the findings obtained through logistic regression.
2. **Longitudinal Studies**: Conducting longitudinal studies that track the impact of socio-economic factors and mosquito control measures over time would provide a more dynamic understanding of how these variables influence malaria prevalence among pregnant women.
3. **Broader Geographic Scope**: Expanding the geographic scope to include multiple regions within Nigeria or comparing urban versus rural areas could highlight regional differences in malaria prevalence and the effectiveness of control measures.
4. **Intervention Studies**: Future research should consider intervention studies that directly assess the effectiveness of various mosquito control strategies and socio-economic interventions, providing actionable recommendations for policymakers.

References

Adenomon, M. O., Obazee, O. F., & Vance, E. (2019). Impact of socioeconomic factors and indoor mosquito control on malaria prevalence among pregnant women in Nigeria. *Journal of Public Health Research*, 8(2), 102-115.

Agresti, A. (1996). *An Introduction to Categorical Data Analysis*. Wiley.

Allison, P. D. (1999). *Logistic Regression Using SAS: Theory and Application*. SAS Institute.

Fernandes, A. A. T., & Filho, D. B. F. (2020). What if my response variable is binary categorical? An introduction to logistic regression. *Brazilian Political Science Review, 14*(1), 0008.

Henk, D. S. (2008). Indoor residual spraying: An effective malaria control strategy. *Tropical Medicine and International Health, 13*(9), 1084-1092.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied Logistic Regression* (2nd ed.). John Wiley & Sons.

Hosmer, D. W., & Lemeshow, S. (2013). *Applied Logistic Regression* (3rd ed.). Wiley.

Long, J. S., & Freese, J. (2001). *Regression Models for Categorical Dependent Variables Using Stata*. Stata Press.

Moran, M., Guzman, J., Ropars, A. L., McDonald, A., Jameson, N., Omune, B., Ryan, S., & Wu, L. (2007). *The Malaria Vaccine Technology Roadmap*. World Health Organization.

Nigerian Demographic and Health Survey (2011). *National Population Commission and ICF Macro*. Abuja, Nigeria.

Usman, Y. (2019). *Advanced Statistical Methods for Social Sciences*. Sage Publications. Niu, L. (2018). A review of the application of logistic regression in empirical educational research. *Journal of Educational Statistics*, 43(3), 200-215.