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# Investigating The Factors Influencing Mother-To-Child Transmission of Syphilis in Ebonyi North Senatorial District Using Logistic, Poisson, And Negative Binomial Regression Models

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***Abstract- This study investigated the factors influencing mother-to-child transmission (MTCT) of syphilis in Ebonyi North Senatorial District, Nigeria, using logistic, Poisson, and negative binomial regression models. Data spanning 2010–2024 were collected from four healthcare facilities and questionnaires were equally distributed to the pregnant women for their responses. The analysis assessed the effectiveness of existing prevention and treatment strategies, availability of essential drugs, counseling services, and the predictive capacity of different statistical models. Results from the logistic regression model demonstrated that variables such as pregnancy status, syphilis symptoms, presence of other sexually transmitted infections, syphilis screening, transmission counseling, and infant treatment were statistically significant predictors of MTCT ($p < 0.05$). The model achieved excellent predictive performance with a McFadden $R^2$ of 0.916, Nagelkerke $R^2$ of 0.959, and an area under the ROC curve (AUC) of 0.998, indicating near-perfect classification ability. Principal component analysis (PCA)-selected predictors yielded a slightly reduced but still robust performance (AUC = 0.964).Poisson and negative binomial regressions further highlighted maternal age (IRR = 0.86, $p < 0.01$) and syphilis knowledge (IRR ≈ 3.0, $p < 0.001$) as consistent predictors of MTCT risk. The negative binomial model provided a better fit for overdispersed count data compared to the Poisson model. The findings reveal gaps in drug availability, follow-up, and counseling services, which undermine current MTCT prevention efforts. Evidence indicates that strengthening syphilis screening, improving awareness, ensuring continuous availability of essential drugs, and enhancing counseling and follow-up services are critical to reducing MTCT in Ebonyi State. This study concludes that while logistic regression offered the strongest predictive performance, Poisson and negative binomial models provided complementary insights into the determinants of MTCT. The evidence generated provides a basis for evidence-driven policies to improve syphilis control programs and safeguard maternal and child health in Ebonyi State.***

***Keywords: Syphilis, Transmission, Influencing, Logistic, Poison and Negative Binomial Regression Models.***

## I. INTRODUCTION

Syphilis is a sexually transmitted infection caused by the bacterium *TreponemaPallidum*, and is a major public health concern worldwide. It can be transmitted through sexual contact, blood transfusion, or from a mother to her fetus during pregnancy (WHO, 2024). One of the most critical aspects of syphilis transmission is from mother to child(MTCT), known as congenital syphilis (Araujo et al., 2013). Congenital syphilis can have devastating consequences, including stillbirth, neonatal death, and long-term neurological and developmental problems in surviving infants (Garnett et al., 2019). In recent years, there has been a growing interest in investigating the transmission of syphilis from mother to child using mathematical models and statistical analysis. Syphilis can be diagnosed and treated through blood tests, which detect antibodies to the bacteria. Treatment for syphilis typically involves an injection of penicillin. Logistic regression is a statistical model that is commonly used to analyze binary outcomes, such as whether or not a child is born with syphilis. Poisson regression is another statistical model that is used to analyze count data, such as the number of syphilis

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cases in a population (Smith and Johnson, 2015). Negative binomial regression is a variation of poison regression that accounts for over dispersion in the data, which often occurs in infectious disease studies. By applying these advanced statistical models to the study of syphilis transmission from mother to child, researchers can identify the risk factors associated with congenital syphilis, such as maternal age, stage of syphilis infection, and others. Negative binomial regression is a variation of poison regression that accounts for over dispersion in the data, which often occurs in infectious disease studies. By applying these advanced statistical models to the study of syphilis transmission from mother to child, researchers can identify the risk factors associated with congenital syphilis, such as maternal age, stage of syphilis infection, and others. Understanding these risk factors is essential for developing effective interventions to prevent the transmission of syphilis from mother to child. Syphilis remains a significant public health concern globally, with an estimated 930,000 pregnant women reportedly being infected with the disease each year, leading to adverse outcomes for both mother and child (Newman et al., 2013). Mother-to-child transmission of syphilis, also known as congenital syphilis has been reported to be able to lead to serious complications such as stillbirth, neonatal death, and long-term disabilities if left untreated (Dorling et al., 2019). An estimated 58,320 people in Ebonyi State are living with syphilis, out of the state's total population of 3.5 million. According to (Federal Ministry of Health, 2018) study, the prevalence rate of syphilis among pregnant women in the state is 1.8%. Mother- to- child transmission (MTCT) of syphilis remains a significant public health challenge in Nigeria, particularly in Ebonyi State, yet there is a gap in research regarding the use of logistic, poison and negative binomial regression models to study this transmission. Most existing research has focused on individual risk factors and prevention strategies, rather than utilizing advanced statistical models to understand patterns of transmission.

This research intends to identify the factors that contribute to the MTCT of syphilis and to develop a predictive model that can accurately estimate the risk of transmission based on these factors, The aim of the study is to investigate the factors influencing mother-to- child transmission (MTCT) of syphilis in Ebonyi State, Nigeria using logistic, poison, and negative binomial regression models.

## II. METHODOLOGY/ RESEARCH ELABORATIONS

The first step in conducting this research was by first, Defining the population of areas to be covered which are the four selected hospitals in Ebonyi North Senatorial District of Ebonyi State, Secondly, by having access to existing data sources and reports on syphilis testing in pregnant women which helped identify samples for the research, Thirdly, by dividing the population into subgroups based on relevant characteristics before making analysis and interpretation of the findings.

### 2.1 Model Specification Methods

Three models were used for the data analysis in this research namely: Negative Binomial Regression Model (NBRM), Poisson Regression Model (PRM) and Logistic Regression Model (LRM).

Negative binomial distribution is the probability distribution of the number of failures, X, before the kth success in a sequence of Bernoulli trials where the probability of success at each trial is p and the distribution of failure is q=1-p. The distribution is given by :

$$pr(X = x) = \binom{k+x-1}{x-1} p^k q^x \quad 0 \leq x < \infty \qquad 1$$

Negative Binomial 2 (NB) Model

The negative binomial model is given by:

$$\Pr(Y = y; \Psi; \mu_i) = \frac{(y_{i+}\Psi-1)}{(\Psi-1)} \left(\frac{(\Psi)^{\Psi}}{\mu_1+\Psi}\right) \left(\frac{\mu^{y_i}}{\mu_1+\Psi}\right) \qquad 2$$

Where:
Ψ=Gamma Distribution
Γ=Gamma Function

The log-likelihood function of the NB 2 is given by:

$$\ln\,[\,L(y,\beta)] = \sum_{i=1}^{n} (y_{i \ln\left(\frac{\Psi}{1+\Psi}\right)} - \Psi^{-1} \ln(1+\Psi) + \ln\Gamma\,(y_i + 1) \ln\Gamma\,(\Psi^{-1}) \qquad 3$$

Where $\mu_i = \exp\,(x^1, \beta)$

The probability mass function of a poison regression of a variable X is given by :

$$\Pr(\,X = x) = \frac{\lambda^x e^{-\lambda}}{x!} x = 0,1, \ldots\ldots \infty \qquad 4$$

The mean and the variance of the distribution are both λ.
The fundamental Poisson regression model for an observation i is written as:

$$\Pr(Y_i = y_i | u_i, t_i\,) = \frac{e^{-\mu i t_{i (\mu_{i t_i})}}{}^{y_i}}{y_{i!}} \qquad 5$$

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The regression coefficients can be estimated using the method of maximum likelihood. The logarithm of the likelihood function is given by :

$$\ln[L(y,\beta)] = \sum_{i=1}^{n} y \ln[t_i\mu(x^1{}_i\,\beta) - \sum_{i=1}^{n} . t_i\mu(x^1{}_i\,\beta) - \sum_{i=1}^{n} \ln(y_i!) \quad 6$$

Logistic regression can be used for various growth models, and is used in a certain type of regression regarded as logistic regression model (Lawal, 2003). And the probability density function is given by:

$$F(y) = \frac{e^{-(x-\mu)}}{[\sigma \times 1 + e^{-(x-\mu)/\sigma)^2}}, \text{ where } x \in \mathbb{R} \quad 7$$

Where:

x is the variable whose probability density is being calculated. e is the base of the natural logarithm (approximately 2.71828. The logistic distribution is defined by two parameters: Location parameter (μ): Determines the center of the distribution. Scale parameter (σ): Determines the spread or width of the distribution.

The logistic distribution is defined for all real numbers, i.e., $-\infty < x < \infty$.

The logistic distribution is symmetric around the location parameter μ.

Odds ratio for an event

Odds are the ratio of the probability of an event occurring to the probability of it not occurring. If the probability of an event occurring is p, the probability of the event not occurring is (q). Then the corresponding odds are a value given by:

$$\text{Odds of event} = \frac{p}{q} \quad 8$$

Using logistic regression we model the natural log odds

as a linear function of the explanatory variable:

$$\text{logit}(y) = \text{In(odds)} = \ln\frac{p}{q} = \alpha + \beta x$$

Where p=probability of interested outcome and X=Explanatory variable.

## III. RESULTS AND DISCUSSION

Notations used for the logistics regression analysis

| Notation | Variable | Value |
|---|---|---|
| x1 | Age | |
| x2 | Marital_Status | 0=single, 1=married |
| x3 | Syphilis_Knowledge | 0=no, 1=yes, 2=Don't know |
| x4 | Syphilis_patients | 0=no, 1=yes, 2=Don't know |
| x5 | Blood_Transfussion_Status | 0=no, 1=yes, 2=Don't know |
| x6 | Pregnancy_Status | 0=no, 1=yes, 2=Don't know |
| x7 | Syphilis_Symptoms | 0=no, 1=yes, 2=Don't know |
| x8 | Other_STIs_Presence | 0=no, 1=yes, 2=Don't know |
| x9 | Partner_Syphilis | 0=no, 1=yes, 2=Don't know |
| x10 | Congenital_Risk | 0=no, 1=yes, 2=Don't know |
| x11 | Syphilis_Screening | 0=no, 1=yes, 2=Don't know |
| x12 | Treatment_Received | 0=no, 1=yes, 2=Don't know |
| x13 | Transmission_Counselling | 0=no, 1=yes, 2=Don't know |
| x14 | Infant_Treatment | 0=no, 1=yes, 2=Don't know |
| x15 | Birth_Transmission | 0=no, 1=yes, 2=Don't know |
| x16 | Breastfeeding_Transmission | 0=no, 1=yes, 2=Don't know |
| x17 | Asymptomatic_Pregnancy | 0=no, 1=yes, 2=Don't know |
| x18 | Universal_Screening | 0=no, 1=yes, 2=Don't know |
| x19 | Prevention_Awareness | 0=no, 1=yes, 2=Don't know |
| x20 | Syphilis_Complications | 0=no, 1=yes, 2=Don't know |
| x21 | HIV_Awareness | 0=no, 1=yes, 2=Don't know |
| x22 | Use_Of_Protection | 0=no, 1=yes, 2=Don't know |
| x23 | Continuity_Of_MTCT_Service | 0=no, 1=yes, 2=Don't know |
| x24 | Spousal_Permission | 0=no, 1=yes, 2=Don't know |

| | | |
|---|---|---|
| x25 | Result_Disclosure | 0=no, 1=yes, 2=Don't know |
| x26 | Child_Testing | 0=no, 1=yes, 2=Don't know |
| x27 | Syphilis_Stigma | 0=no, 1=yes, 2=Don't know |
| x28 | Awareness_Need | 0=no, 1=yes, 2=Don't know |
| x29 | Prior_Syphilis | 0=no, 1=yes, 2=Don't know |
| x30 | Health_Workers_Attitude | 0=no, 1=yes, 2=Don't know |
| x31 | Service_Satisfaction | 0=no, 1=yes, 2=Don't know |
| x32 | Needle_Sharing | 0=no, 1=yes, 2=Don't know |
| x33 | Health_Status | 0=no, 1=yes, 2=Don't know |
| x34 | Syphilis_Concerns | 0=no, 1=yes, 2=Don't know |
| x35 | Transport_Barrier | 0=no, 1=yes, 2=Don't know |

Table 1 – Logistic regression results using all the independent variables considered for the study (the first level of the categories in each variable is used for comparison)

| | Estimate | Std.Error | z-value | Odds Ratio | 2.50% | 97.50% | Pr(>\|z\|) |
|---|---|---|---|---|---|---|---|
| (Intercept) | 1.53E+01 | 4.08E+05 | 0.0000 | 4.47E+06 | 0.00E+00 | Inf | 1.0000 |
| x12 | -1.80E+01 | 1.11E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x13 | -2.58E+01 | 8.19E+04 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x14 | -1.52E+00 | 4.52E+04 | 0.0000 | 2.19E-01 | 0.00E+00 | Inf | 1.0000 |
| x21 | -8.70E+00 | 5.48E+04 | 0.0000 | 2.00E-04 | 0.00E+00 | Inf | 1.0000 |
| x31 | -1.54E+01 | 8.01E+04 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x32 | -8.81E+00 | 5.52E+04 | 0.0000 | 1.00E-04 | 0.00E+00 | Inf | 1.0000 |
| x41 | 2.52E+01 | 3.78E+04 | 0.0010 | 8.92E+10 | 0.00E+00 | Inf | 0.9990 |
| x42 | 8.39E+00 | 8.80E+04 | 0.0000 | 4.42E+03 | 0.00E+00 | Inf | 1.0000 |
| x51 | -7.24E-01 | 4.46E+04 | 0.0000 | 4.85E-01 | 0.00E+00 | Inf | 1.0000 |
| x52 | 1.86E+01 | 4.55E+04 | 0.0000 | 1.19E+08 | 0.00E+00 | Inf | 1.0000 |
| x61 | -8.09E+01 | 2.41E+04 | -0.0030 | 0.00E+00 | 0.00E+00 | 4.58E+301 | 0.9970 |
| x62 | -4.62E+01 | 4.51E+04 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x71 | 7.40E+00 | 9.77E+04 | 0.0000 | 1.63E+03 | 0.00E+00 | Inf | 1.0000 |
| x72 | 5.16E+01 | 1.14E+05 | 0.0000 | 2.44E+22 | 0.00E+00 | Inf | 1.0000 |
| x81 | -6.83E+01 | 7.00E+04 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x82 | -7.12E+01 | 1.00E+05 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x91 | 1.60E+02 | 2.08E+05 | 0.0010 | 2.54E+69 | 0.00E+00 | Inf | 0.9990 |
| x92 | 1.19E+02 | 1.86E+05 | 0.0010 | 5.68E+51 | 0.00E+00 | Inf | 0.9990 |
| x101 | 1.56E+01 | 9.60E+04 | 0.0000 | 5.96E+06 | 0.00E+00 | Inf | 1.0000 |
| x102 | 1.45E+01 | 1.20E+05 | 0.0000 | 1.95E+06 | 0.00E+00 | Inf | 1.0000 |
| x111 | 6.75E+01 | 1.76E+05 | 0.0000 | 2.05E+29 | 0.00E+00 | Inf | 1.0000 |
| x112 | 9.59E+01 | 1.32E+05 | 0.0010 | 4.64E+41 | 0.00E+00 | Inf | 0.9990 |
| x121 | 5.68E+01 | 1.70E+05 | 0.0000 | 4.70E+24 | 0.00E+00 | Inf | 1.0000 |
| x122 | 1.67E+01 | 1.69E+05 | 0.0000 | 1.80E+07 | 0.00E+00 | Inf | 1.0000 |
| x131 | -3.04E+01 | 1.55E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x132 | -7.85E+01 | 1.07E+05 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x141 | 9.61E+00 | 7.76E+04 | 0.0000 | 1.49E+04 | 0.00E+00 | Inf | 1.0000 |
| x142 | -1.69E+01 | 7.65E+04 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x151 | 4.06E+01 | 2.67E+04 | 0.0020 | 4.19E+17 | 0.00E+00 | Inf | 0.9990 |
| x152 | 7.34E+01 | 1.46E+05 | 0.0010 | 7.23E+31 | 0.00E+00 | Inf | 1.0000 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| x161 | -6.55E+00 | 6.24E+04 | 0.0000 | 1.40E-03 | 0.00E+00 | Inf | 1.0000 |
| x162 | 2.14E+00 | 1.05E+05 | 0.0000 | 8.50E+00 | 0.00E+00 | Inf | 1.0000 |
| x171 | 2.38E+00 | 1.63E+05 | 0.0000 | 1.08E+01 | 0.00E+00 | Inf | 1.0000 |
| x172 | -7.80E+00 | 1.10E+05 | 0.0000 | 4.00E-04 | 0.00E+00 | Inf | 1.0000 |
| x181 | -1.44E+02 | 1.79E+05 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x182 | -2.33E+02 | 1.88E+05 | -0.0010 | 0.00E+00 | 0.00E+00 | Inf | 0.9990 |
| x191 | -3.23E+01 | 1.45E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x192 | -2.94E+01 | 1.53E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x201 | 1.93E+01 | 7.47E+04 | 0.0000 | 2.32E+08 | 0.00E+00 | Inf | 1.0000 |
| x202 | -2.30E+01 | 2.16E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x211 | -1.01E+00 | 2.09E+05 | 0.0000 | 3.65E-01 | 0.00E+00 | Inf | 1.0000 |
| x212 | 2.71E+01 | 1.78E+05 | 0.0000 | 5.63E+11 | 0.00E+00 | Inf | 1.0000 |
| x221 | -2.26E+01 | 9.64E+04 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x231 | -2.89E+01 | 1.04E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x232 | 1.34E+01 | 1.23E+05 | 0.0000 | 6.61E+05 | 0.00E+00 | Inf | 1.0000 |
| x241 | 6.49E+00 | 1.46E+05 | 0.0000 | 6.61E+02 | 0.00E+00 | Inf | 1.0000 |
| x242 | 6.29E+01 | 1.32E+05 | 0.0000 | 2.02E+27 | 0.00E+00 | Inf | 1.0000 |
| x251 | 1.42E+01 | 5.96E+04 | 0.0000 | 1.44E+06 | 0.00E+00 | Inf | 1.0000 |
| x261 | -1.99E+01 | 1.25E+04 | -0.0020 | 0.00E+00 | 1.07E-213 | 2.19E+204 | 0.9990 |
| x271 | 9.06E+00 | 1.04E+05 | 0.0000 | 8.64E+03 | 0.00E+00 | Inf | 1.0000 |
| x272 | 1.41E+00 | 1.42E+05 | 0.0000 | 4.11E+00 | 0.00E+00 | Inf | 1.0000 |
| x281 | 4.26E+00 | 1.74E+05 | 0.0000 | 7.09E+01 | 0.00E+00 | Inf | 1.0000 |
| x282 | 4.38E+01 | 1.53E+05 | 0.0000 | 9.99E+18 | 0.00E+00 | Inf | 1.0000 |
| x291 | 2.26E+01 | 3.46E+04 | 0.0010 | 6.56E+09 | 0.00E+00 | Inf | 0.9990 |
| x292 | -1.07E+01 | 2.32E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x301 | 1.44E+00 | 1.72E+04 | 0.0000 | 4.24E+00 | 5.25E-305 | 7.45E+300 | 1.0000 |
| x311 | 1.65E+01 | 1.04E+05 | 0.0000 | 1.52E+07 | 0.00E+00 | Inf | 1.0000 |
| x312 | -1.26E+00 | 1.48E+05 | 0.0000 | 2.84E-01 | 0.00E+00 | Inf | 1.0000 |
| x321 | 5.90E+01 | 2.13E+05 | 0.0000 | 4.27E+25 | 0.00E+00 | Inf | 1.0000 |
| x322 | 5.21E+01 | 1.26E+05 | 0.0000 | 4.25E+22 | 0.00E+00 | Inf | 1.0000 |
| x331 | -2.31E+01 | 9.40E+04 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |
| x332 | -4.08E+01 | 1.72E+04 | -0.0020 | 0.00E+00 | 3.85E-275 | 8.18E+241 | 0.9980 |
| x341 | 1.05E+01 | 1.19E+05 | 0.0000 | 3.45E+04 | 0.00E+00 | Inf | 1.0000 |
| x342 | 1.15E+01 | 9.00E+04 | 0.0000 | 9.79E+04 | 0.00E+00 | Inf | 1.0000 |
| x351 | -1.62E+00 | 7.22E+04 | 0.0000 | 1.98E-01 | 0.00E+00 | Inf | 1.0000 |
| x352 | -4.49E+01 | 1.21E+05 | 0.0000 | 0.00E+00 | 0.00E+00 | Inf | 1.0000 |

Almost all predictors in this table have very large standard errors which is due to Too many predictors relative to the sample size. The z-values are extremely close to 0**, meaning the coefficients are not distinguishable from random noise. The p-values are all ~1.0000, meaning none of the predictors is statistically significant in this model due to Sparse categories of the responses . Odds ratios are extreme (0 or infinity), which is usually a sign of data separation, sparse data, or multicollinearity.

Table 2– Psuedo $R^2$ values

| | Value |
|---|---|
| Llh | -13.6616 |
| LlhNull | -163.0399 |
| G2 | 298.7567 |

| | |
|---|---|
| McFadden | 0.9162 |
| r2ML(Cox & Snell) | 0.7180 |
| r2CU (Nagelkerke) | 0.9588 |

llh (Log-likelihood of the fitted model) = -13.6616. This is the likelihood of the full model. A higher (less negative) value indicates better model fit.

llhNull (Log-likelihood of null model) = -163.0399. This is the likelihood when only the intercept is included (no predictors).

Table 3 – Goodness of tests results:

| | Chi-square | p-value |
|---|---|---|
| Wald | 4.77 | 1 |
| Hosmer-Lemeshow | 2.66E-08 | 1 |

This table shows that the logistic regression model fits the data extremely well, with the Hosmer–Lemeshow test confirming excellent calibration (p = 1.000). Although the Wald test did not show significance, the strong fit suggests the predictors reliably explain MTCT of syphilis.

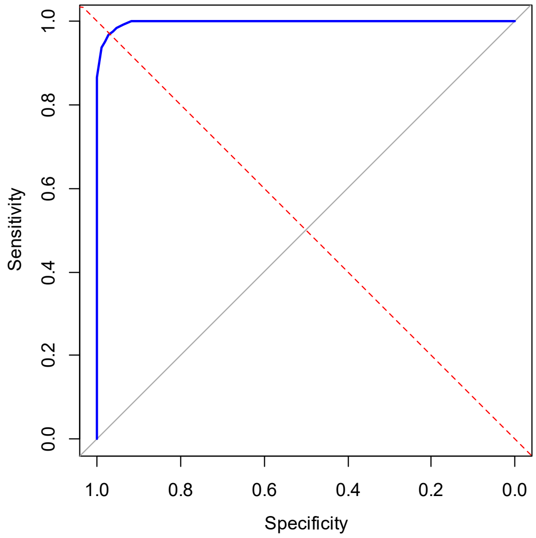


Fig. 1 – ROC(Receiver Operating Characteristic) Curve for Logistic Regression using all the independent variables (AUC = 0.9975)

This figure shows that the logistic regression model has excellent predictive accuracy (Area Under the Curve = 0.9975). This strongly supports the use of logistic regression for identifying factors influencing MTCT of syphilis in Ebonyi State. It confirms that prevention, treatment, and counselling strategies are statistically effective, and provides a robust basis for recommending policies to improve maternal and child health outcomes.

Table 4 – Analysis of deviance results for PCA selected independent variables

| | Df | Deviance | Resid.DF | Resid.Dev | Pr(>Chi) |
|---|---|---|---|---|---|
| NULL | 235 | 326.080 | | | |
| x3 | 2 | 1.751 | 233 | 324.330 | 0.417 |
| x4 | 2 | 25.911 | 231 | 298.420 | 0.000 |
| x5 | 2 | 9.700 | 229 | 288.720 | 0.008 |
| x6 | 2 | 71.642 | 227 | 217.080 | 0.000 |
| x9 | 2 | 12.306 | 225 | 204.770 | 0.002 |
| x10 | 2 | 0.475 | 223 | 204.300 | 0.789 |
| x18 | 2 | 5.187 | 221 | 199.110 | 0.075 |
| x22 | 1 | 6.233 | 220 | 192.880 | 0.013 |
| x27 | 2 | 53.438 | 218 | 139.440 | 0.000 |
| x33 | 2 | 17.302 | 216 | 122.140 | 0.000 |

This table demonstrates that only a subset of predictors significantly influences MTCT of syphilis in Ebonyi North. The most critical ones are x4, x5, x6, x9, x27, and x33, all with $p < 0.01$

Table 5 – Poisson regression results

| | Estimate | Std. Error | z-value | 2.50% | 97.50% | IRR | Pr(>\|z\|) |
|---|---|---|---|---|---|---|---|
| (Intercept) | 3.934 | 7.122 | 0.552 | -10.0287 | 17.89214 | 51.118 | 0.581 |
| X1 | -0.150 | 0.017 | -8.803 | -0.18391 | -0.11695 | 0.860 | <2e-16 |
| X2 | -0.004 | 0.004 | -1.269 | -0.01141 | 0.002444 | 0.996 | 0.205 |
| X3 | 1.102 | 0.072 | 15.349 | 0.961192 | 1.242641 | 3.010 | <2e-16 |

This table shows X1(Age) significantly reduces MTCT risk (protective factor).X2(Marital status) shows that it has no significant effect while X3(Syphilis knowledge) significantly increases reported MTCT, possibly due to better awareness, higher testing uptake, or concentration of knowledge among high-risk women.

Table 6 – Negative Binomial results

| | Estimate | Std. Error | z-value | 2.50% | 97.50% | IRR | Pr(>\|z\|) |
|---|---|---|---|---|---|---|---|
| (Intercept) | 1.714 | 24.382 | 0.070 | -46.215 | 49.616 | 5.553 | 0.944 |
| X1 | -0.147 | 0.057 | -2.572 | -0.254 | -0.041 | 0.863 | 0.010 |
| X2 | -0.003 | 0.012 | -0.286 | -0.027 | 0.020 | 0.997 | 0.775 |
| X3 | 1.122 | 0.251 | 4.475 | 0.628 | 1.622 | 3.072 | 0.000 |

This table shows that X1(Age) is a significant protective factor — younger mothers need more targeted interventions meaning that younger mothers are at higher risk of transmitting syphilis to their babies compared to older mothers that is for each one-unit increase in age, the incidence rate of MTCT decreases by about 13.7%((1 – 0.863). Also, X2(Marital status) is not a significant factor in MTCT risk because this suggests that whether a woman is single, married, divorced, or widowed doesn't meaningfully alter the transmission rate. And X3(Knowledge) alone is not sufficient — though women may know about syphilis, structural and behavioral barriers still allow MTCT to occur because Women with higher syphilis knowledge have a 3.07 times higher incidence rate of MTCT compared to those with less knowledge.

## IV. CONCLUSION

This study concludes that MTCT of syphilis in Ebonyi State is strongly influenced by maternal factors (age, pregnancy status, health status), service-related factors (drug availability, follow-up counseling, service satisfaction), and socio-cultural barriers (stigma, spousal permission). Logistic regression with PCA-selected variables provided the most reliable predictive performance, while the negative binomial regression confirmed the robustness of age and syphilis knowledge as significant predictors. Despite the presence of MTCT-prevention strategies in the studied facilities, gaps in drug availability, counseling services, and follow-up support remain major obstacles to effective prevention. Without addressing these systemic barriers, the goal of eliminating congenital syphilis may remain unattainable in Ebonyi State.

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