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Risk Factors Associated with Mother-to-Child HIV Transmission in Wukari Local Government Areas (LGAs), Taraba State

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Abstract

Mother-to-child transmission (MTCT) of HIV continues to pose a major public health concern in Nigeria, particularly in sub-Saharan Africa. This study investigated the factors influencing MTCT of HIV in Wukari Local Government, Taraba State, using secondary data from 550 nursing mothers attending the General Hospital. A cross-sectional design was adopted, with chi-square tests used to assess associations between MTCT and maternal characteristics, while binary logistic regression identified predictors of transmission. The MTCT rate was 11.5% (63/550). Chi-square analysis revealed significant associations with maternal age ($\chi^2 = 8.181$, $p = 0.017$), mode of delivery ($\chi^2 = 68.469$, $p < 0.001$), maternal education ($\chi^2 = 12.729$, $p = 0.005$), and antenatal care (ANC) visits ($\chi^2 = 36.672$, $p < 0.001$). Logistic regression showed that mothers aged 25–35 years (OR = 3.299) and above 35 years (OR = 3.930) had higher odds of transmission than those under 25. Caesarean delivery markedly increased transmission risk (OR = 15.964), while ANC visits were unexpectedly associated with higher

odds (OR = 12.851). Higher maternal weight appeared protective (OR = 0.951). The findings demonstrate that maternal age, delivery mode, and ANC patterns are significant determinants of MTCT of HIV. Targeted interventions are needed for older mothers and to strengthen prevention strategies, particularly in the context of caesarean deliveries, to reduce transmission rates and improve maternal–child health outcomes.

Keywords: HIV; Mother-to-Child Transmission; Risk Factors; Nigeria; Prevention Strategies

INTRODUCTION

Human Immunodeficiency Virus (HIV) continues to pose a formidable global health challenge, with mother-to-child transmission (MTCT) representing a critical pathway for pediatric HIV infection. The World Health Organization (WHO, 2023) reports that HIV has claimed 40.1 million lives globally, with an estimated 38.4 million individuals currently living with the virus. Sub-Saharan Africa bears the heaviest burden, accounting for approximately two-thirds of global HIV cases.

In Nigeria, HIV infection among women of childbearing age remains a significant concern. The Joint United Nations Programme on HIV/AIDS (UNAIDS, 2021) reported that Nigeria ranked second globally, after South Africa, in new HIV infections among women, with 110,000 new infections among women aged 15-49 years. This high prevalence among reproductive-aged women directly impacts MTCT rates. Without intervention, MTCT risk ranges from 25% to 40%, with transmission occurring during pregnancy (10-25%), labor and delivery (35-40%), and breastfeeding (35-40%) (Volmink & Marais, 2008; King et al., 2013). However, effective prevention of mother-to-child transmission (PMTCT) strategies can reduce this risk to less than 2%. Several factors influence MTCT risk, including advanced maternal disease stage, absence of antiretroviral (ARV) intervention, vaginal delivery, breast pathology, and feeding practices (Ministry of Health, Ethiopia, 2016). Understanding these factors within the Nigerian context is crucial for developing effective prevention strategies.

METHODS

Study Design and Setting

This cross-sectional study was conducted in Wukari Local Government Area, Taraba State, Nigeria. Wukari covers 4,308 square kilometers with a population of 241,546 (2006 census) and serves as the base of the Wukari Federation, primarily inhabited by the Jukun people.

Data Collection

Secondary data were collected from clinic registers at the General Hospital in Wukari Local Government, focusing on nursing mothers who sought treatment at the facility. The dataset included 550 cases with complete information on key variables.

Variables

The dependent variable was MTCT status (Yes/No).

Independent variables included:

- Maternal age (categorized as <25, 25-35, >35 years)
- Educational qualification (No education, Primary, Secondary, Tertiary)
- Number of antenatal care visits (0-3 visits, >3 visits)
- Mode of delivery (Normal delivery, Caesarean section)
- Parity (0-2 children, >2 children)
- CD4 count
- Maternal weight

Method of Data Analysis

This study uses two statistical methods to analyze data on mother-to-child transmission (MTCT) of HIV:

1. **Chi-square Test** – Examines the association between MTCT status (occurred or not) and independent variables like maternal age, education, antenatal visits, delivery mode, parity, and weight. It identifies statistically significant relationships.

2. **Binary Logistic Regression** – Models the binary outcome of MTCT (Yes/No) to assess contributing factors. This method estimates the impact of each variable while controlling for others, helping identify key predictors and their influence on MTCT risk.

The Pearson's chi-square χ^2 test formula to calculate the test statistic is given by:

$$\chi^2 = \sum_{i=1}^{n} \frac{\left(O_f - E_f\right)^2}{E_f} \qquad (1)$$

Where:

χ^2 is the chi-square test statistic

Σ is the summation operator (it means "take the sum of")

O_f is the observed frequency E_f is the expected frequency

The chi-square test for a two-way table with r rows and c columns uses critical values from the chi-square distribution with (r – 1)(c – 1) degrees of freedom. Where r is the number of rows and c is the number of columns. The decision rule for this test stated that Reject H_o if $\chi^2_{cal} > \chi^2_{tab}$, otherwise do not reject H_o.

Binary Logistics Regression

Logistic regression is a category of the generalized linear model (GLM) the follows a Bernoulli (binary) distribution. The dependent variable is usually dichotomous, that is the dependent variable can take a value of 1 with a probability of success or the value of 0, with a probability of failure. The basic mathematical concept that underlay logistic regression is the natural logarithm of an odds ratio (Logit) (Park, 2013). The Logit model analyses the relationship between multiple independent variables and a categorical dependent variable and then estimates the probability of occurrence of an event by fitting data to a Logistic curve (Park, 2013). The mean of the response variable Y in terms of an explanatory variable X_i is modeled relating Y and X through the equation $Y = \beta_0 + \beta_i X_i$. Relationship between $\pi(x)$ and x are usually non-linear rather than linear. For a binary response variable Y and an explanatory variable X, let

$$\pi(x) = P(Y = 1 / X = x) \quad (3)$$

The Logistic regression model is

$$\pi(x) = \frac{\exp(\beta_0 + \beta_i x_i)}{1 + \exp(\beta_0 + \beta_i x_i)} = \frac{e^{\beta_0 + \beta_i x_i}}{1 + e^{\beta_0 + \beta_i x_i}} \quad (4)$$

In this study, the probability of status of MTCT under the logistic model is

$$Logit(\pi(x)) = \log\left(\frac{\pi(x)}{1 - \pi(x)}\right) = \beta_0 + \beta_1 A + \beta_2 E + \beta_3 ANC + \beta_4 MD + \beta_5 P + \beta_6 MW \quad (5)$$

Where

$\beta_0 = Intercept$

$\beta_i = Slope\ (Coefficient\ of\ the\ Explanatory\ Variables)\ \ i = 1, 2, ..., 6$

A=Age of the Mothers

E=Mother's Education

ANC=Antenatal Care Visit

MD=Model of Delivery

P=Parity

MW=Mother's Weight

The Wald statistic

A Wald test is used to test the statistical significance of each coefficient ($\hat{\beta}$) in the model. A Wald test calculates a Z statistic, which is:

$$Z = \frac{\hat{\beta}}{SE(\hat{\beta})} \quad (6)$$

Where $\hat{\beta}$ coefficient in the model and SE is the standard error of the coefficient estimated

100(1-α) % Cl for β_i:

$\hat{\beta}_i + Z_{\alpha/2} SE\left(\hat{\beta}_i\right)$ where $\hat{\beta}_i$ and $SE\left(\hat{\beta}_i\right)$ are obtained from printout and Z from N (0,1) tables.

CI for Odds Ratio: exp (CI for $\hat{\beta}_i$)

Thus, if we consider Model, and if X_i denotes a (0, 1) exposure variable of interest, then a 95% confidence interval for the adjusted odds ratio is given by;

$$\exp(\hat{\beta}_i \pm 1.96 \times SE\left(\hat{\beta}_i\right) \quad (7)$$

RESULTS

Social-Demographic Characteristics of the Respondents

Socio-demographic variables include the following factors: Mother to Child Transmission of HIV/AIDS, Mode of delivery, Mother's Age, ANC Visits, Parity (Number of Children Ever had), and Mother's Education. Table 1 presents the frequency and percentage distribution of various categorical variables related to the transmission of HIV/AIDS from mother to child. A total of 550 cases were considered in this study. Among them, 487 cases (88.5%) showed no transmission of HIV/AIDS from mother to child, while 63 cases (11.5%) indicated transmission of HIV/AIDS from mother to child. Regarding the mode of delivery, 189 cases (34.4%) involved Caesarean delivery, whereas 361 cases (approximately 65.6%) had a normal delivery. In terms of the mother's age, 174 cases (31.6%) had mothers under 25 years old, 281 cases (51.1%) had mothers between 25 and 35 years old, and 95 cases (17.3%) had mothers above 35 years old. Concerning ANC visits, 274 cases (49.8%) had 0-3 ANC visits, and 276 cases (about 50.2%) had more than 3 ANC visits. As for Parity (Number of Children Ever Had), 345 cases (62.7%) had 0-2 children, while 205 cases (37.3%) had more than 2 children. Finally, with respect to mother's education, out of 550 cases, 276 (50.2%) had no education, 96 (17.5%) had primary education, 85 (15.5%) had secondary education, and 93 (16.9%) had tertiary education.

Association Between Socio-Demographic Characteristics and Mothers to Child Transmission of HIV/AIDS

Table 2 shows the test of association between outcome (transmission of HIV/AIDS from mother to child) and independent (Mode of delivery, Mother's Age,

ANC Visits, Parity (Number of Children Ever had) and Mother's Education). The interpretation of the results for each predictor variable are as follows:

Mother's Age:

The chi-square test for Mother's Age has a test statistic of 8.181 and a p-value of 0.017, which is less than the significance level of 0.05. This result indicates that there is a significant association between the mother's age group and the transmission of HIV/AIDS from mother to child.

Mode of Delivery:

The chi-square test for Mode of Delivery has a test statistic of 68.469 and a p-value of 0.000, which is less than the significance level of 0.05. This result indicates that there is a significant association between the mode of delivery (Caesarean Section or Normal Delivery) and the transmission of HIV/AIDS from mother to child.

Mother's Education:

The chi-square test for Mother's Education has a test statistic of 12.729 and a p-value of 0.005, which is less than the significance level of 0.05. This result indicates that there is a significant association between the mother's educational qualifications and the transmission of HIV/AIDS from mother to child.

ANC Visits:

The chi-square test for ANC Visits has a test statistic of 36.672 and a p-value of 0.000, which is less than the significance level of 0.05. This result indicates that there is a significant association between the number of ANC visits and the transmission of HIV/AIDS from mother to child.

Parity (Number of Children Ever Had):

The chi-square test for Parity has a test statistic of 0.168 and a p-value of 0.682, which is greater than the significance level of 0.05. This result indicates that there is no significant association between the number of children a mother has had and the transmission of HIV/AIDS from mother to child.

Therefore, the chi-square test results show that Mother's Age, Mode of Delivery, Mother's Education, and ANC Visits are significantly associated with the transmission of HIV/AIDS from mother to child. However, there is no significant association between

Parity (Number of Children Ever Had) and the transmission of HIV/AIDS from mother to child.

Table 1: Demographic Characteristics of Mother-to-Child Transmission of HIV/AIDs

Variables	Categories	Frequency	Percentage
Mother to Child Transmission of HIV/AIDs	No	487	88.5
	Yes	63	11.5
	Total	550	100.0
Model of Delivery	Caesarean Delivery	189	34.4
	Normal Delivery	361	65.6
	Total	550	100.0
Mother's Age	Less than 25 years	174	31.6
	25-35 years	281	51.1
	Above 35 years	95	17.3
	Total	550	100.0
ANC Visits	0-3 Visits	274	49.8
	Above 3 Visits	276	50.2
	Total	550	100.0
Parity (Number of Children Ever had)	0-2 Children	345	62.7
	Above 2 Children	205	37.3
	Total	550	100.0
Mother's Education	No Education	276	50.2
	Primary Education	96	17.5
	Secondary Education	85	15.5
	Tertiary Education	93	16.9
	Total	550	100.0

Table 2: Chi-Square Test on Demographic Characteristics and Outcome of Mothers to Child Transmission of HIV/AIDS

Variables	Categories	Mothers to Child Transmission of HIV/AIDS		Total	Chi-Square Value	P-value	Remark
		No	Yes				
Mother's Age	Less than 25 years	149 (154.1)	25 (19.9)	174	8.181	0.017*	Significant
	25-35 years	246 (248.8)	35 (32.2)	281			
	Above 35 years	92 (84.1)	3 (10.9)	95			
	Total	487	63	550			
Mode of Delivery	Caesarean Section	138 (167.4)	51 (21.6)	189	68.469	0.000*	Significant
	Normal Delivery	349 (319.6)	12 (41.4)	361			
	Total	487	63	550			
Mother's Education	No Education	245 (244.4)	31 (31.6)	276	12.729	0.005*	Significant
	Primary Education	86 (85)	10 (11)	96			
	Secondary Education	67 (75.3)	18 (9.7)	85			
	Tertiary Education	89 (82.3)	4 (10.7)	93			
	Total	487	63	550			
ANC Visits	0-3 Visits	220 (242.6)	54 (31.4)	274	36.672	0.000*	Significant
	Above 3 Visits	267 (244.4)	9 (31.6)	276			
	Total	487	63	550			
Parity (Number of Children Ever had)	0-2 Children	304 (305.5)	41 (39.5)	345	0.168	0.682	No Significant
	Above 2 Children	183 (181.5)	22 (23.5)	205			
	Total	487	63	550			

Key: * Significant at 5% level

Observed frequency (Expected frequency)

Goodness of Fit Tests

Table 3 show the goodness of fit test for binary logistic regression. The Hosmer-Lemeshow test is a goodness-of-fit test used to assess how well a logistic regression model fits the observed data. It checks whether the predicted probabilities from the model match the observed outcomes across different groups or bins of predicted probabilities. In the given table, the Hosmer-Lemeshow test has a test statistic (Chi-Square) of 20.336 and a p-value of 0.951. The p-value represents the probability of observing the test statistic under the null hypothesis that the model fits the data well. In this case, since the p-value is quite high (greater than the common significance level of 0.05), we do not have enough evidence to reject the null hypothesis. This suggests that the logistic regression model fits the observed data reasonably well.

Table 3: Goodness-of-Fit Tests

Test	Chi-Square	P-Value
Hosmer-Lemeshow	20.336	0.951

Table 4: Binary Logistics Regression of Mother to Child Transmission of HIV/AIDS on the independent variables (Mother's age, mode of delivery, CD4 count, educational, ANC visit and parity)

	Coefficient (β)	Standard Error	Wald (Z)	P-value	Odd Ratio Exp(β)
Mother's Age Less than 25 years (Ref)					1.000
25-35 years	1.194	0.737	2.623	0.105	3.299
Above 35 years	1.369	0.684	4.000	0.046	3.930
Mode of Delivery Normal Delivery (Ref)					1.000
Caesarean Section	2.770	0.407	46.432	0.000	15.964
CD4 Count	0.000005	0.000018	0.280	0.783	1.000
Mothers Weight	-0.051	0.017	9.230	0.002	.951
Educational Qualifications No Education (Ref)					1.000
Primary Education	0.820	0.651	1.586	0.208	2.271

	Coefficient (β)	Standard Error	Wald (Z)	P-value	Odd Ratio Exp(β)
Secondary Education	-0.089	0.716	0.016	0.901	.915
Tertiary Education	1.062	0.702	2.287	0.130	2.891
ANC Visit	2.553	0.478	28.529	0.000	12.851
Parity	0.203	0.388	0.273	0.601	1.225
Constant	-4.612	1.331	12.012	0.001	0.010

Ref: Reference Variable

Interpretation of the Binary Logistic Regression Model

Table 4 displays the results of the logistic regression model, including estimated coefficients, standard errors, Wald statistics (Z-values), p-values, and odds ratios for each predictor variable. The p-values indicate the statistical significance of the predictors in relation to the outcome. If a p-value is less than the chosen significance level (commonly 0.05), the variable is considered statistically significant, implying it has a substantial impact on the outcome. Otherwise, it is not deemed statistically significant.

For mothers aged between 25 and 35 years, the odds of the outcome (transmission of HIV/AIDS from mother to child) are approximately 3.299 times higher than for mothers under 25 years. Similarly, for mothers above 35 years, the odds of the outcome are approximately 3.930 times higher than for mothers under 25 years.

Concerning the mode of delivery, mothers who had a caesarean section exhibit odd of the outcome that are approximately 15.964 times higher than mothers who had a normal delivery. When considering CD4 Count, it has no significant effect on the outcome, as the p-value is 0.783 (greater than the typical significance level of 0.05).

Regarding Mother's weight, for each unit increase in mother's weight, the odds of the outcome decrease by a factor of 0.951. For mothers with primary education, the odds of the outcome are approximately 2.271 times higher than for mothers with no education. For those with secondary education, the odds of the outcome are not significantly different from those with no education, as the p-value is 0.901. However, for mothers with tertiary education, the odds of the outcome are approximately 2.891 times higher than for mothers with no education.

In relation to ANC visits, the odds of the outcome for mothers who had Antenatal Care visits are approximately 12.851 times higher than for mothers who did not have ANC visits. Lastly, parity (the number of children a woman has given birth to) has no significant effect on the outcome, as the p-value is 0.601.

DISCUSSION

The results of the logistic regression analysis provide valuable and novel insights into the factors influencing the transmission of HIV/AIDS from mother to child. Compared to women under 25 years of age, both mothers aged 25 to 35 and those above 35 have significantly higher chances of transmitting HIV/AIDS to their offspring. This conclusion is consistent with previous research, which has indicated that older mothers may face a higher risk of vertical transmission due to factors such as prolonged viral exposure and associated comorbidities (Mepham et al., 2011; Warszawski et al., 2008).

Similarly, mothers who underwent a Caesarean section have significantly higher odds of transmitting HIV/AIDS to their offspring compared to mothers who gave birth naturally. This finding is in line with previous research suggesting that elective Caesarean sections may increase the risk of vertical transmission, possibly due to the procedure's increased exposure to maternal blood (Cooper et al., 2007; Read et al., 2007).

Contrary to expectations, the critical immunological health indicator, CD4 count, showed no impact on the transmission of HIV/AIDS from mother to fetus. This suggests that a mother's CD4 count may not significantly influence the chance of vertical transmission. Previous research has produced conflicting findings regarding the relationship between CD4 count and the risk of vertical transmission (Clouse et al., 2013; Yargawa & Leonardi-Bee, 2015).

Interestingly, for each unit increase in the mother's weight, the odds of the outcome (transmission of HIV/AIDS to the child) decreased by a factor of 0.951. This indicates that higher maternal weight might be associated with a lower risk of vertical transmission. However, this finding requires further exploration, as the relationship between maternal weight and HIV transmission risk is not well-established (Buchmann et al., 2010; Zolfo et al., 2011).

Regarding education, compared to mothers without education, those with only an elementary education had noticeably higher probabilities of passing on HIV/AIDS. However, there were no significant differences in the odds of transmission between mothers with secondary education and those without. On the other hand, the odds of transmitting HIV/AIDS were significantly higher for mothers with tertiary education. This intricate link between education and transmission risk may be influenced by various social and behavioral factors (Dahl et al., 2015; Myer et al., 2013).

Unexpectedly, mothers who had Antenatal Care (ANC) visits had significantly higher odds of transmitting HIV/AIDS to their children compared to those who did not have ANC visits. This finding contradicts previous research that has associated ANC visits with improved prevention of mother-to-child transmission outcomes (Clouse et al., 2013; Zolfo et al., 2011). Further investigation is required to understand this association better.

Lastly, the number of children a mother has given birth to (parity) showed no significant effect on the transmission of HIV/AIDS to the child. This finding aligns with some previous studies that have reported no clear association between parity and vertical transmission risk (Dahl et al., 2015; Myer et al., 2013).

CONCLUSION

This study identifies maternal age, mode of delivery, and ANC visit patterns as significant factors in MTCT of HIV in Wukari Local Government. Key recommendations include:

i. Targeted Prevention: Implement age-specific counseling and monitoring for mothers aged 25-35 years and above 35 years, who demonstrate higher transmission risk.

ii. Delivery Mode Assessment: Carefully evaluate caesarean delivery indications for HIV-positive mothers and optimize pre-operative viral load suppression when caesarean delivery is necessary.

iii. ANC Service Quality: Review and strengthen PMTCT service delivery within antenatal care programs to ensure effective prevention strategies are implemented.

iv. Nutritional Support: Consider maternal nutritional assessment and support as components of comprehensive PMTCT programs.

v. Further Research: Conduct prospective studies to clarify the mechanisms underlying the unexpected associations with ANC visits and caesarean delivery.

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