

STRUCTURAL EQUATION MODELING OF CHOICE OF PLACE OF DELIVERY IN NIGERIA

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ABSTRACT: Medical problems are often experienced during child delivery in a poor place of delivery and health care. The use of immediate health indicator as direct proxies for choice making biases estimates that these proxies are poor correlates. This study is aimed at investigating the hypothesized relationship and effect between choice of place of delivery and among socio demographic risk factors by using Single Factor Model(SFM) in Structural Equation Modeling (SEM). Result of our findings shows that Place of residence, mother education, mother age, mother occupation, marital status and religion are hypothetically significantly correlated with choice of place of delivery. Overall, the measurement model perfectly fits the covariance ($\chi^2 = 8451.279$ with p value =0.000, $df =14$). The model achieved a good fit for a dataset with the sample size adequate for the Chi-Square test. Thus, the measurement model in structural equation modeling is appropriate for the analysis. The importance of the choice of place of delivery cannot be overemphasized. Therefore, government at all levels should provide a means of informing women about it.

KEYWORDS: Measurement model; single factor model and structural equation modeling.

1. INTRODUCTION

High rate of medical errors have been established as a major challenge to women and infants during childbirth. In the healthcare industry, medical errors are becoming an especially serious problem ([KCD99]) and human error in numerous industries. Due to the effect of place of delivery to mortality, the choice of it is closely related to the quality health service and safe delivery. Place of delivery is a major factor for mortality, which associates with other determinants of maternal mortality and infantile mortality. Mortality has been difficult to measure accurately in resource poor states in Nigeria because most birth take place outside health facilities and without skilled attendants in Sub sahara African. From a study it was reported that about 50% of births were attended to by a skilled health workers in African countries ([***14]). However, this is low to the global expectation which ensures that at least 90% of birth worldwide be

attended to by skilled health workers by 2015 ([***11]).

Women and newborn babies in Nigeria are dying as a result of poor place of delivery before and after childbirth. Home delivery is inexpensive option but with risk of infection and that complication often occurs during childbirth because of unavailable health facilities. Non availability of maternal and child health facilities during pregnancy responsible for this home delivery. ([O+05]) reported that private maternity center and traditional birth attendant (TBAs) were the preferred place for child birth and government health facilities available in the south zone of Nigeria were underutilized. A result from a community based cross sectional study revealed that 55(39.3%), 85(60.7%) women opted for home and hospital delivery respectively among 140 pregnant women in the index pregnancy in Russia village of Jos, North Local Government Area of Plateau state, Nigeria ([E+13]). In another study high rate of home delivery and delivery not supervised by skilled attendants, low maternal education, unemployment among fathers and age increase the likelihood of home delivery in Sabuwar Unguwa, Magume district of Zaria in Kaduna state ([IGS06]). Of all the factors examined only distance from healthcare facilities, women education and their ages were the strongest determinants of place of delivery and used of maternal healthcare service in a rural Nigeria community ([E114]). Proximity and accessibility to a health facility and the availability of skilled health worker in the nearest health facility were the consistent influencers for the place of delivery after controlling for confounders in Yobe state of Nigeria ([UB16]).

Majority of maternal and infantile mortality that occur are avoidable if deliveries are supervised by skilled attendants. Nigeria alone has 38% of the estimated 8.3 million annual pregnancies that were attended to by skilled health workers in 2010 ([***13, ***09]) also reported difference between and within the six geopolitical zones of Nigeria with north east having the highest maternal mortality rate. It has been reported that most women deliver at

home for reasons. From recent Demograph and Health Survey (DHS) data in more than 50 developing countries shows that women with little education, little knowledge of health service are less likely to use basic health service such as immunization, maternal care and family planning. The identified reasons for not using obstetric services are financial constraints, lack of awareness of maternity waiting homes, no perceived need for such service, preference for home delivery and location.

2. LITERATURE REVIEW ON STRUCTURAL EQUATION

Structural Equation Modeling (SEM) is a multiple regression method of analysis for testing hypotheses about the relationship among observed and unobserved, latent variable ([Hoy95]). SEM was invented and had its roots in path analysis by the geneticist Sewall Wright ([Wri18, TK09]). It is visualized by Graphical path diagrams. This Path diagram consists of boxes and circles connected by arrow. These arrows are single headed arrow to define causal relationship (regression coefficients) in the model and double headed arrows to indicate covariance or correlation and in extension means and variance ([Ard96]). Latent (unmeasured) variables are represented by circles and observe (measured) variables by rectangles or squares. SEM is classed into a measurement model and a structural model. The measurement model relates observed responses or 'indicators' to latent variables and sometimes to observed covariates while structural model then specifies relations among latent variables and regressions of latent variables on observed variables. ([JMB82]) proposed two step approach to SEM to assess the fit of the structural equation model among latent variables (structural model) independently of assessing the fit of the observed variables to the latent variables (measurement model) and in addition establishing relationship between measurement and structural model.

The measurement models comprise of both confirmatory factor models and mixture models (e.g., latent class analysis). In the full structural equation or Linear Structural RELations (LISREL) model, the following relations are specified among continuous latent dependent variables $\eta = (\eta_1, \eta_2, \dots, \eta_n)$ and continuous latent explanatory variables $\xi = (\xi_1, \xi_2, \dots, \xi_m)$

$$\eta = B\eta + \Gamma\xi + \zeta \quad (1)$$

Here **B** is a matrix of structural parameters relating the latent dependent variables to each other, Γ is a

matrix of structural parameters relating latent dependent variables to latent explanatory variables and ζ is a vector of disturbances. We define $\Phi = \text{cov}(\xi)$ and $\Psi = \text{cov}(\zeta)$ and assume that $E(\zeta) = \mathbf{0}$, $E(\xi) = \mathbf{0}$ and $\text{cov}(\xi, \zeta) = \mathbf{0}$.

Confirmatory factor models are specified for ξ

$$y = \Delta_y \xi + \delta \quad (2)$$

where **y** are continuous measures, y is the factor loading matrix and Δ_y is the covariance matrix of Θ_δ . It is assumed that $E(\delta) = \mathbf{0}$, $\text{cov}(\delta, \xi) = \mathbf{0}$. Thus, y is the observed variables in vector defined as deviation from the mean and the unobserved variable in vector ξ is uncorrelated with the error term. The error term are assumed to be uncorrelated across equations in the system

3. STATISTICAL ANALYSIS

Single Factor Model in SEM typically requires that the choice of place of delivery (latent variable) is operationalized by multiple socio demographic risk factors (manifest variables). This is appropriate for describing the mapping of the risk factors onto the choice of place of delivery, leading to the measurement equation. Traditionally, these models have directly mapped observed features of alternatives and observed characteristics of decision makers to overt choice behavior. To overcome the problem of choice of place of delivery as unobservable variable and the use of immediate health indicators as direct of proxies for preferences biase parameter to the extent that these proxies are poor correlate with the choice, the choice of place of delivery should be estimated using latent variable model

A vector of latent variable choice of place of delivery is indirectly observed via a vector of $x = (\text{resid}, \text{educt}, \text{religi}, \text{mage}, \text{marit}, \text{wealt and occup})$, observable variables. The measurement model is thus defined as

$$\text{manifest}_{il} = \Delta_m \text{construct}_{il} + \text{error}_{il} \quad (3)$$

The matrix Δ_m ($q \times n$) is a so-called factor loading matrix and the element of Δ_m pertaining to manifest i and construct l is denoted $\lambda_{il}^{(m)}$. In addition, manifest equations defined where construct is a vector of individual choice of place of delivery to affect the offered manifests

4. DATA AND METHOD

The data used in this study came from 2013 NDHS. This data set is considered more appropriate for the study because it is a nationally representative sample with a relatively large number of observations on the outcome variable. The survey was designed to gather information on maternal health and obstetric fistula from women of reproductive age (15–49 years). These are provided at national and regional levels; urban and rural areas and at state (district) level. The 2013 NDHS employed a two-stage sampling design. A total of 34,596 women were individually interviewed, and 97% of them were successfully interviewed. Information was collected, among other things, on where the children were given birth to and health care the woman enjoyed during delivery. The alternative place of delivery available and analyzed in this study are: home which includes respondent's home and other homes; public sector which encompasses government hospitals, government health centers/health posts and other public health facilities; private sector which incorporates private hospital centers and other private health facilities; and (4) others; that is, births that took place in any other place not covered by any of the other three categories. These include births that take place in the farm, market place and so on. The individual level variables included in the analysis were mother's age, marital status, type of place of residence, woman's educational status, woman's occupation, wealth index and religion. Some of the categorical variables were recorded. Table 1 presents detailed descriptions of all variables included in the analyses and distributions of variables in fig 1, 2, 3, 4, 5 and 6.

Table 1: Description of variables

Variable	Description
Educat	Maternal education with categories, no education=0, primary school=1, secondary education=2 and tertiary education=3
Occupat	Mother's occupation with categories, no working=0 and working=1
Relig	Religion of the respondent, Christianity and catholic=0, islam=1, traditional =2 and other (including missing values)=3
Marital	Marital status of the pregnant women, never in union=0, married=1, living with partner=2, widowed=3, divorced=4, separate=5
Wealt	Income status of mother, poorest=1, poorer=2, middle=3, richer=4 and richest=5
Resid	Mother place of residence, rural=1 and urban=2
Mage	Mother age are categorized, < 26 year=

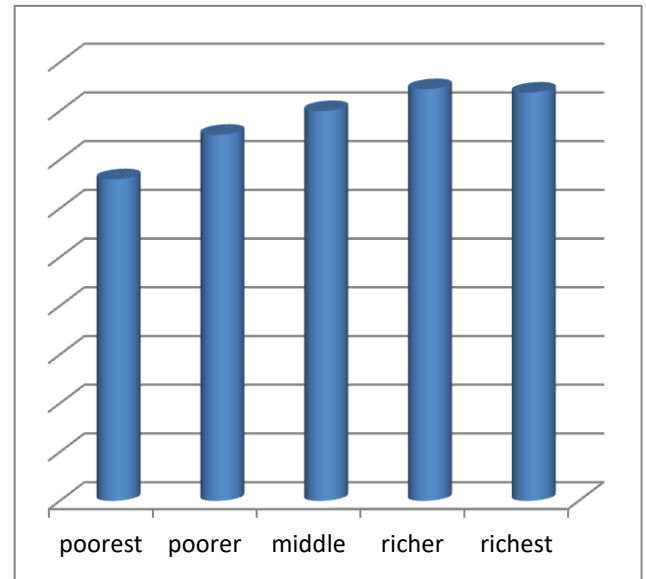


Figure 1: Distribution of wealth index

This chart shows the distribution of wealth index and divided into four categories. Richer group recorded the highest among other groups. This means that women in this group and the richest group are active to make choice from place of delivery. Besides, the poorest group, poorer and middle groups are left out to make preference; however, contrary to believe that women in middle class are not as many as those in richer and richest classes.

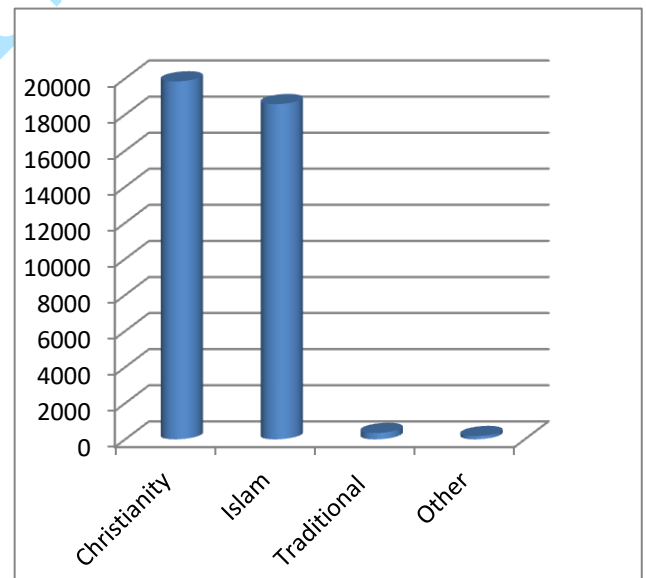


Figure 2: Distribution of religion

The religion distribution is also divided into four groups with which women that practice Christianity are more than Islam. Women that are practicing other (including nothing) are the lowest.

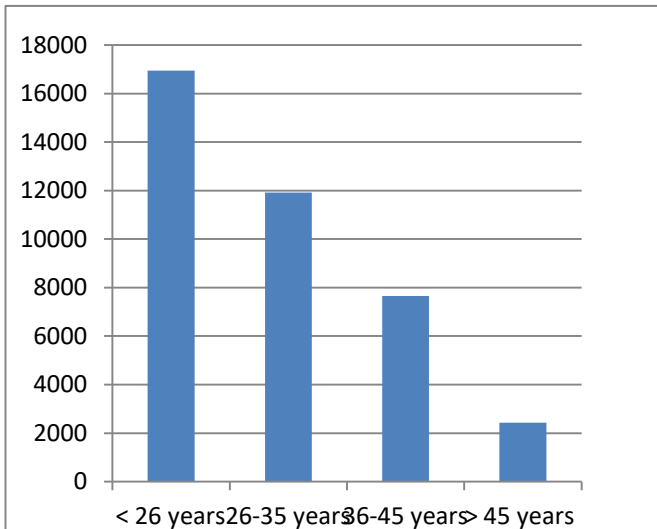


Figure 3: Bar chart of mother's age

Respondents are categorized into four groups. These people are economically active and at their reproductive age. It is obvious from that chart that women less than 26 years of age are pregnant and more than total number of other groups considered in the Nigeria.

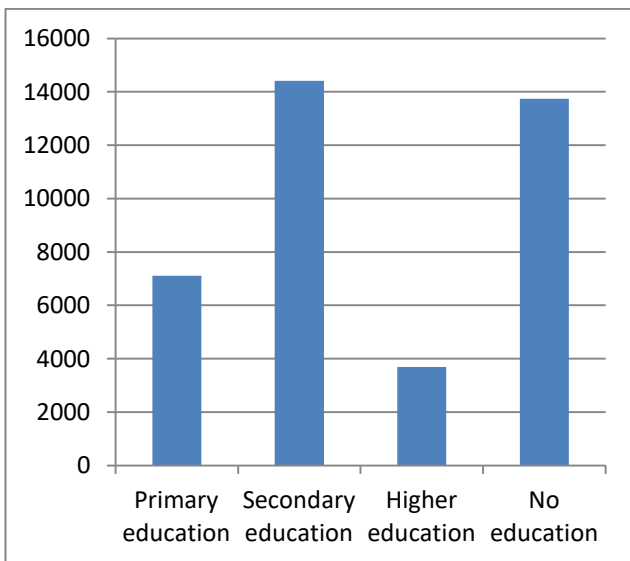


Figure 4: Bar chart of mother's educational status

Women considered in this study had primary, secondary, higher education and no education. The pregnant women that had secondary education are more compared to those that had primary, higher education. However, the number of women at reproductive age with no education is close to those had secondary education.

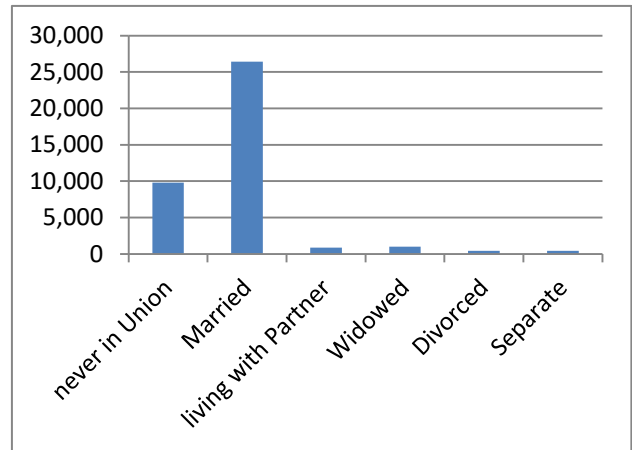


Figure 5: Bar Chart of Marital Status

Fig. 5 shows that large number of married women followed by women that are never in union make choice of place of delivery in pregnancy period. The number of women living with partner and widowed are relatively small compared to the divorced and separated women that make choice of place of delivery.

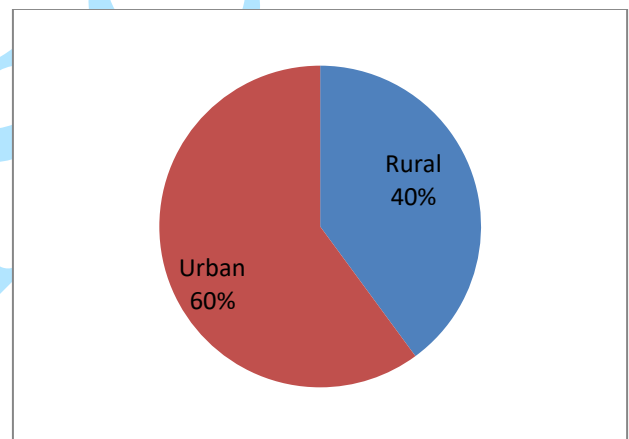


Figure 6a: Pie chart of mother's place residence

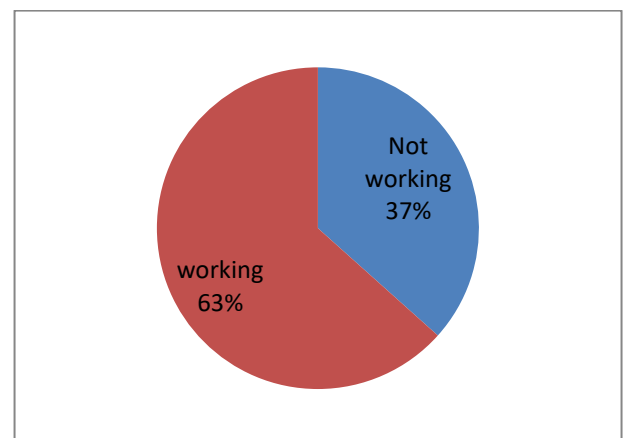


Figure 6b: Pie Chart of Mothers Occupation

Fig. 6a and b show that Percentage of women resided in urban (60%) and working (63%) is higher compared to those resided in rural (40%) and not

working (37%). This shows that majority of women living in urban area are working and rural area are not working. This consequently influences their choice for place of delivery. Also, in large proportion this affects their income level which invariably effect the choice of health centre.

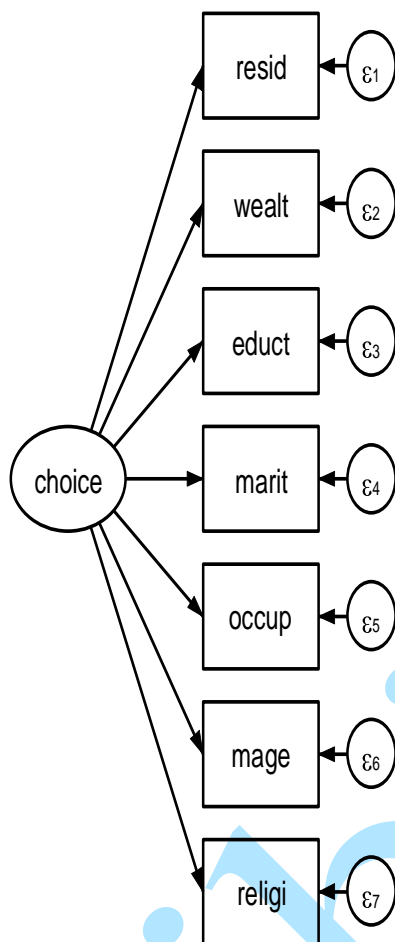


Figure 7: Path diagram of choice (latent variable) of place of delivery: single factor model

This is a simple latent variable model in which choice of place of delivery (latent variable) connects

to demographic risk factors (observed variables). Circles represent latent variables, rectangles represent observed variables, arrows connecting circles and rectangles represent linear regressions, and short arrows pointing at rectangles from circle represent residual variability.

Table 2: Effect of socio demographic risk factors on choice of place of delivery in Nigeria (P<0.05)

Variables	Coefficient	std.er	pvalue
Resid	0.5990	0.0039	0.000
Wealt	-0.9553	0.0036	0.000
Occup	-0.0250	0.0053	0.000
Educt	-0.6996	0.0066	0.000
Mage	-0.0275	0.0053	0.000
Religi	0.0135	0.0052	0.011
Marit	0.1216	0.0055	0.000

Results from the table above show that all determinants considered significantly relate to the choice of place of delivery at 5% level of significance. The results imply that residence, religion and marital status positively influence the choice of place of delivery while wealth index, occupation, education status, mother age negatively influence it. Model identification is established by fixing the latent variable, choice of place of delivery coefficient for selected observed variables to zero. In the measurement model, Choice of place of delivery is significantly operationally depended on socio demographic risk factors. These socio demographic characteristics affect choice towards place of delivery.

Result from fig. 8 shows the hypothetical correlation among socio demographic risk factors and choice of place of delivery that are positive and negative. Place of residence, religion, marital status and wealth index, occupation, educational status, maternal age show positive and negative correlation respectively with unobserved variable, choice of place of delivery.

Figure 8: Correlation matrix of socio demographic risk factors and latent variable

	Re sid	Wealt	Occup	Educt	Mage	Religi	Marit	choice
Re sid	1							
Wealt	-0.5722275	1						
Occup	-0.0149318	0.0238121	1					
Educt	-0.4190799	0.6683189	0.0174392	1				
Mage	-0.0164874	0.0262929	0.006861	0.019256	1			
Religi	0.0080677	-0.0128658	-0.0003357	-0.0094224	0.006861	1		
Marit	0.0728493	-0.1161749	-0.0030315	-0.0850826	-0.0033473	0.0016379	1	
Choice	0.5990192	-0.9552737	-0.024927	-0.6996099	-0.0275239	0.0134681	0.1216143	1

Table 3: Multiple Correlation Coefficient of Socio Demographic Risk Factors

Observed var.	Fitted variance	residual	R.squared	mc	mc squared
	Predicted				
Residence	0.2398	0.0861	0.1535	0.3588	0.5991
Wealth index	1.9359	1.7664	0.1693	0.9126	0.9553
Education	1.0600	0.5188	0.5412	0.4895	0.6996
marital status	0.0642	0.0095	0.6326	0.0148	0.1216
religion	0.2958	0.0000	0.2957	0.0018	0.1347
mother age	0.8685	0.0007	0.8679	0.0008	0.0275
occupation	0.2958	0.0001	0.2318	0.0006	0.0249

The choice of place of delivery, latent variable is predicted by observed socio demographic risk factors. These observed and latent variables entered into model as direct determinants of place of delivery. Residuals are hypothesized by effect of choice of place of delivery on selected risk factors. The correlation between the observed socio demographic risk factors and unobserved variable, choice of place of delivery is 0.96. This implies that the fraction of total variance of observed variables explained by 0.92, and left unexplained $1-0.92=0.8$. R-squared, mc, and mc squared all reported the relatedness of the indicated dependent variable with the model's linear prediction.

5. DISCUSSION OF RESULTS

This study was designed to examine causal relationship between unobserved (choice of place of delivery and observed variables. Also examine the socio demographic risk factors of choice of place of delivery in Nigeria. Our finding confirmed that using SEM in examining the causal relationship between the unobservable variable, choice of place of delivery and observable variables, socio demographic risk factors, residence, educational status, religion, occupation, marital status and wealth index were significantly related to the choice of place of delivery among Nigerian women. The considered risk factors are hypothesized to affect individual choice. All considered independent variables are correlated with which their residual error in multiple regression analysis is unobserved, latent variables. This finding confirms relationship between place of delivery and risk factors in various studies and the effect of place of delivery to maternal and infantile mortality. Many studies have shown that place of delivery is always highly significantly to mortality and morbidity.

Characteristics of women are important to the living conditions of their health status. Both bar and pie charts show the distribution of socioeconomic risk factors. Socio economic risk factors are indicators of choice of place of delivery. Each of these risk factors mentioned above has its direct effect on choice of health centre and service Wealth index is the easiest measure of economic status to produce

good places of delivery. Choice of place of delivery is significantly measured by permanent status, wealth index other than consumption expenditure or income. Ability to pay for place of delivery and service is a prime concern for pregnant women who rationalize service through hospital charges. Wealth index is associated with a household's relative position in the distribution of wealth factors such as motorcycle, car, radio, telephone, electricity, television set, type of flooring, water supply, sanitation facilities and refrigerator. Fig.6a and b shows the distribution of mother's place of residence and their occupational status. Residence and occupation play a significant role in the choice of place of delivery. The both charts reveal that women in rural areas are mostly inhabited by the poorest, poorer households and that the richest, richer households live mostly in urban areas because of working status. Fig.5 shows the current marital status. Many women are bread winners thereby consequently making them to be the heads of household; however, these women are single (never in union and living with partner) mother, divorcee, widow and separated. Choice of place of delivery varies substantially according to the economic status, women occupation and level of education. Maternal educational status shows great differences in educational attainments. Women that had secondary education are informed compared with those with primary education and no education about places of delivery and their service. In Fig. 6 total number of women that are gainful working is comparatively larger than those women not working. This influences the choice of place of delivery and antenatal visit to health centres. Results from Table 2 and 3 are estimates and coefficients of determination at different equation level. All considered observed risk factors are significantly influencing the choice of place of delivery and that each of the risk factors has high total variation explained compared to not explained by unobserved variable, choice of place of delivery. The correlation matrix of in Fig. 8 reveals that there are positive and negative correlations among the socio demographic observed variables and choice of place of delivery.

6. CONCLUSION

The analysis of choice of place of delivery in this study examined in terms of place of residence, wealth index, occupation, level of education, maternal age, religion, marital status. Despite adequate information on Antenatal care by medical personnel, many pregnant women choice of place of delivery was not determined by it. All selected determinants significantly related to the choice of place of delivery. Therefore, pregnant women need urgent and intensive health promotion intervention in order to make right decision on place of delivery.

REFERENCES

- [Ard96] **McArdle J. J.** - *Current directions in structural factor analysis*. Current Directions in Psychological science, 5, 11-18, 1996.
- [EI14] **Etukudo I. W., Inyang A. A.** - *Determinants of use of Maternal Health Care Services in a Rural Nigerian Community*, Research on Humanities and Social Sciences. Vol.4, No.18, 2014.
- [E+13] **Envuladu E. A., Agbo H. A., Lassa S., Kigbu J. H., Zoakah A. I.** - *Factors determining the choice of a place of delivery among pregnant women in Russia village of Jos North, Nigeria: achieving the MDGs 4 and 5*, International Journal of Medicine and Biomedical Research Volume 2 Issue 1 January – April 2013.
- [Hot33] **Hotelling H.** - *Analysis of a complex of statistical variables into principal components*. J. of Educational Psychology, 24:417, 1933.
- [Hoy95] **Hoyle R. H.** - *The structural equation modeling approach: basic concepts and fundamental issues*. In R.H. Hoyle (ed.), *Structural equation modeling: concepts, issues and applications* (pp. 1-15). Thousand Oaks, CA: Sage Publications, 1995.
- [IGS06] **Idris S. H., Gwarzo U. M. D., Shehu A. U.** - *Determinants of place of delivery among women in semi urban settlement in Zaria, Northern Nigeria*, Annals of African Medicine. Vol.5 No, 68-72, 2006.
- [JMB82] **James L. R., Mulaik S. A., Brett J. M.** - *Causal Analysis: Assumptions, Models, And Data*, Beverly Hills, Sage Publications. 1982.
- [KCD99] **Kohn L. T., Corrigan J.M., Donaldson M. S.** - *To err is human: Building a safer health system*. Washington, DC: National Academy Press. 1999.
- [LH68] **Lazarsfeld P. F., Henry N. W.** - *Latent Structure Analysis*. Houghton-Mifflin, Boston, 1968.
- [O+05] **Osobor K. M., Adesugun O., Fatusi O., Chiwuzie J. C.** - *Maternal Health Seeking Behaviour and Associated Factors in a Rural Nigerian Community*. Maternal and Child Health Journal 10 (2):159-169. 2005
- [TK09] **Teo T., Khine M. S.** - *Modeling educational research: The way forward*. In T. Teo & M. S. Khine (Eds.), *Structural equation modeling in educational research: Concepts and applications* (pp.3-10). Rotterdam, the Netherlands: Sense Publishers, 2009.
- [UB16] **Umar A. S., Bawa S. B.** - *Determinants of Institutional Delivery in Yobe State, Nigeria*. American Journal of Public Health Research, 2016.
- [Wri18] **Wright S.** - *On the nature of size factors*. Genetics, 3, 367-374, 1918.
- [***09] *** - National Population Commission Nigeria and ICF Macro. *Nigeria Demographic and Health Survey 2008*. Calverton, MD USA: National Population Commission and ICF Macro. 2009; p14-141. Available: http://pdf.usaid.gov/pdf_docs/PNADQ923.pdf. [Accessed March 10, 2014].
- [***11] *** - UNFPA: Main Report State of the World's Midwifery 2011. UNFPA. Retrieved from <http://www.unfpa.org/sowmy/resources/en/main.htm>, 2011.
- [***13] *** - World Health Organization: World Health Statistics 2013. WHO, Geneva, Switzerland. 2013; p65-141 Available: http://www.who.int/gho/publications/world_health_statistics/2013/en/. [Accessed March 10, 2014]. 2016, Vol. 4, No. 1, 1-7
- [***14] *** - WHO World Health Organisation, UNICEF, UNFPA, The World Bank: Trends in maternal mortality: 1990 to 2013. WHO, UNICEF, UNFPA and The World Bank estimates. Geneva: World Health Organisation, 2014.