STRUCTURAL EQUATION MODELLING OF PROXIMATE DETERMINANTS OF FERTILITY AMONG WOMEN LIVING WITH HIV IN IBADAN, SOUTH WEST NIGERIA.

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CERTIFICATION

I certify that this research work was duly carried out under my supervision and meets the regulations governing the award of the degree of M.Sc. Biostatistics in the Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, University of Ibadan.

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ATTESTATION

Having understood the nature of plagiarism, I, Olalekan Muideen Olakunle, hereby declare that this dissertation is the result of my research undertaken under supervision and that it has not been presented elsewhere either in part or in whole for another degree.

Olalekan Muideen Olakunle

DEDICATION

This dissertation is dedicated to Almighty Allah for His mercy, guidance and protection throughout the course of this study and to my late father for setting my feet on the path of knowledge.

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ABSTRACT

Proximate determinants of fertility, behavioural and biological factors through which socioeconomic variables influence the fertility, plays a crucial role in influencing the fertility. Understanding of these variables is essential for the proper integration of HIV care and reproductive health services. Thus, this study employs structural equation modelling in the assessment of interrelationship among the proximate determinants of fertility among women living with HIV in Ibadan, Nigeria.

A data from a cross-sectional study on childbearing progression among 933 women living with HIV and receiving care at University College Hospital, Ibadan, Nigeria was extracted and analyzed. ANOVA was used for association and comparison of mean of children ever born for the different categories of explanatory variable(s). Structural Equation Modeling was employed to assess the inter relationship among the various proximate determinants of fertility at 5% significance level.

The average age of the women is 38.05 (± SD = 6.08) and most of the women had their first sex at mean age of 20.41 (± SD = 3.68) with 24.27(± SD = 4.57) as their age at first birth. Almost all the women, 812 (87.7%) ever used contraceptive with the condom, 753 (80.7%), as the most preferred method of the contraceptives. Most of the women had 3 or more children before the HIV diagnosis. ANOVA result showed that women who had their first marriage and started child bearing before the age of 24 years had significantly higher number of children ever born compared to women who married and started child bearing at age 25 and above and significant at $p < 0.005$. Women who had at least secondary education had significantly lower number of children ever born than those with Primary or no education at $P < 0.05$. Structural Equation Model provided a good fit to the data with each indicator contributing significantly to their respective constructs at $P < 0.05$. The model showed that there is inter relationship between the proximate variables. Marriage $(\beta = -0.10, p =$

0.305) had direct negative relationship with the contraceptives while contraceptives ($\beta = -0.072, p = 0.036$) had direct negative relationship with postpartum infecundability. Increase in the component of marriage will cause a corresponding decrease in the use of contraceptives. The model showed that marriage ($\beta = -0.227, p = 0.000$) and postpartum infecundability ($\beta = -0.032, p = 0.953$) had a direct negative relationship with the children ever born while contraceptives had direct positive relationship with the children ever born. Women who married and started childbearing late, will have fewer number of children ever born compared to woman who married and started childbearing at early stage.

The model had showed that education, age, age at first sex, age at first birth, and duration of postpartum were associated with fertility. Based on this result, intervention targeting the integration of HIV care and reproductive health service should be given adequate attention.

Key words: Structural equation model, proximate determinant of fertility and children ever born.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Looking only into the association between directly observable variables restricts our horizons and limits our assessment of complex interrelationship among variables (Malaeb *et al.* 2000). Thus, there is need for a statistical technique with the ability to unravel complex interrelationships between variables. Structural equation modeling is a method that can address several of the above restrictions, providing a robust technique for studying interdependencies among a set of correlated variables. (Arhonditsis *et al.* 2006).

Structural equation modeling (SEM), an extension of the general linear model, can be defined as a hypothesized pattern of directional and non-directional relationships among a set of observed (measured) and unobserved (latent) variables (MacCallum and Austin 2000). A measured variable is directly measured whereas a latent variable is not directly or exactly measured. SEM is an advanced statistical technique that incorporates ideas from many of the existing statistical techniques such as factor analysis, path analysis, regression, correlation, and analysis of variance (ANOVA) (Gillespie and Perron 2010).

SEM has been widely explored in different research areas such as social science, psychology, ecological and environmental sciences, chemistry and biology (MacCallum *et al* 2000; Hair, 2012; Arhonditsis *et al* 2006; Iriondo *et al.* 2003; Kline 2011). Also, its application in public health cannot be underestimated. SEM had been applied to study the determinants of malnutrition among children (Cheah *et al.* 2010) to analyze the influencing factors (Direct and Indirect) of the QOL in patients with cancer (Tong 2010) and many more (Fan, 2016); (Rao *et al.* 2012); (Annibale and Rodney 2014). In the view of the above, SEM will be applied in this study to analyze direct and indirect factors (proximate determinants) affecting fertility among HIV positive women.

Generally, Fertility level and trend varies not only in different settings but also at different time across the world. The observed variation in fertility is as result of both biological and behavioral factors. These factors can be regarded as proximate determinants of fertility and popularly termed as intermediate variables of fertility (Davies and Blake 1956). They are the factors through which social, cultural, economic, health and other environmental factors can affect individual reproduction. (Bongaarts 1978) defined eight factors out of the eleven intermediate fertility factors proposed by Davis and Blake (1956). This includes Proportion married, contraception, induced abortion, Postpartum infecundability, frequency of intercourse, sterility, spontaneous intrauterine mortality and duration of the fertile period. From these, Bongaarts and Potter (1983) identified four principal proximate determinants (Marriage, Contraception, Post-Partum infecundability and induced abortion) and regarded them as the inhibitoriest factors because they account for nearly 96% variation of fertility in a population.

Bongaart later developed a framework to quantify the effect of these factors on the observed variation in fertility. This framework has been widely used for analyzing fertility changes overtime and how it differs from one group to another. Studies carried out in Bangladesh showed that contraception is the highest inhibiting factor among the proximate determinants of fertility (Islam *et al.* 2004). Research done in Malaysia revealed that marriage postponement and contraception were the two most important proximate determinants of fertility (Tey *et al*. 2011). In Africa, Various studies have shown the influence of proximate determinants on fertility (Palamuleni *et al.* 2007); (Palamuleni 2010); (Chola and Michelo 2016). In Nigeria, Makinwa et al used the Bongaart framework and found that proportion marriage was one of the most important factors as it is responsible for 25% changes in fertility level (Makinwa *et al,* 1994). Furthermore, some studies have shown that HIV could be responsible for the variation (decline) in fertility through its interaction with the proximate determinants of fertility (Asiimwe-Okiror *et al* 1997; Kaida, 2006; Bongaart 2006).

There is bi-directional relationship between HIV/AIDS and fertility. It has been found that the same factors such as marriage, contraception, Breastfeeding that affect the fertility rates impact the spread of HIV (Kaida, 2006; Bongaart, 2006). Also, HIV serostatus and prevalence is related to changes in the proximate determinants of fertility (Ntozi 2002). The major proximate determinants of HIV infection and fertility are virtually the same – marriage, contraceptive use, reproductive tract infection, breastfeeding practices. Thus, the association between the two seems almost unavoidable.

Several studies have shown that HIV decreased the fertility of women through proximate fertility determinants in both the world and Africa. Studies performed in some parts of the world have shown that the incidence of pregnancy decreases dramatically from around 20.4 per 100 years before diagnosis of HIV to less than half, 7.9 per 100 years after diagnosis of HIV. (Kaida, 2006; D'Ubal, 1997; Thackway, 1997)

Lower fertility among HIV positive women in Africa was also confirmed in a study on impact of HIV on fertility conducted by James Ntozi (Ntozi, 2002). In addition, it was also found that HIV infected women have between 25 – 40 percent lower fertility than non-infected women (Zaba, 1998)

After the occurrence of the first case of infection in 1986, HIV has been found to have a significant impact on fertility in Nigeria. The prevalence has been found to increase gradually since then. A rise in the prevalence rate from 1.8 percent in 1991 to 5.8 percent in 2001 was shown by the outcome of periodic national surveys among ante-natal clinic participants. However, in 2003, the rate was registered at 4.4 percent (FMOH, 2007, Awofala, 2018). In addition, a significant proportion of HIV infected individuals are women of reproductive age (UNAIDS 2018). This broad impact of HIV on fertility in developing countries has been found to account for a lack of adequate awareness and parenting choices on contraceptives (Orner *et al*. 2008; Cooper *et al*. 2007; Paiva *et al*., 2003, 2002; Nebie *et al*. 2001).

Most fertility studies in Nigeria used methods to classify factors affecting fertility that presume direct factors rather than indirect factors (such as Chi-square, Weighted regression, Ordinary Least Square and Logistic Regression, etc). (Olatoregun *et al* 2014; Rampedi 2015; Alaba *et al* 2017). The role of fertility-influencing factors is that proximate variables directly affect fertility, while proximate variables influence fertility by socioeconomic and demographic variables (Kassar *et al*, 2013). Structural Equation Modeling (SEM), allows the evaluation of the relative intensity of various variables, whether or not they can be measured directly. Hence, understanding of these proximate variables is necessary for the health care system for adequate designation of targeted public health intervention.

Consequently, structural equation modeling was employed to assess the interrelationship among proximate determinants of fertility among women living with HIV in Ibadan, Southwest Nigeria. The proximate variables are Marriage, Contraception, Post-Partum infecundability and induced abortion. The three - Marriage, Contraception, Post-Partum infecundability most important variables were used in this study.

1.2 Problem Statement

Nigeria has the second largest HIV epidemic in the world and one of the highest rates of new infection in sub-Saharan Africa (NACA 2017). Of all people living with HIV globally, 9% of them lives in Nigeria (UNAIDS, 2014). Studies conducted in 2018 showed that 1.9 million people were living with HIV, 58% of this people are women (UNAIDS 2018). Unprotected heterosexual sex has been found to be responsible for 80% of new HIV infections in Nigeria (NACA 2015). It is also found that women are at greater risk of HIV due to barriers in choosing partners, use of contraceptives and spacing of children. The pandemic has affected every state in the country.

Evidence synthesized in six Africa revealed that HIV positive women have between 25% and 40% lower fertility than HIV negative women (Zaba and Gregson, 1998). Studies carried out in three Africa cities namely Zambia, Cameroon and Congo showed that the proportion of HIV positive women using contraceptives is more than that of HIV negative women. It was also found that infected women who had given one birth were more likely to have used contraceptives than HIV negative women. (Glynn *et.al* 2000). The evidence of reduced fertility among HIV positive was also substantiated by estimation made by Lewis et al that for a unit increase in population prevalence of HIV in SSA countries leads to a population-attributable decline in fertility of 0.37% (Lewis *et al.* 2004) Most of the available literatures in Nigeria only explored fertility desires and childbearing among PLWHIV (Ilyasu *et al*, 2009; Kipp *et al* 2011; Ragassa and Fantahun 2012) but none has addressed the relationship between proximate determinants of fertility among HIV positive women.

1.3 Objectives of the study

1.3.1 General Objective

To assess the inter-relationship among the proximate determinants of fertility among women living with HIV.

1.3.2 Specific Objectives

1. To assess the proximate determinants of fertility among women living with HIV.
2. To examine the socio-demographic factors (distal determinants) associated with proximate determinants of fertility among HIV infected women in Ibadan.
3. To explore the relationship between the various components of proximate determinant of fertility among women living with HIV.

4. To examine the extent to which the model fit the relationship between the proximate variables and fertility.

1.4 Justification

Several models have been used to analyze the relationship between proximate determinant and fertility but none has explored structural equation model. Majority of these models only address the directly observable variables and fail to simultaneously address both the direct and indirect variables which influence the fertility level. Understanding the inter-relationship among factors affecting fertility among HIV positive women is important for policy-makers to assist in designing appropriately targeted public health interventions.

Prior to the existence of HIV, Bongaart and Potter developed the proximate determinant of fertility framework, Marriage, Contraception, Induced abortion, and postpartum abstinence infecundability, which has been widely explored for the analysis of fertility level among HIV negative woman. Since the framework was developed before the advent of HIV, its suitability during the era of HIV has not been assessed especially in SSA. Understanding of the inter-relationship among different components of the framework in the context of HIV is essential for proper integration of HIV care and reproductive health services.

CHAPTER TWO

LITERATURE REVIEW

2.1 PROXIMATE DETERMINANTS OF FERTILITY

The biological and behavioural factors that directly influence fertility over the reproductive lifetime of women are proximate determinant of fertility (Kaida *et al*. 2006; Hasan, 2018). These factors are marriage, sterility, contraceptives, age at sexual intercourse, postpartum amenorrhoea, abstinence, frequency of sexual activity and induced abortion (Bongaart 2012). It is through these proximate determinants that social, economic, and cultural variables act to affect fertility. Marriage and sterility determine the duration a woman's reproductive period will last while other five proximate determinants influence the rate of childbearing and the duration of birth intervals (Kaida *et al.* 2006). If any of these proximate determinants change as a result of the biological and behavioural variation, then, the fertility also changes. For instance,a rise in marriage age may have a negative effect on fertility, whereas increase in oth er proximate determinants may have positive effects (decrease in postpartum infecundity). The proximate determinant of fertility has been extensively used for various purposes such as determinants of fertility, comparative analyses of fertility and fertility trend. (Kaida, 2006; Osuafor 2011).

Studies conducted in some countries indicated marriage as a major factor of fertility change (Islam *et al* 2015; Islam, 2012). Chola , in his analysis of Zambia Demographic and Health Survey, found that Marriage and postpartum infecundity accounted for the largest inhibiting effect on natural fertility (Chola *et al*, 2016). Breastfeeding and postpartum abstinence reduce childbearing in rural area than urban in Nigeria (Chimere-Dan 1990). Study of Ibisomi's three NDHSs revealed that postpartum insusceptibility has the greatest inhibitor factor among the nearest fertility determinants. (Ibisomi, 2008).

2.2.1 HIV AND FERTILITY IN THE DEVELOPED COUNTRIES

In developed countries, HIV has been found to be associated with a decline in fertility. Lack of access to the ARV had been reported to be responsible for the decline in fertility among HIV infected woman. Studies conducted prior to advent of ARV showed a less likely pregnancy (Benthem, 2000) and birth (Kaida *et al.* 2006);(Forsyth, 2002) among HIV infected woman. There is evidence that pregnancy and live birth decline as the HIV develops. This evidence was based on the research conducted by Lee et al, 2000. (De Vincenzi, *et al.* 1997) carried out a cohort study to study pregnancy and contraception among HIV infected women. He found that HIV infected women suffer high rates of adverse outcomes such as induced and spontaneous abortion. Similar result was also reported in a retrospective study carried out by (D'Ubaldo, 1998)

However, with the advent of ARV, available studies have shown a reverse in the decline of fertility among HIV positive women. And the increase in fertility was thought to be due to increase in survival times which lead to more opportunities to give birth. It was found in a study conducted in United states that pregnancies were 20% more likely to occur among HIV infected women in the era of ARV (1997 – 2001) than in previous year (1992 – 1996) (adjusted Relative Risk (ARR): 1.2; 95% CI: 1.1, 1.4) (Blair, 2004).

2.2.2 HIV AND FERTILITY IN SUB-SAHARA AFRICA

Sub-saharan Africa remains the major area that is greatly affected by HIV. The impact of HIV on fertility in this area cannot be underestimated. Review of several studies of the impact of HIV on fertility has shown a decline in fertility among HIV infected women (Ntozi 2011). (Lee *et al*. 2000)

Zaba and Gregson measured the impact of HIV on fertility in a number of countries in sub Saharan Africa and found out that HIV infected women have 25-40 percent lower fertility than non-infected (Zaba and Gregson 2002).

Lewis et al conducted a study on the population impact of HIV on fertility in Sub-Saharan Africa with the aim of examining evidence from studies on estimates of the fertility rate ratio of population change in total fertility attributable to HIV compared to HIV infected and uninfected women and to review evidence of changes in fertility in non-infected HIV using a mathematical model. The analysis found that women infected with HIV had lower fertility than women uninfected with HIV. The researchers also calculated that there will be a population attributable decrease in overall fertility of 0.37 percent for every one percent rise in population prevalence of HIV in SSA. (95% CI. 0.3%-0.4%). The research concluded that there was a significant difference between HIV-infected and uninfected women with age-related variations (Lewis *et al* 2004). The results were further confirmed by SSA studies reporting lower fertility in HIV-infected women than in non-infected women. (Ross *et al* 2004; Fabiani 2006).

2.2.3 HIV AND FERTILITY IN NIGERIA

In Nigeria, there has been a substantial increase in the prevalence of HIV since the report of the incidence of the first case in 1986 in Lagos. Since then, the prevalence of HIV rose from 1.8% in 1991 to 5.8% in 2011. However, there has been a significant decline in the prevalence of HIV starting with 5.0% in 2003, 4.4% in 2005, 4.6% in 2008, 4.1% in 2010 and 3.4% in 2013.(FMOH 2005, NARHS, 2013; Nigeria National Agency for the Control of AIDS, 2012, 2010a).

An allusion is provided that HIV will increase fertility by two parameters; HIV positive women may decide to engage in early marriage in order to give birth as soon as possible (Feyisetan and Bankole 2002). Also, HIV positive women may decide to give birth to as many as possible in order to account for unpredictable death from AIDS. Smith 2003 studied condom use and perceptions of risks of HIV infection in Nigeria; He found out that increased contraception may not reduce fertility (Smith 2003). He concluded that condom use is common and largely determined by social norms but not generally as a response to AIDs fears (Smith 2003). In 2018, of 1.9 million People living with HIV, 1 000 000 were women of reproductive age (UNAIDs 2019). This shows that HIV may have a devastating impact on fertility.

2.3 BONGAARTS' PROXIMATE DETERMINANTS OF FERTILITY FRAMEWORK: MECHANISM THROUGH WHICH HIV MAY INFLUENCE FERTILITY

HIV/AIDs could influence fertility through the biological and behavioural mechanism via proximate determinant of fertility. This effect is based on the changes in the proximate determinants of fertility and physiological consequences of HIV on women's fertility. Examination of the effect of HIV/AIDS on number of proximate determinants of fertility in various parts of Sub-Saharan Africa has been described in researches conducted in SSA (Ntozi 2012; Gregson *et al* 2002). There are a lot of ways through which HIV/AIDs could influence fertility but the section below outlines how HIV / AIDs could influence fertility via each proximate determinants of fertility, namely, Marriage, Contraceptives and Postpartum Infecundability.

2.3.1 Marriage

There is an inverse relationship between marriage and fertility. Fertility is expected to increase if there is a decline in the median age at marriage. This is because early marriage increases the number of reproductive years a woman will spend within marriage and thus, exposure to the risk of pregnancy and diseases. Also, age at marriage determines the timing of childbearing. The timing of childbearing is responsible for increase or decrease in the fertility. Thus, decrease in the age at marriage of a country could lead to high rates of fertility regardless of the national prevalence of HIV of the country. However, there could be some variation in the effect of HIV on fertility since the mechanism through which fertility can be affected could be different in country with high or low HIV.

Mukiza-Gapere and Ntozi (1995) conducted a focus group discussion in Uganda. In their research, they found out that fear of HIV infection has been a major hindrance preventing women from entering marital union (Mukiza and Ntozi 1995). Similar result was also found in research conducted in Zimbabwe (Gregson *et al* 1998). Also, studies conducted in SSA have shown an increase in the age at marriage due to fear of HIV epidemic (Mukiza and Ntozi 1995; Asiimwe-Okiroret al 1997). This shortens the reproductive life span and hence led to decline in fertility (Bongaart 1978; Gregson and Zaba 2002; Ntozi 2002).

Report indicated that HIV epidemic is causing a reduction in the duration of marriage among the couples as a result of high rate of divorce and widowhood (Porter *et al* 2004).

Most researches indicate that HIV epidemic has a negative effect on both age at marriage and fertility rate. However, this effect is not straightforward. This is because HIV could be responsible for high fertility rate due to desire and survival of a preferred number of children. Also, wide availability and access to ART is expected to increase the fertility rate because of increase in the survival time of the infected individuals.

2.3.2 CONTRACEPTION

Research has shown that contraceptive use is one of the major proximate determinants of fertility decline (Bongaarts 1983). Studies conducted in Sub-Saharan Africa showed an increase in the rate of using condom for protection against HIV and STIs (Okeibunor 1999; Fabiani *et al* 2006).There is another evidence in a study conducted in Nigeria on condom use among antiretroviral patients that the condom usage increased from 14.5% at the commencement of ART to 43.3% after some period of treatment (Akinyemi *et al* 2010).

HIV epidemic could increase the use of contraceptives due to the need to protect against infection and fear of leaving orphans. Studies have revealed that HIV positive women were afraid of leaving orphans and thus use contraceptives to prevent pregnancy (Okeibunor1999; Lutalo *et al* 2000). This act will tend to decrease the fertility. However, high infant mortality rate associated with HIV could increase the desire of HIV infected women to give birth to more children with the belief that some will survive. This action will increase the fertility rate among HIV infected individuals (Gregson *et al* 2002).

Following the availability of ARV therapy which improves the health and reduces the fears of infected women, it is expected that HIV positive women on therapy will desire to have more children and therefore reduce the use of contraceptives to prevent pregnancy. This will result to increase in the fertility.

2.3.3 POST PARTUM INSUSCEPTIBILITY

Postpartum amenorrhea (a period without menstruation after child birth, often linked to the duration of breastfeeding) and postpartum abstinence (avoiding sex after a birth) constitute postpartum insusceptibility. Both are primary determinants of birth spacing especially in developing countries.

Knowing that breastfeeding is a mode of HIV infection, HIV infected women decide to minimize or stop breastfeeding for the fear of mother to child transmission (Gregson *et al* 1997). This action can shorten the length of infecundability amenorrhea and therefore contribute to early pregnancy and increased fertility (Ntozi 2002).

The impact of ARV on breastfeeding has not been greatly explored especially in Southwest Nigeria. Evidence indicates that access and availability of ARVs decreases the viral load in breast milk and significantly lowers the risk of transmission by breastfeeding (Gaillard *et al* 2004). HIV infected women on therapy are expected to increase the period of breastfeeding at lower risk to the infant. This action is expected to lead to decline in fertility (Becker *et al* 2003).

Traditionally, Women of SSA have maintained periods of postpartum abstinence. This period of postpartum abstinence varies from country to country. Research showed that postpartum abstinence period ranging from 12 to 15 months in SSA (Caldwell 1981; van de Walle 1989). This was based on the cultural beliefs that sperm can spoil milk and affect the health of the child (Mbekenga *et al* 2013). Recent research conducted in Nigeria showed that the median duration of postpartum abstinence has decreased from 15 to 3 months without positive changes in contraceptive use (Fagbemigbe *et al* 2018).

During this cultural abstinence period, husbands may be more likely to result to extra marital sex (Cleland *et al*, 1999; Lawoyin and Larsen 2002; Becker *et al* 2003; Desgrees-du-Lou *et al* 2005). This motivated more concerns about the transmission of HIV via the husband's extramarital sex. Thus, women may reduce the duration of the postpartum abstinence to prevent the husband from engaging in extramarital sex which can lead to family HIV infection (Cleland *et al*., 1999; Ntozi 2002; Gregson *et al* 2002). This reduction in the period of postpartum abstinence had been hypothesized to lead to higher fertility rate (Carael *et al* 1995; Zaba and Gregson 1998; Ntozi 2002)

Availability of ARV is associated with the decline in sexual abstinent. With the widespread of ARV, Moattiet al 2003 found out that HIV positive women on therapy were less likely to be sexually abstinent compared with women not on therapy (Moatti *et al*, 2003).This may result in higher fertility in the absence of contraceptives.

2.4 STRUCTURAL EQUATION MODELING (SEM).

Fertility is being influenced by a number of direct and indirect factors. A number of models had been previously employed to measure the direct impact of socio economic factors on fertility (Vavrus and Larsen, 2003; Feyisetan and Bankole, 2002; Westoff and Bankole, 2001; Zaba *et al*. 2004; Ntozi *et al.* 2001; Lewis *et al*. 2004). Some studies have also used the Bongaart model to research direct and indirect variables that separately affect fertility (Aladeniyi *et al* 2013; Bongaart 2004). However, the direct and indirect effect of those variables on fertility has not been simultaneously examined. Structural equation modeling

(SEM) is used to simultaneously estimate a given system of hypothesized relationships between observed and latent variables to determine if these associations are compatible with an extracted data sample (Schumacker and Lomax, 2010).

Structural equation modeling (SEM) is a set of statistical methods that make it possible to analyze complex relationships between one or more independent variables, either continuous or discrete, and one or more continuous or discrete dependent variables. The calculated variables (directly observed) or the latent variables may be both IVs and DVs (unobserved, not directly observed). Causal modeling, causal analysis, simultaneous equation modeling, covariance structure analysis, path analysis, or CFA are also referred to as SEM.

Though there are many ways to characterize SEM, it is most commonly thought of as a hybrid between some form of analysis of variance (ANOVA)/regression and some form of factor analysis Structural equation modeling (SEM) uses various types of models to depict relationships among observed variables, with the same basic aim of providing a quantitative test of a theoretical model hypothesized by the researcher. More precisely, various theoretical models can be tested in SEM that hypothesize how sets of variables describe constructs and how these constructs are linked to each other.

SEM unlike traditional statistical methods which normally utilize one statistical test to determine the significance of the analysis relies on several statistical tests to determine the adequacy of model fit to the data.SEM employs maximum likelihood estimation, an iterative feature of the statistical software that determines if the hypothesized model is consistent with the observed data (i.e., whether the model fits) to allow one to analyze simultaneously a system of equations that represent a theoretical process (Micheal *et al* 2006). This approach is in direct contrast to conventional general linear model (GLM)-based techniques such as multiple regressions that use partial-information ordinary least square estimators which solve systems of equations one by one, not as a set of equations that can be solved simultaneously (Ahmed & Mosely, 2002).

In the most common form of SEM, the aim of the model is to account for variation and co variation of the measured variables (MVs). Path analysis (e.g., regression) measures models and associations among MVs. Confirmatory factor analysis examines models of relationships between latent variables (LVs) and MVs that are indicators of latent variables. Latent growth curve models (LGM) determines initial level (intercept), rate of change (slope), structural slopes, and variances. Specific cases of SEM are regression, canonical correlation, confirmatory factor analysis, and repeated measures analysis of variance (Kline, 1998).

SEM analysis utilizes two models namely, measurement model and the structural model (Schumacker and Lomax, 2010). The measurement model analyses the association between the set of manifest variables and a predetermined number of latent variables. Manifest variables are those collected in the researcher measurement instrument, while latent variables exist beyond human measurement. The association among the manifest variable and the latent variables in a model are established a priori and tested against a data set to determine if the hypothesized measurement relationships match the data set that have been collected. Apart from the associations analyzed by measurement model, the structural parts of the model analyze a series of a priori relationship established between latent variables (Schumacker and Lomax, 2010).

The process of structural equation modeling (SEM) involves five general stages, namely: model specification, model identification, model estimation, model testing and model modification. Model identification is the most important stage as it helps to determines whether it is possible to find unique values for the parameters of the specified model (Kline

2011). That is, a model is identified if we are able to obtain a unique solution for every parameter. Model can be under-identified, just-identified and over-identified.

In structural equation modeling, the estimated parameters are functions of the sample covariance. That is, the model is a series of equations with unknown parameters. If the equations can be solved resulting in a unique value for and unknown, then the model is said to be defined. Therefore the model is said to be under-identified.

Identified models are the only models that can be estimated (Kline 2011). An over-identified model has a number of possible solutions, and the mission is to select the one that comes closest to explaining the manifest data within some boundary of error (Peter and Russell, 2009).

Important and application of SEM have been found in various fields like Psychology (Joldie 2006), social science (Bollen 1989), ecological and environmental sciences (Arhonditsis *et al* 2006), Health communication (Micheal *et al* 2006) and Public health (Deepa *et al* 2012; Annibale and Rodney 2014).

2.5 Previous Studies on fertility involving SEM

Eight socio-economic and demographic variables and the outcome variable (fertility) were developed in a cross-sectional study conducted by Islam *et al* 2016 with the objective of using structural equation modeling to empirically evaluate the effects of socio-economic and demographic variables on the fertility of Manipuri women in Bangladesh. Socio-economic variables considered include Place of residence, maternal education and standard of living index while Contraceptive use, information on Fetal loss, Health care during pregnancy, and Age at first marriage were considered as demographic and intermediate variables. The number of children ever born was used as a proxy measure of fertility. He found out that maternal education and place of residence have significantly direct positive influence on fertility. Fetal loss, contraceptive use and age at first marriage have significantly direct negative impact on fertility.

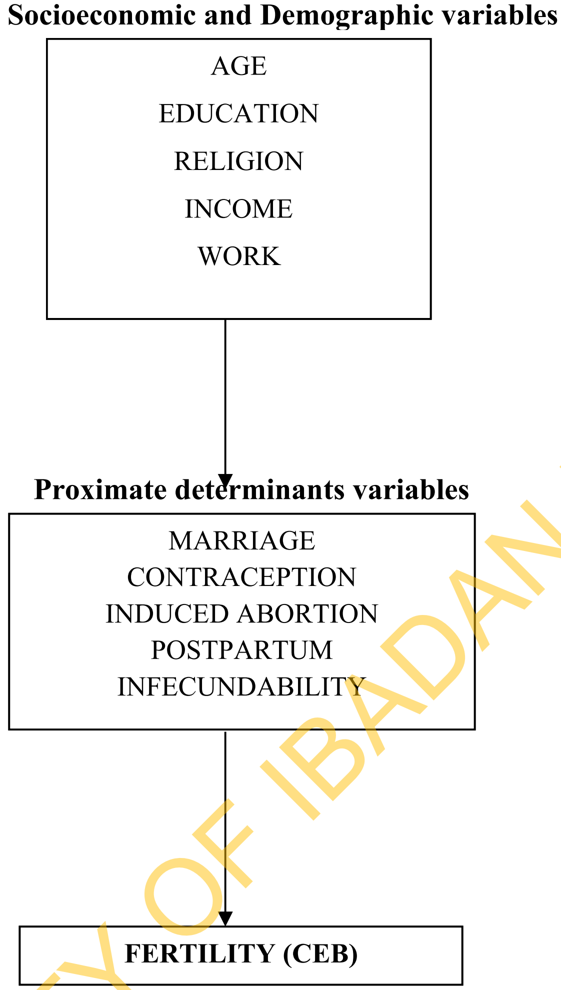
Snopkowsk *et al*. used Structural Equation Modeling in 2016 to explore possible pathways between education and fertility, including: infant/child mortality, involvement of women in the labor market, education of husbands, effects of social networks, and use or awareness of contraceptives in three very different contexts. Education was found to be associated with delayed age at first birth by increased involvement of women in the labor force in all three contexts.

Mahsa Saadati and Arezoo Bagheri have used a path analysis technique in Iran in 2018 to examine the effect of the importance of children on fertility in a cross-sectional sample. The study considered three dimensions of the importance of children (cultural, social and economic), as well as demographic and attitudinal variables. Four structural equation models were fitted to the data based on age groups of females. It was inferred from the outcome that as the favorable cultural opinion of women of childbearing increases, desired children increase.

2.6 CONCEPTUAL FRAMEWORK

The figure below showed that socio economic and demographic factors influence fertility through the proximate determinant of fertility. The socio economic and demographic determinants directly influence the proximate determinants, have both behavioral and biological components, which determine the number of children ever born (fertility) by women. Bongaart summarized the eleven proximate variables, proposed by Davis and Blake, into eight factors - Proportion married, contraception, induced abortion, Postpartum infecundability, frequency of intercourse, sterility, spontaneous intrauterine mortality and duration of the fertile period. He further indentified four, Marriage, Contraception, Postpartum infecundability and induced abortion, out of the summarized eight and regarded them as the most important proximate variables because they account for nearly 96% variation of fertility in a population. Due to the legal restriction on abortion in Nigeria, this study used the three available variables, Marriage, Contraception, and Postpartum infecundability, in the assessment of proximate determinant of fertility among HIV positive women in Ibadan, Southwest, Nigeria using SEM.

Figure 1: Conceptual framework for the analysis of factors that influence fertility.



Source: Based on Bongaart Framework (2012)

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter gives an overview of the research methodology and its design. The methodological approach is written based on the data collected and analyzed. The specific objective of the study is to assess the inter relationship among the proximate determinants of fertility among HIV infected women in South West Nigeria using Structural Equation Modeling. This was to widen our understanding of the inter-relationship among different components of the proximate frame work for proper integration of HIV care and reproductive health.

3.2 STUDY AREA

The study area was Antiretroviral Clinic in University College Hospital (UCH). The UCH was established by an August 1952 Act of Parliament as a result of the need for the training of medical personnel and other health care professionals for the country and West Africa Sub region. The UCH was situated in Ibadan, the largest city in West Africa.

The physical development of the hospital commenced on 20th November, 1953 in its present site and was formally commissioned after completion on 20th November, 1957. The UCH was initially commissioned with 500 bed spaces. Presently, the hospital has 850 bed spaces and 700 examination couches with occupancy ranging from 65-70%.

The hospital has about 65 service and clinical departments, 96 consultative out-patients clinics a week with 50 specialty and sub specialty disciplines. Additionally, the hospital has a special HIV/ care clinic which was ART. The ART was one of 25 ART centres established and funded by Federal Government of Nigeria in 2002 to provide treatment (for ART eligible), care and support to PLWH at subsidized rate. Since 2004, the President Bush

Emergency Plan for AIDS Relief (PEPFAR) has provided immense support for the scale-up of the nation's antiretroviral treatment programme, initially at the government-subsidized rate of 1,000 Naira per month (US $7.0) but free since January, 2006. The Hospital started patient recruitment in 2002.

3.3 Study Design

The current study is a secondary analysis of data collected in a project on childbearing progression and proximate determinants of fertility among women living with HIV in Ibadan sponsored by Medical Education Partnership Initiative in Nigeria (MEPIN).

3.4 Study Population

The population of women age 15 years and above who consented to participate in the study.

3.5 Inclusion Criteria

Women who have children and have been enrolled for treatment and care for at least 12 months

3.6 Exlusion criteria

Women who refuse consent or too ill to respond to interview questions

3.7 Sampling technique

A stratified random sampling technique with proportional allocation was employed in selection of study participants. Stratification was done by heallth facility and enrollment year.The sample size was proportionately allocated to the hospital and for different years of enrollment depending on the number of available active patients for each year (2005-2013). The sampling frame was a list of patient identification numbers for currently active patients which was obtained from the records section of the Antiretroviral Therapy clinic of the University College Hospital (UCH), Ibadan

3.8 Sample Size

A sample size of 900 women of reproductive age (15years and above) receiving HIV care were interviewed in the study. These women provided complete information about their fertility preference and experiences.

3.9 Data Collection

The data was collected by trained research assistants. Female research assistants interviewed the study participants.Data collection instrument was structured questionnaires with relevant sections such as socio-demographic characteristics, HIV care/treatment profile, contraceptive use, reproduction (birth history), fertility preferences and desires. The questionnaires were pre-tested and piloted at sites other than UCH. There was a research supervisor who worked alongside the research assistants to check questionnaires for completeness and logical consistency on daily basis.

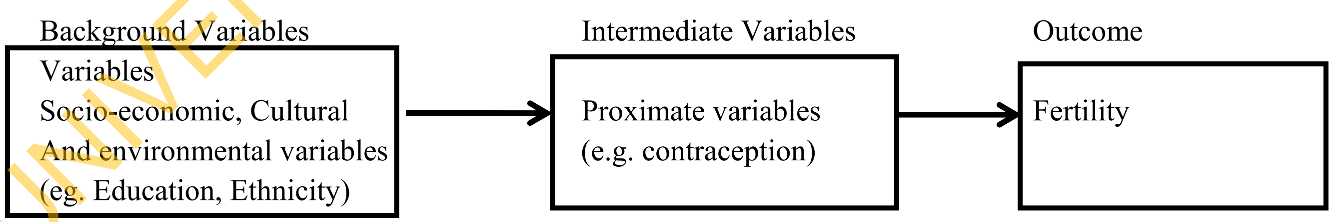
3.10 Data Processing

The validated questionnaires were entered by a trained data entry clerk as soon as data collection started. The process was facilitated through a data entry template with data quality checks that was designed using CsPro which is a very good software for data capture. After data entry, data was verified and validated using inbuilt tools in the software. Validated and cleaned data was exported to Stata version 12 for exploration and subsequent analyses. Specified number of patients for each strata was selected using the randomisation module in SPSS version 20.0

3.11. Study Variables.

Women have been interviewed on a range of variables that directly or indirectly affect fertility among HIV positive women. The hallmark of analysis of this study is based on the (Bongaarts *et al.* 1984). In this framework, the background and socioeconomic characteristics are set to influence fertility by their effects on the intermediate variables.

Figure 2: Bongaarts' framework on the role of the proximate variables on fertility



The variables used in this study are as follow:

3.11.1 Independent Variables
Background Variables

These variables indirectly affect fertility via the proximate determinant variables. The variables are: Age, level of education, religion, ethnicity, occupation, income, marital status. The choice of these variables was based on existing literatures.

3.11.2 Intermediate Variables (Proximate Variables)

These are variables that directly influence fertility. The variables include: Marriage, Contraception and Postpartum Infecundability: Sexual abstinence and breastfeeding.

3.11.4 Outcome Variables

The dependent variable is Fertility (Number of Children Ever Born)

3.11.5 Description of Independent Variables

Age Distribution of the Women

Age can be defined as the number of complete years lived since birth. It is one of the important demographic variables. Age specific fertility may follow a normal curve, low fertility at young age; fertility can increase to a maximum in the twenties, then decline at older age.

Thus, in this study, the age distribution was restricted to the age of women of reproductive age 15 - 49 receiving HIV care because this group is vulnerable to childbearing and exposure risk. The age distribution was categorized in this study as 15-19=1, 20 – 24=2, 25 – 29=3, 30 – 34=4, 35 – 39=5, 40 – 44=6, 45 – 49=7

Marital Status

Marital status is an important determinant of fertility. This is because there more birth within the union than outside. This variable measures the status of the HIV positive women and it was categorized thus:

Married/ living with a man = 1

Never Married = 2

Divorced / Separated = 3

Widowed = 4

Level of Education

Education is an important socio-economic variable that affects fertility by influencing the age at first marriage, the desired family size and contraceptive use.

This variable measures the education attainment of HIV positive women. The variable was categorized thus:

No education = 0

Primary education = 1

Secondary education = 2

Higher education = 3

Religion

Religion is one of the socio-economic variables that influence fertility via marriage and number of birth. This is because individual's beliefs in the rebirth of ancestors and early marriage can increase the fertility.

This variable measures the religion belief of the respondent. The variable was categorized as follow:

Christianity = 1

Islam = 2

Ethnicity

Ethnicity may either increase or decrease fertility. This is due to the customs, beliefs, values and norms of the ethnic groups. Ethnic groups have different perceptions about different component of fertility. The popular ethnic groups out of about 374 ethnics in Nigeria are Yoruba, Igbo and Hausa. Thus, this variable was categorized thus:

Yoruba = 1

Igbo = 2

Others = 3

Occupation

Female employment influences fertility and might increase or decline the fertility rate since working reduces a woman's available time, and as raising children is time-intensive. This variable measures the nature of occupation the respondents engage with. This variable was categorized as follows:

Professional = 1

Skilled = 2

Unskilled = 3

Unemployed = 4

Income

Income is essential to determine the standard of living of women of reproductive age. Though, income was categorized as follows:

< 20,000 = 1

20,000 – 999,000 = 2

>= 100,000 = 3

3.12 Data Analysis

Categorical Variables were presented using percentages while quantitative variables were summarized using mean and standard deviation.

ANOVA was used for association and comparison of mean of children ever born for the different categories of explanatory variable(s).

Structural Equation Modeling was employed to assess the inter relationship among the various component of proximate determinant of fertility.

3.13 Structural Equation Modeling (SEM)

3.13.1 Measurement Models

A measurement model analyzes relationships among a set of observable variables and a predetermined number of latent variables (Kline 2011). This model was specified based on the latent variables in the model. The latent variables are measured from the observed variables. The observed variables are age, marital status, occupation, level of educational, ethnicity, religion and income, proximate variables. The measurement equation model is represented mathematically in the matrix form as follows.

$$X_{(mx1)} = \Lambda_{x\,(mxp)} \times \xi_{(px1)} + \delta_{(mx1)}$$
$$Y_{(nx1)} = \Lambda_{y\,(nxq)} \times \eta_{(qx1)} + \varepsilon_{(nx1)}$$

Where X= vectors of indicators of exogenous variables

Y= vectors of indicators of endogenous variables

Λ_x = Matrix of loading coefficient of the regression of X on ξ

Λ_y= Matrix of loading coefficient of the regression of Y on η

ξ = Vectors of exogenous latent construct.

η = Vectors of endogenous latent construct.

δ = Vectors of random measurement error of exogenous variables

ε = Vectors of random measurement error of endogenous variables

m = Number of indicators of exogenous variables

p = Number of exogenous latent

n = Number of indicators of endogenous variables

q = Number of endogenous latent.

The measurement equations group together the correlated indicator variables to form the latent variables in η and ξ given the observed data describing the vectors y and x. This is done by assigning fixed parameter and defining unknown parameter in $\Lambda_x$and Λ_y.

3.13.2 Structural Model

The interrelationship among the latent variables is explained through a structural equation model. It is mathematically expressed in matrix form as follows:

$$\eta_{nx1} = \beta_{nxm}\, \eta_{mx1} + \Gamma\xi + e$$

η = Vectors of endogenous latent constructs

β = Matrix of structural parameter relating the endogenous latent construct together

Γ = Matrix of structural parameter relating the exogenous latent construct

ξ = Vectors of exogenous construct

e= Vectors of disturbances representing the unexplained variation in the exogenous.

m = Number of indicators of exogenous variables

3.13.3 Model Identification

This is to determine whether the proposed model is over-, under-, or just identified. This was done by calculating the number of degrees of freedom in a model by subtracting the number of parameters to be estimated from the number of known elements. The formula used to obtain this was:

(No. observed variables [no. observed variables + 1])/2.

If the value obtained was greater than 0, then the model is over identified, if it less than zero than it is under identified, otherwise, it will be just identified. Thus, the model of this study was over identified.

3.13.4 Model Estimation Method

The method of maximum likelihood (ML) was used to estimate the parameters in the model. This method provides an assurance that the estimation process yielded an admissible solution, eliminating any concern about multico-linearity effects. The right sign and size of the estimates are then evaluated together with standard errors with reasonable ranges and correlations. Coefficient of variation was also computed by subtracting standardized error associated with each latent variable from one (1).

3.13.5 Model Evaluation Criteria: Goodness of Fit

Chi Square (χ^2) Goodness of Fit.

The Chi square goodness of fit metric was used to assess the overall fit and the discrepancy between the sample and fitted covariance matrices, Hu and Bentler (1999). The cut off for good fit is set at p-value >0.05 Barrett (2007). Normed chi square was also computed by dividing the chi square value by degree of freedom. Chi square was computed using the following formula

χ^2=F*(N-1) where **F**=the value of the fitting function and **N**=sample size

Comparative Fit Index (CFI)

The CFI was used to compare the performance on our model to performance on baseline model (Bentler, 1990; Bentler and Bonnet, 1980; Hu and Bentler, 1999). CFI values above 0.90 are usually associated with a model that fits well. But a revised cut off value close to 0.95 was suggested by Hu and Bentler (1999). This index was computed as: CFI= 1

Normed Fit Index (NFI)

The NFI was used to assess the model by comparing the χ^2value of the model to the χ^2 value of the null model. NFI was set to greater than 0.90 to indicate a good fit as recommended by Bentler and Bonnet (1980)

$$NFI= (\chi^2_{null} - \chi^2_{model})/\chi^2_{null}$$

Root Mean Square Error of Approximation (RMSEA)

Root Mean Square Error Approximation (RMSEA) was used to measure the discrepancy per degree of freedom. Lower RMSEA values indicate better fit. RMSEA values was set at<0.05 to indicate good fit. (Browne and Cudeck, 1993).

$$RMSEA= \sqrt{\{\chi^2_{model} - df_{model}\}/\{(N-1)df_{model}\}}$$

If model fit is acceptable, the parameter estimates are examined. The ratio of each parameter estimate to its standard error is distributed as a z statistic and is significant at the 0.05 level if its value exceeds 1.96 (Hoyle 1995)

3.13.6 Model Modification

If model fit is unacceptable, the model would be revised when the modifications are meaningful. Model modification involves adjusting a specified and estimated model by either freeing parameters that were fixed or fixing parameters that were free. The Lagrange multiplier test provides information about the amount of chi-square change that results if fixed parameters are freed. The Wald test provides information about the change in chi square that results if free parameters are fixed (Hoyle, 1995)

3.14 ETHICAL APPROVAL

The original study was approved by the University of Ibadan/University College Hospital Instituional Review Ccommittee (UI/UCH IRC).

CHAPTER FOUR

RESULTS

4.1 Demographic Characteristics

The table 4.1 below shows the frequency and percentage distribution of a total of 933 patients' reproductive age HIV / AIDS on ART according to their socio-demographic characteristics. The age of the patients ranged from 18 to 49 years with the mean of 38.05 (6.08) years. Majority of the patients, 277 (29.7%) were aged 35 years and above. Out of the total records, about 77% of the patients were married while 13.1% were widowed. The table also shows further that 80.5% of the entire patients were Yoruba. Secondary education, 443 (49.7%), was the most level of education attained while about a quarter had tertiary level of education, 232 (24.9%). Most of the patients (593; 63.6%) are presently working and more than half (59.6%) of them earned less than ₦20, 000 as monthly salary.

TABLE 4. 1 Frequency and Percentage Distribution of Patients by Socio-Demographic Characteristics

Variables	Frequency (%)	Mean (SD)
Age (years)		**38.05 (6.083)**
<= 29 yrs	75 (8.0)	
30-34 yrs	173 (18.5)	
35-39 yrs	277 (29.7)	
40-44 yrs	252 (27.0)	
45-49 yrs	156 (16.7)	
Level of Education		
None	63 (6.8)	
Primary	195 (20.9)	
Secondary	443 (47.5)	
Higher	232 (24.9)	
Marital Status		
Married	721(77.3)	
Never Married	9 (1)	
Divorced/separated	81 (8.7)	
Widowed	122 (13.1)	
Ethnicity		
Yoruba	751 (80.5)	
Igbo	77 (8.3)	
Others	105 (11.3)	
Religion		
Christianity	567(60.8)	
Islam	366 (39.2)	
Occupation		
Professional	118 (12.6)	
Skilled	134 (14.4)	
Unskilled	593 (63.6)	
Unemployed	88 (9.4)	
Income		
< 20,000	498 (59.6)	
20,000 – 999,000	304 (36.4)	
>= 100,000	33 (3.95)	
Total	**933 (100.0)**	

SD: Standard Deviation

4.2 Proximate Determinant of Fertility

The table 4.2 below shows the frequency and percentage distribution of participants according to the proximate determinant of fertility. Most of the women, 394 (42.2%) had started having sex before age 20 with the mean age of 20 (3.7). The table revealed that 392 (42.4%) of the women had their marriage after age 20 years and 376 (40.3) had their first birth between the age 20 - 24.

Almost all the women, 812 (87.7%) ever used contraceptive with the condom, 753 (80.7), as the most preferred method of the contraceptives. The table further revealed that majority of the women left more than 12 months between consecutive birth intervals. The mean children ever born of the women were 3 (1.5) with majority, 736 (78.9), of them having one or more child before HIV diagnosis.

TABLE 4. 2: Frequency and percentage determination of the proximate determinant of fertility

Variables	Frequency (%)	Mean (SD)
Age at first Intercourse		**20.41 (3.679)**
<= 19 yrs	394 (42.2)	
20-24 yrs	384 (41.2)	
25-29 yrs	138 (14.8)	
30 yrs and above	17 (1.82)	
Age at first Marriage		**23.81 (4.388)**
<= 19 yrs	126 (13.6)	
20-24 yrs	392 (42.4)	
25-29 yrs	296 (32.0)	
30 yrs and above	110 (11.9)	
Age at first birth		**24.27 (4.57)**
<= 19 yrs	119(12.8)	
20-24 yrs	376 (40.3)	
25-29 yrs	297 (31.8)	
30 yrs and above	136 (14.6)	
Ever use of contraceptive		
No	114 (12.2)	
Yes	812 (87.7)	
Contraceptives		
Pill	224 (24)	
IUD	131 (14)	
Injectable	220 (23.6)	
Condom	753 (80.7)	
Periodic Abstinence	305 (32.7)	
Withdrawal	351 (37.6)	
LAM	107 (11.5)	
Implants	64 (6.9)	
Duration of Breastfeeding(in month)		**13.63 (8.3)**
0 – 6	94 (15.9)	
7 – 12	241 (40.8)	
13 – 18	194 (32.8)	
19 – 24	51 (8.6)	
25+	11 (1.86)	
Duration of Breastfeeding(in month)		**15.6 (27.3)**
0 – 6	494 (61.2)	
7 – 12	156 (19.3)	
13 – 18	36 (4.5)	
19 – 24	29 (3.6)	
25+	92 (11.4)	

Variables	Frequency (%)	Mean (SD)
Duration of Abstinence		**15.6 (27.3)**
0 – 6	494 (61.2)	
7 – 12	156 (19.3)	
13 – 18	36 (4.5)	
19 – 24	29 (3.6)	
25+	92 (11.4)	
Children Ever Born		**3.05 (1.48)**
1	142 (15.2)	
2	218 (23.4)	
3	257 (27.5)	
4	166 (17.8)	
5	90 (9.6)	
6	40 (1.8)	
7+	20 (2.1)	
Had children before HIV diagnosis		
No	197 (21.1)	
Yes	736 (78.9)	
Had children after HIV diagnosis		
No	365 (39.1)	
Yes	568 (60.9)	

4.3 Mean Number of Children Ever Born (CEB), Standard Deviation (SD) and Analysis of Variance (ANOVA) by Demographic Characteristics of the patients.

The table 4.3 below shows the mean number of children ever born (CEB), standard deviation and Analysis of Variance by Demographic Characteristics of the patients.

The table showed that Education (F = 17.668, p = 0.000), Religion (F = 6.66, p = 0.010), and Occupation (F = 3.465, p = 0.01) had significant effects on the fertility differential among the patients at 5% level of significance.

Specifically, the mean number of children ever born among the women with no education or primary education (3.57) was significantly higher than their counterpart with secondary (2.95) or higher education (2.66). The mean children ever born by the Muslim women were higher than that of the Christian. In addition, women that are professional or skilled with high income had significantly lower number of children ever born than women that are unskilled or unemployed with low monthly income. The more educated a woman is the lower the mean number of children ever born. Being engaged with work reduces the chances of having more children.

TABLE 4. 3: Mean Number of Children Ever Born (CEB), Standard Deviation (SD) and Analysis of Variance (ANOVA) by Demographic Characteristics of the patients.

Socioeconomic Variable	Number	Mean CEB	SD	D.F	F	p-value
Age (years)				4	18.585	0.000
<= 29 yrs	75	2.23	1.269			
30-34 yrs	173	2.59	1.196			
35-39 yrs	277	3.06	1.432			
40-44 yrs	252	3.24	1.475			
45-49 yrs	156	3.64	1.630			
Level of Education				3	17.668	0.000
None	63	3.57	1.573			
Primary	195	3.57	1.589			
Secondary	443	2.95	1.405			
Higher	232	2.66	1.339			
Religion				1	6.66	0.010
Christianity	567	2.95	1.438			
Islam	366	3.21	1.532			
Ethnicity				1	0.019	0.892
Yoruba	751	3.05	1.495			
Others	182	3.07	1.417			
Occupation				3	3.465	0.016
Professional	118	2.92	1.662			
Skilled	134	2.73	1.293			
Unskilled	593	3.16	1.453			
Unemployed	88	3.02	1.597			
Income				1	0.815	0.367
>20,000	248	2.98	1.438			
<=20,000	685	3.08	1.495			
Total	**933**	**3.05**	**1.480**			

SD: Standard deviation CEB: Children Ever Born DF: Degree of Freedom

4.4 Mean Number of Children Ever Born (CEB), Standard Deviation (SD) and Analysis of Variance (ANOVA) by Proximate determinant of fertility

The table 4.4 below shows the mean number of children ever born (CEB), standard deviation and Analysis of Variance by Proximate determinant of fertility.

From the table, it was deduced that age at first intercourse, age at first marriage and age at first birth had significant effect on the mean number of children born at 5% level of significance.

The mean number of children ever born of the women whose age at first intercourse was below 24 years was significantly higher than women who had first intercourse at 25 years and above. Similarly, women who married and gave birth at early age (within <= 19 years and 20 - 24 years) had significantly higher mean number of children ever born than their counterpart who married and gave birth at age 25 years and above. These imply marriage at early age increases the chance of having more children within the reproductive age.

The table further revealed that women who did not breastfed had higher mean number of children ever born than those that breastfed. It was also shown in the table, that HIV status had significant effect on the mean number of children ever born by the women. Specifically, majority of the women had 3 or more children before they were diagnosed of HIV than after the diagnosis.

TABLE 4. 4: Mean Number of Children Ever Born (CEB), Standard Deviation (SD) and Analysis of Variance (ANOVA) by Proximate determinant of fertility

Socioeconomic Variable	Number	Mean CEB	SD	D.F	F	p-value
Age at first Intercourse				3	4.594	0.003
<= 19 yrs	394	3.21	1.553			
20-24 yrs	384	3.01	1.411			
25-29 yrs	138	2.82	1.405			
30 yrs and above	17	2.24	1.348			
Age at first Marriage				3	24.633	0.000
<= 19 yrs	135	3.71	1.740			
20-24 yrs	392	3.22	1.402			
25-29 yrs	296	2.82	1.377			
30 yrs and above	110	2.28	1.197			
Age at first birth				3	22.694	0.000
<= 19 yrs	124	3.60	1.587			
20-24 yrs	376	3.27	1.488			
25-29 yrs	297	2.89	1.348			
30 yrs and above	136	2.31	1.285			
Ever use of contraceptive				1	14.630	0.000
No	119	2.57	1.435			
Yes	814	3.12	1.474			
Did you ever breastfed				1	2.703	0.101
No	229	3.15	1.554			
Yes	593	2.96	1.427			
Has menses returned				1	6.056	0.014
No	92	3.41	1.40			
Yes	839	3.01	1.483			
Had Children				1	118.795	0.367
Before HIV	766	3.28	1.472			
After HIV	166	1.98	.931			
Total	**932**	**3.05**	**1.477**			

SD: Standard Deviation CEB: Children Ever Born D.F: Degree of freedom

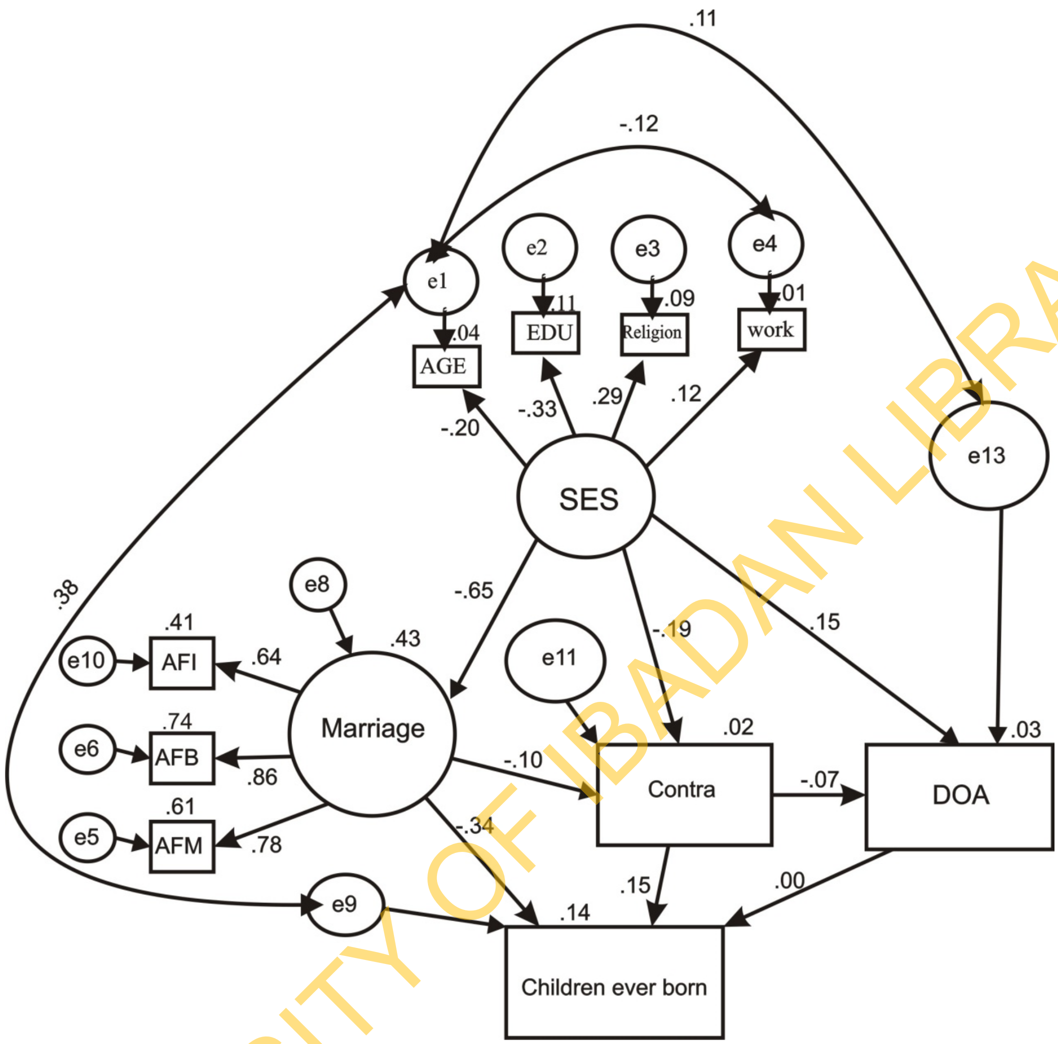
4.5 PATH DIAGRAM

The figure below showed the result of the estimated path diagram with the standardized coefficient between the latent variables and manifest variables for the model. The figure showed that latent variable (SES) had direct positive impact on the postpartum infecundability – Duration of Amenorrhea but direct negative impact on marriage and contraceptives.

Also, Marriage had direct negative impact on the contraceptives and contraceptives had direct negative impact on the postpartum infecundability – Duration of Amenorrhea.

Socioeconomic status had indirect relationship with the children ever born through the marriage, contraceptives and postpartum infecundability as it is evident in the figure below.

Figure 3*: Path Diagram*



Note: AFB=Age at first birth, AFM = Age at first marriage, EDU = Education, DOA =Duration of Amenorrhea, SES = Socioeconomic status, Contra = Contraceptives.

4.6 Goodness of Fit of the Model

As shown in the table below, this over identified model implies that the model provides a good fit for the data. This is evident in the measures of fit, (x^2, 63.473, d.f = 2.35); GFI = 0.987; NFI = 0.954; CFI = 0.973 and RMSEA = 0.038, shown in the table below.

Having shown that the model provides a good fit to the data, subsequent tables summarize the coefficient of the estimates.

TABLE 4. 5: Fit Indexes of the model (N = 933)

Fit Index	**Observed Model**	**Recommended Level**	**References**
X^2	63.473, d.f = 2.35	0.05	Hair *et al*., 2009
GFI	0.987	>= 0.90	Meyers *et al*., 2013
NFI	0.954	> 0.95	Meyers *et al*., 2013
CFI	0.973	> 0.95	Hu & Bentler., 1999
RMSEA	0.038	< = 0.05	Schumaker & Lomax, 2004

Note: $\chi 2$=Chi-square statistics; df=degree of freedom; GFI=Goodness of fit indices; CFI=Comparative fit Index; RMSEA=Root Mean Square Error of Approximation;

4.7 Unstandardized direct and indirect coefficients of Path Diagram

The table revealed that the indicators contribute significantly to their respective constructs. Specifically, Two indicators (Age and Education) contribute negatively to the latent construct (Socioeconomic status) while Religion contribute positively to the construct. The three indicators are significant ($p < 0.005$) at 5% level of significance. Also, the three indicators, age at first marriage, age at first intercourse and age at first birth, contribute positively to the latent construct (Marriage) and are significant at 5% level of significance.

The table also showed the estimates of relationships (direct and indirect) between the endogenous variables and exogenous variables.

Exogenous variable (socioeconomic status) assumes direct negative relationships with marriage and contraceptives and direct positive relationship with the postpartum infecundability. These imply that increase in the level of education; increase the chances of marrying late and giving birth at old age. The more religious a woman is, the lesser the age at which a she get married and give birth. These also imply that the higher the level of education, the more literacy a woman is to the use of contraceptives while the more religious a woman is, the lower she makes use of contraceptives. It was further revealed that increase in the socioeconomic status (age and level of education), the more the length of interval that will be left between two consecutive birth, vice versa.

The table further revealed that Marriage assumes direct negative relationship with the children ever born while contraceptive assumes direct positive relationship with the children ever born. This implies that the higher the age at marriage and birth, the lower the number of children ever bore by the patients, vice versa.

TABLE 4. 6: Unstandardized direct and indirect estimates of the path diagram

Endogenous Variables		Exogenous Variables	Direct Effect	Indirect Effect	Total	P
MARRIAGE	<---	SES	-43.108	0.000	-43.108	.026
CONTRA	<---	SES	-1.803	0.000	-1.803	.214
CONTRA	<---	MARRIAGE	-.014	0.000	-.014	.305
PPI	<---	SES	88.879	0.000	88.879	.058
PPI	<---	CONTR	-4.667	0.000	-4.667	.036
AGE	<---	SES	-35.133	0.000	-35.133	.023
EDU	<---	SES	-2.320	0.000	-2.320	.020
Religion	<---	SES	4.061	0.000	4.061	.022
WORK	<---	SES	1.000	0.000	1.000	
AFI	<---	MARRIAGE	1.000	0.000	1.000	
AFM	<---	MARRIAGE	1.650	0.000	1.650	***
AFB	<---	MARRIAGE	1.777	0.000	1.777	***
CEB	<---	MARRIAGE	-.217	-0.010	-.227	***
CEB	<---	CONTR	.665	0.001	.664	***
CEB	<---	PPI	.000	0.000	.000	.924

CEB = children ever born; SES = socioeconomic status; CONTRA = Contraceptives; PPI = Postpartum Infecundability (Duration of Amenorrhea); EDU = Education; AFI = age at first intercourse; AFB = Age at first birth; AFM = Age at first marriage.

4.8 Standardized direct and indirect estimates of the Model

The table revealed that the indicators contribute significantly to their respective constructs. Specifically, Two indicators (Age and Education) contribute negatively to the latent construct (Socioeconomic status) while Religion and Work contribute positively to the construct (Socioeconomic status). Three indicators (Age at first birth, Age at first marriage and age at first intercourse) contribute positively to the latent construct (Marriage) and are significant at 5% level of significance.

The table also showed that standardized estimates of relationships (direct and indirect) between the endogenous variables and exogenous variables. Exogenous variable (socioeconomic status) assumes direct negative relationships with marriage ($\beta = -0.652, p = 0.026$) and contraceptives ($\beta = -0.191, p = 0.214$) and direct positive relationship with the postpartum infecundability ($\beta = 0.146, p = 0.058$). These imply that the higher the level of education, the higher the age at which women get married and give birth to their first child while the higher the one's faith, the lower the age at first marriage and at first birth. This means that education contributes to the late marriage by the patients while religion encourages early marriage and birth. These also imply that the higher the level of education, the higher the chances of using contraceptives while the higher the one's faith, the lower the use of contraceptives. It was further revealed that the higher the socioeconomic status (age and level of education), the higher the length of interval that will be left between two consecutive birth, vice versa.

The table further revealed that Marriage and postpartum infecundability assume direct negative relationship with the children ever born while contraceptive assumes direct positive relationship with the children ever born. This implies that the higher the age at marriage and birth, the higher the length of postpartum, the lesser the fertility, vice versa.

TABLE 4. 7 : Standardized Estimates of the Model

Indicators		Latent Variables	Direct Effect	Indirect Effect	Total	P
MARRIAGE	<---	SES	-.652	0.000	-.652	.026
CONTRA	<---	SES	-.191	0.065	-.126	.214
CONTRA	<---	MARRIAGE	-.100	0.000	-.100	.305
PPI	<---	SES	.146	0.009	.146	.058
PPI	<---	CONTR	-.072	0.000	-.072	.036
AGE	<---	SES	-.205	0.000	-.205	.023
EDU	<---	SES	-.327	0.000	-.327	.020
Religion	<---	SES	.294	0.000	.294	.022
WORK	<---	SES	.121	0.000	.121	
AFI	<---	MARRIAGE	.637	0.000	.637	
AFM	<---	MARRIAGE	.781	0.000	.781	***
AFB	<---	MARRIAGE	.859	0.000	.859	***
CEB	<---	MARRIAGE	-.341	-0.015	-.341	***
CEB	<---	CONTR	.149	0.000	.149	***
CEB	<---	PPI	-.003	0.000	-.003	.924

CEB = children ever born; SES = socioeconomic status; CONTRA = Contraceptives; PPI = Postpartum Infecundability (Duration of Amenorrhea); EDU = Education; AFI = age at first intercourse; AFB = Age at first birth; AFM = Age at first marriage.

4.9 Coefficient for the structural equation model by group of variables

The standardized (β) and unstandardized regression weight from the structural equation model for each of the relationship and the proportion of the variation in latent factors explained by each indicator are presented in the table 4.9 below.

The model indicated age, education, religion and work explained almost 99% of the variation in the socioeconomic status. Also, socioeconomic status explained 57% of the variation in marriage, 96% of the contraceptives and 99% of the postpartum infecundability.

Furthermore, marriage explained 95% of total variation in fertility (children ever born), contraceptives explained 98% while postpartum explained 99% of the variation.

TABLE 4. 8: Coefficient for the structural equation model by group of variables

Indicators		Latent Variables	Unstandardised estimate	Standardized estimate	S.E	Z	P	R^2
MARRIAGE	<---	SES	-43.108	-.652	19.359	-2.227	.026	0.574
CONTRA	<---	SES	-1.803	-.191	1.452	-1.242	.214	0.96
CONTRA	<---	MARRIAGE	-.014	-.100	.014	-1.025	.305	0.99
PPI	<---	SES	88.879	.146	46.890	1.895	.058	0.98
PPI	<---	CONTR	-4.667	-.072	2.224	-2.099	.036	0.99
AGE	<---	SES	-35.133	-.205	15.411	-2.280	.023	0.96
EDU	<---	SES	-2.320	-.327	.999	-2.321	.020	0.89
Religion	<---	SES	4.061	.294	1.771	2.292	.022	0.91
WORK	<---	SES	1.000	.121				0.99
AFI	<---	MARRIAGE	1.000	.637				0.59
AFM	<---	MARRIAGE	1.650	.781	.090	18.362	***	0.39
AFB	<---	MARRIAGE	1.777	.859	.096	18.543	***	0.26
CEB	<---	MARRIAGE	-.217	-.341	.023	-9.345	***	0.95
CEB	<---	CONTR	.665	.149	.130	5.116	***	0.98
CEB	<---	PPI	.000	-.003	.002	-.096	.924	0.99

CHAPTER 5

Discussion, Conclusion, Limitation and Recommendation

5.1 Discussion

This study showed the findings about the proximate determinant of fertility among women living with HIV in Ibadan. These findings will be discussed in line with the study objectives and the context of existing literature on the study. The general objective of this study was to develop a structural equation modeling to assess the inter-relationship among the proximate determinants of fertility among women living with HIV.

This study showed that women who had their first marriage and started child bearing before the age of 24 years had significantly higher number of children ever born compared to women who married and started child bearing at age 25 and above and this is significant at ($p = 0.000 < 0.05$). This is consistent with the findings of Oyefara, 2012 in his findings of age at first birth and fertility differential among women in Osun State Nigeria (Oyefara 2012). It was also deduced that there is inverse relationship between the level of education of the women and fertility. Women with at least secondary education had lower mean number of children ever born than their counterpart with primary or no education. And education influences fertility through its direct negative impact on marriage and contraceptives. The more educated a woman is, the lesser her exposure to the risk of child bearing and the more literacy she is in the use of contraceptives. This result corroborates with the result of the findings conducted in Nigeria. (Skirbekk 2008; Onipede 2012; Oyefara 2012).

Almost all the participants ever use contraceptives with the condom as the most preferred method of contraceptives. This aligns with the findings of (Akinyemi *et al.* 2010). Religion also had direct negative relationship with marriage and contraceptive usage. The more religious a woman is, the lower the age at which she got married and started child bearing and the lesser her usage in the use of contraceptives. This finding is consistent with the report of previous studies conducted (Westoff and Kristin 2015).

It was also found that those women who did not breastfed had higher mean number of children ever born than those that breastfed. This is similar to the findings conducted in Nigeria (Sule-Odu *et al.* 2008). The findings also showed that HIV status had significant effect on the mean number of children ever born by the women. Specifically, majority of the women had 3 or more children before they were diagnosed of HIV than after the diagnosis. The result of the findings is similar to what was documented in previous findings (Ntozi 2012, Zaba and Gregson 2002).

The findings revealed that the estimated structure equation model for the relationship between endogenous variables and exogenous variables provide a reasonable fit to the data. This shows that the model described the data adequately as the fit indices ranges from 95% to 98%. The indicators contribute significantly to their respective construct. From the findings, it was shown that there is inter relationship between the various components of the proximate variables. Marriage had direct negative relationship with the contraceptives while contraceptives had direct negative relationship with postpartum infecundability. These imply that an increase in the component of marriage will cause a corresponding decrease in the use of contraceptives. This is because women who married late (older age) will use fewer contraceptives in order to meet up with the desired number of children prior the menopause and account for unpredictable death from AIDS. This aligns with the result of the findings of Smith in 2003. Similarly, the more a woman use contraceptives, the lesser is her duration of postpartum infecundability. Women leave about 15 months of postpartum infecundability between two consecutive births which reduce her usage of contraceptives. this is not far from the result of previous studies (Sule-Odu *et al.* 2008)

The study also found out that marriage and postpartum infecundability had a direct negative relationship with the children ever born while contraceptives had direct positive relationship with the children ever born. This means that an increase in the component of marriage and postpartum infecundability will cause a corresponding decrease in the children ever born by the patients. This implies that a woman who married late will have fewer number of children ever born compared to woman who married and started child bearing at early age. This aligned with the findings of (Oyefara 2012). In the same vein, a woman with high duration of post partum infecundability will have less number of children ever born. It is evident in the findings that changing in any component of the proximate determinant of fertility will cause a changing in the fertility. This implies that proximate determinant influences the rate of fertility.

5.2 Conclusion

This study had showed that socioeconomic status plays an indispensable role in influencing fertility through proximate determinant of fertility. More educated women and those that are skilled had their marriage and birth late and thus, have less number of children ever born to them. Most of the women had higher fertility before they were HIV positive than after they were HIV positive. The findings had also showed that there is interrelationship among various proximate determinants and change in one determinant will cause change in the fertility of women. The study also showed that the estimated model provides a good fit to the data which makes its result to be accepted and adequately described the data. This result is essential for the understanding of factors through which fertility is influenced for proper integration of HIV care and reproductive health services.

5.3 Limitation

The usage of secondary data in this study limits the choice of variables to be used in the analysis. The result of this study may be influenced by the cross sectional nature of the study since verbal reporting of the historical events such as age at first sexual intercourse, consistent use of contraceptives are often prone to recall bias. The use of structural equation modeling involves a broad sample size and usually several hundred observations, as the sample size determines the accuracy of the estimates.

5.4 Recommendations

Structural equation modeling should be regarded in studies that involve the revealing of direct and indirect causes of a phenomenon. Education, which is an indicator of fertility, has been proved as a significant determinant of marriage, Encouraging women to have a minimum of secondary education would make it easier to improve fertility after HIV diagnosis. As it has been demonstrated that HIV status has significant effect on fertility, intervention targeting the integration of HIV care and reproductive health service should be given adequate attention.

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