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Modelling of childbearing progression among women living with HIV in Ibadan, Nigeria

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Abstract

Background Childbearing is a major concern for women living with HIV especially in low-middle income countries. There are fears about access to care, risk of vertical transmission, health challenges, maternal and child morbidity/mortality. Investigation of childbearing progression and its associated factors among these women will be useful for design of reproductive healthcare services of these women and ultimately address their multifaceted concerns. This study examined childbearing progression and its correlates another among women living with HIV in Ibadan.

Method The study used a dataset from a cross-sectional study on childbearing progression among 933 respondents aged (18–49) receiving HIV care at the University College Hospital, Ibadan. Synthetic Relational Gompertz method was used to estimate fertility rate in the study population while a multistate model was developed to identify the factors associated with progression from one birth to the next.

Results The average age of participants was 38 years, with majority being Yoruba tribe (80.5%). Nearly all had at least basic education (93%), and about half had 1–2 children at the time of their HIV diagnosis (47.6%). The likelihood of progressing from the first to a second birth was 77%, though no specific factors were statistically significant. However, progression to a third birth was significantly less likely (86% lower), and associated with factors such as: Having 1–2 children at HIV diagnosis (59% less likely to progress). Having more than 2 children at HIV diagnosis (94% more likely to progress), marital status (widowed women were 36% more likely to progress), partner's education (secondary education increased the likelihood by 23%), partner's employment status (unemployed partners increased the likelihood by 40%), desire for more children, partner's HIV-negative status. Progression to fourth and subsequent births showed a continued decline, with the likelihood of a fourth birth being 82% lower and a fifth or sixth birth 85% lower. Women with secondary education were significantly less likely to progress to fifth births.

Conclusion Overall, the corrected total fertility rate is 3.54, it's below the national estimates and Southwest region which implies fertility is declining among women living with HIV in Ibadan. The findings revealed the relevance of socio-economic and demographic factors in childbearing progression among women living with HIV. Focused interventions should aim to provide better family planning support and integrate reproductive health counseling into HIV care programs.

Keywords Fertility, Parity (childbearing) progression, Multistate model, Women living with HIV, Fertility rate, Nigeria

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Introduction

HIV/AIDS remains a significant global health concern, with approximately 40.1 million lives lost to the disease [1]. About 38.4 million people live with HIV at the end of 2021. Additionally, 54% of these people were females [1, 2].

About 3.2 million people in Nigeria are living with HIV, making it the country with the second highest burden of the virus globally. The annual estimated rate of new infection is 8 per 10,000 population [3]. Women are at higher risk of HIV infection due to biological vulnerabilities, epidemiological factors, and the dominant sexual practices of males [4] including HIV being more easily transmitted from men to women than from women to men [5].

Fertility is an important aspect of life in sub-Saharan Africa, where fertility rates are generally higher than in other parts of the world. Before the availability of antiretroviral therapy in Africa, there were major concerns about the risk of mother-to-child transmission during pregnancy, childbirth, and breastfeeding. The Antiretroviral therapy (ART) can have impact on fertility desire among women living with HIV [6, 7]. In Nigeria, 70% of sexually active women living with HIV (WLHIV) have fertility rates of around 5.5 children per woman, and there is low uptake of contraceptives (15%) among this population [8].

Despite the prevalence of HIV among women in sub-Saharan Africa, research have shown that women living with HIV/AIDS (WLWH) desire to have children [9, 10, 11, 12]. Other researchers have identified age, being married, duration of marriage, high educational status, income, partner's HIV status, non-use of contraceptives, number of surviving children, remarriage and ART adherence as predictors of fertility desire among women living with HIV [11, 13, 14].

Parity or childbearing progression is an important concept that affect the reproductive health of women in Nigeria and the developing countries, because of its implications for birth interval, health of mother and babies, and the general level of fertility in the population. High parity progression is also a problem in Nigeria due to the economic, health, environmental, and educational challenges it poses. The implication of parity progression among WLWH compounds the increased health risks for women and children, access to care, vertical transmission from mother to child. Studies on parity progression among women living with HIV is very important to inform actions that could address the challenges. Previous studies have examined fertility desire among women living with HIV in Nigeria [7, 15, 16, 17, 18] but parity progression is scantly discussed. However, it is important to explore the parity progression and the associated factors.

Studying parity progression (the proportion of women that proceed to have additional child(ren)) among women living with HIV can help to better understand the fertility transition in this population subgroup. It can also inform the development of HIV prevention strategies that take into account their reproductive health and fertility desires. Therefore, the aim of this study is to estimate the fertility rate, describe the childbearing progression and identify its associated factors among women living with HIV in Ibadan, Nigeria.

Methods

Study design

The study was cross-sectional in design. It used data collected in a study on childbearing progression and proximate determinants of fertility among WLWH in Ibadan. Details on the design, data collection and study context have been reported in prior publications [14, 15, 17].

Study area

The University College Hospital, Ibadan is the first tertiary hospital in Nigeria. It is the teaching hospital to the College of Medicine, University of Ibadan. The Antiretroviral Clinic of the facility was established in 2002 as one of 25 Antiretroviral Clinics nationwide, it provides services to the southwestern region of Nigeria and surrounding areas.

Data collection technique

Data was collected from those who had received care for at least one year in the HIV Program located in the Infectious Disease Institute, College of Medicine, University College Hospital/University of Ibadan. The HIV program currently provide care for about 7,000 people living with HIV (PLHIV) and many other seeking HIV prevention services like HIV testing services (HTS), HIV Pre-exposure prophylaxis (PrEP); HIV post-exposure services (PEP).

The questionnaire used for data collection was a validated instrument adapted from the Nigeria Demographic and Health Survey [19] and questions related to HIV care and treatment were adapted from a prior survey on fertility in the era of HIV which was conducted in Nigeria and Zambia [15, 20].

Variables

The independent variables were categorized into two subgroups which are: sociodemographic characteristics of women (e.g. age at diagnosis, ethnicity, religion, education, employment and number of children at HIV diagnosis); and marital profile (marital status at diagnosis, partner's education, partner's employment, desire more children and family setting).

The intermediate variables represent HIV Care profile of the women which are ART duration, status disclosure to partner, HIV duration and partner's HIV status. These variables have been used in previous publication [15].

The dependent variable for this study was parity (childbearing) progression which captured how women moved from birth of a child to the next. Data was collected through a questionnaire that captured the participants' complete birth history. The questionnaire included questions about the birth date of each child, birth order, which indicates the child's position among their siblings. These questions allowed us to measure the total number of children each participant had and the intervals between their births.

Data analysis

Descriptive analysis of socio-demographic characteristics of women, marital profile and HIV care profile including parity progression were presented using frequency and percentages; while quantitative variables were described using mean and standard deviations, or median and interquartile range as appropriate. To estimate the total fertility rate, Synthetic Gompertz Relational model was employed [21, 22]. Multistate model was thereafter used to examine factors associated with parity progression. During analysis, each childbirth represents a "state". To investigate the factors associated with progression from the first birth to all the births a woman has had, the multistate model was employed for the sake of statistical efficiency. Firstly, we fitted a model that revealed the baseline hazard of progression to higher order of birth. Secondly, we assessed the effect of independent variables on parity progression.

Multistate model

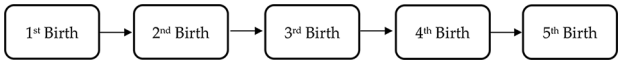
Multistate model is a statistical technique used to represent discrete events that occur over time. It is a model that is used to analyse life course events with a discrete state where study participants can move from one state to another.

Model definition

The multistate process is defined by its transition probabilities between states h and j. The transition probabilities assume to exist, which indicate the immediate risk of moving to state *j* (e.g., from second to third birth) from state *h*.

Considering modeling the birth progression of women from the first to the fifth birth. The states S represent the number of births: S = {1, 2, 3, 4, 5}. At any time t, a woman can be in one of these states. The transition probabilities $p_{hj}\,(s,\ t)$ might represent the likelihood of progressing from the first birth to the second birth, from the second to the third, and so on, within the time interval [s, t].

The model is defined by the transition between one state to another i.e. between one birth to another.



The multistate model is preferred over traditional methods like regression model for studying parity progression because they focus mainly on a single transition. Multistate model captures the entire birth history by considering different ordered states. This facilitates a comprehensive analysis of parity progression which includes the likelihood of transitions between births and factors associated with these transitions. This flexibility makes the multistate model valuable for assessing parity progression.

Results

Women characteristics

The background characteristics of the women are shown in Table 1. The mean age of the women was approximately 38.0 ± 6.1 years. Most respondents were aged 35–39 years (29.7%), followed by those aged 40–44 (27.0%). Many of the women were Yoruba (80%), Christians (61.0%) and currently working (90.4%). Almost half of the women (47%) had completed secondary school education. At the time of HIV diagnosis, about 48% of the women had between 1 and 2 children, 35.7% had 3 and more than 3 children and more, while 16.7% did not have a child (Table 1).

More than three-quarter of the women (77.3%) were currently married. Most women partners had secondary education (48.4%), and were employed (84.8%). More than half of the women desired more children (53.6%), while nearly two-thirds were in monogamous relationship (65.6%).

The average HIV duration among the respondents was 6.3 ± 3.4 years. Nearly two-thirds of the women had been living with HIV for 3-8years (62.3%) About 37% of the women had been on ART between 3 and 5 years, while 18.4% had been on ART in less than 2 years. Nearly 80% of the women have disclosed their HIV status to their partner, and half of the respondents' partner were HIV negative (48.0%), 27.5% were tested positive to HIV while 24.4% of the women did not know their partner's HIV status (Table 1).

Total fertility rate estimate

The Table 2 below presents data on age specific fertility rates (ASFRs) and total fertility rate (TFR). Of 933 women, a total of 415 births were recorded 12 months before the survey, and the total children ever born was

Table 1 Background characteristics of women living with HIV, Ibadan

Variable	Frequency (*n* = 933)	Percentage
Socio-demographic Characteristics		
Age group (38.01 ± 6.08)		
<29 years	75	8.0
30– 34 years	173	18.5
35– 39 years	277	29.7
40– 44 years	252	27.0
45– 49 years	156	16.7
Ethnicity		
Yoruba	751	80.5
Igbo	77	8.3
Others	105s	11.3
Religion		
Christianity	567	60.8
Islam	366	39.2
Education		
No education	63	6.8
Primary	195	20.9
Secondary	443	47.5
Tertiary	232	24.9
Employment		
Working	843	90.4
Not working	90	9.6
Number of Children at HIV Diagnosis		
None	156	16.7
1– 2	444	47.6
3+	333	35.7
Marital Profile		
Marital Status		
Married	721	77.3
Never Married	9	1.0
Divorce/Separated	81	8.7
Widowed	122	13.1
Partner's Educational Status (n = 918)		
None	38	4.1
Primary	99	10.8
Secondary	444	48.4
Tertiary	337	36.7
Partner's Employment Status (n = 915)		
Employed	776	84.8
Unemployed	139	15.2
Desire more children		
Not Desired	433	46.4
Desired	500	53.6
Family Setting (n = 908)		
Polygamous	312	34.4
Monogamous	596	65.6
HIV Care Profile		
ART Duration (n = 906)		
<2 years	167	18.4
3– 5 years	333	36.8
6– 8 years	250	27.6
9+ years	156	17.2
Status Disclosure to Partner (n = 919)		

Table 1 (continued)

Variable	Frequency (n = 933)	Percentage
Disclosed	727	79.1
Non-disclosed	192	20.9
Partner's HIV Status		
Positive	257	27.5
Negative	448	48
Unknown	228	24.4
HIV Duration (6.34 ± 3.38)		
< 2 years	116	12.4
3– 5 years	294	31.5
6– 8 years	287	30.8
9+ years	236	25.3

Table 2 Age specific fertility rate and total fertility rate

Age Group	No of women	No. of Children Ever Born	Average Parities	Adjusted Parities
10–14				0.128
15–19	2	2	1	0.840
20–24	14	21	1.5	1.671
25–29	59	144	2.4407	2.311
30–34	173	448	2.5896	2.801
35–39	277	848	3.0614	3.179
40–44	252	817	3.2421	3.442
45–49	156	568	3.6410	3.545
Total fertility				**3.54**

2848. The average parities refer to the average number of children born to women in a specific age group while the shifted age is an adjusted midpoint age used in the Gompertz model, aligning the data more closely with the model's assumptions. The corrected ASFRs and cumulative P/F ratios address discrepancies in data collection, ensuring reliable TFR estimation. The total fertility rate (TFR) derived from the corrected age-specific fertility rates using Synthetic Gompertz model is 3.54. This means, the average number of children a woman would have by the end of her childbearing years if she bore children at the current age-specific fertility rates is 3.54.

Birth progression among women living with HIV

Figure 1 below summarized the proportion of women who fall within that birth order category relative to the total number of women covered in this study. All women included in the study had at least one birth, 84.7% of them proceeded to have a second child. The progression from second birth to third birth was 61.6%. Among the people that had third birth, about half of them did not progress to fourth birth, only 34% had fourth child.

As the birth order increases, the percentage of women progressing to next birth decreases.

Birth progression by timing of HIV diagnosis

The results showed that about 82% of the women had first birth before HIV diagnosis. Among the women that progressed to second birth, 58% were before diagnosis 27% were after diagnosis. From second to third, 38% had the third child before diagnosis, 24% after diagnosis. At higher order of birth, birth progression before or after diagnosis were similar. However, the proportion of women that progressed to 6th birth after HIV diagnosis are somewhat higher than before diagnosis (Fig. 2).

Model results parity progression among WLWH

Table 3 shows the likelihood of women living with HIV progressing from one birth to the next. The results showed that women living with HIV were 77% more likely to progress from their first birth to their second birth (HR = 1.77, 95% CI: 1.40, 2.23). The likelihood of progressing from a second birth to a third birth drops dramatically, women were 76% less likely to progress to third birth after second birth (HR = 0.14, 95% CI: 0.13, 0.16).

The chances of having fourth birth were 72% less likely among women living with HIV (HR = 0.18, 95% CI: 0.15, 0.20). For the transition to fifth and sixth births, the likelihood of progression were equal, women were approximately 75% less likely to progress from a fourth to a fifth birth or from a fifth to a sixth birth (HR = 0.15, 95% CI: 0.13, 0.19).

The results showed how the chances of having another child decrease as the birth order increases. Women living with HIV were more likely to progress from their first to second birth, but the likelihood decreases at higher birth-orders.

Factors associated with parity progression

The results from the Multistate model showed that women were 77% more likely to have a second child after their first. However, none of the factors studied (e.g., education, marital status) significantly influenced this transition.

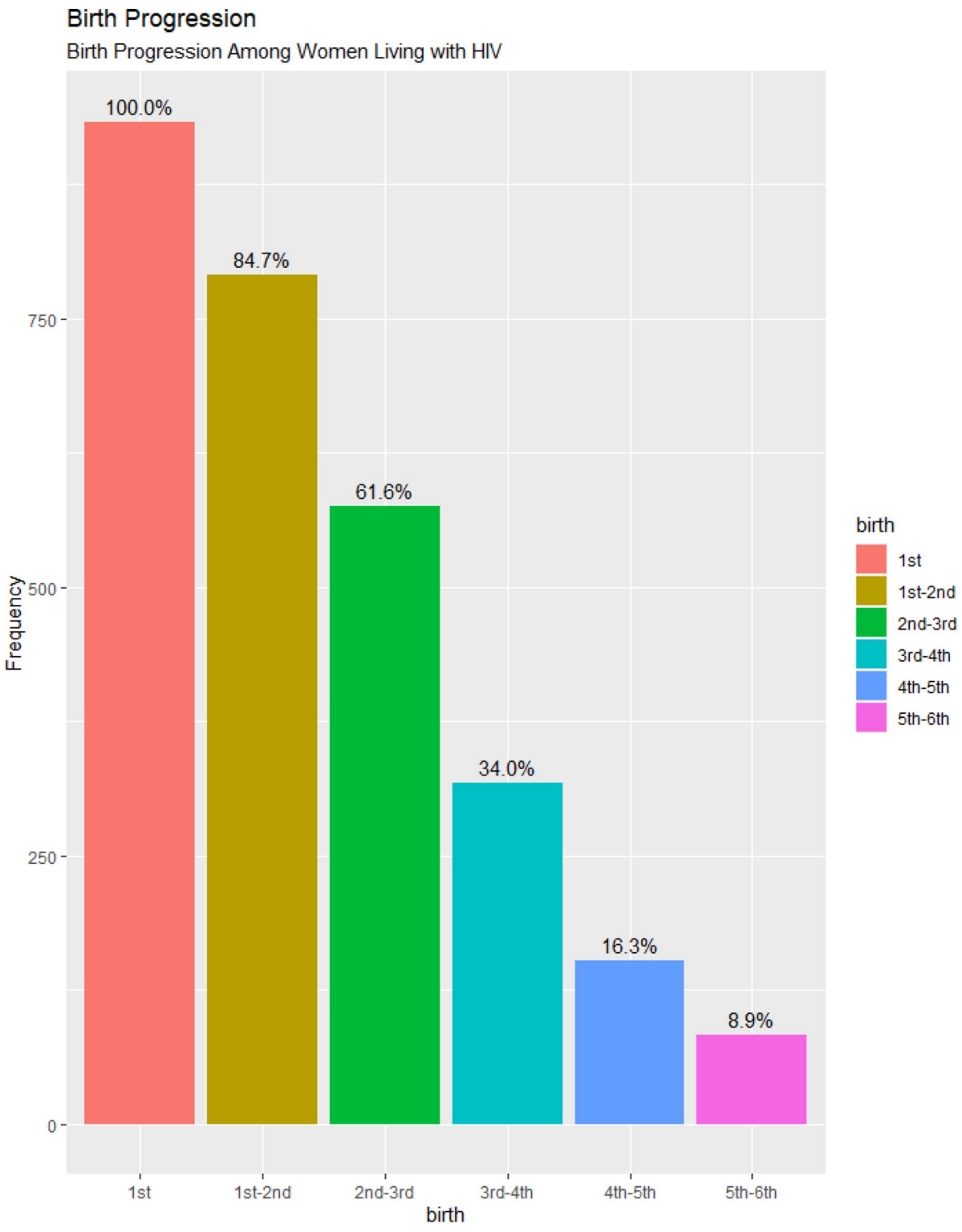


Fig. 1 Birth progression among women WLWH

Factors that were found to be statistically significant for the progression from second to third birth include the number of children at HIV diagnosis, marital status, educational attainment, employment status of the partner, desire for more children, and partner's HIV status. Women who were widowed (HR = 1.36, 95% CI: 1.04, 1.80) had 36% increased risks of progression to third birth, though the likelihood of progression was higher

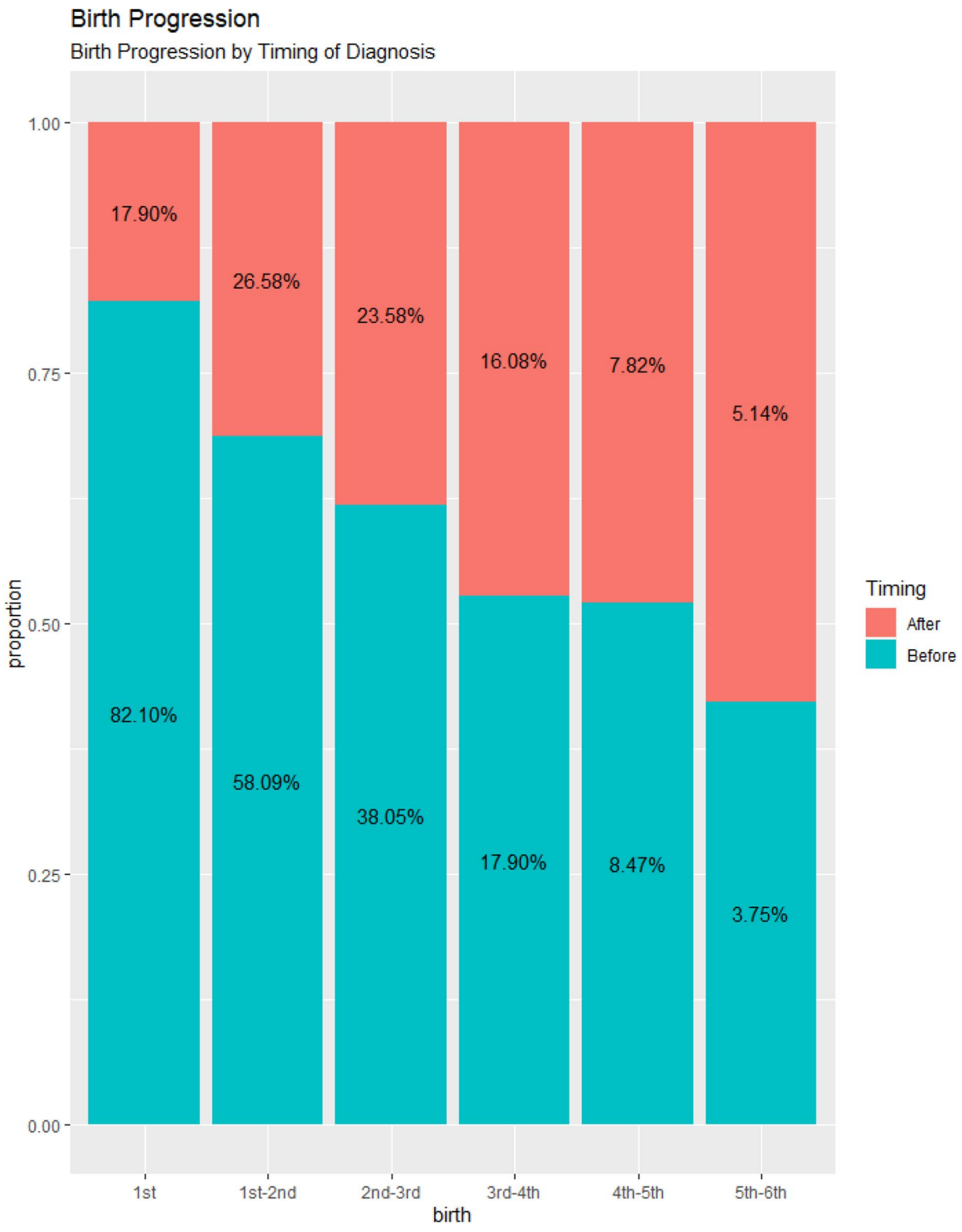


Fig. 2 Birth progression by timing of HIV diagnosis

among women that have never married compared to the married women. Women whose partners attained secondary education (HR = 1.23, 95% CI: 1.02, 1.49) were 23% more likely to progress to third birth compared with partners with no education. Regarding partner's employment status, women who had unemployed partners (HR = 1.40, 95% CI: 1.04, 1.80) were 40% more likely to progress to third birth to women whose partners were

Table 3 Hazard ratio for likelihood of birth progression among WLWH in Ibadan, Nigeria

Progression	*n* (%)	HR (95% CI)
1st	933(32.7)	
1st– 2nd Birth	790(27.7)	**1.77 (1.40, 2.23)**
2nd– 3rd Birth	575(20.2)	**0.14 (0.13, 0.16)**
3rd– 4th Birth	317(11.1)	**0.18 (0.15, 0.20)**
4th– 5th Birth	152(5.3)	**0.15 (0.13, 0.19)**
5th– 6th Birth	83(2.9)	**0.15 (0.11, 0.21)**

HR = Hazard Ratio; CI = Confidence Interval; Bold face values indicate significance

employed. The results revealed that women whose partner completed only primary education were consistently at increased risk of progressing to higher order of births. Women that desire more children (HR = 0.65 (0.53, 0.78) were about 35% less likely to having third birth after having second birth. Women whose partner has negative status (HR = 0.75, 95% CI: 0.61, 0.94) were 25% less likely to having third birth.

From third to fourth birth, number of children at diagnosis was statistically significant. Women who had more than two children at diagnosis were 34% more likely to progress to a fourth child.

Transitioning from fifth to sixth birth were 75% less likely among the women. Women who completed secondary education are 70% less likely to have a sixth child compared to women with no education. Similarly, women who had primary or tertiary education had lower likelihood of progression to sixth birth relative to women with no education. Women whose partner had primary and tertiary education were at increased risk of progression to sixth birth relative to women whose partner had no education Table 4.

Discussion

This study employed multistate model to examine factors associated with childbearing progression among women receiving HIV care at University College Hospital, Ibadan, Nigeria. The total fertility rate was lower compared to the southwest region estimate of total fertility rate of 4.4 children per women [23] according to the DHS report. This may reflects the possible effect of HIV on fertility intentions and outcomes, which has significant implications for reproductive health policies and programme. Alternatively, the demographic profile of women receiving HIV care at the study site suggests that these were more educated than the average women population in Southwest Nigeria. A common trend is that educated women tends to have lower fertility [24, 25].

Assessment of the childbearing progression showed that more than 80% of women proceeded to a second birth irrespective of HIV status. However, it was observed from this study that progression dropped mostly at birth order 3. The pattern of progression revealed that most women did not want to stop at having only one child. This result is in tandem with previous studies on fertility desires among women living with HIV. It also corroborates the women's desire to use childbirth as a means of coping with HIV diagnosis according to similar studies in Nigeria and Canada [15, 26]. These findings underscore the importance of integrating reproductive health counselling with care of people living with HIV and emphasizing early discussions on family size to help women make informed decisions.

This study revealed that women's level of education was one of the factors associated with parity progression among WLWH. Women with formal education had reduced risk of progressing to higher order births relative to women with no formal education. This aligns with other findings in Europe [27, 28].Education empowers women to make informed reproductive choices, often leading to a preference for smaller family sizes.

Another factor associated with parity progression was number of children at HIV diagnosis. women that had 1–2 children were less likely of progressing to third birth. Studies in Nigeria [7, 15] found that the higher the number of children at diagnosis, the less is the likelihood of having another child after HIV diagnosis. This attitude may relate to the burden associated with childcare and concerns about mother-to-child transmission of HIV. Educated women living with HIV and equipped with relevant information usually limit child births to smaller numbers that they can cope with.

It is also worth to note that the partner's education had a complex relationship with parity progression. Women whose partners had primary or tertiary education were more likely to progress to second, third and sixth birth compared to those whose partners had no education. Despite the common assumption that higher education leads to better social and economic status for women and provides them with opportunities outside of childbearing, having an educated partner increased childbirth rates among these women. This may be due to the partner's influence in reproductive decision-making and their knowledge of the preventative effects of ART on HIV transmission [15, 29].

Marital status was associated with progression from second to third birth. Widowed women were more likely to progress to second third birth relative to married women. A previous investigation on the role of remarriage in fertility desire among the study sample revealed that women who ever married were more likely to want more children [14] The marriage dynamics in women living with HIV is rather complex because when many of these women lose a partner. There is a high tendency to remarry and consolidate the new union with birth of another child. The implications of this practice for

Table 4 Factors associated with parity progression among WLWH

	1^{st}– 2^{nd}	2^{nd}– 3^{rd}	3^{rd}– 4^{th}	4^{th}– 5^{th}	5^{th}– 6^{th}
	HR (95% CI)	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**
Education					
None (Ref. Cat.)	1	1	1	1	1
Primary	0.89 (0.29, 2.40)	1.09 (0.73, 1.60)	0.90 (0.52,1.60)	0.82 (0.38, 1.70)	0.51 (0.18, 1.40)
Secondary	1.04 (0.35, 3.09)	0.96 (0.66, 1.40)	0.77 (0.45, 1.31)	0.56 (0.27, 1.19)	**0.30 (0.10**, **0.94)**
Tertiary	0.99 (0.34, 2.90)	0.84 (0.56, 1.30)	0.66 (0.36, 1.20)	0.51 (0.21, 1.20)	0.65 (0.19, 2.20)
Number of Children at HIV Diagnosis					
None (Ref. Cat.)	1	1	1	1	1
01-Feb	1.13 (0.70, 1.81)	**0.59 (0.48**, **0.71)**	0.78 (0.58,1.05)	1.03 (0.66, 1.62)	1.11 (0.52, 2.40)
3+	0.73 (0.46, 1.20)	**1.94 (1.61** ,**2.40)**	**1.34 (1.01**, **1.80)**	0.97 (0.63, 1.50)	0.90 (0.43, 1.90)
Marital Status					
Married (Ref. Cat.)	1	1	1	1	1
Never Married	1.33 (0.08, 22.10)	4.16 (0.86, 20.20)	1.56 (0.28, 8.70)	0.67 (0.08, 5.50)	2.37 (0.23, 24.80)
Divorce/Separated 0.87 (0.38, 2.00)	0.87 (0.38, 2.00)	0.94 (0.65, 1.30)	0.72 (0.41, 1.30)	0.86 (0.33, 2.30)	1.89 (0.51, 7.00)
Widowed	0.99 (0.54,1.80)s	**1.36 (1.04**, **1.80)**	1.14 (0.79, 1.60)	1.05 (0.64,1.70)	0.79 (0.32, 2.00)
Partner's Educational Status					
None	1	1	1	1	1
Primary	0.83 (0.42, 1.60)	1.02 (0.76, 1.40)	1.27 (0.85, 1.90)	1.38 (0.80, 2.40)	1.66 (0.73, 3.80)
Secondary	1.01 (0.64, 1.60)	**1.23 (1.02**, **1.49)**	0.93 (0.71, 1.23)	0.96 (0.63, 1.45)	0.48 (0.24, 0.98)
Tertiary	1.11 (0.68, 1.82)	0.80 (0.65, 0.98)	0.98 (0.72,1.33)	0.82 (0.50, 1.33)	1.41 (0.65, 3.10)
Partner's Employment Status					
Employed	1	1	1	1	1
Unemployed	1.10 (0.58, 1.90)	**1.40 (1.04**, **1.80)**	1.10 (0.77, 1.60)	1.30 (0.78, 2.10)	1.00 (0.46,2.30)
HR– Hazard Ratio, **Ref. Cat: Reference Category; Bold face values indicate significance**					
Desire more children					
Not Desired	1	1	1	1	1
Desired	1.43 (0.87, 2.35)	**0.65 (0.53**, **0.78)**	0.80 (0.59, 1.08)	0.78 (0.48, 1.27)	1.27 (0.57, 2.79)
ART Duration					
< 2 years	1	1	1	1	1
3– 5 years	0.87 (0.54, 1.40)	1.00 (0.82, 1.20)	0.88 (0.65, 1.20)	0.90 (0.58, 1.40)	0.88 (0.41, 1.90)
6– 8 years	0.99 (0.60, 1.60)	1.02 (0.82, 1.30)	0.95 (0.70, 1.30)	0.97 (0.61,1.50)	1.02 (0.47, 2.20)
9+ years	0.87 (0.54, 1.40)	1.00 (0.82,1.20)	0.88 (0.65, 1.20)	0.90 (0.58, 1.40)	0.88 (0.41,1.90)
Partner's HIV Status					
Positive	1	1	1	1	1
Negative	1.16 (0.69, 1.95)	**0.75 (0.61**, **0.94)**	1.07 (0.78, 1.46)	0.87 (0.54, 1.39)	1.49 (0.67, 3.28)s
Unknown	1.12 (0.61,2.10)	0.87 (0.67,1.10)	1.07 (0.73,1.60)	1.14 (0.67,2.00)	0.84 (0.33,2.10)

HR– Hazard Ratio, Ref. Cat: Reference Category; Bold face values indicate significance

secondary prevention has been highlighted and it should be part of reproductive health education.

Furthermore, partner's employment was associated with parity progression. Women whose partner were unemployed were more likely of progressing to higher order of birth. A general belief was that people with unemployed partners tends to procreate more than their counterparts that were employed. This result agrees with previous studies [15],. Even in the general population, fertility has been showing to be lesser among employed women. This is not surprising because employed woman or those with employed spouses have some advantages in terms of exposure to information about family size planning. Besides, the additional responsibility of coping with employment and childcare serves as incentive for smaller family sizes (12,16,30). The result from this study has implications for reproductive health and HIV care programs. Integration of reproductive health and HIV care is imperative. Health education and counselling sessions need to address issues such as family size preferences, birth interval (frequency of pregnancy and childbearing) and providing family planning. Linkage of women living with HIV to social and empowerment programmes would enhance their socio-economic status and provide them with opportunities that can enhance their reproductive health decision-making. Education policies targeting both women living with HIV and their partners can reduce the risks of unintended higher-order births. In the future, follow-up studies among the study population can be conducted to establish temporal sequence

and identify causal relationships. In addition, qualitative studies can be conducted to get deeper understanding about the socio-cultural drivers of childbearing progression among women living with HIV in other regions and settings.

Limitations

The computation of age-specific fertility rates, total fertility rate, parity progression and multistate model for factors associated with childbearing progression depend on the accuracy of the full birth history provided by the respondents. However, there is a possibility of recall bias as some respondents may have forgotten the exact date of birth of their child(ren). Aside from the limitations, this study has expanded the methodological possibilities for investigation of childbearing progression.

Conclusions

Exploration of parity progression among women living with HIV provides information on fertility transition, prevention of mother-to-child transmission, maternal and child health and reproductive health of this population. The outcome of this study revealed that women's educational attainment, number of children at diagnosis, marital status, partner's educational attainment, partner's employment status, desire for more children, antiretroviral therapy duration, knowledge of HIV partner's status were significantly associated with parity progression among women living with HIV in Ibadan, Nigeria. The modifiable factors among these variables can be targeted as part of reproductive health services in HIV care.

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
ASFR	Age specific fertility rate
HAART	Highly active antiretroviral therapy
HIV	Human immune deficiency syndrome
NAIIS	National HIV/AIDS Indicator Survey
TFR	Total fertility rate
WLWH	Women living with HIV

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Author contributions

Conceptualization (JOA); Analysis and drafting of manuscript (AO, JOA), revision of intellectual content (RA and OAA) All authors approved the final manuscript.

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Data availability

The dataset used for the study is not available for public sharing to protect the privacy of the participants.

Declarations

Consent for publication

All authors hereby consent to the publication of the manuscript titled "Multistate model for correlates of parity progression among women living with HIV in Ibadan, Nigeria". We affirm that this manuscript is an original work, has not been published before, and is not under consideration for publication elsewhere.

Institutional review board statement

Ethical approval for the original study was granted by the University of Ibadan/University College Hospital Institutional Review Committee - approval number-UI/EC/15/0230. Informed consent to participate was obtained from all of the participants in the study.

Competing interests

The authors declare no competing interests.

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