Pregnancy Incidence and Fertility Desires Among Couples by HIV Status in Rakai, Uganda

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Background: The desire for more children and pregnancy rates are influenced by many relationship dynamics and HIV serostatus of couples.

Setting: Rakai Community Cohort Study in Uganda.

Methods: Couple data were retrospectively linked from survey rounds between 2007 and 2015 to assess drivers of fertility desire and pregnancy incidence by HIV status (M−F−; M+F+; M−F+; and M+F−). Multivariable modified Poisson regression was used to estimate prevalence ratios of fertility desire, whereas multivariable Poisson regression was used to estimate incidence rate ratios of pregnancy associated with couple characteristics.

Results: Six thousand six hundred forty-seven couples contributed to 7656 person-years. Approximately 40% of couples (where at least 1 HIV+) desired more children. Unmet need for family planning was evident; couples of medium or low Socioeconomic status and with coresident children had lower fertility desires but higher pregnancy rates. Older age, being in a polygamous union, and having a HIV+ spouse in care were associated with lower fertility desire while having an older male partner was associated with higher fertility desire. Pregnancy incidence was lower with older age, among women using hormonal contraception and condoms, HIV+ concordant couples and couples where the HIV+ spouse was in care while pregnancy incidence were higher among women who desired more children, and serodiscordant couples (M−F+).

Conclusions: There are many drivers of fertility desires and pregnancy rates, and HIV does not diminish the desire for more children. Unmet need for family planning was evident and highlighted the need to understand and meet the contraceptive needs of couples.

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INTRODUCTION

It was estimated that by the end of 2016, of the 36.7 million people living with HIV (PLHIV) globally, 48.5% were women and 5.7% children aged younger than 15 years, mainly infected through mother-to-child HIV transmission (MTCT).[1] Uganda continues to have one of the highest fertility rates in the world at about 5.4 births per woman[2] and a HIV prevalence rate by the end of 2016 about 6.5%,[1] with the largest burden of HIV among women of reproductive age. Historically, the policies and practices in many settings discouraged PLHIV from having children due to the risk of vertical transmission to the child. As HIV treatment is becoming more widely available and PLHIV are living longer, healthier lives, the reproductive desires, and behaviors of HIV-positive individuals are changing and need to be better understood.[3]

In the previous research, the impact of HIV infection on fertility desires is mixed. In South Africa,[4] Uganda,[5] and Kenya,[6] pregnancy desires were significantly lower among HIV-infected women, while other studies found that the fertility desires of HIV-infected women are not affected by HIV-positive status, especially in the context of combination antiretroviral therapy (ART).[7–9]

When examining pregnancy rates, studies have shown that a substantial proportion of PLHIV continue to have children after being diagnosed with HIV. In Burkina Faso, the incidence of pregnancy among HIV-positive women was similar to the general population, despite being counseled against pregnancy and being provided with contraception.[10] Decisions about contraceptive use and childbearing are complex in the context of HIV, as many factors need to be considered, the health of the mother, risk of MTCT, and risk of horizontal transmission among HIV serodiscordant couples.[11–14]

Men play an important role in decision making in the home in many African contexts; studies have shown that the desire for children was often shared among couple members, and the strongest predictor of participants' desire for children was having a partner who wanted children.[15–17] In the context of HIV, relationship dynamics are more complex; studies have highlighted the important role men play in both fertility among HIV-positive women and in the successful uptake of

PMTCT.[17,18] However, a majority of the studies on fertility and pregnancy either focus on the woman's perspective, are cross-sectional, or are qualitative in nature with little longitudinal quantitative data on couples. Our study fills an important gap in our knowledge about determinants of fertility desire and pregnancy incidence by assessing fertility desires and pregnancy incidence over time among couples of varying HIV status. Our hypothesis was that HIV status of couples will have a significant impact on fertility desires and pregnancy incidence.

METHODS

Data on couples in this study are accrued from consenting adults aged 15–49 years in the Rakai Community Cohort Study (RCCS) with an approximate annual surveillance since 1994.[19,20] The RCCS is an open cohort run by the Rakai Health Science Program (RHSP) and collects detailed behavioral, reproductive health, sexual, HIV, and sexually transmitted infections data from all participants.

Details are described elsewhere,[21–23] but briefly, consenting men and women are surveyed every 12–18 months and asked questions about fertility desires and any pregnancies and births in the previous year. HIV status was determined from venous blood using 2 different enzyme immunoassays (Vironostika HIV-1; Organon Teknika, Charlotte, NC, and Cambridge Biotech, Worcester, MA), with Western blot (HIV-1 WB Bio-Merieux–Vitek, St Louis, MO) confirmation of all discordant enzyme immunoassays and all HIV seroconverters. Data on basic sociodemographics for women and men were collected on the census/listing form, which included age in years, sex, marital status, and relationship to the household head as well as the household member number of the corresponding spouse if she/he is coresident in the same household. Every household member (index) has a unique identifier composed of the Community_Household_Membernum. The index's corresponding spouse identification is then a substring of the household index's identification "Community_Household" + spousenum. The spouse identification is then used to merge spouse's data into the index member's data record, so that a couple's data are achieved. Using this household census and survey data, we retrospectively linked married couples and categorized them by their HIV status as follows: HIV-negative concordant (male HIV-negative and female HIV-negative: M−F−), HIV-positive concordant (M+F+), or HIV serodiscordant (either M+F− or M−F+).

As part of the RHSP HIV care program, all participants testing HIV-positive were referred to one of the RHSP clinics nearest to their home or of their choice and offered ART. In addition to ART monitoring, counselors are trained to provide other health services, which include provision of contraceptives (both condoms and other long-term reversible contraceptives), cotrimoxazole prophylaxis and insecticide-impregnated bed nets for malaria prevention.[24,25]

Description of Variables

The main outcomes of this study were fertility desire and pregnancy incidence among couples by HIV status. The covariates that were assessed and were included in the adjusted models included: age (categorized as 15–19; 20–29; 30–39; and 40–49 years), couple's education (none, primary, and after primary), socioeconomic status (based on materials used in construction of dwelling and categorized as low, medium, and high), type of marriage (monogamous, polygamous, and mono-poly if 1 couple member reported monogamous and the other a polygamous union), nonmarital relationships, religion (Catholic/Protestant, Pentecostal, and Muslim), age difference with sexual partner (female individual older and male individual older by: 0–4 years; 5–9 years; and 10+ years), coresident children (none, 1–2, 3–5, 6+), duration since HIV voluntary counseling and testing (VCT) receipt (no VCT within 30 days, 31–182, 183–365, and 366+), and contraceptive methods reported by couple [none, condoms, or hormonal contraception (HC), which included injectables, pills, and implants]. The couples' use of contraception was categorized as (1) HC if hormonal contraceptive use was reported by the female partner, (2) use of condoms alone if mentioned by the male partner but without female partner's mention of HC, and (3) none if no modern methods were mentioned by either partner. Some female individuals use female-controlled methods, which they do not disclose to their spouses; this certainly resulted into discrepancy in the couple's report of contraceptive methods. However, the female mentioned method took precedence over the male mentioned method if such a method was more effective than a male condom.

Statistical Analyses

Descriptive analysis was conducted for the distribution of couples' characteristics, stratified by couples' HIV status. Statistically significant differences in the distribution of couples' characteristics by HIV status were determined by χ^2 test with $P < 0.05$. Differences in continuous data such as age were determined by the use of nonparametric test, the Kruskal–Wallis test. The measure of association between fertility desire and couples' characteristics was prevalence ratio (PR) and 95% confidence intervals obtained using a generalized linear model (glm) with a Poisson family, log link, and robust variance estimation. The couples had multiple observations in the data set suggesting clustering. The correlation of observations was adjusted for in the model by clustering on the couple identification through a glm with robust standard errors of the estimates.

The incidence of pregnancy was determined as the number of incident pregnancies divided by the number of person-years of couple observation. To determine factors associated with incidence of pregnancy, a glm model with Poisson family, log link, and person-years as offset was used. This model generated the incidence rate ratio (IRR) as a measure of association. In the adjusted analyses, all variables in the bivariate models with a $P < 0.15$, potential confounders, or variables with an IRR of ≥ 2.0 or ≤ 0.5 were included, irrespective of their statistical signficance. All statistical analyses were performed using STATA software package version 13.0 (College Station, TX).

The studies were approved by institutional review boards in Uganda (the Research and Ethics Committee of

the Uganda Virus Research Institute, and the Uganda National Council for Science and Technology) and the United States (Western IRB, Olympia, WA, and the Johns Hopkins University, School of Public Health).

RESULTS

A total of 6647 couples contributed to 7656 couple observations from annual RCCS surveys conducted between 2007 and 2015 (rounds 12–15). Based on the couples' HIV status, 85.9% were concordant HIV-negative, 6.6% were concordant HIV-positive, 3.3% were discordant, with a HIV-positive female individual, and 4.3% were discordant with a HIV-positive male individual.

Table 1 summarizes the baseline characteristics of the participants, stratified by the couples' HIV status. There were significant differences at $P < 0.05$ level in all sociodemographic and behavioral factors across couples by HIV status in our study. In addition to differences by HIV status on some of the sociodemographic factors summarized in the table, a higher proportion of female individuals married to HIV-positive male individuals were in intergenerational relationships (10+ years older). Contraceptive use was significantly different by HIV status; a majority of HIV-seronegative couples reported not using any family planning method and a lower proportion of HIV+ female individuals in serodiscordant couples reporting using HC. Condom use was more common among all couples where at least 1 partner was HIV-positive. Approximately 40% of couples where at least 1 was HIV+ desired more children, and pregnancy prevalence was lowest among HIV-seropositive concordant couples.

The prevalence of female individuals desiring more children was calculated by couple's HIV status. Across all couple HIV status, desire for more children was higher in younger female individuals (15–19 years) and lowest among older (45–49 years) female individuals in serodiscordancy. By Socioeconomic status (SES), female individuals in uninfected concordant (M−F−) couple relation had the highest desire for more children, and the desire was higher in higher SES. A higher portion of female individuals in monogamous relationships desired more children, compared with polygamous couples, irrespective of HIV status. When assessed by the report of nonmarital partners, among couples where at least 1 member was HIV-positive, the proportion of female individuals desiring more children was highest among female individuals reporting a nonmarital relationship, followed by female individuals where the male partner reported a nonmarital relationship and lowest among female individuals where there was no report of a nonmartial relationship. As expected, the proportion of women desiring more children was lower among women with higher number of coresident child/ren, irrespective of HIV status. When assessed by enrollment into HIV care, desire for more children was lower in female individuals when the HIV+ couple member was enrolled into HIV care.

Table 2 summarizes adjusted PR of desire for more children, stratified by the couples' HIV status.

All factors statistically significantly associated with fertility desire ($P < 0.05$) have been included in the table, and in addition to factors listed, we controlled for education level and difference in age with sexual partner. Among HIV-seronegative couples, the PR of desiring more children was lower if the couples were older than 15–19 years, of low SES [adjusted prevalence ratio (adj.PR = 0.93), confidence interval (CI): 0.9 to 0.96], monogamous/polygamous discordant (adj.PR = 0.87, CI: 0.81 to 0.94), or polygamous (adj.PR = 0.86, CI: 0.82 to 0.9); and there were 3–5 (adj.PR = 0.74, CI: 0.71 to 0.78) or 6+ coresident children (adj.PR = 0.36, CI: 0.32 to 0.41). Fertility desire was higher among couples where the duration between VCT and interview was between 1 and 6 months. The PR for fertility desire was significantly higher among all female individuals with older partners (male individuals older by: 0–4 years: PR = 1.37; CI: 1.25 to 1.51; by 5–9 years: PR = 1.38; CI: 1.25 to 1.53; by 10+ years: PR = 1.45; CI: 1.31 to 1.60); however, this difference was no longer statistically significant in the adjusted model.

Among HIV-positive concordant couples, factors that reduced the desire for more children were as follows: being older than 15–19 years; both were in a polygamous marriage (adj.PR = 0.69, CI: 0.53 to 0.8); having any children (adj.PRs decreased from 0.8 with 1–2 children to 0.23 with 6+ children), and if both partners were in HIV care (adj.PR = 0.6, CI: 0.46 to 0.78). Factors associated with an increased desire for more children was a report of a nonmarital relationship by either the female or male individual (adj.prevalence rate ratio = 1.43, CI: 1.03 to 2.0 and adj.PR = 1.24, CI: 1.05 to 1.4, respectively).

Among HIV serodiscordant couples (female HIV+), factors associated with decreased fertility desire were older age, low SES (adj.PR = 0.76, CI: 0.59 to 0.9), being in a monogamous–polygamous union (PR = 0.3, CI: 0.11 to 0.83), having 3–5 coresident children (adj.PR = 0.53, CI: 0.39 to 0.71), and having a HIV-positive spouse in care (adj.PR = 0.56, CI: 0.4 to 0.78). A factor associated with an increased desire for more children was a report of a nonmarital relationship by the female individual (adj.PR = 1.9, CI: 1.13 to 3.18). Among serodiscordant couples where the male individual was HIV-positive, factors that decreased the desire for more children were being older than 15–19 years, and being of low SES (adj.PR = 0.77, CI: 0.63 to 0.94), and the factor associated with an increase in fertility desire was the female individual in the partnership reporting a nonmarital relationship. The difference in age between partners was collinear with the female age variable and hence was dropped in the multivariate model. Among serodiscordant couples where the female individual was HIV+, fertility desire was higher with increase in age of older partner, but that increase was not statistically significant in the adjusted model (the male individual older by: 0–4 years: PR = 2.25 CI: 1.36 to 3.73; by 5–9 years: PR = 2.53; CI: 1.53 to 4.17; by 10+ years: PR = 2.58; CI: 1.53 to 4.36).

Trends over time in pregnancy incidence are summarized in Figure 1. HIV serodiscordant couples started with the lowest pregnancy incidence rates that went from about 9.0/100 py to 2.5/100 py by the end of follow-up. For HIV-positive concordant couples, the incidence of pregnancy started at about 17.0/100 py, dropped to less than 5/100 py in round 12, and then surged to about 10/100 py in the last

TABLE 1. Characteristics of Participants by Couple's HIV Status

	Overall	M−F−	M+F+	M−F+	M+F−	
Total	**N = 17,368 (%)**	**N = 14,919 (%)**	**N = 1143 (%)**	**N = 567 (%)**	**N = 739 (%)**	***P***
Age (yrs)						
Male partner: mean (SD)	33.9 (6.9)	33.6 (7.0)	35.3 (6.3)	34.4 (6.6)	36.5 (6.5)	<0.001
15–19	27 (0.2)	26 (0.2)	0 (0.0)	1 (0.2)	0 (0.0)	
20–29	5230 (30.1)	4738 (31.8)	233 (20.4)	143 (25.2)	116 (15.7)	
30–39	8152 (46.9)	6896 (46.2)	593 (51.9)	294 (51.9)	369 (49.9)	
40–49	3959 (22.8)	3259 (21.8)	317 (27.7)	129 (22.8)	254 (34.4)	
Female partner: mean (SD)	28.4 (6.5)	28.1 (6.5)	29.9 (6.0)	29.9 (6.4)	30.3 (6.7)	<0.001
15–19	885 (5.1)	829 (5.6)	25 (2.2)	12 (2.1)	19 (2.6)	
20–29	9714 (55.9)	8558 (57.4)	533 (46.6)	269 (47.4)	354 (47.9)	
30–39	5660 (32.6)	4607 (30.9)	517 (45.2)	239 (42.2)	297 (40.2)	
40–49	1109 (6.4)	925 (6.2)	68 (5.9)	47 (8.3)	69 (9.3)	
Highest schooling						
None	1659 (10.0)	1372 (9.0)	139 (12.0)	71 (13.0)	77 (10.0)	<0.001
Primary	13,388 (77.0)	11,477 (77.0)	884 (77.0)	444 (78.0)	583 (79.0)	
After primary	2321 (13.0)	2070 (14.0)	120 (10.0)	52 (9.0)	79 (11.0)	
SES						
High	6202 (36.0)	5319 (36.0)	400 (35.0)	209 (37.0)	274 (37.0)	<0.001
Medium	5718 (33.0)	4982 (33.0)	382 (33.0)	163 (29.0)	191 (26.0)	
Low	5448 (31.0)	4618 (31.0)	361 (32.0)	195 (34.0)	274 (37.0)	
Type of marriage						
Both monogamous	13,284 (76.0)	11,544 (77.0)	873 (76.0)	376 (66.0)	491 (66.0)	<0.001
Mono/poly discordant	656 (4.0)	528 (4.0)	51 (4.0)	30 (5.0)	47 (6.0)	
Both polygamous	3428 (20.0)	2847 (19.0)	219 (19.0)	161 (28.0)	201 (27.0)	
Nonmarital relationships						
None	13,690 (79.0)	11,779 (79.0)	886 (78.0)	451 (80.0)	574 (78.0)	<0.001
Female	267 (2.0)	214 (1.0)	21 (2.0)	17 (3.0)	15 (2.0)	
Male	3274 (19.0)	2802 (19.0)	224 (20.0)	99 (17.0)	149 (20.0)	
Religion						
Both Catholic/Protestant	13,173 (76.0)	11,199 (75.0)	963 (84.0)	392 (69.0)	619 (84.0)	<0.001
Pentecostal (at least 1)	622 (4.0)	558 (4.0)	25 (2.0)	17 (3.0)	22 (3.0)	
Muslim (at least 1)	3573 (21.0)	3162 (21.0)	155 (14.0)	158 (28.0)	98 (13.0)	
Difference in age of sexual partner						
Female individuals older	1209 (7.0)	937 (6.3)	127 (11.1)	95 (16.8)	50 (6.8)	<0.001
Male individuals older: by 0–4 yrs	6487 (37.4)	5688 (38.1)	370 (32.4)	192 (33.9)	237 (32.1)	
Male individuals older: by 5–9 yrs	6731 (38.8)	5834 (39.1)	423 (37.0)	188 (33.2)	286 (38.7)	
Male individuals older: by 10+ yrs	2941 (16.9)	2460 (16.5)	223 (19.5)	92 (16.2)	166 (22.5)	
Coresident biological children						
None (0)	1357 (8.0)	1026 (7.0)	157 (14.0)	99 (17.0)	75 (10.0)	<0.001
1–2	6376 (37.0)	5420 (36.0)	450 (39.0)	253 (45.0)	253 (34.0)	
3–5	7702 (44.0)	6706 (45.0)	479 (42.0)	192 (34.0)	325 (44.0)	
6+	1933 (11.0)	1767 (12.0)	57 (5.0)	23 (4.0)	86 (12.0)	
Duration between VCT and interview (d)						
No VCT within 30 d	3171 (18.0)	2669 (18.0)	242 (21.0)	132 (23.0)	128 (17.0)	<0.001
31–182	976 (6.0)	860 (6.0)	56 (5.0)	27 (5.0)	33 (4.0)	
183–365	2618 (15.0)	2297 (15.0)	128 (11.0)	76 (13.0)	117 (16.0)	
366+	10,603 (61.0)	9093 (61.0)	717 (63.0)	332 (59.0)	461 (62.0)	
Couple reported FP methods						
None	8770 (50.0)	7831 (52.0)	399 (35.0)	247 (44.0)	293 (40.0)	<0.001
HC	4397 (25.0)	3814 (26.0)	294 (26.0)	116 (20.0)	173 (23.0)	
Condoms	4201 (24.0)	3274 (22.0)	450 (39.0)	204 (36.0)	273 (37.0)	
Desire for more children	10,405 (60.0)	9419 (63.0)	434 (38.0)	235 (41.0)	317 (43.0)	<0.001
Pregnancy prevalence	2830 (16.0)	2533 (17.0)	107 (9.0)	90 (16.0)	100 (14.0)	<0.001

FP, family planning.

TABLE 2. Prevalence Rate Ratios of Desiring More Children by HIV Status of Couples

	M−F−	M+F+	M−F+	M+F−
	Adjusted PRR* (95% CI)	Adjusted PRR* (95% CI)	Adjusted PRR* (95% CI)	Adjusted PRR* (95% CI)
Average (SD) age in years				
Female partner				
15–19	1.00	1.00	1.00	1.00
20–29	0.94 (0.92 to 0.96)	0.66 (0.57 to 0.78)	0.96 (0.68 to 1.36)	0.86 (0.70 to 1.07)
30–39	0.64 (0.61 to 0.67)	0.46 (0.36 to 0.58)	0.60 (0.40 to 0.89)	0.44 (0.32 to 0.61)
40–49	0.18 (0.14 to 0.22)	0.21 (0.09 to 0.50)	0.17 (0.04 to 0.69)	0.14 (0.06 to 0.29)
Socioeconomic status				
High	1.00	1.00	1.00	1.00
Medium	0.98 (0.95 to 1.01)	0.95 (0.79 to 1.1)	0.97 (0.79 to 1.20)	0.82 (0.67 to 1.01)
Low	0.93 (0.90 to 0.96)	0.89 (0.74 to 1.0)	0.76 (0.59 to 0.99)	0.77 (0.63 to 0.94)
Type of marriage				
Both monogamous	1.00	1.00	1.00	1.00
Mono/poly discordant	0.87 (0.81 to 0.94)	0.92 (0.63 to 1.3)	0.30 (0.11 to 0.83)	0.87 (0.62 to 1.23)
Both polygamous	0.86 (0.82 to 0.90)	0.69 (0.53 to 0.8)	0.80 (0.61 to 1.03)	1.09 (0.89 to 1.34)
Religion				
Both Catholic/Protestant	1.00	1.00	1.00	1.00
Pentecostal (at least 1)	1.00 (0.94 to 1.07)	1.25 (0.80 to 1.9)	1.29 (0.83 to 2.01)	0.87 (0.57 to 1.33)
Muslim (at least 1)	0.95 (0.91 to 0.99)	0.97 (0.76 to 1.2)	1.10 (0.87 to 1.39)	0.87 (0.70 to 1.09)
Nonmarital relationships				
None	1.00	1.00	1.00	1.00
Female	0.95 (0.86 to 1.06)	1.43 (1.03 to 2.0)	1.90 (1.13 to 3.18)	1.83 (1.20 to 2.80)
Male	0.99 (0.96 to 1.02)	1.24 (1.05 to 1.4)	0.96 (0.76 to 1.21)	1.03 (0.86 to 1.22)
Coresident biological children				
None (0)	1.00	1.00	1.00	1.00
1–2	0.96 (0.93 to 1.00)	0.80 (0.66 to 0.9)	0.88 (0.71 to 1.08)	0.78 (0.65 to 0.94)
3–5	0.74 (0.71 to 0.78)	0.51 (0.40 to 0.64	0.53 (0.39 to 0.71)	0.48 (0.38 to 0.61)
6+	0.36 (0.32 to 0.41)	0.23 (0.07 to 0.69)	0.37 (0.13 to 1.03)	0.26 (0.12 to 0.56)
Duration between VCT and interview (d)				
No VCT within 30 d	1.0	1.0	1.0	1.00
31–182	1.07 (1.02 to 1.12)	0.73 (0.50 to 1.0)	0.96 (0.66 to 1.4)	1.18 (0.85 to 1.63)
183–365	0.99 (0.95 to 1.03)	0.84 (0.66 to 1.0)	0.78 (0.55 to 1.10)	0.93 (0.75 to 1.17)
366+	1.02 (0.99 to 1.06)	0.94 (0.79 to 1.1)	1.08 (0.88 to 1.32)	1.00 (0.82 to 1.23)
Enrolled into HIV care				
HIV+ not in care/w/in 30 d		1.00	1.00	1.00
HIV+ spouse in care		0.82 (0.63 to 1.0)	0.56 (0.40 to 0.78)	0.85 (0.67 to 1.07)
Both partners in care		0.60 (0.46 to 0.78)	—	—

*Adjusted for education level and difference in age with sexual partner.
PRR, prevalence rate ratio.

year of follow-up. Pregnancy incidence for HIV-negative concordant couples started at about 16/100 py to about 10/100 py by the last year of follow-up. We conducted a trend analysis to assess if the pregnancy rates significantly changed over time. The rate of pregnancy incidence significantly declined by 1.57 per study visit, $P < 0.001$. Compared to M−F− couples, pregnancy rate was significantly lower in M + F+, −6.0 (−8.94 to −3.9) $P < 0.001$, and in the HIV discordant couples, −3.3 (−6.22 to −0.36), $P = 0.027$. However, by the last round of follow-up, pregnancy incidence rates about HIV-positive concordant couples surged to about the same levels as negative couples.

Factors associated with pregnancy incidence (adjusted IRR) among women, stratified by the couples' HIV status, are summarized in Table 3. All factors statistically significantly associated with pregnancy incidence ($P < 0.05$) have been included in the table, and in addition to factors listed, we controlled for education level, type of marriage, religion, and difference in age with sexual partner. Among all women, factors associated with reduced incidence of a pregnancy were as follows: being older than 15–19 years (20–29 years, adj.IRR = 0.73, CI: 0.58 to 0.92 and 30–49 years, adj.IRR = 0.45, CI: 0.35 to 0.59), use of HC (adj.IRR = 0.85, CI: 0.74 to 0.98) or condoms (adj.IRR = 0.8, CI: 0.65 to 0.98), and the couples were in a HIV-positive concordant versus HIV-negative concordant relationship (adj.IRR = 0.56, CI: 0.39 to 0.8). Factors associated with an increased incidence of pregnancy were as follows: being in a medium or high SES

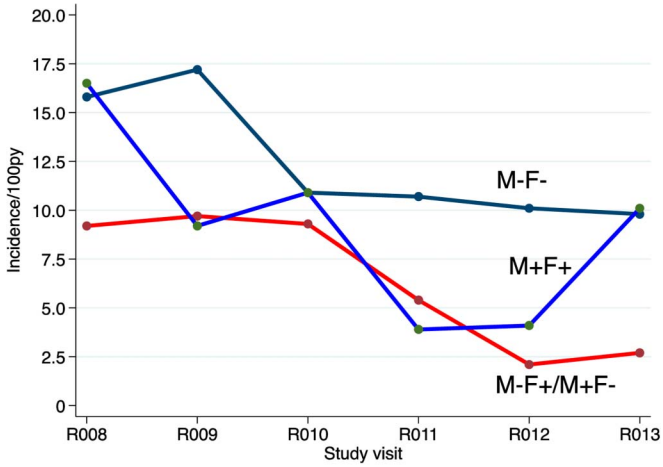

FIGURE 1. Trends in pregnancy incidence over time.

compared with low SES background (adj.IRR = 1.2, CI: 1.03 to 1.4 and IRR = 1.36, CI: 1.17 to 1.58, respectively), having more than 1 coresident biological child/ren, and desiring more children (IRR = 1.56, CI: 1.33 to 1.83). Among couples where at least 1 member was HIV-positive, having a HIV+ spouse in care was associated with a decreased risk in pregnancy (adj.IRR = 0.49, CI: 0.26 to 0.93). Factors associated with an increase in pregnancy were being of medium or low SES (adj.IRR = 1.46, CI: 0.83 to 2.57, and adj.IRR = 1.42, CI: 0.83 to 2.47, respectively) and the female individual in the serodiscordant couple being HIV+ (adj.IRR = 1.89, CI: 1.1 to 3.26). The difference in age between partners was collinear with the female age variable and hence was dropped in the multivariate model.

DISCUSSION

In settings with overlapping high rates of fertility and HIV prevalence, couples are faced with making fertility decisions while simultaneously trying to avoid or manage HIV infection. Globally, the focus on reproductive health decisions among PLHIV has been focused on women's reproductive desires and behaviors with only a few studies assessing these outcomes in couples. The goal of our study was to understand what factors drove the desire for more children and pregnancy incidence among couples in a rural African community setting with overlapping high fertility and HIV prevalence rates. Our longitudinal study followed 6647 couples of varying HIV status prospectively for over 8 years. Our main findings were that the couple's HIV status significantly impacts fertility desires and incidence of pregnancy. Pregnancy incidence over time decreased overall for all couples but was lowest among HIV serodiscordant couples, whereas among HIV-positive concordant couples, there was a surge in pregnancy incidence in the last year of observation of this study. Fertility desires and pregnancy rates often did not align, demonstrating unmet need for family planning and the need to provide the resources for these couples to have safe and healthy pregnancies with minimal risk of horizontal or vertical HIV transmission.

Drivers of fertility desire are complex, and our study found many significant factors associated with the desire for more children. The desire for more children decreased significantly with age, irrespective of the couples' HIV status and is similar to other studies.[4,5,26] The relationship between education and fertility desires has been studied in many settings, with a view a few decades ago that fertility will fall uniformly with rising education levels.[27] However, over time, studies have rarely found any significant impact of education levels on fertility, and this was confirmed by our study.[27] Couple's SES was significantly associated with the desire for more children; fertility desires were lower among low SES compared with high SES couples. The relationship between SES and fertility is complex with studies finding in general, lower fertility desires, and rates among women with high SES in western countries.[28] However, in less developed countries such as our setting, higher SES may provide resources to ensure a safe pregnancy and delivery and higher survival of children.

Uganda is one of the few countries with a majority Christian population that legally recognizes polygamous unions, and overall, approximately 20% of couples in our study were in polygamous unions. Compared with monogamous couples, irrespective of HIV status, couples in polygamous or mono/polygamous discordant unions reported significantly less desire for children. This could be because overall, the fertility desires of polygamous families are met with multiple wives or that survival of children in polygamous unions is lower, as was shown by a previous study in the same setting.[29]

Studies from multiple contexts have shown that HIV-infected individuals engage in high-risk sexual behaviors characterized by their fertility intentions.[30] When the female reported multiple sexual partners, the desire for more children was significantly higher if she was in a HIV concordant or serodiscordant union, irrespective of her HIV status. Male individuals reporting multiple sexual partners had an increased fertility desire only if they are in a HIV-positive concordant union. It is interesting that HIV-infected female individuals in our study reporting multiple sexual partners were more likely to desire additional children. A previous study on the same population[31] found that both hormonal contraceptive and condom use were significantly lower in serodiscordant couples where the female individual compared with the male individual was HIV-positive. Studies have found that PLHIV often manifest high-risk sexual behaviors characterized by their fertility intentions and contraceptive use.[30] Fertility desires specifically among serodiscordant couples are complex; studies find that some factors driving fertility desire are societal expectations of the ideal number of children, personal and partner's desire for more children, and nondisclosure of HIV status. In addition, the widespread availability of ART may significantly impact fertility desires of PLHIV.

Studies have found an increase in HIV incidence and risk behaviors in age-disparate relationships, with risk increasing the older the male partner is.[32–34] Our study found that with higher age difference with the male partner, fertility desires were significantly higher among all HIV-negative

TABLE 3. Pregnancy Incidence by HIV Status of Couples

	N	Incidence/py	Incidence/100 py	Adjusted* IRR	N	Incidence/py	Incidence/100 py	Adjusted* IRR
Overall	**7656**	**1205/10,590.6**	**11.4**	**(95% CI)**	**917**	**97/1312.4**	**7.4**	**(95% CI)**
Female age								
15–19	344	87/426.3	20.4	1.0	21	4/27.5	14.5	1.0
20–29	4280	804/5779.5	13.9	0.73 (0.58 to 0.92)	410	59/566.7	10.4	0.99 (0.38 to 2.61)
30–49	3032	314/4384.8	7.2	0.45 (0.35 to 0.59)	486	34/718.1	4.7	0.58 (0.20 to 1.66)
SES								
High	2562	341/3653.0	9.3	1.0	313	27/463.7	5.8	1.0
Medium	2539	411/3513.2	11.7	1.20 (1.03 to 1.40)	281	32/397.9	8.0	1.46 (0.83 to 2.57)
Low	2555	453/3424.3	13.2	1.36 (1.17 to 1.58)	323	38/450.8	8.4	1.42 (0.83 to 2.47)
Coresident biological children								
None (0)	338	28/483.2	5.8	1.0	88	6/131.4	4.6	1.0
1–2	2581	475/3469.6	13.7	2.08 (1.40 to 3.08)	330	46/460.6	10.0	2.10 (0.86 to 5.14)
3–5	3758	585/5242.0	11.2	2.15 (1.45 to 3.17)	421	39/605.3	6.4	1.89 (0.76 to 4.72)
6+	979	117/1395.8	8.4	2.37 (1.54 to 3.65)	78	6/115.1	5.2	1.73 (0.53 to 5.63)
Desire more children								
No	2930	302/4165.3	7.3	1.0	531	44/772.2	5.7	1.0
Yes	4726	903/6425.2	14.1	1.56 (1.33 to 1.83)	386	53/540.2	9.8	1.19 (0.72 to 1.96)
Use of modern contraception								
No	4542	792/6161.6	12.9	1.0	423	56/580.4	9.6	1.0
Hormonal contraception	1985	278/2788.4	10.0	0.85 (0.74 to 0.98)	183	15/262.0	5.7	0.74 (0.40 to 1.35)
Condoms	883	109/1264.8	8.6	0.80 (0.65 to 0.98)	244	22/365.1	6.0	1.15 (0.65 to 2.02)
Dual	246	26/375.9	6.9	0.69 (0.47 to 1.01)	67	4/104.9	3.8	0.77 (0.25 to 2.31)
Couple HIV status								
M−F−	6739	1108/9278.2	11.9	1.0				
M+F+	439	33/643.8	5.1	0.56 (0.39 to 0.81)	439	33/643.8	5.1	1.0
M−F+	183	28/257.3	10.9	1.17 (0.80 to 1.71)	183	28/257.3	10.9	1.89 (1.10 to 3.26)
M+F−	295	36/411.2	8.8	0.92 (0.66 to 1.27)	295	36/411.2	8.8	1.59 (0.94 to 2.70)
Enrolled into HIV care								
HIV+ not in care/w/in 30 d					630	79/857.2	9.2	1.0
HIV+ spouse in care					184	14/290.1	4.8	0.49 (0.26 to 0.93)
Both partners in care					103	4/165.1	2.4	0.37 (0.12 to 1.17)

*Adjusted for education level, type of marriage, religion, nonmarital relationship, and difference in age with sexual partner.

concordant couples and among HIV+ female individuals in serodiscordant couples. Understanding and responding to the reproductive health needs of PLHIV is critical to minimize horizontal and vertical transmission of HIV.

When assessing the impact of coresident children on fertility desires, our results are also consistent with other studies,[5,26,35] demonstrating that already having children reduces the desire for more children.

Interestingly, among HIV-positive concordant couples, a VCT session in the past 6 months or year was associated with a decrease in fertility desire. Another study on the same population found that the desire for more children increased among all women, and HIV-positive women after ART became widely available in the communities.[36] There was a significant decrease in fertility desires among couples where the HIV-positive female individual was in HIV care. When both partners were in HIV care (HIV-positive concordant couples), there was a 40% decrease in fertility desires reported. A previous study examining the contraceptive practices of these couples found that the odds of using hormonal contraceptives was significantly higher among HIV-positive concordant and serodiscordant couples where the female individual was HIV-negative, but there was no impact among HIV-positive female individuals in serodiscordant unions.[31] Fertility desires of HIV-infected women in serodiscordant relationships may be driven in part by the desires of the negative partner and societal expectations of the ideal family size. Studies have found that among serodiscordant couples where the female individual was HIV-positive, younger age and the relative's expectations for children drove fertility desires, whereas where the male individual was HIV-positive, knowledge of ART effectiveness was a significant factor in fertility desires.[37] Although data on the impact of ART on fertility desires were not specifically collected in this study, it is possible that ART availability had an impact on the desire for more children among HIV-infected women in our study. Given that there was no information on HIV disclosure among couples, it is unclear to what extent this played a role in fertility desires and pregnancy rates of serodiscordant couples.

Although there is a lot of work conducted in understanding fertility desires, there is less on examining drivers of pregnancy incidence and to what extent desires are aligned

with pregnancy rates. Studies have found that in the absence of ART, HIV-positive women have lower pregnancy rates and higher rates of pregnancy loss.[20,26,38] The prevalence of pregnancy was lowest among HIV-positive concordant couples and highest among HIV-negative couples (9% and 17%, respectively, $P < 0.05$), and compared with HIV-negative couples, pregnancy incidence was significantly lower only among HIV-positive concordant couples but not among serodiscordant couples. Qualitative studies have found that among serodiscordant couples, unprotected sex was deemed an acceptable risk to meet their desire for more children.[39] With the advent of ART, studies have found that both reproductive desires and pregnancy rates among HIV-positive women have increased with an increased life expectancy and reduced rates of MTCT.[40,41]

Factors that were significantly associated with a higher pregnancy incidence among women in our study were being of medium or low SES compared with high SES, having more than 1 coresident biological children and having the desire for more children. Older age was associated with a decrease in fertility desires and pregnancy incidence among all women, but the decrease was not statistically significant among serodiscordant couples. Interestingly, women of medium or low SES were less likely to desire children but had higher pregnancy rates compared with women in high SES unions, irrespective of the HIV status of the couples. Similarly, coresident children were associated with a decreased desire for children but an increase in pregnancy rates among all women. Although our findings are aligned with both cross-sectional studies[26] and qualitative studies,[42] demonstrating that couples who already have children were less likely to desire more children, in our study, pregnancy rates increased among women with higher number of coresidence. The use of HC and condoms was both associated with significant decreases in pregnancy rates, demonstrating that among couples where these methods are used consistently and effectively, the rates of unwanted pregnancy are lower. Unintended pregnancy is a significant global issue and a quantitative study among couples in the same setting found that of almost 3000 current pregnancies, approximately 30% were mistimed, 13% were unwanted,[43] and HIV was an important predictor of unwanted pregnancy. Our study highlights the specific populations where reproductive health programs can focus on to meet the unmet contraceptive needs of women in these communities.

When looking at trends of pregnancy incidence over time, although incidence decreased for all couples over time, among HIV-positive concordant couples, the rates dropped and then surged in the last round. These rates have probably increased because of the use of ART but also demonstrate an unmet need for family planning among these couples; 38% of HIV-positive concordant couples desired more children compared with 63% of HIV-negative couples and about 42% of HIV serodiscordant couples. Despite the decrease in fertility desire, these couples had the most significant increase in pregnancy incidence in the last year of analyses of our data. It could be that having both partners in HIV care motivated both of them to adhere to ART, and hence, their pregnancy rates peaked over time. Unmet need for family planning for PLHIV has been shown in other studies; a study in western Uganda found that 75% of HIV-infected individuals reported an unmet need for contraception compared with about 33% of HIV-negative individuals.[13]

The desire for more children is influenced by many relationship dynamics,[16,44] and studies focusing on the perspective of women alone miss an important dimension impacting on reproductive desires and rates. Studies have shown that HIV-affected couples desire to have children, and among HIV serodiscordant couples, despite transmission risks with unprotected sexual intercourse, the desire for additional children and pregnancy rates are significant.[45] However, the decision-making process regarding fertility desires, child spacing, and pregnancy is poorly understood among couples, especially when faced with the dual risk of HIV infection and pressure to have more children. In addition, the lack of information on HIV status disclosure and impact of ART use, it is unclear to what extent knowledge of partner's HIV status or ART impacted on fertility desires and contraceptive use. The lack of consistent long-term effective contraceptive use may explain the discrepancy between fertility desires and pregnancy incidence we see among some couples. Although reproductive technology may not be widely available to assist couples who want children where at least 1 member is infected,[14] studies have found that male circumcision[46,47] and lower viral loads as a result of ART use[48] minimize the risk of vertical and horizontal transmission. The reproductive needs of couples need to be assessed, so that there is awareness of methods to minimize the risk of HIV transmission and couples are provided with the information and resources to meet their fertility desires. In addition, a more targeted approach to delivery of services and integration of HIV and reproductive services is needed to meet the reproductive needs of HIV-positive and serodiscordant couples. Qualitative studies have found that there was a strong perceived community disapproval associated with PLHIV desiring more children and lack of proper counseling environment, which was perceived as being unsupportive to the reproductive needs of PLHIV. Training of health care providers to specifically address reproductive desires and needs of PLHIV needs to be strengthened so as to better meet the needs of HIV-positive concordant and serodiscordant couples.[3]

A limitation of this study is that if couples were seen about every 12 months, there could be potential recall bias when asking about desires and contraceptive use in the past 12 months.

CONCLUSIONS

Our study highlighted that HIV infection does not diminish the desire of couples to want additional children, and that there is significant unmet need for family planning among couples where at least 1 member is HIV-positive. As HIV care and reproductive health services continue to strengthen in resource poor settings, special attention to the reproductive needs of PLHIV is critical to minimize the risk of vertical and horizontal transmission of HIV among couples desiring more children.

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