Partnership concurrency and HIV incidence in a population-based cohort study in rural Uganda

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ABSTRACT:

Concurrent partnerships are suggested to be a primary driver of the HIV epidemic in sub-Saharan Africa. Current attempts to empirically test the concurrency hypothesis have been unsuccessful and that is in part due to the lack of data with linked-partnerships and HIV incidence over time. In this paper we overcome both limitations by comparing HIV incidence among spouses of men who report extra-marital relationships and those that do not. The data come from a rural community of about 20,000 inhabitants in south-western Uganda and span a 10-year period starting in 2000. We present Kaplan-Meier estimates of cumulative incidence, and discrete-time hazard models to determine the risk of sero-conversion among women. In preliminary analyses, we are unable to detect an effect of the husband's extra-spousal partnerships on the HIV incidence among their wives. These findings add to a growing body of literature casting doubt on the importance of concurrency for the spread of HIV.

EXTENDED ABSTRACT:

With sub-Saharan Africa accounting for over two-thirds of the 33 million people infected with HIV worldwide (UNAIDS, 2009), epidemiological research has attempted to determine what factors account for the disproportionate share of HIV cases on the continent. One of the most notable covariates of heterosexual HIV transmission which also accounts for some of the heterogeneity within sub-Saharan Africa is the absence of male circumcision (B. Auvert et al. 2005; Bailey et al. 2007; Gray et al. 2007). Sexual behavioral research initially focused on the number of partners, but there is no evidence that there are important differences in the number of sexual partners between Africans and populations with smaller epidemics (Caraël 1995; Wellings et al. 2006). The attention thus shifted to sexual network dynamics, and in particular to the role of concurrent partnerships.

Concurrency is defined as two overlapping sexual partnerships, where sex with one partner falls in between two acts of sexual intercourse with another partner (UNAIDS Reference Group on Estimates Modelling and Projections: Working Group on Measuring Concurrent Sexual Partnerships 2010). Among others, partnership concurrency is important because an HIV positive person's viral load, and therefore his or her infectiousness, peaks in the first couple of months after seroconversion (Boily et al. 2009; Wawer et al. 2005). Someone who just acquired HIV is therefore more likely to pass the virus to someone else if he or she has a concurrent seronegative partner. Under serial monogamy the gap between HIV acquisition and sexual intercourse with a new partner is longer and thus less likely to occur in the highly infectious window period. An important, yet often misunderstood repercussion of partnership concurrency is that it only affects the probability of *transmitting* HIV, not the probability of *acquiring* HIV (Morris 2001) . In other words, the concurrency hypothesis predicts a positive correlation between the index case's concurrency and the HIV status of his partners (but not his own HIV status). This last point has important methodological implications because it means that individual-level, and ego-centered studies of HIV risk factors cannot detect individual-level concurrency effects, and these are precisely the most commonly available type of data sources.

Morris and Kretzschmar (1997) relied on mathematical modeling to illustrate the effect on concurrency on the epidemic size. Even though the concurrency hypothesis has intuitive appeal and the mathematical models are very persuasive indeed, a considerable debate has evolved around the empirical evidence –or lack thereof– for the concurrency hypothesis (Halperin and Epstein 2004; Mah and Halperin 2009; Mah and Halperin 2010; Maas and Zijdeman 2010; Morris 2009; Lurie and Rosenthal 2009a; Lurie and Rosenthal 2009b; Emmanuel Lagarde et al. 2001; Sawers and Stillwaggon 2010; Reniers and Watkins 2010). One of the issues with the concurrency models is that they often assume unrealistically high levels

of coital frequency with each (concurrent) partner. Instead a coital dilution effect may in large part compensate for the elevated transmission rates in concurrent partnerships (Sawers, Isaac, and Stillwaggon 2011; Reniers and Tfaily 2011)

If partnership concurrency explains HIV prevalence, then we should be able to observe different rates of concurrency in sub-Saharan Africa compared to other nations of the world, and between low and high prevalence countries within the continent. However, current estimates of concurrency among sub-Saharan African countries and the rest of the world does not show any clear trend. Sawers and Sillwaggon (2010) reviewed 28 country and city estimates and highlighted the high variability in prevalence estimates depending on the method of data collection.

Recent research by Tanser et al (2011) examined the geographic relationship between men's reported concurrency and the HIV-incidence of women within the same area and found no association. While advancing the empirical evidence against concurrency, the assumption that sexual partnerships primarily occur within the same geographic space limits the reliability of these findings.

Data limitations remain the largest obstacle to empirically testing the effect of concurrency on HIV transmission. First, most studies have relied on cross-sectional data at both the individual and country level to determine associations between concurrency and HIV prevalence. However, the risk of concurrency operates via increased transmission of the virus, which is best captured by measuring HIV incidence. The second major data limitation is the lack of linked partnership data to evaluate HIV incidence in individuals with partners who report concurrent partnerships. One sexual network study was able to use linked partner data, and found an association between concurrency and HIV transmission, though the sample size was relatively small (N=142) (Helleringer, Kohler, and Kalilani-Phiri 2009).

In this paper we seek to overcome both of these limitations by examining extra-spousal partnerships among married couples in a large population-based cohort in rural south-western Uganda. Using extra-spousal partnerships as a proxy for concurrency, we examine men's reports of extra-spousal partnerships and their wives HIV incidence over a 10 year period, starting in 2000. Initial results suggest that HIV incidence rates among women whose husbands report extra-spousal partnerships are not significantly different from women whose husbands don't report extra-spousal partnerships.

Data

Data for this analysis comes from the General Population Cohort (GPC) study conducted by the Medical Research Council (UK) and the Uganda Virus Research Institute (MRC/UVRI). The GPC is an annual population census and sero-survey that has been conducted in the area since 1989. It is comprised of a rural population cohort in south-western Uganda with approximately 20,000 respondents from the 25 villages in the study site. Details of the population cohort study and methodology have been described elsewhere (Nakibinge et al. 2009; Nunn et al. 1997). This paper draws on annual data from 2000-2009 (Rounds 10-20). The dataset includes information on household composition and characteristics, individual demographics, sexual behavior and marriage histories, and sero-status. The adult survey has response rate of 69%, and of those who take the survey, 83% also participate in the sero-survey. Positive sero-status can be imputed forwards, and negative sero-status imputed backwards, such that sero-status is known for a larger number of respondents than those who participate in the sero-survey in any given year. Marriages are used as the unit of analysis for this investigation, where only linked-spousal partnerships are included. This gives a sample of a 4,513 marriages over 10 years, contributing a total of 26,810 marriage-years of exposure.

Measuring Concurrency

Concurrency is measured as any report of an extra-spousal partnership within the preceding 12 months. Due to the limited number of women reporting an extra-spousal partnership (2%), we only use husband's reports of extra-spousal partnerships. The main assumption of this measure is that all individuals who are married are engaging in coitus with their spousal partner. Lacking exact relationship duration and coital frequency information, this measure serves as the best means of capturing concurrency. While this does not adhere to the recommended UNAIDS measure for concurrency, it serves as a close proximate measure among married individuals. We will also explore alternative measures of concurrency our analysis, whereby we classifying men in polygynous along with men in monogamous unions with extra-spousal partners.

Preliminary Data Analysis

Only preliminary data analysis is currently complete. Of a total of 4,513 marriage, 277 wives HIV positive in the first round of analysis, and 127 wives sero-converted over the period of observation, giving an HIV incidence within marriage over the 10 years of 3%.

First we constructed Kaplan-Meier failure curves to indicate the risk of HIV infection over time. Previous papers have only been able to examine an individual's reports of concurrency partners and their own risk of HIV infection. Figure 1 replicates this method of analysis, showing that men who report extra-spousal partnerships are at an increased risk of HIV infection. Figure 2 on the other hand, that looks at wives' cumulative HIV incidence highlights that the wives of men reporting an extra-spousal partnership are not at an increased risk of HIV infection.

We then use discrete time survival analysis with a complementary-log-log link to compare the hazard of HIV infection among wives over time. In preliminary analysis we add controls for the wife's age, whether the union is polygynous, as well as husbands sexual characteristics. These include age at first sex (AFS), age at first marriage (AFM) and if the husband reported ever using a condom. AFS was recorded as above or equal to the median (18 years for men; 17 years for women), and AFM as above or equal to the median (22 years for men; 18 years for women).

HIV transmission to women was not associated with men's reports of extra-spousal partnerships. In fact, the magnitude of this association showed a decreased risk of HIV, which was significant at $p<0.05$. Further analysis will develop these models to take into account more individual and marriage-level characteristics, as well as explore competing risks within marriage. Analyses will be performed to test the sensitivity of these results to our measurement of concurrency, examining the effect of including and excluding polygynous men from the sample. We will also explore whether sample selection is biasing our results, including the effect of censoring through out-migration and marital dissolution, as well as whether individuals without linked partner data are significantly different from those with linked partner data.

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Figure 1: Husband's Cumulative HIV incidence over 10 years

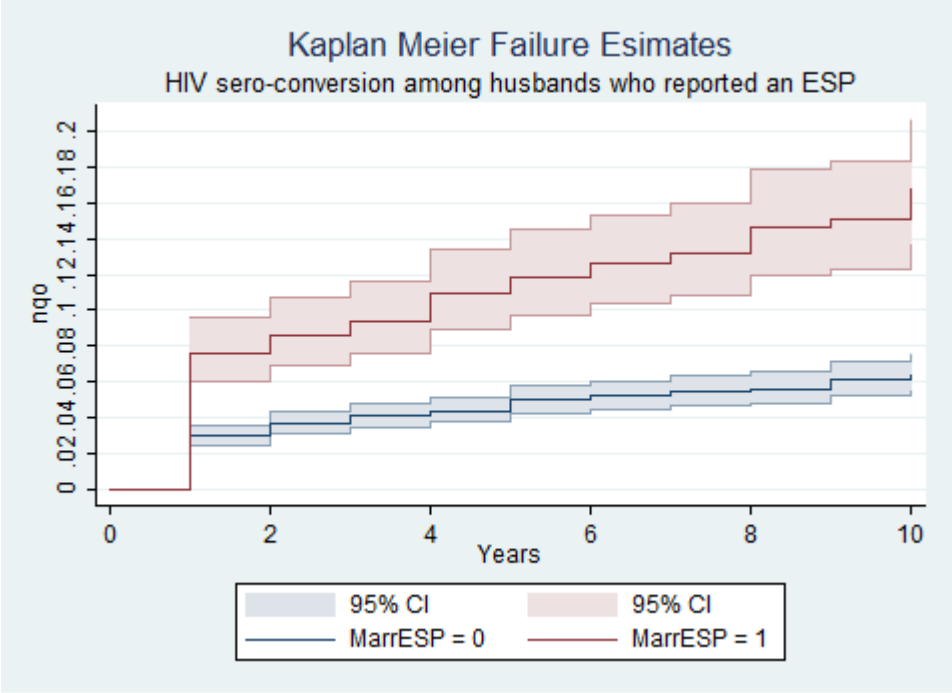

Figure 1: Wive's Cumulative HIV incidence over 10 years

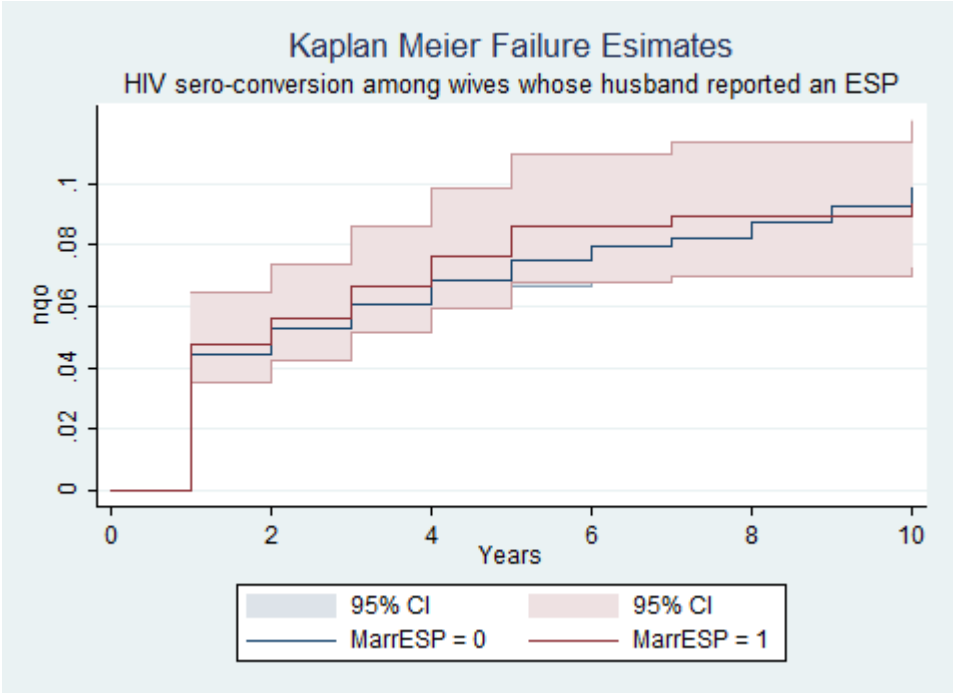

Table 1: Hazard of HIV sero-conversion among married women with linked-partner data in rural Uganda

	(1)	(2)
Husband reported an extra-spousal	**0.880**	**0.758****
	(0.698 - 1.110)	**(0.578 - 0.994)**
Wife's Age	0.986***	0.988***
	(0.979 - 0.993)	(0.981 - 0.996)
Husband reported ever using a condom		1.894***
		(1.435 - 2.500)
Husband's Age at First Sex>= 18		0.994
		(0.767 - 1.288)
Husband's Age at First Marriage >= 22		1.108
		(0.849 - 1.447)
Polygynous Union		0.911
		(0.619 - 1.342)
Observations	26,810	26,810

*** p<0.01, ** p<0.05, * p<0.1