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Partnership Concurrency and Coital Frequency

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Abstract

National HIV prevalence estimates across sub-Saharan Africa range from less than 1 percent to over 25 percent. Recent research proposes several explanations for the observed variation, including prevalence of male circumcision, levels of condom use, presence of other sexually transmitted infections, and practice of multiple concurrent partnerships. However, the importance of partnership concurrency for HIV transmission may depend on how it affects coital frequency with each partner. The coital dilution hypothesis suggests that coital frequency within a partnership declines with the addition of concurrent partners. Using sexual behavior data from rural Malawi and urban Kenya, we investigate the relationship between partnership concurrency and coital frequency, and find partial support for the coital dilution hypothesis. We conclude the paper with a discussion of our findings in light of the current literature on concurrency.

Keywords

Concurrency; Coital frequency; HIV/AIDS; Malawi; Kenya

Introduction

In an attempt to explain the surprising cross-national variation in HIV prevalence across sub-Saharan Africa, many scholars point to biological, social and behavioral factors, including the prevalence of male circumcision, other sexually transmitted infections, levels of education, age at marriage and condom use [1–6]. Another behavioral factor is the practice of concurrent sexual partnerships; the concurrency hypothesis posits that HIV transmission rates are higher in some countries due to the practice of overlapping sexual partnerships that, in comparison to serial partnerships, increase the size, pace and persistence of the epidemic [7–9]. Partnership concurrency may trigger large HIV epidemics because a monogamous relationship traps the virus in a partnership until that partnership dissolves and new partnerships are formed. The sequential nature of relationships in serial monogamy thus acts as a buffer to reduce the pace at which the epidemic spreads and also constrains the number of possible transmission paths itself [7, 10]. Acute infection may amplify the effect of concurrency because an HIV positive person's viral load, and therefore his or her infectiousness, peaks in the first few months following seroconversion [11, 12]. A newly

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infected person is therefore more likely to pass the virus to someone else if he or she has a concurrent seronegative partner. In contrast, the gap between HIV acquisition and sexual intercourse with a new partner is usually longer in serial monogamy, and thus less likely to occur in the highly infectious window period. This interaction between primary infection and partnership concurrency has been corroborated by several studies [13, 14]. However, empirical evidence for the importance of concurrency as a driver of the epidemic is inconclusive. A positive effect of concurrency may be offset by a reduction in the partnership-specific frequency of intercourse of men and women with concurrent partnerships, an effect that we hereafter refer to as coital dilution [15–17].

There are two difficulties in assessing the impact of concurrency on coital frequency. First, there may be reverse causality between concurrency and coital frequency: individuals in relationships with low coital frequency may be dissatisfied and seek out additional relationships.[1] We address this reverse causality problem through a fixed effects analysis comparing coital frequency in a given relationship before and after the addition of a concurrent partner.

Second, empirical estimates of coital frequency and concurrency may be affected by biases in reporting. When respondents are questioned about their sexual behavior, they may provide inaccurate responses in order to reflect socially desirable or expected behavior. It is widely perceived that men exaggerate their sexual activity, while women tend to underreport their sexual behavior, particularly when it pertains to non-marital relationships [19–21]. Married men, however, may also under-report the extent of their extra-marital relations [22]. Finally, some respondents may be more open to talking about sexual behavior, and thus more inclined to report both higher coital frequency and partnership concurrency, leading to a (spurious) positive relationship between the two. In this study, we use two datasets collected with non-traditional interviewing techniques that are aimed to circumvent some of these reporting biases. Our first dataset (LNS) improves on standard datasets of sexual behaviors in two ways. First, it was collected using audio computer assisted self-interviewing (ACASI). ACASI may elicit more accurate information on sexual behavior with specific partners, although results are mixed [23]. Second, in the LNS, both partners in a relationship are interviewed and their reports are linked. This permits assessing the inter-partner reliability of sexual partnership histories and identifying respondents who may under/over report the extent of their sexual networking [22]. The second of our datasets (ULYKP) consists of data collected by means of a relationship history calendar, a method of data collection that has been demonstrated to elicit less ‘swaggering’ reports from men, and less ‘secretive’ reports from women [24, 25].

Data and Methods

The data for this project are drawn from two studies of sexual behavior, the Likoma Network Study (LNS) and the Urban Life among Youth in Kisumu Project (ULYKP). Whereas the samples and methodologies of the studies are distinct, both provide measures of concurrency and coital frequency.

Likoma Network Study

Likoma, a small island located near the Mozambican shores of Lake Malawi, is roughly 18 square kilometers and home to more than 7,000 inhabitants. The LNS is a sociocentric study of the factors of HIV transmission on the island, with details of the context and methods documented elsewhere [26, 27]. In the first round of the LNS, the prevalence of HIV among

[1] A study of the determinants of partnership concurrency using the ULYKP data finds that coital frequency of the initial relationship is not predictive of entry into a second, concurrent partnership [18].

adults was 8 % [28]. We use data from the second round of the study (2007/2008), wherein 2,014 adults aged 18–49 years old were interviewed about their sexual behavior.

Data on sexual partnerships were obtained in two stages. First, a census of every individual on Likoma Island was conducted to obtain a roster of potential sexual partners. Second, all inhabitants aged 18–49 years old were enrolled in an ACASI sexual network survey, asking respondents for information about their most recent sexual partners. During the ACASI survey, respondents were asked to provide the names of up to five of their most recent sexual partners using recording headsets. Each nominated partner was then searched in the roster of potential partners using a phonetic name-matching algorithm (soundex). Potential links were confirmed by clerical review. The saturated sampling frame allowed construction of the population-level sexual network by matching the reported sexual partners with the census roster, and then linking the data of all young adults to their reported sexual partners residing in the sample villages [28].

For analyses of the LNS we use two analytic samples. The first consists of 1,256 current sexual relationships reported by 1,163 individuals (see Table 1 for descriptive statistics). For the second set of analyses we use matched couples in ongoing relationships where both partners were interviewed within 5 days of each other to ensure they are referring to the same reference period, resulting in an analytic sample of 215 couples. The nature of the sexual network data allows us to compare information on sexual relationships and coital frequency from both partners in the dyad. For additional analyses we restrict this sample to couples with consistent reports of coital frequency, reducing the sample to 143 couples (see Table 2 for descriptive statistics and Fig. 1 for a depiction of the sample breakdown). Our primary measure of coital frequency is an indicator for whether or not the respondent reports having sex with a given partner in the last month. Table 2 compares the characteristics of couples who matched on reports of coital frequency to those who did not. Matched couples are more likely to report sex in the last month and are more recent than those with inconsistent reports. Individuals in couples with matching reports are also slightly less likely to report concurrent partnerships.

We measure concurrency as a composite measure of two indicators. The first is self-reported concurrency where the respondent affirmatively answers the question whether s/he had any other sexual partners during an index relationship. The second indicator measures concurrency at the time of the survey and is based on questions wherein the respondent reports on ongoing partnerships (marital and non-marital but without explicitly referring to concurrency). This composite measure of concurrency thus reflects concurrency at any point during an ongoing relationship, and is expected to be higher than the concurrency point-prevalence. Because coital frequency is measured as sex in the last month, there is a possible lack of correspondence in the reference period for our outcome and predictor measures. However, our findings are robust to the use of only the second indicator of concurrency (concurrency at the time of the interview).

Urban Life Among Youth in Kisumu Project

On the shores of Lake Victoria, Kisumu is Kenya’s third largest city, with an estimated population of 420,000. The ULYKP was designed to compare a new instrument for the collection of sexual behavior data, the relationship history calendar, against the standard face-to-face partnership questionnaire method. Implemented in 2007, the project randomly sampled 1,275 young adults aged 18–24 and 308 of their recent sexual partners from 45 urban enumeration areas in the city. Individuals were then randomly assigned to receive the relationship history calendar instrument or the standard partnership questionnaire. A random sample of 608 index respondents were administered the relationship history calendar, along with 125 of their nominated partners. We restrict the analysis to index respondents only, as they are a representative sample and nominated partners may present a selection bias. This study uses data collected through the relationship history calendar only because the standard partnership questionnaire collects information on sexual partners within the last year and asks questions about sexual behavior only for the first and last months of relationships. Furthermore, as compared to other methods of data collection the relationship history calendar reduces social desirability bias and increases reporting of concurrency among women [25]. Using important personal and historical landmarks, the 608 index respondents reported on the characteristics of each of their romantic and sexual relationships for each month from January 1998 through June/July 2007. The context and methods of the ULYKP are described in more detail elsewhere [25]. HIV prevalence in Kisumu is estimated at 15 % [29].

For this project we use two analytic samples from the ULYKP. First, we reproduce our analysis from the LNS by restricting our sample to all relationships that were ongoing at the time of the interview. This restriction results in 428 current relationships reported by 378 individuals (see Table 1 for descriptive statistics). Second, for our fixed effects analysis we use relationship-month as the unit of analysis; each month in which a relationship was ongoing is considered a separate observation. We first use all relationship-months reported in the relationship history calendar, covering a time frame of 10 years. We then restrict the sample down to relationship-months in the last 3 years, and the last year. The resulting analytic samples are 21,320, 10,567, and 3,435 relationship-months, respectively (see Table 3 for descriptive statistics and Fig. 2 for a depiction of the sample breakdown).

In the relationship history calendar, respondents were asked about the frequency of intercourse with each reported partner for each month of the relationship. The questions proceeded as follows. First, respondents were asked, ‘‘During this relationship, did you and [partner] have sex?’’ If so, respondents were asked, ‘‘In the first month you had sex, how many times did you and [partner] have sex? Did the frequency change over the course of the relationship? When?’’ Interviewers were instructed to repeat this questioning through the last month of the relationship. Response categories for the monthly coital frequency measure were 0 times, 1–4 times, 5–14 times, and 15 or more times. To ensure comparability with the LNS dataset, we have collapsed this categorical report of coital frequency into a dichotomous variable taking a value of 0 if the respondent reports no sex in the month, and 1 if the respondent reports having sex in the month. In a set of extended analyses (shown in Tables 3, 9) we model coital frequency (1–4 times vs. 5 times or more) among those who report sex in the month.

Due to the nature of the relationship history calendar, respondents could report on overlapping partnerships without being explicitly queried about concurrency. The measure of concurrency we employ is more than one sexual partnership in the month. A sexual partnership is defined as a relationship where partners have sex at some point in the relationship, but unlike the measure used by Xu et al. [18], our measure is agnostic to the timing of first and last sex. We prefer this measure for several reasons. First, it allows for comparison between the LNS and ULYKP analyses. Second, we choose the more inclusive definition of a partnership because we model sex in the month of interview as an outcome in one of our analyses. The definition of a partnership as the episode between first and last sex means that all individuals in concurrent partnerships at the time of interview must have had sex in the month of interview, making this measure of concurrency inappropriate for our analysis. We thus construct a time-varying indicator for concurrency that takes a value of 1 if respondents reported more than one partnership (that has ever been sexual) in a given month, and 0 if only one partnership was reported. This dataset thus overcomes the limitation from the LNS because it captures concurrency for every month of the relationship, for which we also have data on coital frequency. In extended analyses (shown in Tables 8,

9) we present results using the Xu et al. [18] measure of concurrency. Results are generally consistent with the findings discussed here.

Methodology

We employ two analytical strategies to address the mis-reporting of sexual partnerships and the number of sex acts. First, we exploit the network nature of the LNS data to link partners, allowing us to assess the reliability of their reports of coital frequency. Matching couple reports are a necessary but not sufficient condition for accurate reports of coital frequency within a relationship [30]. Second, using the longitudinal nature of the relationship history data from ULYKP, we employ fixed effects estimation to control for unobservable characteristics within individuals and relationships that may influence bias in reporting. For example, if a man exaggerates his report of coital frequency, as long as he does so consistently across the duration of the relationship, the fixed effects analysis will control out his braggadocio. In contrast, if a woman is reluctant to talk about her sexual behavior, as long as this reluctance affects her reports consistently across the calendar, we can examine how the addition or subtraction of overlapping partners influences coital frequency. The fixed effects analysis does not address potential underreporting of concurrency; as discussed above, we hope this concern is addressed at least in part by the data collection strategies.

We model coital frequency as a dichotomous variable indicating sex in the last (or a given) month using logistic regression. We present results for three sets of models. In all models we include controls for age of the respondent, whether the reported relationship is marital, has been ongoing for more than 1 year, and whether the respondent and the partner live in the same house or village.[2] We do not include a control for education in our models because this results in a reduced sample size due to missing data (between 4 and 12 % depending on the analytic sample).[3] The inclusion of education as a control in these reduced samples, however, does not change our substantive conclusions (see Online Appendices 1–3). For the first two sets of models, the unit of analysis is the relationship reported by the respondent, and the outcome of interest is sex in the last month. Standard errors are clustered to account for the reporting of multiple relationships by a single respondent.[4] In the first set of models, we consider all current relationships in the LNS and ULYKP controlling for gender of the respondent. For the second set of models we attempt to reduce bias in reporting by looking at couples in the LNS, using male report of coital frequency and female report of concurrency and vice versa. We then model the same outcome in a sample restricted to couples with matching reports of coital frequency. In this set of models for current couples in the LNS, we control for the age of both partners. Finally, in the third set of models we shift to relationship-month as the unit of analysis (ULYKP data), modeling the odds of having sex in a given month with a fixed effect for the relationship to control for constant unobservable characteristics of the relationship and the respondent reporting on that relationship.

Results

In Table 1, we report sample descriptive statistics for individuals and partnerships. Even though we use partnerships and partnership months as the units in the analyses that follow, concurrency prevalence and other aspects of sexual behavior are usually reported for

[2]We tested for a non-linear relationship with age, but the quadratic term was not significant. This specification of relationship duration is a restriction of the LNS data; the question asking about first sex in the LNS included response categories for within the last week, within the last month, within the last year, and more than 1 year ago. Inclusion of a linear and quadratic term for relationship duration in the ULYKP does not change the results.

[3]12 % is for the ULYKP sample in Table 7.

[4]The same relationship may also be reported on by both partners and thus included twice in the sample.

samples of individuals. We thus also report statistics with individuals as the base to ensure comparability with other studies. The share of men and women who report sex in the last month is around 45 %. Men in the ULYKP study report a lower frequency of sex in the last month, however, and that is probably due to the fact that men become sexually active at an older age (the sample was restricted to 18–24 year olds). Quite understandably, reports of sex in the last month are considerably higher if partnerships are taken as the unit of analysis.

Table 1 contains various concurrency indices. The only individual-level measure of concurrency available from the LNS is concurrency at the time of the survey. The ULYKP measure that is comparable, albeit not identical, is a report of more than one relationship during the month of the interview. In theory, this does not need to imply partnership concurrency as it could also pertain to two sequential partnerships in close succession. The next two indicators provide concurrency prevalence estimates 6 months before the interview. That time reference is preferred by some authors because respondents may not know whether a relationship is ongoing at the time of the interview (see [13, 22, 31–33] for a discussion of various measures of concurrency). The first of these two indicators counts ties (partnerships that end and start in the same month) as concurrent; the second provides a more conservative estimate of concurrency because it requires true overlap and ties are not taken as evidence of concurrency. Both indicators consider partnerships that have been sexual at some point, but may not have been so during the first and or last month(s). Partnerships defined in terms of the episode between first and last sex with a particular partner are the foundation for the last two indicators of concurrency. Again, we define an upper and lower bound that depends on the treatment of ties. This definition corresponds to the point prevalence proposed by the UNAIDS Reference Group on Estimates, Modeling, and Projections [32]. This is also the operationalization of concurrency by Xu et al. [18] using the same data-source. The results that we report are marginally different from theirs because we included individuals who never had sex in the denominator, whereas Xu et al. excluded them.

Our point prevalence estimates of partnership concurrency are much higher for men (3.2–7.8 % depending on the definition) than for women (2.8–4.2 %) and that is consistent with other studies on this topic.[5] The estimates for male concurrency are well within the range of values observed in various Demographic and Health Surveys (DHS) that have utilized the protocol for measuring concurrency proposed by the UNAIDS Reference Group [34]. For women, our estimates are, however, higher than the point prevalence estimate reported in any of the recent DHS (this appears to characterize the LNS sample even more than the ULYKP sample). Concurrency prevalence estimates with partnerships as the unit of analysis are naturally higher but retain similar gender differences. Estimates dated 6 months before the interview are also lower than those at the time of the survey. This is also true for the point prevalence of concurrency among individuals and consistent with the literature [13, 22, 35]. Because the ULYKP sample consists of younger persons, partnerships are less often marital, but the distribution of partnership duration is similar across both studies. Partners co-reside in about 70 % of reported relationships in both samples.

In Table 4 we examine the bivariate relationship between concurrency and coital frequency. We see that in the LNS, individuals who have concurrent relationships are less likely to report having sex with their index partner in the last month, a finding in support of the coital dilution hypothesis.

[5]There is no mathematical requirement that levels of concurrency be the same for men and women. While the total number of sex acts must be the same (assuming only heterosexual sex), levels of concurrency may be different.

In Table 5 we present results from the logistic regression of having sex in the last month on individual reports of concurrency in all current relationships. For the LNS, this analysis takes all current relationships as the unit of analysis, regardless of whether the partner was also interviewed. In the LNS, reporting of concurrent partners at any time during the tenure of the current relationship is associated with 37 % lower odds of having sex in the last month. This translates into a predicted probability of having sex in the last month of 74 % for a 30 year old male with no concurrent partners in a marital relationship that has been ongoing for more than 1 year where the partners live in the same household or village. For an individual with the same values of covariates who is recorded as having multiple concurrent partnerships, the probability of sex in the last month declines to 64 %. In the ULKYP sample, concurrency in the last month is positively associated with sex in the last month, but the relationship is non-significant. Across all models, age is positively associated with coital frequency, as is marital relationship and co-location. Relationship duration is negatively associated with coital frequency, although not consistently significant across models. The results from our first analysis of all current couples provide preliminary evidence in support of the coital dilution hypothesis in the LNS sample.[6]

In columns one and two of Table 6 we take advantage of the sociocentric study design of the LNS, and use male partner's report of coital frequency and female partner's report of concurrency, and vice versa. We present results for a logistic regression predicting the odds of having sex in the last month for all current couples where both partners were interviewed. We find that when using ego's report of coital frequency and partner's report of concurrency there is suggestive evidence in support of the coital dilution hypothesis; the relationship is in the expected direction but is only significant for female reports of coital frequency and male concurrency. This evidence is stronger and significant when we restrict the sample to couples with agreement on coital frequency. Again we find that in couples where the man has concurrent partners, the odds of having sex in the last month are reduced by 80 %. The predicted probability of having sex in the last month is 92 % for a married, coresiding couple between a 30 year old male and 25 year old female that have been together for more than 1 year, when neither partner reports having a concurrent partnership. This declines to 71 % for a couple with the same covariates but where the male reports having a concurrent relationship. There is no demonstrated effect of female concurrency. Nevertheless, we find evidence supporting the coital dilution hypothesis for men with concurrent partners.

Returning to the ULYKP sample, in our final analysis the unit of analysis is relationship-month and we employ a fixed effects estimation strategy at the relationship level. We include time-varying covariates for respondent's age, marital status of the partnership, relationship duration greater than 1 year, and co-location, and run the analyses separately for men and women. The first and second columns of Table 7 present results for all relationship-months reported by respondents spanning the 10 year timeframe of the relationship history calendar. We find that, for women, concurrency in the month is associated with a 48 % decrease in the odds of having sex in the month. In columns three through six we restrict our analysis to relationship months in the last 3 years and 1 year, respectively. Again we find that women who have concurrent partners in a given month have lower odds of having sex in that month, net of differences in age, marital status, relationship duration, co-location of partners, and time-invariant unobservables. The relationship is inconsistent in direction and non-significant for men. This analysis provides strong evidence in support of the coital dilution hypothesis for women.

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[6]Results are of comparable magnitude and significance for spousal (formal) and non-spousal (informal) relationships in the LNS. For ULYKP, there is a negative but non-significant association between concurrency and coital frequency for spousal relationships. There is a positive but non-significant association between concurrency and coital frequency for non-spousal relationships. See Online Appendix 4 for results.

In Tables 8 and 9 we take advantage of the detail on monthly coital frequency offered by the ULYKP. In Table 8 we restrict the sample to individuals who had sex in the last month, and model whether the respondent had sex more than 5 times versus 1–4 times. In the first model we define a partnership as a relationship episode that has been sexual at some point, and in a second model we define a partnership as the episode between first and last sex (i.e., the definition of a partnership proposed by the UNAIDS Reference Group and Xu et al. [18, 32]).[7] We find that concurrency is negatively associated with the odds of having sex five times or more in the month for all current partnerships with at least one coital act, but the analysis with the UNAIDS Reference Group based measure of concurrency (Model 2) is not statistically significant. In Table 9 we replicate the fixed effects analysis with the measure of coital frequency that contrasts partnership months with 5 or more coital acts against those where coital frequency is lower. The results are inconclusive. Among all relationship months reported in the calendar[8] in which the respondent reports having sex with the partner, concurrency is negatively associated with the number of coital acts for men and women, but is insignificant. Conversely, the UNAIDS Reference Group based measure of concurrency is positively associated with the number of coital acts for men and women, but is again insignificant.

Discussion

In this paper we investigate the relationship between partnership concurrency and coital frequency in two recent datasets from Eastern Africa. In particular, we test the coital dilution hypothesis, which posits a negative association between partnership concurrency and the partnership-specific frequency of intercourse. In the Likoma Network Study, we find that the direction and strength of the relationship depends on whose report of sexual behavior we use. When we control for reporting bias in sexual behavior data by restricting the analysis to couples with matching coital frequency reports, we find evidence in support of the coital dilution hypothesis, but only for male concurrency. Comparable analysis of all current relationships reported in the relationship history calendar of the ULYKP finds no association between concurrency and coital frequency. However, when we employ a relationship level fixed effects specification comparing relationship months with and without concurrent partners, we again find evidence of a negative relationship, but this time only for women: women are less likely to have sex with their index partner during months when they have a concurrent partnership compared to the times when they are monogamous. The quantity of sex appears to be negatively related to concurrency as well, but the results are not always significant. For men the results are not consistent: men with concurrent partners are not more or less likely to have intercourse with an index partner. Provided that they have sex, the relationship between concurrency and coital frequency depends on the measure of concurrency used.

Partnership concurrency is a popular explanation for the elevated HIV seroprevalence levels in some sub-Saharan African countries [7, 8, 36–38]. The most persuasive evidence in support of the concurrency hypothesis comes from simulation results, which are also its greatest weakness [39–41]. The simulation studies demonstrating a positive effect of concurrency on HIV prevalence are only loosely based on observed patterns of sexual behavior, and many behavioral factors that could be pertinent for the spread of a sexually-transmitted infection are not modeled at all (and therefore assumed not to co-vary with concurrency). One such factor is coital frequency. Several authors have pointed to the

[7] Even though the number of cases are not numerically important, it is worth noting that the UNAIDS definition forces us to right censor ongoing partnerships at the month of last sex if no sex was reported for the month before the survey.

[8] We cannot repeat the analysis for the 3 years and 1 year preceding the survey because of the small number of relationship-months in which individuals have concurrent partners.

importance of the number of coital acts over and above other aspects of sexual behavior that are more conventionally modeled (e.g., concurrency, partnership turnover rates) [42, 43]. One recent modeling study suggests that coital dilution can, under certain circumstances, offset partnership concurrency effects [16].

Our study corroborates that coital dilution is a phenomenon that ought to be accounted for in simulation studies of the effects of partnership concurrency for the spread of the HIV epidemic. However, we also stress that (a) further empirical inquiry is necessary to establish its relationship with partnership concurrency (our results were not always conclusive), and (b) our results do not directly translate into the assumptions underlying the simulations by Sawers et al. [16]. First, we model coital frequency primarily as a dichotomous outcome of sex in the (last) month in both primary and secondary partnerships, whereas coital dilution enters the simulations by Sawers et al. [16] as a reduction in the monthly HIV transmission rate in secondary partnerships only. Second, and more importantly, Sawers et al. impose a fixed number of partnerships in the simulated population because that allows for a direct comparison between scenarios with partnership concurrency and serial monogamy (in that sense they follow the example set by Morris and Kretzschmar) [7, 16]. Adding coital dilution to these models therefore implies that the total number of coital acts in the population decreases as the frequency of partnership concurrency increases (with the expected mitigating effects on epidemic propagation). In our study, we find some evidence of reduction in coital frequency if one of the partners in the index relationship has concurrent partners, but we cannot make any claims about the population-level change in the number of coital acts. The latter will crucially depend on the association between partnership concurrency and the population-level quantity of partnerships, and it may well be that assuming a fixed number of partnerships when simulating scenarios with and without concurrency is as unrealistic as assuming a fixed number of coital acts per partnership.[9]

Conclusion

This paper contributes to the ongoing debate around the role of partnership concurrency for HIV transmission. Our findings suggest that concurrency may not necessarily lead to increased transmission if the positive effect of multiple overlapping partnerships is offset by a reduction in coital frequency among individuals with concurrent partners. We reiterate that the effects of partnership concurrency are insufficiently understood to justify generic policy interventions targeting partnership concurrency. Further research is needed to better understand whether the coital dilution effect is genuine and, if so, whether its magnitude is indeed large enough to offset the increase in risk of transmission associated with partnership concurrency.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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[9]The assumption of a fixed number of partnerships implies that the number of men or women without a partner (i.e., the number of isolated nodes in a sexual network) increases as rates of partnership concurrency increase. In an empirical study of polygyny, for example, there is no evidence that young men's access to sexual partners is restricted in populations with a higher prevalence of polygyny [17]. In other words, there is no evidence of an increase in the number of isolated nodes in populations where older polygynous men might be expected to crowd out the younger men from the partnerships market.

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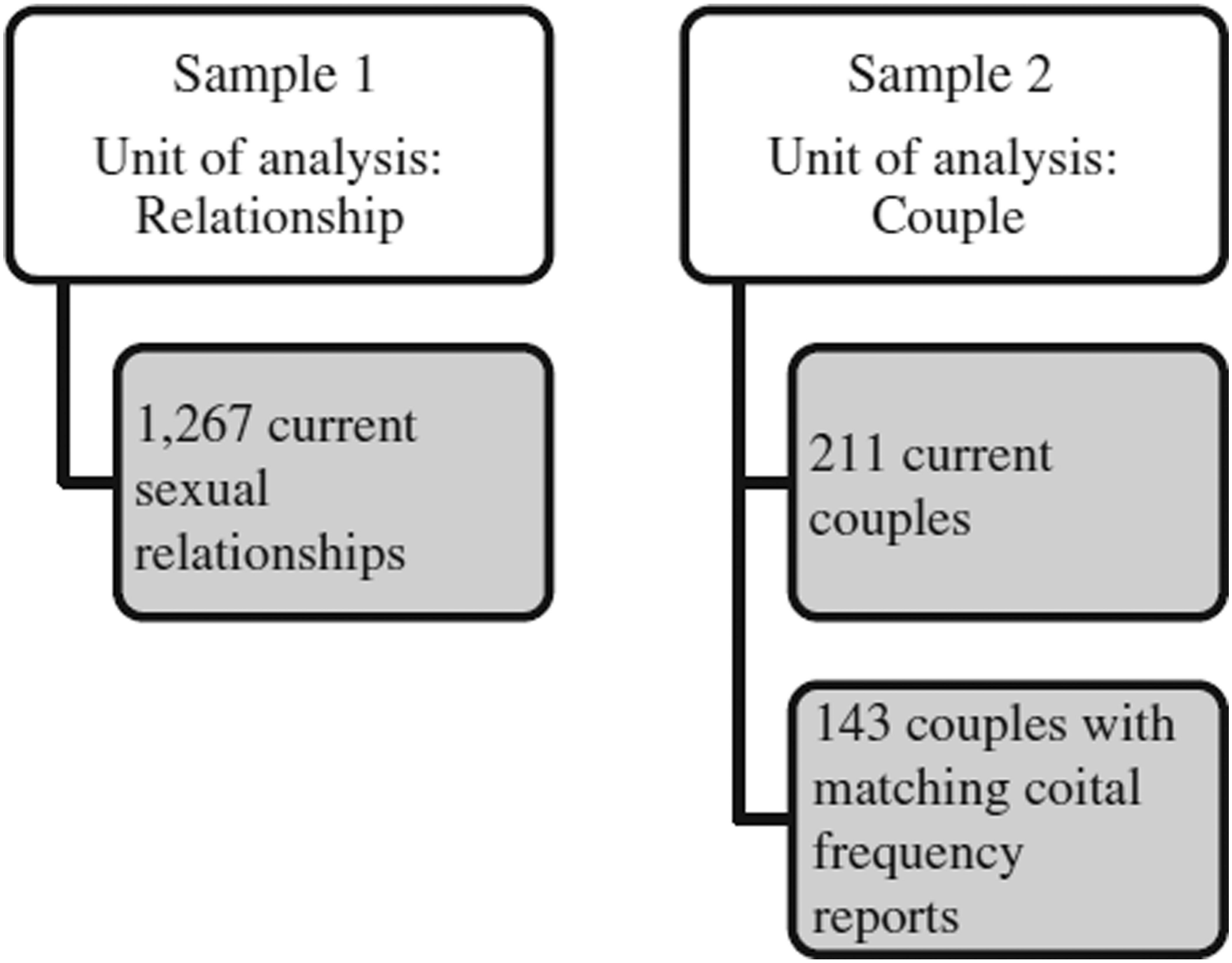

Fig. 1.
Likoma Network Study analytical samples

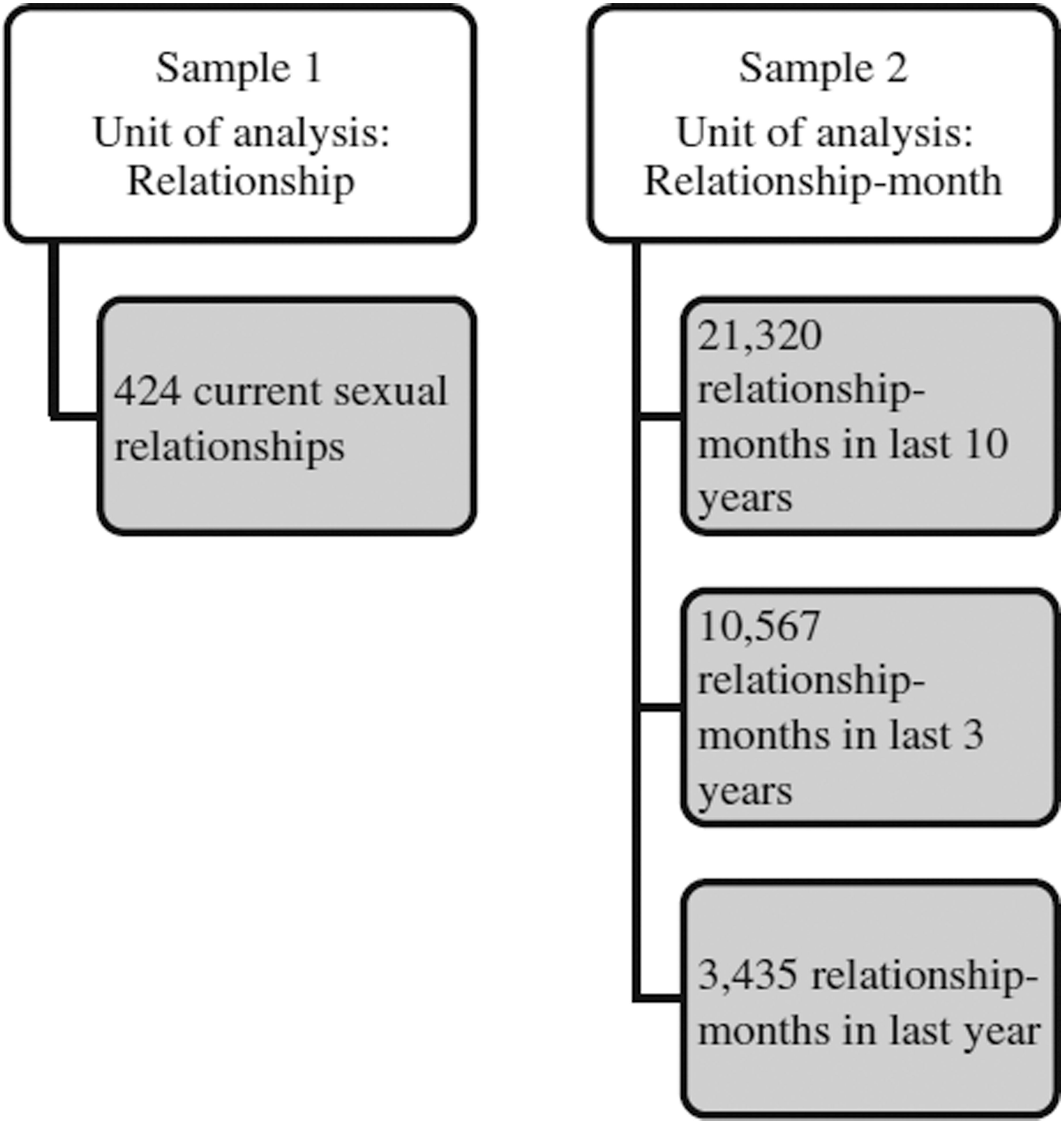

Fig. 2.
Urban Life among Youth in Kisumu Project analytical samples

Table 1

Sample descriptive statistics for individuals and partnerships

	Individuals				Partnerships			
	LNS		ULYKP		LNS		ULYKP	
	Men	Women	Men	Women	Men	Women	Men	Women
Sex in the last month	41.4 %	44.3 %	31.7 %	46.5 %	71.5 %	71.7 %	49.3 %	70.9 %
Concurrency (composite index)	–	–	–	–	47.1 %	26.2 %		
Concurrency at any time during the partnership	–	–	–	–	34.5 %	16.2 %	–	–
Concurrency at the time of survey[a]	6.3 %	4.9 %	–	–	24.6 %	14.2 %	–	–
More than 1 partner during the month of the survey	–	–	7.5 %	3.5 %	–	–	23.6 %	10.1 %
More than 1 partner, 6 months before the survey	–	–	7.8 %	4.2 %	–	–	19.7 %	10.6 %
Partnership overlap, 6 months before the survey	–	–	6.5 %	3.9 %	–	–	17.9 %	9.6 %
More than 1 sex partner, 6 months before the survey (UNAIDS upper bound)[b]	–	–	4.0 %	3.2 %	–	–	12.2 %	8.0 %
Sex partner overlap, 6 months before the survey (UNAIDS lower bound)	–	–	3.2 %	2.8 %	–	–	9.6 %	8.0 %
Mean age	28.3 (8.6)	29.1 (8.2)	20.7 (1.9)	20.6 (1.9)	30.7 (8.5)	29.8 (8.0)	20.7 (1.8)	20.6 (1.9)
Mean years education	8.3 (3.2)	7.6 (3.0)	11.0 (2.1)	10.8 (2.3)	8.1 (3.3)	7.2 (3.0)	10.8 (2.3)	10.6 (2.4)
Index relationship is marital	–	–		–	64.6 %	77.6 %	24.9 %	58.3 %
Index relationship duration greater than 1 year[c]	–	–	–	–	59.9 %	61.8 %	55.5 %	73.9 %
Co-resident	–	–	–	–	70.1 %	68.8 %	72.5 %	74.9 %
n	935	1075	322	286	588	679	227	197

The analytical sample used in Table 5 is that sample of partnerships

[a]This is based on self-reports only

[b]This is the definition used by Xu et al. [18] based on the same data source. Note that the authors excluded individuals who never had sex (they are included in our calculations)

[c]In the LNS, partnership duration is assessed as follows. First, all relationships that were already reported by one of the two partners during round 1 of the LNS (January 2006) are classified as having duration greater than 1 year. For relationships first reported during round 2 of the LNS, we used information from a question asking respondents when they first had sexual intercourse with a given partner. If the respondent reported having first had sex with that partner more than a year ago, the relationship was considered older than one year. For relationships already reported during round 1, there were frequent discrepancies between assessments of duration based on longitudinal follow-up and retrospective reports. For example, out of 520 relationships already reported during round 1 and reported again

during round 2, roughly one-third were reported by respondents as having started less than 1 year before round 2. The distribution of partnership duration derived from self-reported retrospective data in the second round of the LNS may thus be affected by significant reporting errors.

Table 2

Couples with matching and inconsistent reports of coital frequency, LNS

	Matching		Inconsistent	
	Men	**Women**	**Men**	**Women**
Had sex in the last month	86.7 %		47.1 %	52.9 %
Has concurrent partners	37.1 %	20.3 %	47.1 %	22.1 %
Mean age	34.8 (7.4)	29.4 (6.8)	32.1 (7.4)	27.7 (6.1)
Mean years education	8.2 (3.2)	7.0 (2.8)	7.2 (3.6)	7.1 (2.7)
Index relationship is marital	85.3 %		82.4 %	
Index relationship duration greater than 1 year	62.9 %		70.6 %	
Co-resident	83.2 %		83.8 %	
n	135		68	

Standard errors are in parentheses

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Table 3

Descriptive statistics for all partnerships; analytical samples in Table 7, ULYKP

	All relationships		**Last 3 years**		**Last year**	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Had sex in the last month	36.6 %	59.0 %	36.3 %	59.0 %	34.4 %	51.4 %
Has concurrent partners[a]	17.1 %	6.8 %	19.8 %	8.9 %	23.9 %	9.3 %
Mean age	17.7 (2.7)	18.1 (2.5)	19.4 (2.0)	19.3 (2.0)	20.0 (1.9)	20.1 (1.9)
Mean years education	9.9 (2.3)	9.8 (2.4)	10.7 (2.1)	10.3 (2.4)	10.9 (2.2)	10.6 (2.4)
Index relationship is marital	11.2 %	45.5 %	17.4 %	50.9 %	19.1 %	51.8 %
Index relationship duration greater than 1 year	53.5 %	64.4 %	54.0 %	70.3 %	45.6 %	71.5 %
Co-resident	77.3 %	80.6 %	76.7 %	78.7 %	74.3 %	74.4 %
n	10,463	10,857	4,938	5,629	1,845	1,590

[a]Defined as “more than 1 partner during the month”

Standard errors are in parentheses

Table 4

Sex in the last month by concurrency, all current relationships

	LNS		ULYKP	
	Monogamous	**Concurrent**	**Monogamous**	**Concurrent**
No	23.9 %	37.0 %	39.8 %	44.6 %
Yes	76.1 %	63.0 %	60.2 %	55.4 %
n	817	457	354	74

Table 5

Odds ratio for having sex in the last month, all current relationships

	LNS	ULYKP
Ego has concurrent partners	0.63*** (0.10)	1.20 (0.42)
Age	1.02*** (0.01)	1.19** (0.08)
Male	1.10 (0.15)	0.39*** (0.10)
Index relationship is marital	1.59*** (0.27)	1.70** (0.44)
Index relationship duration greater than 1 year	0.31*** (0.05)	0.90 (0.22)
Live in same house/village	1.58*** (0.22)	6.85*** (1.82)
n	1,267	424
Hosmer–Lemeshow	$p = 0.90$	$p = 0.87$
Pseudo *R*-squared	0.08	0.17
Proportionate reduction in classification error	3.30 %	31.67 %

Clustered standard errors are in parentheses

*$p < 0.10$;

**$p < 0.05$;

***$p < 0.01$

Table 6

Odds ratio for having sex in the last month, current couples LNS

	Male report	Female report	Matched report
Man has Concurrent partners		0.54* (0.20)	0.20*** (0.12)
Woman has concurrent partners	0.57 (0.22)		1.24 (0.83)
Man's age	0.99 (0.04)	1.13*** (0.05)	1.15 (0.12)
Woman's age	1.06 (0.05)	0.94 (0.05)	0.97 (0.11)
Index relationship is marital	1.64 (0.74)	0.80 (0.39)	1.13 (0.79)
Index relationship duration greater than 1 year	0.42** (0.17)	0.84 (0.32)	0.33 (0.24)
Live in same house/village	2.39* (1.07)	1.34 (0.62)	5.04** (3.49)
n	211	211	143
Hosmer–Lemeshow	$p = 0.50$	$p = 0.65$	$p = 0.09$
Pseudo R-squared	0.07	0.07	0.23
Proportionate reduction in classification error	36.14 %	40.98 %	69.78 %

Clustered standard errors are in parentheses

* $p < 0.10$;

** $p < 0.05$;

*** $p < 0.01$

Table 7

Odds ratio for having sex in the month, ULYKP

	All relationships		Last 3 years		Last year	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Ego has concurrent partners	1.00 (0.13)	0.52 *** (0.08)	0.87 (0.15)	0.58 ** (0.13)	1.09 (0.34)	0.48 (0.23)
Age	1.29 *** (0.04)	1.14 *** (0.03)	1.08 (0.08)	1.27 *** (0.07)	1.33 * (0.22)	1.45 ** (0.22)
Index relationship is marital	1.75 *** (0.33)	1.06 (0.11)	2.07 *** (0.52)	1.73 *** (0.26)	10.24 *** (7.53)	1.96 ** (0.60)
Index relationship duration greater than 1 year	1.21 ** (0.10)	1.16 ** (0.09)	1.14 (0.16)	0.95 (0.11)	1.33 (0.32)	0.58 ** (0.16)
Live in same house/village	11.44 *** (1.37)	4.01 *** (0.37)	18.67 *** (3.48)	4.01 *** (0.51)	16.26 *** (4.50)	5.66 *** (1.42)
n	10,463	10,857	4,938	5,629	1,845	1,590

Standard errors are in parentheses. Models include a fixed-effect for the relationship

* $p < 0.10$;

** $p < 0.05$;

*** $p < 0.01$

Table 8

Odds ratio for having sex 5 times or more in the month, current partnerships who have sex in the month, ULYKP

	Model 1	Model 2
Ego has concurrent partners	0.45* (0.20)	0.56 (0.26)
Age	1.00 (0.07)	1.00 (0.07)
Male	0.71 (0.21)	0.69 (0.20)
Index relationship is marital	1.56 (0.48)	1.64 (0.50)
Index relationship duration greater than 1 year	0.62 (0.19)	0.61 (0.18)
Live in same house/village	1.95 (0.80)	1.94 (0.80)
n	253	253

Clustered standard errors are in parentheses

Model 1 partnerships defined as relationship episodes that have ever been sexual, *Model 2* partnerships defined as episodes between first and last sex

* $p < 0.10$;

** $p < 0.05$;

*** $p < 0.01$

Table 9

Odds ratio for having sex more than five times in the month, relationship-months when partners have sex in the month, ULYKP

	Model 1		Model 2	
	All partnerships		All partnerships	
	Men	Women	Men	Women
Ego has concurrent partners	0.88 (0.24)	0.93 (0.22)	1.28 (0.28)	1.15 (0.27)
Age	1.06 (0.07)	0.99 (0.03)	1.05 (0.07)	0.99 (0.03)
Index relationship is marital	0.09*** (0.03)	1.37* (0.24)	0.09*** (0.03)	1.38* (0.24)
Index relationship duration greater than 1 year	1.32 (0.24)	0.92 (0.12)	1.33 (0.24)	0.92 (0.12)
Live in same house/village	14.47*** (4.83)	1.28 (0.27)	15.07 (5.05)	1.28 (0.27)
n	2,128	3,735	2,128	3,735

Standard errors are in parentheses. Models include a fixed-effect for the relationship

Model 1 partnerships defined as relationship episodes that have ever been sexual, *Model 2* partnerships defined as episodes between first and last sex

* $p < 0.10$;

** $p < 0.05$;

*** $p < 0.01$