

Concurrent sexual partnerships among youth in urban Kenya: Prevalence and partnership effects

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Research on concurrent sexual partnerships is hindered by lack of accurate partnership data. Using unique life-history calendar data from a population-based sample of youths aged 18–24 in urban Kenya, we estimated the prevalence and correlates of concurrency. In the sixth month before the survey, 3.5 per cent of females and 4.0 per cent of males were engaged in concurrent sexual partnerships. In the previous 9.5 years, males experienced more concurrent partnerships than females and they were of shorter duration. Using survival analysis, we find that the characteristics of initial partnerships affect entry into a second (concurrent) relationship. For females, geographic separation from a partner increases the risk of concurrency, while concurrency is positively associated with the duration of the initial relationship for males. For both sexes, the perception of partner infidelity increases the risk, suggesting that concurrency expands individuals' sexual networks and bridges additional networks involving partners' other sexual partners.

Keywords: concurrency; sexual behaviour; sexual networks; youth; Kenya; survival analysis

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Introduction

There is increasing debate about the role of concurrent sexual partnerships in the HIV epidemic in sub-Saharan Africa (Lurie and Rosenthal 2010), the region that remains the most severely affected by the disease worldwide (UNAIDS 2007). Concurrency is defined as engagement in two or more sexual relationships at the same time. In contrast to sequential monogamy, concurrent partnerships can transmit infection across multiple partnerships simultaneously because existing partners are exposed when the subject becomes infected by a new partner (Morris and Kretzschmar 1997). Concurrency has been associated with the spread of HIV and other sexually transmitted infections in simulation and observational studies (Morris and Kretzschmar 2000; Helleringer et al. 2009; Morris et al. 2009). However, lack of detailed estimates on the prevalence and characteristics of concurrent sexual partnerships hinders more thorough examinations of the relationship between concurrency and infection (Lurie and Rosenthal 2010).

There is no standard indicator of concurrency or means of measuring it and its correlates in survey

research. Surveys have generally gathered information to construct concurrency measures in one of three ways. In one method, respondents are asked direct questions about whether they had another sexual partner during their most recent relationship (Manhart et al. 2002; Carter et al. 2007; Nelson et al. 2007; Richards et al. 2008; Magnus et al. 2009). One problem with this method is that it is difficult to construct concurrency estimates for specific time periods before the survey (Carter et al. 2007). In a second method, researchers infer concurrency from information collected about the respondent's involvement in multiple sexual relationships that are ongoing or occurred in brief periods before the survey (Harrison et al. 2008; Lichtenstein et al. 2008; Senn et al. 2009). These measures cannot always distinguish between concurrency and serial monogamy, however, and tend to overestimate concurrency levels (Kalichman et al. 2007). The third and most precise method is to estimate concurrency from respondents' reports of the timing of first and last sexual intercourse within each of their sexual partnerships (Adimora et al. 2002, 2004, 2007; Nelson et al. 2007; Sandøy et al. 2010). This method is recommended by the UNAIDS Reference Group

on Estimates, Modelling, and Projection, which has also proposed standardized indicators of concurrency (UNAIDS 2009). Although such information allows more detailed analyses of the duration and timing of concurrency, it is often difficult to collect accurate data on sexual partnerships. Whether respondents are asked to estimate 'how long ago' sexual intercourse occurred (such as the last week, month, or year) (UNAIDS 2009) or to report specific dates of sexual intercourse (by month and year) (Adimora et al. 2002, 2004; Sandøy et al. 2010), the information may be difficult to recall, particularly if the events are infrequent or occur over longer time periods (Nelson et al. 2007).

Another issue with survey data is that information on covariates at the time of concurrency is often lacking. Most studies examine associations between individual characteristics at the time of the survey and past involvement in concurrency (Santelli et al. 1998; Adimora et al. 2002, 2004, 2007; Manhart et al. 2002; Harrison et al. 2008). Current characteristics may be poor predictors of previous behaviour, however, and reveal little about how individuals initiate and expand their sexual networks over time. Furthermore, little is known about the types of partnerships involved in concurrency. While several studies have examined the association between concurrency and sexual partner's race (Manhart et al. 2002), residence (Manhart et al. 2002; Senn et al. 2009), incarceration (Manhart et al. 2002; Adimora et al. 2004), infidelity (Senn et al. 2009), and partnership duration (Manhart et al. 2002; Nelson et al. 2007; Harrison et al. 2008), these studies fail to differentiate between characteristics of the initial partnership and subsequent concurrent ones. The characteristics of and behaviours within the initial partnership could be key drivers in the decision to enter into a second (concurrent) sexual relationship.

Data collected using life-history calendars can be particularly useful for estimating the prevalence and correlates of concurrency because the method helps respondents to recall accurately the occurrence, sequence, and timing of past events (Caspi et al. 1996; Belli 1998; Axinn et al. 1999). Demographers have used calendars to gather high-quality retrospective information on births, marriage, contraceptive use, migration, and illness worldwide (Freedman et al. 1988; Goldman et al. 1989; Leridon 1990; Goldman et al. 1998; White et al. 2008). For our study, we used data collected with the Relationship History Calendar (RHC) from a population-based sample of youths in Kisumu, Kenya, to explore concurrency in this high-HIV-prevalence

setting. The RHC was designed to elicit detailed monthly information on the sexual-partnership histories of youths, including the dates of first and last sexual intercourse within each relationship as well as a variety of time-varying individual and relationship characteristics (Luke et al. forthcoming).

The analysis was completed in two parts. First, for males and females, we estimated prevalence measures suggested by the UNAIDS Reference Group (UNAIDS 2009) for various time periods before the survey and described several important attributes of concurrency, including the number of episodes of concurrency per individual and their duration (Aral 2010). These descriptive statistics provide one of the first insights into such detailed aspects of concurrency and how they vary by sex. Second, we employed survival analysis to examine the risk of entering concurrency as a function of the characteristics of the individual and his or her initial sexual partnership. This analysis helps to identify the immediate conditions that affect the decision to enter a second (concurrent) partnership and reveal whether and how this process differs between males and females.

Methods

Data and sample

Kisumu, the third largest city in Kenya and capital of Nyanza Province, provided a useful setting in which to explore concurrent sexual relationships among youth. An economic hub and destination for many internal migrants as well as the site of many schools and colleges, it attracts a range of young people seeking employment and educational opportunities. Kisumu is also the epicentre of an ongoing HIV/AIDS epidemic in the region. HIV prevalence in Nyanza Province was estimated at 14.9 per cent in 2007, more than double the national rate (NASCO 2008). Given the typical pattern of urban areas having higher HIV prevalence rates than rural areas in Africa, we would expect the prevalence rate for Kisumu City to be higher than the average for the province. The latest estimates of infection rates for Kisumu come from a UNAIDS study undertaken in the late 1990s (Buvé et al. 2001). Rates of HIV infection were considerably higher among females than males in the youngest age groups. Among sexually active 15–19 year olds, 23.0 per cent of females and 3.5 per cent of males were infected, and among 20–24 year olds, 38.3 and 12.3 per cent of females and males, respectively, were infected.

The data we used for the analyses came from the Urban Life among Youth in Kisumu Project conducted in 2007. The study was designed to compare the quality of sexual behaviour reporting using the RHC with that of a standard sexual-partnership instrument, such as the one used in Demographic and Health Surveys. The sample included 1,275 young people aged 18–24. Enumeration areas (EAs) mapped by the Government of Kenya's Central Bureau of Statistics were used as primary sampling units. Of the urban EAs, 45 were randomly chosen for the survey. A team of 10 interviewers contacted every other household in each enumeration area, and one eligible respondent was selected randomly from each household. Respondents were randomly assigned to be interviewed with the RHC or with the standard instrument. Interviews took place in a private room or area in the house or nearby neighbourhood. The overall response rate was 94.9 per cent, with no significant differences by sex or instrument type (for further details of the study design, see Luke et al. forthcoming).

The RHC is a fold-out grid in which monthly information on each topic is recorded in a timeline format over a 9.5-year retrospective period (January 1998–June/July 2007). Like other life-history calendars, the RHC gathered information on changes in residence, employment, and schooling. In addition, respondents provided detailed information for each month of each of their romantic (non-sexual) and sexual partnerships, including partner characteristics, relationship dimensions (such as type and duration), and sexual activities (including frequency of intercourse). The RHC interview procedure was flexible and conversational in nature, with the order of questions left up to a trained interviewer.

The collection of retrospective data is particularly subject to recall error, and life-history calendars were created to help minimize the risk of its occurrence (Balán et al. 1969; Belli 1998; Axinn et al. 1999; Schwarz and Oyserman 2001; Luke et al. forthcoming). Numerous evaluations have found that calendars significantly improve the reliability of retrospective reporting (Freedman et al. 1988; Goldman et al. 1989; Caspi et al. 1996; Belli and Callegaro 2009; Smith 2009). To help respondents recall the timing of past events for the RHC, they were asked to relate them to the dates of public and personal events (such as national elections or a parent's death) as well as the timing of events in their schooling, migration, and partnership histories. In addition to these memory aids, the flexible

interview style allowed for clarification and cross-checking of event dating. These procedures are likely to make recall of the exact timing (by month and year) of the frequency of sexual intercourse within relationships relatively accurate.

Another important type of measurement error is social-desirability bias, which is particularly relevant when gathering information on sensitive sexual behaviours. The RHC method incorporated qualitative techniques, which can help reduce this type of bias (Plummer et al. 2004). Interviewers were trained to take the time to develop significant rapport with respondents before beginning the RHC and broaching the topic of romantic and sexual partnerships, and relationships were discussed in the sequence and detail with which respondents felt most comfortable. The structure of the questioning also minimized the potential embarrassment of questions on sexual behaviour by embedding them within the more innocuous context of relationships as well as in conjunction with schooling, work, and migration histories. Studies have found that calendar interviews, including the RHC, are interesting and enjoyable experiences, which increase respondent motivation (Freedman et al. 1988; Belli and Callegaro 2009; Luke et al. forthcoming). The results of the RHC methodological experiment suggest that, compared with the standard instrument, the RHC decreased social-desirability bias and improved the reporting of a variety of measures of sexual behaviour (Luke et al. forthcoming). In particular, young females, who have been found to underreport their sexual activities in survey interviews (Mensch et al. 2001; Nnko et al. 2004), reported more sexual partners in the year before the survey on the RHC than on the standard instrument, and young males, who tend to exaggerate sexual activities on standard surveys, reported fewer sexual partners in their lifetimes on the RHC. Thus, because concurrency estimates depend on accurate reports of the number of sexual partners, our estimates for the last year for females and for the last 9.5 years for males are likely to be more valid than those obtained from standard surveys.

For our study, concurrency estimates were calculated using data from RHC respondents ($N = 608$) and, among them, those who were sexually active in the last 9.5 years ($N = 522$ or 85.9 per cent). For the survival analysis, we used the sample of sexually active individuals with four excluded owing to missing values on independent variables.

Definitions of concurrency in sexual partnerships

Detailed data from the RHC on the frequency of sexual intercourse each month for each partnership provided the opportunity to define concurrency precisely by month. We compared the months of first and last sexual intercourse within each relationship for the same individual and defined *concurrency* as having two or more sexual partnerships that overlapped in time (Adimora et al. 2002; Manhart et al. 2002; Doherty et al. 2007). The period of consecutive months when two or more sexual partnerships overlapped was treated as a *concurrency episode*. Because we did not know the order of events within a particular month and to rule out the possibility of serial monogamy (UNAIDS 2009), we also calculated *conservative estimates of concurrency* by dropping those episodes where last sexual intercourse in one partnership and first sexual intercourse in another partnership overlapped by 1 month only.

The UNAIDS Reference Group recommends calculating concurrency indicators for short periods (6 months–1 year) before the survey (UNAIDS 2009). We used these as well as longer time periods for comparison purposes. *Point prevalence* is the percentage of all respondents who had one or more episodes of concurrency at one point in time, which is a monthly interval using the RHC data. We calculated point prevalence for a monthly interval at the following periods before the survey: 6 months before (January 2007), 1 year before (June 2006), 5 years before (June 2002), and 9.5 years before (January 1998, the first month of the RHC). We also examined the *cumulative prevalence* of concurrency 1, 5, and 9.5 years before the survey, which is the percentage of respondents who had at least one concurrency episode during the time period. Because some observers suggest that cumulative prevalence should be estimated for those who have been sexually active only (UNAIDS 2009), we also calculated estimates with the number of these individuals in the denominator. In addition, for all measures of point and cumulative prevalence, we calculated conservative estimates for comparison purposes.

Finally, we estimated additional attributes of concurrency, including the percentage of respondents who experienced one, two, three, or four concurrency episodes within each time period before the survey. Using concurrency episodes as the unit of analysis, we also calculated the number of sexual

partners per episode and the duration of each episode in months.

Survival analysis

The longitudinal RHC data allowed us to use survival analysis techniques to estimate the probability of entering into a second (concurrent) sexual partnership in each month as a function of individual and initial sexual-partnership characteristics that vary by month. The analysis spanned the period from the start of the calendar, when respondents were aged 8–14, to the time of the survey. During this period, a respondent was treated as being *at risk of entering concurrency* from the first month in which he or she had sexual intercourse (which is the month of sexual debut for 89.7 per cent of respondents). A respondent *entered concurrency* in the first month in which he or she had sexual intercourse with a second partner before the last month of sexual intercourse with the *initial partner*. When one concurrency episode ended, the ongoing relationship was treated as a new initial partnership that was at risk of concurrency. A respondent's sexual history was right-censored if no concurrency occurred by the end of a partnership or the end of the survey, whichever came first. We analysed the risk of entering concurrency as the risk of moving from one initial sexual partner to two sexual partners. A respondent could have entered concurrency numerous times throughout the exposure period, the occasions being treated as repeated events in survival analysis.

For each concurrency episode, we needed to designate which sexual partnership was the initial one. If a concurrency episode began at least 1 month after first sexual intercourse in an ongoing partnership, we designated the ongoing partnership as the initial partnership (which was the case in 130 or 92.2 per cent of the concurrency episodes identified). If first sexual intercourse occurred in the same month for two partnerships (which occurred in six concurrency episodes), we designated the one that was established earlier as the initial partnership. If two partnerships were established in the same month and began sexual intercourse in the same month (three episodes), we designated the one that lasted longer as the initial partnership. If two partnerships started and ended in the same month and sexual intercourse started and ended in the same month as well (two episodes), we designated the one

that was more serious as the initial partnership (see below for categories of partnership type).

Correlates of entering concurrency

To measure individual characteristics, we included socio-demographic variables investigated in previous cross-sectional studies of concurrency as well as those likely to increase sexual activity and hence the likelihood of concurrency. All individual-level variables were time-varying monthly measures with the exception of age at sexual debut. Current age and age at sexual debut were measured in years. Being of older age or younger age at first sexual intercourse increases time of exposure to the risk of concurrent relationships. Further, individuals who initiate sexual intercourse at very young ages are more likely to engage in unsafe sexual behaviours (Adimora et al. 2002, 2007; Manhart et al. 2002; Sandøy et al. 2010). Other variables were coded dichotomously: attending school or not, employed or not, urban or rural residence, and whether the respondent migrated in the month (from a rural to an urban area or vice versa). Higher levels of education and school attendance generally decrease the risk of sexual activity for both sexes (Gillespie et al. 2007). Employment may increase the resources often required to attract female sexual partners for males (Luke 2008) and decrease the need for additional sexual partners for further economic support among females (Luke 2003). Urban residence and migration are generally thought to expand individuals' sexual networks and expose them to new social norms (Brockhoff and Biddlecom 1999; Doodoo et al. 2007) and therefore could also increase the risk of concurrency.

We were particularly interested in examining the effect of initial partnership characteristics on the risk of entering concurrency. All initial partnership variables were time-varying monthly measures. To start with, we examined the type and duration of the initial partnership. Past studies have found that concurrency depends partly on the degree of commitment in existing partnerships (Carey et al. 2010), which is usually measured crudely by marital status. Married individuals are assumed to be more committed and therefore less likely to acquire a concurrent partner than single individuals (Santelli et al. 1998; Adimora et al. 2002; Manhart et al. 2002; Sandøy et al. 2010). The RHC data distinguished between various types of relationship among youths in Kisumu, as follows (in order of seriousness):

spouse, fiancé/fiancée, serious relationship, dating relationship, casual relationship, and less common partnership types such as commercial sex or a one-night stand. Because some categories contained few observations, we reduced the number of types to four by combining 'spouse' and 'fiancé/fiancée' and 'casual' and 'other types' into single categories. Previous studies have also found that the length of a partnership is associated with concurrency (Manhart et al. 2002). Relationships of longer duration increase the time of exposure to the risk of entering a concurrent partnership and possibly the desire to seek out new or different partners. Duration of the initial partnership to date was coded in months.

Several studies report an association between partner infidelity and an individual's likelihood of engaging in concurrency (Adimora et al. 2004; Brady et al. 2009; Senn et al. 2009). For each relationship recorded on the RHC, respondents were asked the number of spouses their partner had during each month (excluding the respondent if he or she was married to the partner). Respondents were then asked how many non-marital sexual partners their partner had during each month (excluding themselves, if applicable) and how certain they were of their answer (response categories were: certain, think it is likely, uncertain, or really cannot tell). We created a dichotomous variable for perceived partner infidelity and coded it 1 if the initial partner had a spouse or the respondent was certain or thought it likely that the initial partner had at least one non-marital sexual partner in the month. The variable was coded zero if the partner did not have a spouse and the respondent was certain or thought it likely that the partner had no non-marital partners. In 10.6 per cent of relationship-months, respondents were uncertain, really could not tell, or did not know if a partner had other marital or non-marital partners, and these were coded zero.

Geographic distance from a partner could increase the risk of entering a concurrent relationship if loneliness or reduced access to sexual activity encourages individuals to seek new partnerships (Harrison et al. 2008; Sandøy et al. 2010). A dichotomous variable was used to indicate whether or not the respondent resided in the same village or city as the initial partner during the month.

A final risk factor measured was coital frequency. Those involved in relationships with low levels of sexual activity could be more apt to enter a concurrent sexual partnership if they felt their sexual needs were not being satisfied (Carey et al. 2010). Frequency of sexual intercourse was coded

categorically: zero, one to four, and five or more acts of coitus a month.

Analytical strategy

We used conditional gap time models (an extension to the conventional Cox model) to estimate the correlates of concurrency, and ran models separately for males and females. Given that concurrency is a relatively infrequent event for young women in particular, the regression results should be interpreted with caution.

As noted, we could not determine the sequence of entering concurrency and changes in time-varying independent variables within each month. Therefore, the time-varying independent variables were lagged by 1 month (with the exception of age, residence, and duration of initial partnership) on the assumption that changes in covariates in the previous month would affect the probability of entering into a second (concurrent) sexual partnership in the current month. We experimented with lagging initial partnership variables by 6 months, which produced generally similar coefficient sizes and significance levels. We present estimates for variables lagged by 1 month to show more temporally direct effects of the independent variables on concurrency.

An individual respondent could enter concurrency numerous times in the observation period. These repeated events could introduce within-individual correlation that could lead to underestimates of standard errors and hence inflated statistical significance. The conditional gap time model accounts for the fact that multiple transitions to concurrency are not independent (Box-Steffensmeier and Jones 2004). Robust standard errors were estimated using the 'cluster' option in Stata. We present hazard ratios (HR, the relative hazard of entering concurrency for one group compared to that for the reference group), robust standard errors, and significance levels from the multivariate regressions.

Results

Sample characteristics

Table 1 presents characteristics of respondents during the month of first sexual intercourse during the previous 9.5 years (the first month of the survival analysis). The average age at first sexual intercourse is 16.1 years for females (median 16.1 years) and 15.4 years for males (median 15.5 years). These figures are slightly lower than the average age for each sex during the first month of analysis because some respondents experienced sexual debut before

Table 1 Individual characteristics of urban youths (aged 18–24 in 2007) in the month of first sex in the previous 9.5 years, Kisumu, Kenya

	Females		Males	
	Mean	SD	Mean	SD
Age (years)	16.7	2.4	16.5	2.5
Age at first sex (years)	16.1	2.5	15.4	2.9
	<i>N</i>	%	<i>N</i>	%
Residence				
Rural	69	28.6	72	26.0
Urban	172	71.4	205	74.0
Migrated in previous month				
No	233	96.7	266	96.0
Yes	8	3.3	11	4.0
Employed				
No	211	87.6	231	83.4
Yes	30	12.5	46	16.6
In school				
No	115	47.7	75	27.1
Yes	126	52.3	202	72.9
<i>N</i>	241	100.0	277	100.0

Note: SD = standard deviation.

Source: The Urban Life among Youth in Kisumu Project, Kenya, 2007.

the start of the calendar period. Although all respondents resided in urban Kisumu at the time of interview, during the first month of the period analysed, over 25 per cent lived in rural areas, and recent migration had been low, with approximately 4 per cent having migrated in the previous month. Over one-half of females and almost three-quarters of males were in school, and a much smaller proportion (approximately 15 per cent) were employed.

Concurrency estimates

Tables 2 and 3 present information on concurrency indicators for various time periods and samples. Individuals are the unit of analysis. Estimates of point prevalence, calculated for a specific month before the survey, are shown in Table 2. In the sixth month before the survey, 3.5 per cent of females and 4.0 per cent of males had more than one ongoing sexual partner. Smaller percentages of the entire sample were involved in concurrency as we go further back in time, and no respondent experienced concurrency in the first month of the calendar (January 1998). Point prevalence is higher when the sample is restricted to sexually active respondents owing to the smaller denominator of each measure. Only 11 females (3.8 per cent) and 9 males (2.8 per cent) were sexually active in the first month of the calendar, reflecting respondents' young ages at the time (8–14 years old) and the fact that only 8.9 per cent of the entire sample had begun having sexual intercourse before this time. Finally, we see

that the crude and conservative figures for point prevalence are generally the same.

Estimates of cumulative prevalence are shown in Table 3. During the year before the survey, 5.6 per cent of females and 12.7 per cent of males had at least one concurrency episode, and 13.6 per cent of females and 22.4 per cent of males experienced concurrent relationships in the previous 9.5 years. If we restrict the sample to those who were sexually active, the estimates again increase. We also see that the cumulative prevalence figures do not increase substantially from the 5-year period before the survey to the 9.5-year period, particularly for males, because few additional individuals were sexually active and at risk of concurrency and few additional concurrency episodes were experienced more than 5 years before the survey. With respect to the conservative estimates, all are lower than the crude estimates, especially for males, indicating that males are more likely to be engaged in concurrencies that were dropped in these calculations (concurrencies where partnerships overlapped by only 1 month).

The mean age at first concurrency for females is 18.1 years (median 18.3 years) and 18.5 years (median 18.3 years) for males (Table 3). Of those who experienced concurrent relationships in the previous 9.5 years, over 80 per cent of both males and females had only one episode. Of the remainder, all but one of the females and approximately 10 per cent of males had two, and another 10 per cent of males had three or four. In the year before the survey, approximately 85 per cent of both sexes had one episode and the remainder had two. No one

Table 2 Point prevalence of concurrent sexual partnerships of urban youths (aged 18–24 in 2007), Kisumu, Kenya

	Females				Males			
	Period before interview of selected month				Period before interview of selected month			
	6 months (January 2007) %	1 year (June 2006) %	5 years (June 2002) %	9.5 years (January 1998) %	6 months (January 2007) %	1 year (June 2006) %	5 years (June 2002) %	9.5 years (January 1998) %
Of all respondents								
Point prevalence	3.5	2.5	1.4	0.0	4.0	2.8	1.2	0.0
Point prevalence (conservative)	3.5	2.5	1.4	0.0	4.0	2.8	1.2	0.0
N	286	286	286	286	322	322	322	322
Of sexually active respondents								
Point prevalence	6.2	4.4	5.3	0.0	9.4	7.6	6.6	0.0
Point prevalence (conservative)	6.2	4.4	5.3	0.0	8.7	7.6	6.6	0.0
N	162	160	75	11	138	119	61	9

Source: As for Table 1.

Table 3 Individual concurrency measures of urban youths (aged 18–24 in 2007), Kisumu, Kenya

	Females			Males		
	Period before interview			Period before interview		
	1 year %	5 years %	9.5 years %	1 year %	5 years %	9.5 years %
Of all respondents						
Cumulative prevalence	5.6	10.5	13.6	12.7	20.5	22.4
Cumulative prevalence (conservative)	4.5	9.4	11.2	9.6	15.5	17.4
<i>N</i>	286	286	286	322	322	322
Of sexually active respondents						
Cumulative prevalence	7.8	12.8	16.1	19.6	24.1	25.7
Cumulative prevalence (conservative)	6.3	11.5	13.2	14.8	18.3	20.0
<i>N</i>	205	235	242	209	274	280
Of those who had concurrency episodes						
Mean age at first concurrency (years)	–	–	18.1	–	–	18.5
Median age at first concurrency (years)	–	–	18.3	–	–	18.3
No. of episodes						
1	87.5	80.0	82.1	85.4	81.8	80.6
2	12.5	20.0	15.4	14.6	7.6	9.7
3	0.0	0.0	2.6	0.0	9.1	6.9
4	0.0	0.0	0.0	0.0	1.5	2.8
<i>N</i>	16	30	39	41	66	72

Source: As for Table 1.

experienced more than two concurrency episodes in the previous year.

Table 4 uses concurrency episodes as the unit of analysis and provides further details on the attributes of concurrency. Overall, approximately 90 per cent of young women's episodes and approximately 80 per cent of young men's episodes involved two ongoing sexual partnerships simultaneously. The percentage of episodes involving three partners is lower for

females than for males, and one episode among young males involved four partners. The duration of concurrency episodes is highly variable: 34.0 per cent of females' and 55.8 per cent of males' episodes in the previous 9.5 years lasted 1 month, while 19.1 per cent of females' and 12.6 per cent of males' episodes lasted over 1 year. On average, young men's episodes (5.2 months) were shorter than young women's (7.0 months). The pattern of longer

Table 4 Characteristics of concurrency episodes of urban youths (aged 18–24 in 2007), Kisumu, Kenya

	Females			Males		
	Period before interview			Period before interview		
	1 year %	5 years %	9.5 years %	1 year %	5 years %	9.5 years %
Number of concurrent sexual partners ¹						
2	94.4	91.7	93.6	78.7	82.6	82.1
3	5.6	8.3	6.4	19.2	16.3	16.8
4	0.0	0.0	0.0	2.1	1.2	1.1
Duration of episodes (months)						
1	22.2	30.6	34.0	59.6	55.8	55.8
2–3	33.3	30.6	25.5	17.0	11.6	12.6
4–6	22.2	16.7	12.8	12.8	11.6	10.5
7–12	22.2	5.6	8.5	10.6	9.3	8.4
>12	–	16.7	19.1	–	11.6	12.6
<i>N</i>	18	36	47	47	86	95

¹Maximum number of simultaneous partners during episode.

Source: As for Table 1.

concurrency episodes for females also holds for the results for 1 and 5 years before the survey.

Survival analysis

Table 5 presents characteristics of young men’s and women’s initial partnerships in the month before entry into a second (concurrent) sexual partnership (the sample comprises 141 concurrency episodes with complete information). At the onset of concurrency, initial partnerships had been ongoing for almost 2 years on average. For both sexes, over one-half of initial partnerships were of a serious nature (spouse/fiancé/fiancée or serious partner), one-sixth were dating relationships, and the remainder were casual or other types. With respect to partner infidelity, both males and females believed that about one-third of their initial partners were involved in sexual partnerships in addition to their own in the month before entering concurrency. These results refer to a specific initial partnership-relationship-month—the one immediately preceding concurrency—which may explain why the level of perceived partner infidelity is twice as high in this month as partner infidelity across *all* initial partnership-relationship-months regardless of whether and when respondents entered concurrency (15.6 per

cent). This higher level of partner infidelity might have motivated respondents to obtain a second (concurrent) partner. At the onset of concurrency, most initial partners (approximately 80 per cent) lived in the same city or village as respondents. The frequency of sexual intercourse varied within initial partnerships. Fifteen per cent of females and 30 per cent of males had not had sexual intercourse during the previous month with their initial partners, and approximately 30 per cent of both sexes had had sexual intercourse five or more times during the month before acquiring a concurrent partner.

Table 6 presents the estimates from the multivariate models. There are several interesting differences in the correlates of entering concurrency by sex. None of the individual characteristics considered here show a significant effect for females, with the exception of age at first sexual intercourse, which has a positive association with the transition to concurrency (HR = 1.30, marginally significant at $\alpha = 0.10$ level). This result runs counter to the view that early sexual initiation leads to unsafe sexual behaviour in terms of concurrency (Manhart et al. 2002). For males, age (HR = 1.13) and recent migration (HR = 2.83) elevate the risk of concurrency, and these associations are marginally significant. Urban residence, employment, and schooling are not associated with concurrency for either sex.

Table 5 Characteristics of initial partnerships of urban youths (aged 18–24 in 2007) in month before entering concurrency, Kisumu, Kenya

	Females		Males	
	Mean	SD	Mean	SD
Duration to date (months)	21.3	19.1	23.0	24.1
	<i>N</i>	%	<i>N</i>	%
Type				
Spouse/fiancé/fiancée	9	19.2	12	12.8
Serious	18	38.3	34	36.2
Dating	9	19.2	14	14.9
Casual or other type	11	23.4	34	36.2
Partner had other partner(s)				
No	30	63.8	65	69.2
Yes	17	36.2	29	30.9
Partner lived in a different city/village				
No	36	76.6	78	83.0
Yes	11	23.4	16	17.0
Frequency of sex during month				
0 times	7	14.9	28	29.8
1–4 times	26	55.3	33	35.1
5–15 or more times	14	29.8	33	35.1
<i>N</i>	47	100.0	94	100.0

Note: SD = standard deviation.

Source: As for Table 1.

Table 6 Estimated hazard ratios of entering concurrency in the previous 9.5 years for urban youths (aged 18–24 in 2007) from conditional gap time models, Kisumu, Kenya

	Female			Male		
	HR	RSE	<i>p</i> -value	HR	RSE	<i>p</i> -value
Individual characteristics						
Age (years)	0.80	0.14		1.13	0.07	+
Age at first sex (years)	1.30	0.21	+	1.01	0.06	
Urban residence (ref: rural)	0.87	0.33		0.97	0.33	
Migrated in previous month (ref: no)	0.79	0.57		2.83	1.59	+
Employed in previous month (ref: no)	0.63	0.28		0.86	0.28	
In school in previous month (ref: no)	0.61	0.24		1.18	0.37	
Initial partnership characteristics						
Duration to date (months)	0.98	0.02		1.01	0.01	*
Type in previous month (ref: serious)						
Spouse/fiancé/fiancée	0.30	0.14	*	1.06	0.41	
Dating	0.91	0.41		0.78	0.24	
Casual or other types	2.44	1.03	*	1.67	0.43	*
Partner had other partner(s) in previous month (ref: no)	2.14	0.94	+	2.45	0.57	***
Partner lived in different city/village in previous month (ref: no)	2.36	0.91	*	1.11	0.32	
Frequency of sex in previous month (ref: 0 times)						
1–4 times	2.10	0.99		0.87	0.27	
5–15 or more times	1.87	0.95		1.06	0.35	
Log pseudolikelihood	–165.50			–342.96		
No. of individuals	241			277		
No. of relationship-months	8,918			7,356		

Note: ref = reference category; HR = hazard ratio; RSE = robust standard error; +*p* < 0.1; **p* < 0.05; ***p* < 0.01; ****p* < 0.001.

Source: As for Table 1.

Numerous initial partnership variables are significantly related to the risk of entering concurrency. One that appears to matter is the nature of the initial relationship. The duration of the initial partnership is positively and significantly associated with the likelihood of entering concurrency among males (HR = 1.01) but not females. In addition, compared with those who had serious (non-marital) initial partners, young women who were the wives or fiancées of their initial partners were considerably less likely to enter concurrency (HR = 0.30), while those with casual initial partners were over twice as likely (HR = 2.44). Further analysis (details not shown) found that married or engaged women were significantly less likely to enter concurrency than were young women in dating or casual relationships. Among males, those with casual initial partners were significantly more likely to enter concurrency (HR = 1.67) than were males with serious partners, although there is no significant difference in the risk of entering concurrency for young men married or engaged to their initial partners. Further analysis (details not shown) found that married or engaged men were no different from men in dating or casual relationships in their propensity to enter concurrency.

Another factor that influences the individual's propensity to enter concurrency, for both sexes, is the perceived infidelity of the initial partner. If an initial partner was perceived to have one or more other partners, young men were approximately two and a half times as likely to enter concurrency (HR = 2.45) and young women twice as likely (HR = 2.14) as those who were certain their partners had no other partners or did not know; the hazard ratio for females is marginally significant.

Finally, an initial partner living in a different city or village elevates the risk of concurrency (HR = 2.36) for young women. This association does not hold for young men, indicating that males are just as likely to enter a second partnership whether the initial partner resides near or far. Frequency of sexual intercourse with the initial partner is unrelated to concurrency for both sexes.

Discussion and conclusions

We used retrospective information gathered from an innovative data collection method, the Relationship History Calendar, to provide a detailed analysis of the prevalence and correlates of concurrent sexual

partnerships among youth in urban Kisumu, Kenya. In the 9.5 years before the survey, estimates show that 13.6 per cent of females and 22.4 per cent of males aged 18–24 were involved in concurrent relationships, and 3.5 per cent of females and 4.0 per cent of males had overlapping sexual partnerships in the sixth month before the survey (point prevalence).

There are several limitations of the RHC method that could affect the quality of our concurrency estimates. First, life-history calendars like the RHC use a variety of memory aids and data cross-checking procedures to improve retrospective reporting, which is particularly useful for gathering accurate information on the dates of sexual intercourse within relationships in order to estimate concurrency (Aral 2010; Mah and Halperin 2010). Nevertheless, remembering details over a 9.5-year retrospective period could be difficult for some respondents. Recall error could affect our prevalence estimates in either direction, and overall, our shorter-term estimates are likely to be more accurate. Second, while the RHC has been shown to decrease social-desirability bias and improve reporting on measures such as the number of sexual partners, it has not been tested specifically for its accuracy in the reporting of concurrent sexual relationships. To the extent that respondents perceived that involvement in concurrent sexual partnerships was considered socially unacceptable (Sandøy et al. 2010), they may have been reluctant to report overlapping dates of sexual intercourse or relationships. If underreporting occurred, this would have led to underestimates of concurrency. Future studies should subject the RHC to reliability and validity testing on these issues.

Third, surveys that attempt to record the start and end dates of sexual partnerships have had problems with missing data (Manhart et al. 2002; Nelson et al. 2007). While missing data on relationship dates was not an issue for the RHC given its time-line format, some respondents did not report all of their previous partnerships owing to constraints of time, recall, or discomfiture (Luke et al. forthcoming). This resulted in partial sexual histories for the previous 9.5 years for 8.7 per cent of respondents, and for the previous year for 1.6 per cent. Because dates of first and last sexual intercourse are missing for any omitted partnerships, our figures may underestimate levels of concurrency. In a separate analysis (details not shown), we determined that individuals with full and partial relationship histories in the previous 9.5 years were not significantly different by age, education, and marital status; however, those with partial histories had more lifetime sexual partners on

average. Thus, our estimates could be further biased downward if these individuals had a higher propensity to engage in concurrency than the rest of the sample. To get an idea of the extent of this potential underestimation, we added individuals with missing relationship-history information to the concurrency prevalence numerators (if they were not otherwise included) to create an upper bound. Our 9.5-year prevalence estimate for all males increased by six percentage points from 22.4 to 28.6 per cent, and the figure for all females increased four points from 13.6 to 17.8 per cent. Adjusting for partial histories, the figures for the previous year increased to 14.0 per cent for males and 6.6 per cent for females from 12.7 and 5.6 per cent, respectively.

Despite these caveats, it appears that prevalence levels of concurrency among young people in Kisumu are relatively lower than those reported by other studies of youths in sub-Saharan Africa (Harrison et al. 2008; Kenyon et al. 2010). However, differences in age range, sample selection, and sexual-partnership information make these comparisons difficult. A recent evaluation of an intervention to increase the use of circumcision by males in Kisumu provides a more direct comparison (Mattson et al. 2007). The study found that 63 per cent of sexually active males aged 18–24 had had at least one episode of concurrency in their lifetimes (compared to our figure of 25.7 per cent in the previous 9.5 years) and 49 per cent of these reported three or more concurrency episodes (compared to our figure of 9.7 per cent). There are several possible explanations for the poor agreement between the two studies. Substantially higher estimates of concurrency in the intervention study could be due to the fact that it did not use a random sample: those who entered the trial may have perceived themselves at highest risk of HIV, and hence experienced more risk behaviours. The intervention study also recruited men who were sexually active in the last year, and thus lifetime estimates are based on those with recent sexual experience, which may overestimate lifetime concurrency in the general population. In addition, different interview modes were implemented in each study. As noted, the RHC yields more accurate (lower) levels of reported lifetime sexual partners for young males than do standard survey methods. The standard instrument used in the intervention study probably overestimated this figure, thereby potentially biasing concurrency figures upward as well.

On the other hand, our 9.5-year figure is likely to underestimate *lifetime* concurrency, albeit slightly. Our figure does not include sexual relationships that

occurred more than 9.5 years ago, though this reference period encompassed lifetime partnerships for the majority of male respondents (85.0 per cent), and few concurrencies were likely to have occurred before this period (before respondents were aged 8–14). As noted, our 9.5-year figure could be further biased downward because some respondents' relationship histories were incomplete. Nevertheless, taking into account this underreporting, our upper-bound estimate is 32.8 per cent of sexually active males in the previous 9.5 years, which still remains much lower than the intervention study estimate of 63 per cent. Overall, the large differences in estimates emphasize the necessity of standardizing concurrency indicators, obtaining population-based measurements, and collecting accurate and complete data on partnership histories in order to make valid comparisons across studies and settings (UNAIDS 2009).

Our descriptive statistics provide a more detailed picture of the nature and extent of concurrency than has been offered by previous studies. Interestingly, youths in Kisumu do not appear to engage in multiple concurrencies or become involved with a large number of partners simultaneously. For example, among the young people who experienced concurrency, we find that less than 20 per cent had been involved in multiple concurrency episodes in the previous 9.5 years and episodes usually included only two partners at a time. There are important differences by sex, however. In line with the view that males are generally more sexually active and have more sexual partners than females in sub-Saharan Africa (Nnko et al. 2004), we find that young men in Kisumu have more episodes of concurrency than young women and that these episodes are of shorter duration. The detailed dimensions of concurrency that we measured—duration, the number of simultaneous partners, and the type of initial partner—could be important determinants of HIV infection (Doherty et al. 2009; Aral 2010; Kenyon et al. 2010) and could be used in simulation or network studies to help provide more realistic reflections of the spread of the epidemic (Lurie and Rosenthal 2010).

A major advantage of the life-history calendar is the detailed time-series data it collects on respondents and their sexual partnerships, which allowed us to investigate concurrency dynamics. The survival analysis finds several differences between young men and women in their risk factors for entering concurrency, with older ages at sexual debut increasing the risk for young women, and age and recent migration increasing the risk for young men. The

finding that recent migration affects males but not females also suggests that the context of residential change—such as living arrangements or supervision in the destination—differs by sex and thus affects sexual activity.

The characteristics of initial partnerships also help to explain individuals' motivations for acquiring a second (concurrent) sexual partner. We find evidence that marriage has a protective effect against the risk of concurrency for young women, but not for young men. We also find that involvement in the least committed casual partnerships significantly elevates the risk of concurrency for both young men and women compared to relationships with serious non-marital partners. Furthermore, geographic distance from an initial partner increases the risk of concurrency for females. There is a high degree of migration among youths in many sub-Saharan Africa settings (54.4 per cent of our sample migrated at least once in the previous 9.5 years). Many partnerships continue despite this separation, and new relationships are formed in the interim (Manhart et al. 2002; Harrison et al. 2008; Sandøy et al. 2010), thereby expanding sexual networks further across space. Interestingly, infrequent sexual intercourse in the initial partnership is not associated with concurrency for either sex. Future research should consider how the quality of sexual activity and sexual satisfaction are related to concurrency beyond the frequency of intercourse.

We also discovered interesting findings relating to the perceived infidelity of partners and concurrency. The descriptive statistics show that over 30 per cent of respondents believed that their initial partner had another sexual partner (marital or non-marital) during the month before concurrency, suggesting that approximately one-third of concurrency episodes were 'mutually concurrent', that is, both partners were engaged in sexual relationships with other individuals at the same time (Kenyon et al. 2010). The survival analysis reveals an association between perceived infidelity of the initial partner and one's own likelihood of entering concurrency for both sexes, which suggests that concurrency in this population not only expands the individual's personal sexual network but also bridges additional networks involving partners' other partners. Indeed, if young people respond to infidelity by engaging in additional concurrent partnerships rather than terminating the existing relationship, this pattern of mutual concurrency could be a key factor in the spread of HIV in Kisumu (Aral 2010; Kenyon et al. 2010). Overall, our results support the view that research and interventions should reach beyond the

individual-level determinants of concurrency and HIV infection and take partnership characteristics and dynamics into account.

Notes

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- 2 The data on which the analyses in this paper are based came from the Urban Life among Youth in Kisumu Project, directed by Nancy Luke, Brown University, Shelley Clark, McGill University, and Eliya Msiyaphazi Zulu, Director, African Institute for Development Policy (AFIDEP), P.O Box 1 14688-00800, Westlands, Nairobi, Kenya. The project was supported by a grant from the Eunice Kennedy Shriver National Institute for Child Health and Human Development (#R21-HD 053587) and received supplementary funding from the Population Studies and Training Center, Department of Sociology, and UTRA at Brown University, and the Population Research Center at the University of Chicago. The authors thank Rachel Goldberg, Kaivan Munshi, Martina Morris, and participants at the 2009 IUSSP International Population Conference for helpful comments on the paper.

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