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Concurrent Sexual Partnerships among Youth in Urban Kenya: Prevalence and Partnership Effects

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Abstract

Research on concurrent sexual partnerships in sub-Saharan Africa is hindered by lack of accurate partnership data. Life history calendars could be beneficial for gathering such information. Using retrospective calendar data from a population-based sample of youth ages 18–24 in Kenya (N=608), 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 experienced concurrency. Males had more concurrencies and of shorter duration than females. Using survival analysis, we found that the characteristics of initial partnerships affect entry into a second (concurrent) relationship. Among females, marriage decreases and geographic separation from a partner increases the risk of concurrency, and relationship duration increases the risk for males. For both sexes, casual relationships and the perception of partner infidelity increase the risk, suggesting that concurrency expands one's egocentric sexual network and bridges additional networks involving partners' other partners.

Keywords

concurrency; sexual behavior; sexual networks; youth; Kenya; survival analysis

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, where earlier partners can be exposed when the subject becomes infected by a later partner (Morris and Kretzschmar 1997). Concurrency has been associated with the spread of HIV and other sexual 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 to measure concurrency and its correlates in survey research. Surveys have generally gathered information to construct concurrency measures in three ways. First, respondents have been asked direct questions regarding their involvement in concurrency, such as 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). This method makes it difficult to construct concurrency estimates for specific time periods before the survey, however (Carter et al. 2007). Second, researchers infer concurrency based on information collected about respondents' 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). Third, the most precise estimates of concurrency stem from reports of the timing of first and last sexual intercourse within respondents' multiple partnerships (Adimora et al. 2002, 2004 and 2007; Nelson et al. 2007; Sandøy et al. 2010). This line of questioning is recommended by the UNAIDS Reference Group on Estimates, Modelling, and Projection, which has also proposed standardized indicators of concurrency (UNAIDS 2009). Although such partnership history data allow more detailed analyses of the duration and timing of concurrency, it is difficult to collect accurate data on sexual partnerships. Whether respondents are asked "how long ago" these events 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), this 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 are 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; Manhart et al. 2002; Adimora et al. 2004 and 2007; Harrison et al. 2008). Current characteristics may be poor predictors of previous behavior 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 partners' race (Manhart et al. 2002), residence (Manhart et al. 2002; Senn et al. 2009), incarceration (Manhart et al. 2002; Adimora et al. 2004), non-monogamy (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 initial partnerships and subsequent concurrent ones. The characteristics of and behaviors 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 could be particularly beneficial for estimating the prevalence and correlates of concurrency. The calendar method aids respondents to accurately recall the occurrence, sequence, and timing of past events (Caspi et al. 1996; Belli 1998; Axinn et al. 1999), and 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). In this study, we used Relationship History Calendar (RHC) data collected from a population-based sample of youth 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 youth, including the dates of first and last sexual intercourse within relationships as well as a variety of time-varying individual and relationship characteristics (Luke et al. forthcoming).

Our study has two specific aims. First, for males and females, we estimate various prevalence measures suggested by the UNAIDS Reference Group (UNAIDS 2009) for multiple time periods before the survey and describe several important attributes of concurrency, including the number of concurrency episodes per individual and the duration of episodes (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 individuals and their initial sexual partnerships at the time of concurrency. This analysis helps to isolate the immediate conditions that affect the decision to enter a second (concurrent) partnership and reveals how this process differs for males and females.

Methods

Data and sample

Kisumu, the third largest city in Kenya and capital of Nyanza Province, provided an important context to explore concurrency among youth. An economic hub and destination for many internal migrants as well as the site of multiple schools and colleges, it attracts a range of young people seeking employment and educational opportunities. Kisumu is also the epicenter 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 (NASCOP 2009). Given the typical pattern whereby urban areas have higher HIV prevalence rates than rural areas in Africa, the prevalence rate for Kisumu City should be higher than the average for the province. The latest estimates 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 per cent and 12.3 per cent of females and males, respectively.

The data we used for the analyses come from the Urban Life among Youth in Kisumu Project conducted in 2007. The study was designed to test the quality of sexual behavior reporting with the RHC compared to a standard sexual partnership instrument, such as the one used in Demographic and Health Surveys. The sample included 1275 young people ages 18-24. Enumeration areas (EAs) mapped by the Government of Kenya's Central Bureau of Statistics were used as primary sampling units, and of the urban EAs, 45 were randomly chosen for the survey. A team of ten 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 the standard instrument. Interviews took place in a private room or area in the house or nearby neighborhood. 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 with monthly information on each topic recorded in a time-line format over a 9.5-year retrospective period (January 1998 to 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 about 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.

Collection of retrospective data is particularly subject to recall error. Life history calendars were created to help minimize the risk of this type of measurement error, however (Balán et

al. 1969; Belli 1998; Axinn et al. 1999; Schwarz and Oyserman 2001; Luke et al. forthcoming), and multiple 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 recall the timing of past events on the RHC, respondents referenced the dates of public and personal events (such as national elections or a parental death) as well as the timing of their schooling, migration, and partnership trajectories. In addition to these memory aids, the flexible interview style allowed for clarification and cross-checking of event dating. These procedures could make recall of the exact timing (by month and year) of sexual intercourse within relationships quite accurate.

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

For this paper, 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 due to missing values on independent variables.

Definitions of concurrency

Detailed data on the frequency of sexual intercourse each month within each partnership provided the opportunity to define concurrency precisely by month. We compared the months of first and last sexual intercourse across relationships for the same individual and defined *concurrency* as two or more sexual partnerships that overlapped in time (Adimora et al. 2002; Manhart et al. 2002; Doherty et al. 2007). The months when multiple sexual partnerships continuously overlapped were treated as a *concurrency episode*. Because we do 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 one month only.

The UNAIDS Reference Group recommends calculating concurrency indicators for short periods before the survey (six months to one year) (UNAIDS 2009). We used these as well

as longer time periods for comparison purposes. *Point prevalence* is the percentage of all respondents who had more than one ongoing partnership at one point in time, which we calculated as having one or more concurrency episode in the sixth month before the survey (January 2007) as well as one year before the survey (June 2006), five years before the survey (January 2002), and 9.5 years before the survey (January 1998, the first month of the RHC). We also examined the *cumulative prevalence* of concurrency in the one year, five years, and 9.5 years before the survey, which is the percentage of respondents with at least one concurrency episode during the time period. Because some observers suggest that cumulative prevalence should be estimated among those who have been sexually active only (UNAIDS 2009), we also provide estimates with the number of these individuals in the denominator. In addition, for all measures of point and cumulative prevalence, we report conservative estimates for comparison purposes.

Finally, we report 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 report 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 began at the start of the calendar, when respondents were ages 8-14, and continues up to the time of the survey. During this period, a respondent became *at risk of entering concurrency* in the first month when he or she had sexual intercourse with a partner (first month of sexual intercourse in the last 9.5 years, which is the month of sexual debut for 89.7 per cent of respondents). A respondent *entered concurrency* in the first month when he or she had sexual intercourse with a second partner that occurred 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 analyzed the risk of entering concurrency from one initial sexual partner to two sexual partners. A respondent could have entered concurrency multiple times throughout the exposure period, known 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 one month after first sexual intercourse in an ongoing partnership, we designated the ongoing partnership as the initial partnership (130 or 92.2 per cent of concurrency episodes). If first sexual intercourse occurred in the same month for two partnerships (six 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 partnership type categories).

Correlates of entering 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. Older age and younger age at first sexual intercourse not only increase exposure time to concurrency

but could also proxy for individuals more likely to engage in risky sexual behaviors (Manhart et al. 2002; Adimora et al. 2002 and 2007; 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 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; Dodo 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. First, we examined the nature of the initial partnership in terms of type and duration. Past studies have found that concurrency depends partly on the degree of commitment in existing partnerships (Carey et al. 2010), usually measured crudely by type as marital or nonmarital, with more committed, married individuals less likely to engage in concurrency (Santelli et al. 1998; Adimora et al. 2002; Manhart et al. 2002; Sandøy et al. 2010). The RHC data distinguished between multiple types of relationships among youth in the Kisumu context, including (in order of seriousness) spouses, fiancés/fiancées, serious relationships, dating relationships, casual relationships, and less common partnership types like commercial sex or one-night stands. Because some categories contained few observations, we collapsed spouses and fiancés/fiancées as well as casual and other types and created a four-category initial partnership type variable. 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 exposure time to developing concurrency and could be associated with individuals' desire to seek out new or different partners. Duration of the initial partnership to date was coded in months.

Second, several studies report an association between non-monogamy of partners and individuals' likelihood of engaging in concurrency (Adimora et al. 2004; Brady et al. 2009; Senn et al. 2009). For each relationship 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 the number of nonmarital sexual partners other than themselves their partner had during each month and how certain they were in this knowledge (response categories included: certain, think it is likely, uncertain, or really can't tell). We created a dichotomous variable for perceived partner infidelity and coded it one if the partner had a spouse and/or the respondent was certain or thought it was likely that the initial partner had at least one nonmarital 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 was likely that he or she had no nonmarital partners. In 10.6 per cent of relationship-months, respondents were uncertain, really couldn't tell, or did not know if a partner had other marital or nonmarital partners, and these were coded zero.

Third, geographic distance from a partner could increase the risk of concurrency because of 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 the respondent lived in the same village or city as the initial partner or not during the month. Finally, to the extent that partnerships satisfy sexual needs, those involved in relationships with low levels of sexual activity could be more apt to enter a concurrent sexual partnership (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. We 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 cannot sequence the timing of concurrency and changes in time-varying independent variables within each month. Therefore, the time-varying independent variables were lagged by one month (with the exception of age, residence, and duration of initial partnership) on the assumption that changes in covariates in the prior month affect the probability of entering into a second (concurrent) sexual partnership in the current month. We experimented with lagging initial partnership variables by six months, which produced generally similar results in terms of coefficient sizes and significance levels. We present estimates for variables lagged by one month to show more temporally direct effects of the independent variables on concurrency.

A respondent's multiple events (entering concurrency) 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 in the last 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 the start of the calendar period. Although all respondents resided in urban Kisumu at the time of interview, during the first month of analysis over 25 per cent lived in rural areas, and recent migration was low, with approximately four 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) was 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, which were calculated for a specific month prior to 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, given the smaller denominator in each measure. It is interesting to note that only 11 females (3.8 per cent) and nine males (2.8 per cent) were sexually active in the first month of the calendar, reflecting respondents' young ages at this time (8-14 years old) and the fact that only 8.9 per cent of the entire sample had begun having sexual intercourse prior to this time. Finally, we see that the crude and conservative figures are generally the same for point prevalence.

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 concurrency in the last 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 five-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 five years ago. 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 one 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 concurrency in the last 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 ten per cent of males had two episodes, and another ten per cent of males had three or four episodes. In the year before the survey, approximately 85 per cent of both sexes had one episode and the remainder had two. No one experienced more than two concurrency episodes in the last 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 last 9.5 years lasted one month, while 19.1 per cent of females' and 12.6 per cent of males' episodes lasted over one year. On average, young men's episodes (5.2 months) are shorter than young women's (7.0 months). The pattern of longer concurrency episodes for females holds for the results in the one year and five years before the survey as well.

Survival analysis

Table 5 presents characteristics of young men's and women's initial partnerships in the month prior to entry into a second (concurrent) sexual partnership (the sample is 141 concurrency episodes with complete information). At the onset of concurrency, initial partnerships had been ongoing for almost two years on average. For both sexes, over one half of initial partnerships were of a serious nature (spouses/fiancés/fiancées or serious partners), one sixth were dating relationships, and the remainder were casual or other types of partners. With respect to non-monogamy, 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 prior to entering concurrency. These results refer to a specific initial partnership relationship-month—the one immediately preceding concurrency—which could explain why the level of perceived partner infidelity is twice as high in this month compared to partner infidelity across *all* initial partnership relationship-months (15.6 per cent) regardless of whether and when respondents entered concurrency (not shown). This higher level of partner infidelity could motivate 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. Finally, 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 sexual 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 for females (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 behavior 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.

Numerous initial partnership variables are significantly related to the risk of entering concurrency. First, the nature of initial relationships appears to matter. 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 (nonmarital) initial partners, young women who are married to or fiancées with their initial partners are considerably less likely to enter concurrency (HR=0.30), while those with casual initial partners are over twice as likely (HR=2.44). Further analysis finds that married or engaged women are significantly less likely to enter concurrency than young women in dating or casual relationships as well (not shown). Among males, those with casual initial partners are significantly more likely to enter concurrency (HR=1.67) compared to 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 finds that married or engaged men are no different than men in dating or casual relationships in their propensity to enter concurrency (not shown).

Second, the perceived fidelity of initial partners also influences individuals' propensity to enter concurrency for both sexes. If an initial partner was perceived to have other partner(s), young men are approximately two and one-half times as likely to enter concurrency (HR=2.45), while young women are twice as likely (HR=2.14) to engage with a second (concurrent) sexual partner compared to those who were certain their partners had no other partners or did not know; the latter finding 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 with partners near or far are just as likely to enter a second partnership. Frequency of sexual intercourse with the initial partner is unrelated to concurrency for either sex.

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 ages 18-24 were involved in concurrency, 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 utilize multiple memory aids and data cross-checking 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 was not specifically tested regarding the validity of concurrency reporting. Involvement in concurrent sexual partnerships could be considered socially unacceptable in some contexts (Sandøy et al. 2010), and respondents could therefore have been cognizant about reporting overlapping dates of sexual intercourse or relationships. This could lead to underestimates of concurrency. Future studies should subject the RHC to reliability and validity testing regarding these issues.

Third, surveys that attempt to record sexual partner start and end dates have had problems with missing data (Manhart et al. 2002; Nelson et al. 2007). While missing data on relationship dates was not an issue given the time-line format of the RHC, some partnerships in their entirety were not reported due to respondent constraints on time, recall, or discomfort (Luke et al. forthcoming). This resulted in partial sexual histories in the last 9.5 years for 8.7 per cent of respondents and in the last year for 1.6 per cent. Because dates of first and last sexual intercourse are missing for any omitted partnerships, our figures could underestimate levels of concurrency. In a separate analysis (not shown), we determined that individuals with full and partial relationship histories in the last 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 sexual 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 per cent to 28.6 per cent, and the figure for all females increased four points from 13.6 per cent to 17.8 per cent. Adjusting for partial histories, the figures for the last 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.

With these caveats in mind, we found that prevalence levels of concurrency among youth in Kisumu appear to be relatively low compared to other studies of youth in sub-Saharan Africa (Harrison et al. 2008; Kenyon et al. 2010). Differences in age ranges, sample selection, and sexual partnership information make these comparisons difficult, however. A recent male circumcision intervention study in Kisumu provided a more direct comparison (Mattson et al. 2007). The study found that 63 per cent of sexually active males ages 18-24 had at least one episode of concurrency in their lifetimes (compared to our figure of 25.7 per cent in the last 9.5 years) and 49 per cent of these had 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 nonrandom selection of the sample, where participants who perceived themselves at highest risk of HIV, and hence experienced more risk behaviors, could have entered the trial. 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 could 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 the standard survey approach. Thus, the standard instrument used in the intervention study likely overestimated this figure, thereby potentially biasing concurrency figures upward as well.

At the same time, our 9.5-year figure is likely to slightly underestimate *lifetime* concurrency. Our figure does not include sexual relationships that occurred more than 9.5 years ago; nevertheless, 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 ages 8-14). As noted, our 9.5-year figure could be further biased downward due to partial relationship histories for some respondents. Nevertheless, our upper bound estimate of underreporting due to this issue is 32.8 per cent of sexually active males in the last 9.5 years, which still remains much lower than the intervention study estimate of 63 per cent. Overall, the large differences in estimates underscore 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 in previous studies. Interestingly, youth in Kisumu do not appear to engage in multiple concurrencies nor become involved with large number 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 last 9.5 years and episodes usually included only two partners at a time. There are important gender differences, 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 and of shorter duration compared to young women. 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 data is the detailed time-series information 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 of entering concurrency, with older ages at sexual debut increasing the risk for young women while age and recent migration increasing the risk for young men. The finding that recent migration affects males but not females also suggests that the underlying 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 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 nonmarital partners. Furthermore, geographic distance from an initial partner increases the risk of concurrency for females. There is a high degree of migration among youth in many sub-Saharan Africa settings (54.4 per cent of our sample migrated at least once in the last 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 uncover interesting findings regarding perceived infidelity of partners and concurrency. The descriptive statistics show that over 30 per cent of respondents believed that their partner had another sexual partner (marital or nonmarital) during the month before concurrency, suggesting that approximately one third of concurrency episodes were “mutually concurrent,” where both partners were engaged in sexual relationships with additional 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 one's egocentric 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 (Kenyon et al. 2009; Aral 2010). Overall, our results support the view that research and interventions should focus beyond the individual-level determinants of concurrency and HIV infection and take partnership characteristics and dynamics into account.

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Table 1

Individual characteristics of urban Kenyan youth (ages 18-24 in 2007) in the month of first sex in the last 9.5 years

	Female		Male	
	Mean	S.D.	Mean	S.D.
Age (years)	16.7	2.4	16.5	2.5
Age at 1st sex (years)	16.1	2.5	15.4	2.9
	N	%	N	%
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
N	241	100.0	277	100.0

Note: S.D. = standard deviation.

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

Table 2

Point prevalence of concurrent sexual partnerships of urban Kenyan youth (ages 18-24 in 2007)

	Female					Male				
	Month prior to interview					Month prior to interview				
	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 Kenyan youth (ages 18-24 in 2007)

	Female			Male		
	Time period prior to interview			Time period prior to 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
N	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
N	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
N	16	30	39	41	66	72

Source: As for Table 1.

Table 4
Characteristics of concurrency episodes of urban Kenyan youth (ages 18-24 in 2007)

	Female			Male		
	Time period prior to interview			Time period prior to interview		
	1 year %	5 years %	9.5 years %	1 year %	5 years %	9.5 years %
Number of concurrent sexual partners <i>I</i>						
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
N	18	36	47	47	86	95

I Maximum number of simultaneous partners during episode
Source: As for Table 1.

Table 5

Characteristics of initial partnerships of urban Kenyan youth (ages 18-24 in 2007) in month prior to entering concurrency

	Female		Male	
	Mean	S.D.	Mean	S.D.
Duration to date (months)	21.3	19.1	23.0	24.1
	N	%	N	%
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 types	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
N	47	100.0	94	100.0

Note: S.D. = standard deviation.

Source: As for Table 1.

Table 6

Hazard ratio estimates 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	R.S.E.	P-value	HR	R.S.E.	P-value
Individual characteristics						
Age (years)	0.80	0.14		1.13	0.07	+
Age at 1st 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	8918			7356		

Note: ref = reference category; HR = hazard ratio; R.S.E.=robust standard error;

+ p<0.1;

* p<0.05;

** p<0.01;

p<0.001.

Source: As for Table 1.