Measuring Prevalence and Correlates of Concurrent Sexual Partnerships among Young Sexually Active Men in Kisumu, Kenya

Authors: Nelli Westercamp[1], Christine L. Mattson[1], Robert C. Bailey[1]

Correspondence and request for reprints:

Nelli Westercamp

Division of Epidemiology and Biostatistics

University of Illinois Chicago

1603 W. Taylor St. MC 923

Chicago, IL 60612

Tel: (312) 355-0440

Fax: (312) 996-0064

E-mail: nweste1@uic.edu

Short Title ('running head'): Sexual Concurrency in Young Kenyan Men

Published in *AIDS & Behavior* on March 27, 2013

Digital Object Identifier (DOI) **10.1007/s10461-013-0457-5**

http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s10461-013-0457-5

[1] School of Public Health, University of Illinois at Chicago, Chicago, IL, USA

ABSTRACT

Our objectives were to: 1) compare multiple measures of partnership concurrency, including the UNAIDS-recommended definition and 2) describe the prevalence and correlates of concurrent sexual partnerships among young Kenyan men. We analyzed 10,907 lifetime partnerships of 1,368 men ages 18-24 years enrolled in a randomized trial of male circumcision to reduce HIV-1 incidence in Kisumu. Partnership concurrency was determined by overlapping dates and examined over varying recall periods and assumptions. The lifetime prevalence of concurrency was 77%. Sixty-one percent of all partnerships were concurrent and factors associated with concurrency differed by partner type. Point prevalence of concurrency at the time of the interview was consistently the highest and UNAIDS-recommended definition was the most conservative (25% vs. 18% at baseline, respectively). Estimates of concurrency were influenced by methods for definition and measurement. Regardless of definition, concurrent partnerships are frequent in this population of young, sexually active men in high HIV prevalence Kisumu, Kenya.

Keywords: Sexual Concurrency; Concurrent Partnerships; Multiple Sexual Partners; Kenya; HIV Prevention

INTRODUCTION

The significance of sexual partner concurrency in explaining the severity of the HIV epidemic in Sub-Saharan Africa is a subject of considerable debate [1-8]. Mathematical models have consistently illustrated that compared to serial monogamy, concurrent partnerships increase the magnitude, spread, and persistence of the HIV epidemic [9-11]. When there are high levels of concurrency, a significant proportion of new infections is likely to occur due to increased exposures during the primary phase of infection [12, 13]. Due to methodological challenges, however, few empirical studies have documented an association between concurrency and HIV incidence [14-17] and some studies have argued that it is simply the total number of partners that matters, regardless of their overlap in time [18].

Multiple studies have assessed the prevalence of concurrent partnerships in Sub-Saharan Africa [17, 19-25] and found large differences both between (from 6% of urban men in Zambia [24] to 21% of urban men in Uganda [26]) and within (from 16% in South Africa nationally [27] to 38% in Kwa-Zulu Natal [28]) countries, as well as across time (from 13% in 1998 to 8% in 2003 in rural Zambian men [24]). Comparing such results, however, is difficult due to variation in the operational definitions and measurement methods used [4, 7]. The most common operational definitions of concurrency are based on extrapolated overlap determined by provided relationship start and end dates or by asking directly about sex with other partners during each reported partnership. Measurement of concurrency prevalence has been principally reported as point prevalence (at interview or at some specified time-point) [17, 19, 23-28], as cumulative prevalence [17, 20-23, 27], and as a proportion of all partnerships [29, 30]. Additionally, there are often meaningful differences in the denominators chosen to express these measures. To facilitate consensus, the UNAIDS Reference Group on Estimates, Modeling and Projections recently issued a recommendation on standard indicators of concurrency [31]. While these indicators should facilitate more meaningful comparisons in the future, other measures that take into account the diversity of sexual concurrency and provide greater emphasis on associated characteristics may offer additional insights. Few studies to date have focused on the complexity of measuring concurrency in practice and the impact that different measurement methods have on the magnitude of concurrency prevalence estimates [32-35].

In this analysis, we used data from a sub-study of the randomized control trial (RCT) of male circumcision (MC) in Kisumu, Kenya [36], to explore and compare different measures of concurrency, including the UNAIDS-recommended indicator. In addition, we assessed prevalence and correlates of concurrency in our sample of young, sexually active men; defined characteristics that differed between concurrent and non-concurrent sexual partnerships; and examined to what extent the number of partners reported by men is related to the proportion of all their partnerships that are concurrent.

MATERIALS AND METHODS

Study participants

Data for this analysis were collected as part of a study evaluating sexual risk behavior during the RCT of male circumcision to reduce HIV incidence in Kisumu, Kenya [36]. Detailed description of study methodology and the sample has been provided elsewhere [37-40]. In brief, RCT participants were volunteers recruited between February 2002 and September 2005 through newspapers, community theater, radio, fliers, STI clinics, youth groups, and peer outreach [36]. Trial participants were followed every six months for two years with risk reduction counseling, a brief questionnaire, biologic sample collection and health examination taking place at each visit. Men enrolled in the present study were self-selected from men screened for the RCT with study eligibility defined as being sexually active in the preceding 12 months and being 18-24 years of age. Participants provided signed informed consent in their language of choice (English, Kiswahili, or Dholuo), and ethical approval was obtained from the Kenyatta National Hospital Ethics and Research Committee, the University of Illinois at Chicago IRB #3, and the University of Manitoba Biomedical Research Ethics Board.

Measures

Study questionnaire

Face-to-face, structured interviews were conducted at baseline, and at 6 and 12 months after enrollment. The interview included demographic and behavioral characteristics, lifetime sexual behavior and STI history, and detailed partnership characteristics for the most recent 12 sexual partners. The validated Timeline Followback (TLFB) approach [41] was used to enhance memory recall. Variables collected for each sexual partner and examined in the concurrency analysis included: partner's age, gender, type (wife, regular / steady partner, casual partner, or commercial sex worker), length of time knowing partner prior to sex, approximate number of sexual encounters (once, 2 to 5, 6 to 10, more than 10), sexual practices (oral, vaginal, anal, sex during menstruation), transactional sex, condom use (ever, first encounter, last encounter, every encounter), perception that the partner had other partners at the time of the relationship, and beliefs about the partner's HIV/AIDS status.

Definition and measurement of concurrency

At each study visit, participants provided "month and year the sexual relationship began" and "month and year the sexual relationship ended", as well as whether they considered the relationship as formally ended, for each reported partner. Partnerships were considered concurrent if there was any overlap, by month, of the start and end dates of any two partnerships. For example, if one partnership began in September and ended in December, and another began that same December and ended in February, those partnerships were considered concurrent. Because partnership start and end dates were limited to the month and year, it is possible that partnerships reported in the same month may not have overlapped at the day level. To evaluate the impact of this potential misclassification, we did a sensitivity analysis assuming all partnerships that overlapped by one month were not concurrent.

Concurrency indicators

We calculated five different measures of concurrency: 1) the UNAIDS-recommended point prevalence measure: the proportion of men with at least two ongoing partnerships at 6 months before interview [31]; 2) point prevalence at 3 months before interview; 3) point prevalence at the time of the interview; 4) cumulative prevalence in the past 6 months; and 5) lifetime cumulative prevalence at the beginning and the end of the study. Longitudinally, each of the first four measures was calculated at baseline, 6, and 12-month follow-up visits. Point prevalence at 6 months before interview was estimated for the entire sample at baseline; however, some men were unable to provide 6-month sexual history at follow-up due to returning before 6 months had passed, but within the study allowed follow-up window of ± 3 months. Therefore, the denominator for the UNAIDS indicator is limited to 521 men at 6-month and 539 men at 12-month follow-up. Our other recall time points, 3-months and at the time of the interview, were not subject to this limitation.

Complete sexual histories were not collected on 14% of men due to greater than 12 lifetime sexual partners at baseline. This had no effect on lifetime concurrency (all had concurrent partnerships) and likely had minimal effect on 6-month cumulative prevalence and point prevalence due to those measures' focus on recent sexual partners.

Data analyses

We evaluated factors associated with concurrency on two levels: the respondent level and the partnership level. The respondent level refers to the characteristics of men practicing concurrency in this study - the unit of analysis is men. The partnership level refers to the characteristics of partnerships that are concurrent - the unit of analysis is partnerships. At the respondent level, χ^2 tests were used to assess differences in categorical factors, and logistic regression was used in the analysis of point prevalence to adjust for multiple correlates of interest. Mixed-effect models were used at the partnership level to correct for correlation between the multiple reports provided by each respondent. Separate analyses were carried out for regular/spousal and casual partnerships. Variables were selected for inclusion in multivariable models based on significance in bivariate analyses ($p<0.10$) and previous literature.

To ensure the comparability of our results with those from studies that analyzed partnership data without accounting for multiple reports, population-averaged odds ratios (OR) were calculated by transforming our subject-specific regression estimates as described by Hu et al. [42]. All presented odds ratios are population-averaged. Statistical analysis was performed using SAS v8.2 (SAS Institute, Cary, NC) with the NLMIXED procedure for mixed-effect modeling.

RESULTS

Study sample

We enrolled 1,393 of the 2,059 men who were screened for participation in the RCT between March 2004 and September 2005. Information from 25 enrolled participants was excluded for incomplete (n=20) and unreliable (n=5) data. Of 1,368 men included in the analysis, 1,032 (75%) returned for the 6-month follow-up and 1,041 (76%) returned at 12 months.

Information was available on 11,066 partnerships (7,977 reported by 1368 men at baseline, 1,561 reported by 852 men at 6 months, and 1,528 reported by 860 men at 12 months). Of these, 159 were excluded: 66 for missing start and/or end date, 85 for missing data on key partnership-level variables, and 8 for involving same-gender partners, for a final partnership sample size of 10,907 (99%). The small number (n=8) of same-gender partnerships reported by four men precluded meaningful comparison and they were excluded from the analysis.

Participant characteristics

Study participants were predominantly single (92%), comparatively well educated (>70% had at least a secondary education), and self-identified as belonging to the Luo ethnic group (99%). Median participant age was 20 years and the median age at sexual debut was 15 years. Despite our relatively young sample, 57% reported five or more partners since their sexual initiation, and only 67 (5%) reported having a single lifetime partner. Most men (83%) had a casual partner at some time in their lives; 14% had sex with a sex worker; and 41% had intercourse with a woman the same day they met. Few respondents (7%) consistently used condoms, 74% reported some condom use, and 19% never used condoms. Twenty-one percent (21%) reported history of treatment for an STI.

Prevalence of concurrency

Table 1 provides the comparison of our three point prevalence measures of concurrency (at 6 – month recall - UNAIDS-recommended indicator, at 3-months recall, and at interview) and a 6-month cumulative prevalence. The UNAIDS-recommended indicator was consistently the most conservative point prevalence estimate. Calculations based on 3-month recall produced slightly higher estimates, but lower than point prevalence at interview. As expected, estimates of concurrency were consistently lower when one-month overlap was excluded with 3 to 9% decrease observed in both cumulative and point prevalence. We noted a decrease in prevalence over time, with a considerable drop following the baseline interview with relative stabilization across follow-up visits. Cumulative lifetime prevalence of concurrency was 71% (65% excluding one-month overlap) and 77% (71% excluding one-month overlap) at the beginning and end of the study, respectively.

Partnership-level concurrency and duration of overlap

Sixty-one (61%) percent of all partnerships in our sample were concurrent. Concurrency was present during 58% of regular or spousal partnerships, 63% of casual partnerships and 76% of relationships with sex workers. Excluding one-month overlap, 958 of the 6,700 originally concurrent partnerships were no longer defined as concurrent, reducing partnership concurrency to 52%. These 958 partnerships were characterized by short duration (one month – 57%), few sexual encounters (one - 40%; 2 to 5 – 38%), belief that this partner had other partners at the time of relationship (47%), and always using condom with the partner (46%).

Duration of overlap ranged from 1 month to 107 months (8.9 years), with a mean of 4.9 months and a median of 2 months. Considerable variability by partnership type was noted with regular/spousal partnerships having a mean overlap with other partnerships of 6.7 months (median: 3 months, range: 1-107 months), casual partnerships 3.5 months (median: 1 month, range: 1-99 months), and sex workers 2 months (median: 1 month, range: 1 to 31 months).

Participant characteristics associated with concurrency

In bivariate analyses, the only respondent-level demographic factor significantly associated with having concurrent partnerships was higher income (OR=1.4; 95%CI 1.1-1.8) (Table 2).

Behavioral factors more prevalent among participants who had concurrent partners were: younger age at sexual debut (≤ 15 years vs. >15 years: OR=2.1; 95%CI 1.7-2.7), higher number of lifetime sexual partners (>4 vs. 2-4: OR=7.3; 95%CI 5.5-9.7), and any history of condom use (OR=2.2; 95%CI 1.6-2.9). While HIV status and HIV testing history were not associated with concurrency, ever being treated for an STI was more common (OR=1.5; 95%CI 1.1-2.0) among men having concurrent sexual partnerships.

Correlates of concurrency by partnership type

The likelihood of concurrency was higher when a respondent was in a relationship with a casual partner (OR=1.1; 95%CI 1.1-1.2) or a sex worker (OR=1.6; 95%CI 1.3-2.0) than with a regular/spousal partner. In mixed-effect modeling of regular/spousal partnerships, older age of the man, greater lifetime number of partners, longer duration of the partnership, shorter time knowing the partner before first sex, belief that the partner has other partners, fellatio, and exchanging gifts or money for sex were independently associated with concurrency (Table 3). For casual partnerships, older age of the man at the time of partnership, greater number of lifetime partners, longer duration of partnership, consistent condom use with this partner, believing that the partner is HIV-positive, and the perception that the partner has other partners were associated with the partnership being concurrent (Table 3).

Relationship between concurrency and number of sexual partners

To investigate the extent to which reducing a man's number of partners will reduce concurrency, we plotted the mean proportion of partners that are concurrent by number of lifetime partners (Figure 1). As can be seen in the curvilinear shape of the relationship, the greatest increase in the proportion of concurrent partners with each additional partner occurs in men with history of fewer than 12 partners. Once 18-24 year-old men exceed 18 partners, greater than 90% of those partnerships are concurrent. Viewed another way, the odds of partnership concurrency increase with lifetime number of partners (Figure 2) such that partnerships of men with a history of 5-6 partners have 1.9 times (95% CI: 1.5-2.4) the odds of being concurrent compared to those with 1 to 4 partners. This increases to an OR of 9.6 (95% CI: 7.5-12.2) for partnerships of men with a history of >12 partners.

There was also significant association between lifetime number of partners and point prevalence of concurrency at interview. Adjusted for age, men who had 3-5 partners were 2.7 times (95% CI: 1.6-4.6) more likely to have ≥2 ongoing partnerships in the month of the interview, compared to men with <3 partners, increasing to an OR of 8.6 (95% CI: 5.0-14.7) in men with > 5 lifetime partners. This association of current concurrency with lifetime sexual history indicates that the cumulative sexual experience of an individual does influence the propensity to have concurrent partners at any point in time.

DISCUSSION

We examined the effects of using four different measurement methods on estimating the prevalence of concurrent partnerships. In this study, the UNAIDS-recommended indicator (point prevalence at 6 months before interview) was consistently the most conservative estimate of concurrency, and point prevalence at the time of the interview was consistently the highest. Several studies have found that concurrency prevalence at the time of the interview was equal to or more accurate compared to the UNAIDS indicator [32, 33]. However, it has also been hypothesized to overestimate concurrency, especially in younger men, due to unrealized optimism regarding future sexual encounters with recent partners [43]. Our findings support this hypothesis.

Due to our follow-up schedule, the UNAIDS recommendation for 6-month recall resulted in significant sample restriction (approximately 50% loss). It was hypothesized that a shorter recall period (e.g. 3 months) would maintain the same theoretical advantage in assessment of ongoing relationships, while avoiding missing data and selection bias. An empirical study indicated that stable estimates could be calculated at retrospective points between 3 and 7 months with prevalence decreasing before and after this period [43]. This was not consistent with our finding of relatively unstable estimates and significantly increased estimates at 3 versus 6-month recall. This difference may relate to selection or reporting biases, if men restricted at 6-months were more likely to have concurrent partnerships or if partnerships taking place closer to end of recall were under-reported. This highlights the importance of careful consideration in the application of the UNAIDS suggested recall time point in secondary analyses and in future studies designed specifically to address concurrency.

Exclusion and inclusion of one-month overlap in defining concurrency provides extreme estimates with consequences in two domains: 1) the accurate classification of concurrent partnerships as "partnerships in which sexual intercourse with one partner occurs between two acts of intercourse with another partner" [31]; and 2) assessing the effect of concurrency in the context of HIV and STI transmission [12]. In our sample, the impact of redefining partnerships overlapping during only one month as non-concurrent was significant, reducing both the point and cumulative prevalence of concurrency by 3-9%. This reduction was largely due to redefining short-term (one month) partnerships as non-concurrent. In general, point prevalence tends to exclude partnerships with short-term overlap, and several studies have found that date-based measurement, such as ours, may additionally underreport short-term partnerships [32, 34]. While long-term partnerships may play a greater role in HIV transmission dynamics in the specific context of concurrency [7], a wider view encompassing an appreciation of acute phase viremia and full consideration of short-term relationships in assessing concurrency seems prudent [12].

A common observation, and one noted here, is that early sexual debut and lifetime number of sexual partners are strongly associated with concurrency [21, 24, 27, 35, 44, 45]. Correlatively, a main thrust of the controversy surrounding concurrent partnerships and reduction of HIV incidence is whether interventions specifically addressing it would achieve results beyond existing efforts toward partner reduction [2-4, 7, 8]. That an overall reduction in sexual partners decreases the risk of concurrency is intuitive and supported by our findings (Figures 1 and 2). However, the curvilinear shape of the relationships suggests that for higher risk men, those with a greater lifetime number of partners, a prevention strategy directly addressing concurrency may be more effective than partner reduction alone. Specifically, once a man has reached 18 partnerships his average number of concurrent partnerships becomes largely insensitive to additional relationships. This suggests that, at least for the highest risk men, counseling directed at the dissolution of current partnerships (concurrency reduction) may have importance independent of future partner reduction. Mathematical modeling has also suggested that targeting higher risk men for concurrency reduction would result in the most significant decrease in HIV infections [25].

The factors we found to be associated with concurrency differed by partnership type. Partnerships of longer duration were more likely to be concurrent, which is intuitive, as the probability that an incoming partnership will overlap with a current partnership increases with the partnership duration [35, 44]. Consistent with Kenyon et al., the belief that a partner has other partners was strongly associated with that partnership being concurrent [21]. This either represents a degree of self-justification or a propensity for “open” relationships in both parties, which could further bridge sexual networks and increase the density of network connectivity [10, 21, 23].

Considering that the men in our sample were just 18-24 years of age, we found a remarkably high lifetime concurrency prevalence of 77%. As far as we know, no other study assessed lifetime prevalence of concurrency, but comparing to other long-term cumulative prevalence in South Africa (41% based on last 10 partners) and Kenya (26% in last 9.5 years), our estimate remains high [21, 23]. The point prevalence concurrency estimates observed in this population were also higher than those recently reported throughout sub-Saharan Africa [17, 24, 26, 27] or in Kisumu specifically [23]. As has been discussed, the direct comparison of estimates is problematic; but the overall high HIV risk of this RCT sub-sample likely explains some of these differences. Of note, the only similar level of concurrency published in the region was observed in Kisumu in mid 1990s, concurrent with the peak in the HIV epidemic there [19, 25, 46].

This study has a number of important limitations. The men enrolled were self-selected from sexually active men screened for participation in a RCT for HIV prevention. Levels of concurrency, and overall HIV risk, in the general population are likely lower. At baseline, we collected a comprehensive lifetime sexual history from each participant, and the recall period for this history was as long as 10 years. While the accuracy of recall in our study was enhanced by the use of the Timeline Followback approach, the magnitude and direction of any recall bias could lead to an overestimation or underestimation of long-term concurrency. Our use of face-to-face interview may have resulted in increased social desirability bias; however, this risk was limited by using specially trained interviewers with established rapport over multiple interviews.

Self-reported concurrency was not assessed directly and our data did not allow us to measure any network-level risks associated with concurrency [6]. Lastly, our evaluation of the relationship between concurrency and the number of partners is limited by the intrinsic correlation between the two measures.

CONCLUSION

Our results show that concurrent sexual partners, as part of both regular and casual partnerships and assessed in varying ways and over varying recall periods, are frequent among young, sexually active men in Kisumu – a generalized HIV epidemic setting with an adult HIV prevalence of 20% [47]. While point prevalence at the time of the interview produced higher estimates than point prevalence calculated over longer recall periods, it was more consistent across study visits and less likely to be affected by recall bias, missing data, and sample size fluctuations during follow-up. Further research is needed to explore the effect of the recall period on the timeframe selected for point prevalence calculation, as well as the impact of over- or under-reporting of past, current, and ongoing partners on the magnitude and direction of discrepancies in calculating concurrency [32-34, 43]. Meanwhile, interventions addressing both individual and partnership indicators of concurrency in this population are warranted, whether directed at reducing concurrency specifically or integrated into broader interventions targeting reduction of multiple sexual partners and other behavioral change interventions.

ACKNOWLEDGEMENTS

This work was funded by the Division of AIDS, NIAID, NIH. R.C. Bailey was supported by the NIH funded Chicago Developmental Center for Aids Research. We thank all of the participants, without whom this work would not have been possible. We are grateful to Nicholas Ouma, Evans Otieno, Bob Ogollah, Kevine Amolloh, and the entire UNIM Project staff for their assistance in data collection and recruitment. C.L. Mattson and R.C. Bailey designed the study; C.L. Mattson carried out the study; N. Westercamp analyzed the data and drafted the paper; all authors reviewed and edited the final manuscript.

REFERENCES

1. Epstein H, Morris M. Concurrent partnerships and HIV: an inconvenient truth. J Int AIDS Soc. 2011;14(13):13.
2. Lurie M, Rosenthal S, Williams B. Concurrency driving the African HIV epidemics: where is the evidence? Lancet. 2009;374(9699):1420; author reply -1.
3. Lurie MN, Rosenthal S. The Concurrency Hypothesis in Sub-Saharan Africa: Convincing Empirical Evidence is Still Lacking. Response to Mah and Halperin, Epstein, and Morris. AIDS Behav. 2010;14(1):34.
4. Lurie MN, Rosenthal S. Concurrent partnerships as a driver of the HIV Epidemic in sub-Saharan Africa? The evidence is limited. AIDS Behav. 2010;14(1):17-24; discussion 5-8.
5. Epstein H. The mathematics of concurrent partnerships and HIV: a commentary on Lurie and Rosenthal, 2009. AIDS Behav. 2010;14(1):29-30; discussion 4-7.
6. Morris M. Barking up the wrong evidence tree. Comment on Lurie & Rosenthal, "Concurrent partnerships as a driver of the HIV epidemic in sub-Saharan Africa? The evidence is limited". AIDS Behav. 2010;14(1):31-3; discussion 4-7.
7. Mah TL, Halperin DT. Concurrent sexual partnerships and the HIV epidemics in Africa: evidence to move forward. AIDS Behav. 2010;14(1):11-6; dicussion 34-7.
8. Kalichman SC, Grebler T. Reducing numbers of sex partners: do we really need special interventions for sexual concurrency? AIDS Behav. 2010;14(5):987-90. Epub 2010/06/18.
9. Watts CH, May RM. The influence of concurrent partnerships on the dynamics of HIV/AIDS. Math Biosci. 1992;108(1):89-104.

10. Kretzschmar M, Morris M. Measures of concurrency in networks and the spread of infectious disease. Math Biosci. 1996;133(2):165-95.

11. Morris M, Kretzschmar M. Concurrent partnerships and the spread of HIV. Aids. 1997;11(5):641-8.

12. Eaton JW, Hallett TB, Garnett GP. Concurrent sexual partnerships and primary HIV infection: a critical interaction. AIDS Behav. 2011;15(4):687-92.

13. Powers KA, Ghani AC, Miller WC, et al. The role of acute and early HIV infection in the spread of HIV and implications for transmission prevention strategies in Lilongwe, Malawi: a modelling study. Lancet. 2011;378(9787):256-68.

14. Mermin J, Musinguzi J, Opio A, et al. Risk factors for recent HIV infection in Uganda. Jama. 2008;300(5):540-9.

15. Koumans EH, Farley TA, Gibson JJ, et al. Characteristics of persons with syphilis in areas of persisting syphilis in the United States: sustained transmission associated with concurrent partnerships. Sex Transm Dis. 2001;28(9):497-503.

16. Potterat JJ, Zimmerman-Rogers H, Muth SQ, et al. Chlamydia transmission: concurrency, reproduction number, and the epidemic trajectory. Am J Epidemiol. 1999;150(12):1331-9.

17. Morris M, Epstein H, Wawer M. Timing is everything: international variations in historical sexual partnership concurrency and HIV prevalence. PLoS One. 2010;5(11):e14092.

18. Tanser F, Bärnighausen T, Hund L, et al. Effect of concurrent sexual partnerships on rate of new HIV infections in a high-prevalence, rural South African population: a cohort study. Lancet. 2011;378(9787):247-55.

19. Ferry B, Carael M, Buve A, et al. Comparison of key parameters of sexual behaviour in four African urban populations with different levels of HIV infection. Aids. 2001;15 Suppl 4(4):S41-50.

20. Kwena ZA, Bukusi EA, Ng'ayo MO, et al. Prevalence and risk factors for sexually transmitted infections in a high-risk occupational group: the case of fishermen along Lake Victoria in Kisumu, Kenya. Int J STD AIDS. 2010;21(10):708-13.

21. Kenyon C, Boulle A, Badri M, Asselman V. "I don't use a condom (with my regular partner) because I know that I'm faithful, but with everyone else I do": The cultural and socioeconomic determinants of sexual partner concurrency in young South Africans. Sahara J. 2010;7(3):35-43.

22. Carter MW, Kraft JM, Koppenhaver T, et al. "A bull cannot be contained in a single kraal": concurrent sexual partnerships in Botswana. AIDS Behav. 2007;11(6):822-30.

23. Xu H, Luke N, Msiyaphazi Zulu E. Concurrent sexual partnerships among youth in urban Kenya: Prevalence and partnership effects. Popul Stud (Camb). 2010;64(3):247-61.

24. Sandoy IF, Dzekedzeke K, Fylkesnes K. Prevalence and correlates of concurrent sexual partnerships in Zambia. AIDS Behav. 2010;14(1):59-71.

25. Voeten HA, Egesah OB, Habbema JD. Sexual behavior is more risky in rural than in urban areas among young women in Nyanza province, Kenya. Sex Transm Dis. 2004;31(8):481-7.

26. Kajubi P, Green EC, Hudes ES, et al. Multiple Sexual Partnerships Among Poor Urban Dwellers in Kampala, Uganda. J Acquir Immune Defic Syndr. 2011;57(2):153-6.

27. Steffenson AE, Pettifor AE, Seage GR, 3rd, Rees HV, Cleary PD. Concurrent Sexual Partnerships and Human Immunodeficiency Virus Risk Among South African Youth. Sex Transm Dis. 2011;20:20.

28. Harrison A, Cleland J, Frohlich J. Young people's sexual partnerships in KwaZulu-Natal, South Africa: patterns, contextual influences, and HIV risk. Stud Fam Plann. 2008;39(4):295-308.

29. Lagarde E, Auvert B, Carael M, et al. Concurrent sexual partnerships and HIV prevalence in five urban communities of sub-Saharan Africa. AIDS. 2001;15(7):877-84.

30. Clark S, Kabiru C, Mathur R. Relationship Transitions among Youth in Urban Kenya. J Marriage Fam. 2010;72(1):73-88.

31. UNAIDS. HIV: consensus indicators are needed for concurrency. Lancet. 2010;375(9715):621-2.

32. Glynn JR, Dube A, Kayuni N, et al. Measuring concurrency: an empirical study of different methods in a large population-based survey and evaluation of the UNAIDS guidelines. Aids. 2012;26(8):977-85. Epub 2012/05/05.

33. Helleringer S, Kohler HP, Kalilani-Phiri L, Mkandawire J, Armbruster B. The reliability of sexual partnership histories: implications for the measurement of partnership concurrency during surveys. Aids. 2011;25(4):503-11. Epub 2010/12/09.

34. Maughan-Brown B, Venkataramani AS. Measuring concurrent partnerships: potential for underestimation in UNAIDS recommended method. Aids. 2011;25(12):1549-51. Epub 2011/05/28.

35. Nelson SJ, Manhart LE, Gorbach PM, et al. Measuring sex partner concurrency: it's what's missing that counts. Sexually Transmitted Diseases. 2007;34(10):801-7.

36. Bailey RC, Moses S, Parker CB, et al. Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial. Lancet. 2007;369(9562):643-56.

37. Mattson CL, Bailey RC, Agot K, Ndinya-Achola JO, Moses S. A nested case-control study of sexual practices and risk factors for prevalent HIV-1 infection among young men in Kisumu, Kenya. Sex Transm Dis. 2007;34(10):731-6.

38. Mattson CL, Campbell RT, Bailey RC, et al. Risk compensation is not associated with male circumcision in Kisumu, Kenya: a multi-faceted assessment of men enrolled in a randomized controlled trial. PLoS One. 2008;3(6):e2443.

39. Mattson CL, Campbell RT, Karabatsos G, et al. Scaling sexual behavior or "sexual risk propensity" among men at risk for HIV in Kisumu, Kenya. AIDS Behav. 2010;14(1):162-72.

40. Westercamp N, Mattson CL, Madonia M, et al. Determinants of consistent condom use vary by partner type among young men in Kisumu, Kenya: a multi-level data analysis. AIDS Behav. 2010;14(4):949-59.

41. Carey MP, Carey KB, Maisto SA, Gordon CM, Weinhardt LS. Assessing sexual risk behaviour with the Timeline Followback (TLFB) approach: continued development and psychometric evaluation with psychiatric outpatients. International Journal of STD & AIDS. 2001;12(6):365-75.

42. Hu FB, Goldberg J, Hedeker D, Flay BR, Pentz MA. Comparison of population-averaged and subject-specific approaches for analyzing repeated binary outcomes. American Journal of Epidemiology. 1998;147(7):694-703.

43. Eaton JW, McGrath N, Newell ML. Unpacking the recommended indicator for concurrent sexual partnerships. Aids. 2012;26(8):1037-9. Epub 2012/02/09.

44. Manhart LE, Aral SO, Holmes KK, Foxman B. Sex partner concurrency: measurement, prevalence, and correlates among urban 18-39-year-olds. Sexually Transmitted Diseases. 2002;29(3):133-43.

45. Adimora AA, Schoenbach VJ, Martinson F, et al. Concurrent sexual partnerships among African Americans in the rural south. Ann Epidemiol. 2004;14(3):155-60.

46. NACC and NASCOP. Kenya AIDS Epidemic update 2011. Nairobi, Kenya: 2012.

47. Kenya National Bureau of Statistics (KNBS) and ICF Macro. Kenya Demographic and Health Survey 2008-09. 2010.

TABLES

Table 1. Prevalence of sexual partner concurrency measured by overlapping dates over different recall periods and with inclusion and exclusion of one-month overlap

Concurrency measure	Baseline n (%) N=1,368	6-month visit n (%) N=1,032	12-month visit n (%) N=1,041
Excluding one-month overlap			
Point prevalence 6 months ago (UNAIDS)	**252 (18.4)**	**36 (6.7)**	**51 (9.8)**
Point prevalence 3 months ago	283 (20.7)	97 (9.4)	110 (10.6)
Point prevalence at the time of the interview	345 (25.2)	171 (16.6)	175 (16.8)
Cumulative prevalence, 6 months	716 (52.3)	275 (26.6)	277 (26.6)
Including one-month overlap			
Point prevalence 6 months ago	344 (25.2)	58 (11.1)	83 (15.4)
Point prevalence 3 months ago	388 (28.4)	188 (18.2)	186 (17.9)
Point prevalence at the time of the interview	382 (27.9)	222 (21.5)	217 (20.8)
Cumulative prevalence, 6 months	786 (57.5)	321 (31.1)	326 (31.3)

Note: denominators used for calculation of point prevalence 6 months prior to the interview reflect only men who returned for follow-up ≥ 6 months after the preceding study visit. For men who returned for follow-up earlier than 6 months, point prevalence at 6 months prior to the visit was not possible to calculate. Therefore, for 6-month follow-up, the denominator included n=521; for 12-month follow-up, the denominator included n=539. For further details see methods.

Table 2. Individual participant characteristics: comparison of 18-24 year old sexually active men with and without concurrent lifetime partners at baseline

	Baseline (n=1368)[a]		
	With concurrent partners	**Without concurrent partners**	**p[c]**
Total	**965 (71%)**	**403 (29%)**	
Age at the time of interview			0.07
21-24	468 (48%)	174 (43%)	
18-20	497 (52%)	229 (57%)	
Education			0.12
Primary school or less	202 (21%)	70 (17%)	
Secondary school	547 (57%)	225 (56%)	
Post-secondary school	216 (22%)	108 (27%)	
Religion			0.56
Anglican	135 (14%)	64 (16%)	
Catholic	272 (28%)	105 (26%)	
Other	558 (58%)	234 (58%)	
Employment status			0.31
Employed	203 (21%)	75 (19%)	
Not employed	762 (79%)	328 (81%)	
Income			**0.01**
>2,500 KSH/month	384 (40%)	131 (33%)	
≤2,500 KSH/month	581 (60%)	272 (67%)	
Marital status			0.24
Married or cohabitating	86 (9%)	28 (7%)	
Single	879 (91%)	374 (93%)	
Assigned circumcision group			0.41
Circumcised	429 (44%)	189 (47%)	
Uncircumcised	536 (56%)	214 (53%)	
Age at sexual debut			**<0.001**
≤ 15 years	639 (66%)	194 (48%)	
> 15 years	326 (34%)	209 (52%)	

	Baseline (n=1368)[a]		
	With concurrent partners	**Without concurrent partners**	**p**
Total	**965 (71%)**	**403 (29%)**	
Lifetime number of sexual partners [b]			**<0.001**
5 or more partners	696 (72%)	88 (22%)	
2-4 partners	269 (28%)	248 (62%)	
1 partner	*0 (0%)*	*67 (17%)*	
Ever used condoms with any partners			**<0.001**
Yes	840 (87%)	305 (76%)	
No	125 (13%)	98 (24%)	
HIV status at baseline			0.28
HIV-positive	49 (5%)	15 (4%)	
HIV-negative	916 (95%)	388 (96%)	
Ever tested for HIV outside of the study clinic			0.47
Yes	311 (32%)	122 (30%)	
No	653 (68%)	281 (70%)	
Ever treated for an STI			**0.01**
Yes	222 (23%)	69 (17%)	
No	734 (77%)	334 (83%)	

[a] At baseline, variables refer to the lifetime sexual experience

[b] Participants reporting one partner were not included in this analysis

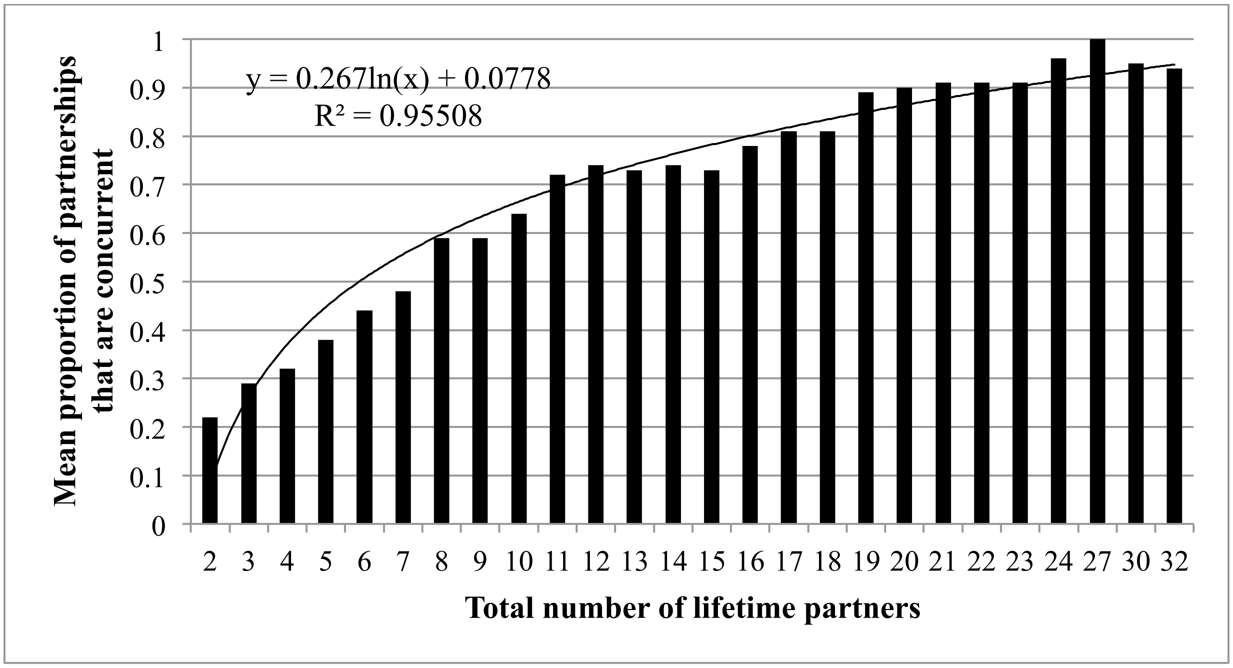
[c] P value from χ^2 test of overall association between having concurrent partners and participant characteristics

Table 3. Unadjusted and adjusted odds ratios for participant and partnership characteristics associated with concurrency in regular/spousal and casual partnerships: results of the mixed-effect modeling.

	Regular partnerships (n=5348)		**Casual partnerships (n=5183)**	
	Unadjusted OR (95% CI)	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Duration of partnership: ≥ 1year	1.98 (1.77; 2.22)[b]	2.29 (2.03; 2.59)[b]	1.66 (1.41; 1.95)[b]	2.50 (2.09; 3.00)[b]
Time knowing this partner before first sex: <6 months	1.31 (1.17; 1.46)[b]	1.24 (1.10; 1.40)[a]	1.30 (1.16; 1.46)[b]	-
Single sexual encounter with this partner	0.68 (0.57; 0.81)[b]	-	0.83 (0.74; 0.93)[a]	-
Partner ≥5 years younger	1.03 (0.89; 1.20)	-	1.76 (1.47; 2.11)[b]	-
Sex during menstruation with this partner	1.33 (1.09; 1.61)[a]	-	1.03 (0.78; 1.37)	-
Receptive oral sex with this partner	2.04 (1.41; 2.96)[b]	1.85 (1.26; 2.72)[a]	1.47 (0.92; 2.37)	-
Exchange of money/gifts for sex with this partner	1.39 (1.12; 1.73)[a]	1.27 (1.01; 1.59)[a]	1.22 (1.02; 1.46)[a]	-
Consistent condom use with this partner	0.77 (0.68; 0.88)[b]	-	1.76 (1.56; 1.99)[b]	1.35 (1.18; 1.54)[b]
Belief that partner is HIV-positive	2.26 (1.04; 4.89)[a]	-	2.3 (1.47; 3.58)[b]	1.79 (1.13; 2.83)[a]
Uncertainty of partner's HIV status	0.93 (0.77; 1.11)	-	1.35 (1.15; 1.59)[b]	-
Belief that partner has other partners	0.99 (0.93; 1.06)	1.48 (1.29; 1.70)[b]	1.06 (0.98; 1.14)	1.22 (1.07; 1.38)[a]
Man's age at the time of partnership: ≥17	1.09 (0.96; 1.24)	1.40 (1.21; 1.62)[b]	2.70 (2.36; 3.08)[b]	2.92 (2.51; 3.39)[b]
Man's lifetime number of sexual partners: ≥5	4.23 (3.33; 5.38)[b]	4.43 (3.46; 5.66)[b]	3.88 (2.85; 5.28)[b]	4.11 (2.99; 5.67)[b]

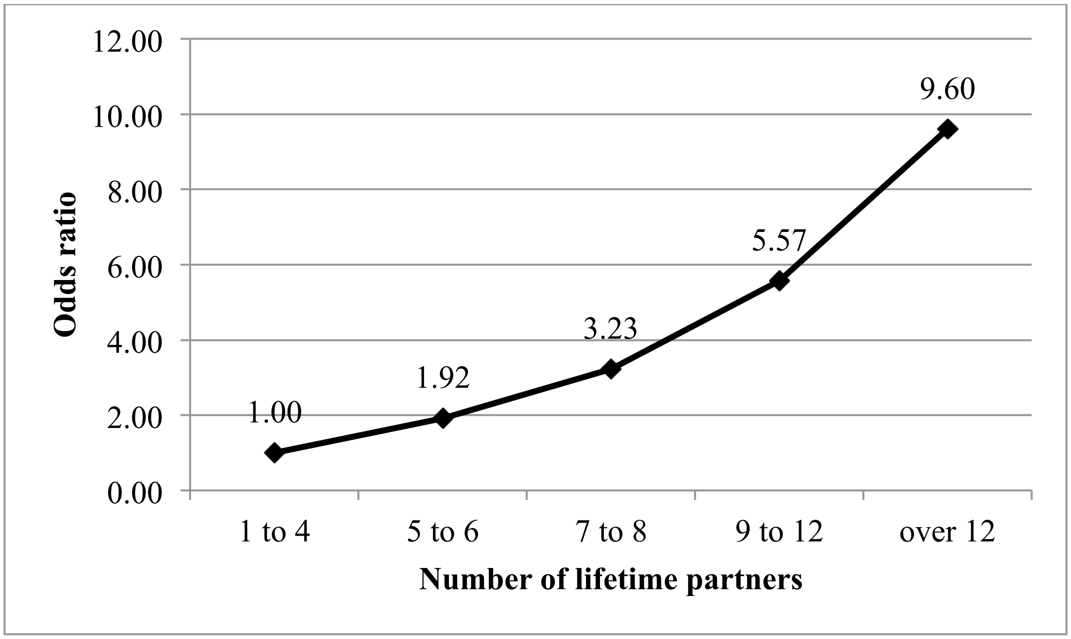
[a] $p<0.05$, [b] $p<0.001$

Figure 1. Mean proportion of partnerships that are concurrent by total number of lifetime partners.



Note: The proportion of partnerships that are concurrent was calculated for each study participant as the number of concurrent partners over the total number of partners. This figure presents the study sample stratified by the total number of partners, with mean proportion of concurrent partners calculated for each stratum. For example, among men who reported 9 lifetime partners, on average 60% of 9 partners were concurrent.

Figure 2. The odds of partnership concurrency as a function of lifetime number of partners



Note: The lifetime number of partners was categorized by quintiles. Reference group is men with 4 or fewer partners.