Title: Social and Sexual Network Factors Associated with Concurrency among Youth in Dar es Salaam, Tanzania

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ABSTRACT

Background: Understanding the social and sexual network factors associated with concurrency may reveal strategic targets for HIV prevention programs for youth. **Methods:** Prior research showed that youth in urban Tanzania participate in "camps", social networks with stable membership. We interviewed members at 10 camps (n = 495 men; 164 women). The UNAIDS method was used to assess concurrency. Social network characteristics were obtained through name generators. Stratified logistic regression analysis was performed in Stata. **Results:** 51% of male and 38% of female camp members reported concurrency during the past 6 months. Youth were more likely to report concurrency if they had a sexual partner at the camp, suggesting that camps may play a role in sexual network formation. Male members were more likely to report concurrency if a greater proportion of their social network engaged in concurrency. **Conclusions:** Future research should investigate how peer social networks may be harnessed to reduce concurrency among youth.

Introduction

In 2009, UNAIDS called for research on understanding the social factors that drive concurrent partnerships in order to better inform HIV prevention programs targeting concurrency [1]. Concurrent sexual partnerships, partnerships that overlap in time, theoretically amplify HIV spread within a population because they decrease the time period between sexual contacts and increase exposure to acute, highly transmissible infections [2-6]. Empirical research has demonstrated that individuals who engage in concurrent partnerships are more likely than those with single or sequential partnerships to acquire HIV and transmit it to their partners [7-9]. The extent to which concurrency has contributed to the generalized HIV epidemic in sub-Saharan Africa has been challenged.[10-12] Whether concurrency is the primary driver of the epidemic or not, it undoubtedly operates synergistically with other sexual partnership dynamics to affect HIV transmission.[13, 14] Furthermore, concurrency reduction programs are being rolled out in ten countries primarily in sub-Saharan Africa[1]. However, studies are lacking regarding the most effective intervention components of such programs [15].

Youth are a strategic target for concurrency reduction interventions because they report the most concurrent partnerships [16-20] and are at a stage when they are forming sexual partnership patterns [21]. One of the strongest influences on youth HIV risk behavior is their peers' behavior [22-24]. Understanding how peers influence risk behavior may be achieved through social network analysis, a methodological tool uniquely suited to determine how social groups influence behavior [25, 26]. Prior studies have demonstrated that *structural characteristics* of networks affect HIV risk behaviors [27, 28]; for example, individuals who are part of dense peer networks are more likely to adopt similar patterns of condom use and are less amenable to change [29]. In the social influence model posits that individuals adopt behavior that is considered normative within their social network [30]. Understanding the contingencies and processes that determine social networks' influence on HIV risk behavior may lead to more effective social network interventions to change such behaviors [25].

This study will examine the associations between youth's social and sexual network characteristics and their engagement in concurrent sexual partnerships in the past six months. Through our previous NIH-funded research in Dar es Salaam, we identified networks of youth who socialized daily in what are called "camps" [31]. Camps are enduring social groups of mostly male youth that have elected leadership, paid membership fees, and physical space to meet. Camps have an average of 53 members and an average lifespan of 8 years. Men in camps reported engaging in HIV risk behavior and other behaviors, such as gender-based violence, that place them and their partners at risk for HIV. Moreover, young men reported being socially pressured by their fellow camp members to engage in concurrent sexual partnerships. In this study we draw on a social influence model to describe the relationship between individual, sexual and social network influences on the camp member's engagement in concurrent sexual partnerships. We stratify our results by male and female camp members.

Methods

Our study site was Tandale, an impoverished ward in Dar es Salaam of about 44,000 people [32, 33], because elevated reports of illicit drug use and commercial sex suggested an increased risk for HIV infections.[34, 35] In our previous NIH-funded research, we applied the PLACE (Priorities for Local AIDS Control Efforts) method to identify the venues where male youth meet new sexual partners.[36] The PLACE method involves a systematic sequence of procedures to identify venues where people at high risk for HIV infection meet each other. We conducted semi-structured interviews with 232 community informants to identify 83 potential venues and interviewed patrons at 66 of the venues, 57 of which were camps.[31]

We selected ten camps for inclusion in this study. In our previous work, we interviewed a subsample of all male camp members who were ages 15-19 at the 57 camps. The rate of men who reported concurrent partnerships at each camp in our previous study ranged from 0-

83% and the inter-cluster correlation coefficient for concurrency by camp was .09. Using our previous data, we ordered the camps from lowest to highest rates of concurrent partnerships and sequentially selected every 6th camp to obtain a random selection of ten camps. All members of the ten camps, regardless of age, were eligible to complete the study.

We obtained consent from the camp leader to survey the members of the camps and requested a membership roster from each camp. All leaders were cooperative and willing to give us the membership lists. To ensure that there were no imposters, we obtained the name, nickname and age of each camp member regardless of gender and age.

Each member was asked if he or she would be willing to complete a one-time hour-long structured survey with a study interviewer. Those members who were interested were asked to provide written informed consent to participate. Those who could not write were allowed to sign with a thumb print. After consent, camp members were interviewed in a quiet, pre-identified location close to their camp. The survey will be completed on paper by the interviewers. All participants and will be given a drink and a snack for their participation. Camp members were provided a referral card with local health resources at the end of their participation. In the event that a member did not participate, we redacted that member's information from all surveys and the membership list. The study was approved by the Institutional Review Board at Duke University and Muhimbili University of Health and Allied Sciences in Dar es Salaam.

Survey instrument

Participants were asked to provide information regarding their demographic characteristics, marital status, education and what level of education they had completed. Participants were asked questions about their sexual networks including whether they had given or received money in exchange for sex in the past twelve months. To assess engagement in concurrent partnerships, participants were asked for their sexual partnership history over the past six months. We used the method for assessing concurrency recommended by UNAIDS [37]. For each of the participant's three most recent partners from the past six months, we asked when they last had sex with the person and how long ago they initiated the sexual relationship. Partnerships classified as concurrent met the following criteria: a) the date of first sex with one partner preceded the date of last sex with another partner; b) sex occurred at least twice with one of the partners. We also asked a series of questions about characteristics of the respondent's three most recent partners, including whether she/he was a member of the camp, whether she/he lived in Tandale, and whether the respondent drank alcohol prior to having sex with the partner. For analysis, responses were categorized according to whether these characteristics were true for any of the respondent's three most recent partners or for none of the respondent's three most recent partners.

To obtain information regarding camp members' social networks and the extent of their overlap, we included several 5-person name-generators that asked participants to name up to five people in a given social domain. Respondents were asked to name up to 15 alters, 5 people with whom they discussed personal matters, 5 people with whom they socialized, and 5 people with whom they had worked in the past 30 days. For each of the alters, respondents specified the alter's name, age and whether the alter was in the same camp as the respondent. Of the 9885 possible alters (659 respondents × 15 alters per respondent), 3373 were labeled as sharing the same camp as the respondent. These alters were matched to the list of respondents using a computerized matching process. Thus, we were able to connect the respondent's data to the data of his/her alters in the same camp.

A SAS program identified close spelling matches[1] between egos and alters using the individuals' last names, first names, and ages. Of the 3373, the SAS program matched 2791 (83%) of the alters. 274 duplicates were removed from the list of 582 unmatched alters, and the remaining 308 unmatched names were visually inspected for matches in the list of respondents.

[1] Close spelling matches were identified using the SAS 9.2 implementation of the Soundex algorithm.

Of the 308, matches were identifies for 233 (76%). When correctly matched, the alter was linked to the caseid of the appropriate respondent. Among the visually inspected alters, 18 were found in different camps; these cases were noted as such.

Social network characteristics were identified for each respondent. These included the density (extent to which alters knew each other) among the up to 15 camp alters named by the respondent; the proportion of these alters who reported engaging in at least one concurrent sexual partnership in the past six months (the denominator was the total number who could have possibly endorsed having had a concurrent sexual partnership); and whether or not the respondent's best friend thought concurrency was a good idea.

Analysis

Our data analysis was completed among the 476 men and 154 women who reported ever having had sex. The dependent variable was whether the respondent reported at least one concurrent sexual partnership in the past six months. We used logistic regression analysis to assess associations between individual, sexual and social network characteristics on concurrency. We stratified the models by male and female camp members. All analyses were completed in Stata 11.0.

Results

The 10 camps selected for this study had an average of 68 members per camp. Out of 662 members total, we interviewed 659, 495 of whom were men. Women ranged from 17-38% of each camp's membership.

Male Camp Members

The average age of the men was 22 (range 14-33) and the women was 21 (range 16-40). 96% of the men and 94% of the women reported ever having sex. The majority (66%) were not in school and still living at home (57%). The men reported an average of 5 years as a camp member and 98% reported being a member of only one camp. About two-thirds (67%) of the men reported that their best friend was a camp member. Over half of the men (51%; n = 261) reported having a concurrent sexual partnership in the past 6 months. Concurrency highly overlapped with having multiple partners in the past 12 months. The correlation between having at least two partners in the last 12 months and having had a concurrent sexual partnership in the past 6 months was .82.

Results of the logistic regression analysis for sexually experienced male camp members are shown in Table 1. In terms of demographic factors, older age was positively associated with concurrency, but being a current student and ever having been married was protective against concurrency. In terms of sexual network characteristics, male camp members who gave someone money in exchange for sex within past 12 months were nearly 4 times more likely to have had a concurrent partnership. Male camp members who reported that at least one of their sexual partners from the past six months was also a member of camp were 4.19 times as likely to have had a concurrent partnership compared to those who did not report having a partner at the camp.

Regarding social network characteristics, the proportion of a respondent's egocentric network that reported concurrent partnerships was associated with a respondent's engagement in concurrency. Finally, male camp members who reported that their best friend thought it was a good idea to engage in concurrency were 2.80 times more likely to have a cc partnership than those whose best friend thought it was not a good idea.

Female Camp Members

The average age of the female camp members was 21 (range 16-40). 94% of the women reported ever having sex. The majority (54%) were not in school and still living at home (74%). The women reported an average of 4 years as a camp member and all of them reported being a

member of only one camp. Over half (59%) of the women reported that their best friend was a camp member. Over one-third of the women (38%; n = 62) reported having at least one concurrent sexual partnership in the past 6 months.

Results of the logistic regression analysis for sexually experienced female camp members are shown in Table 2. Female camp members who reported receiving money in exchange for sex in past 12 months were 55 times more likely to have had a concurrent partnership. Female camp members who reported that at least one of their sexual partners from the past six months was a member of camp were 7.20 times more likely to have had a concurrent partnership than those who had not had a sexual partner from the camp. Female camp members for whom their best friend thought it was a good idea to engage in concurrency were 3.73 times more likely to have a concurrent partnership in the past six months than those whose best friend thought it was not a good idea.

Conclusion

We investigated the factors associated with concurrency for social networks of youth in Dar es Salaam. We performed logistic regression analysis to identify individual, sexual network and social network factors associated with concurrency among male and female members of ten youth camps. Both male and female camp members were more likely to engage in concurrency if they reported having a sexual partner in the past six months who was also a camp member. This suggests that camps may play a role in the formation of these youth's sexual networks. Giving or receiving money in exchange for sex was also a significant factor associated with concurrency. Women were much more likely to have engaged in concurrency if they had received money in exchange for sex in the past 12 months. In addition, male and female camp members were more likely to have had a concurrent partnership in the past six months if their best friend thought that concurrency was a good idea. This is not surprising given that previous studies have reported the strong influence of peers on youth sexual behavior. Male camp members were more likely to engage in concurrency if a greater proportion of their egocentric social network also engaged in concurrency, suggesting that social influence may play a role in these men's behavior. Future studies could investigate the extent to which peer networks such as those in camps may be harnessed to reduce HIV risk behavior among youth.

Table 1. Factors associated with engagement in concurrent partnerships among sexually experienced male members of 10 camps in Dar es Salaam, Tanzania, 2011 (n = 432 in full model)

	Concurrents		Non- Concurrents		Full Model			
	n	%	n	%	OR	95% CI		*p*
Demographic characteristics								
Age (continuous)	n	mean	n	mean				
	272	22.83	202	21.87	1.09	1.00	1.20	0.06
Currently a student								
No	200	75.47	123	61.50	ref			
Yes	65	24.53	77	38.50	0.47	.25	.89	0.02
Education completed*								
Standard 7 or less	94	35.88	73	36.68				
Form 1-3	79	30.15	54	27.14				
Form 4 or higher	89	33.97	72	36.18				
Ever married								
No	220	80.88	165	82.50	ref			
Yes	52	19.12	35	17.50	.47	.22	.98	.05
Sexual network characteristics								
Gave money in exchange for sex within past 12 months								
No	99	36.26	148	76.29	ref			
Yes	174	63.74	46	23.71	3.91	2.46	6.21	0.00
At least one sex partner was a member of the camp								
No	226	83.09	189	95.94	ref			
Yes	46	16.91	8	4.06	4.19	1.62	10.85	.00
Social network characteristics								
	n		mean	n	mean			
Proportion of members of respondent's ego-centric network who reported concurrent partnerships (continuous)								
	273		0.69	199	0.61	2.09	.87	5.01	.10
Density of respondent's ego-centric network (continuous)								
	273		0.13	202	0.13			

Best friend's opinion regarding engaging in concurrency								
Not a good idea	70	26.02	106	53.54	ref			
Good idea	199	73.98	92	46.46	2.80	1.75	4.48	.00

Table 2. Factors associated with engagement in concurrent partnerships among sexually experienced female members of 10 camps in Dar es Salaam, Tanzania, 2011 (n = 139 in full model)

	Concurrents		Non- Concurrents		Full Model			
	n	%	n	%	OR	95% CI		*p*
Demographic characteristics								
Age (continuous)	n	mean	n	mean				
	62	21.02	92	21.5				
Currently a student								
No	36	60.00	50	54.35				
Yes	24	40.00	42	45.65				
Education completed								
Standard 7 or less	24	40.68	26	28.57				
Form 1-3	27	45.76	24	26.37				
Form 4 or higher	8	13.56	41	45.05				
Ever married								
No	49	79.03	73	80.22				
Yes	13	20.97	18	19.78				
Partner characteristics								
Received money in exchange for sex within past 12 months								
No	6	9.68	65	74.71	ref			
Yes	56	90.32	22	25.29	54.73	12.19	245.71	0.00
At least one sex partner was a member of the camp								
No	41	67.21	84	93.33	ref			
Yes	20	32.79	6	6.67	7.20	1.57	32.94	.01
Social network characteristics								
	n		mean	n	mean			
Proportion of members of respondent's ego-centric network who reported concurrent partnerships (continuous)								
	60	.61	91	.56				

Density of respondent's ego-centric network (continuous)								
	62	.18	92	.16				
Best friend's opinion regarding engaging in concurrency								
Not a good idea	30	48.39	74	82.22	ref			
Good idea	32	51.61	16	17.78	3.73	1.08	12.85	.04

1. Eaton JW, Case KK, Secretariat of the UNAIDS Reference Group on Estimates, Modelling, and Projections. Consultation on concurrent sexual partnerships: recommendations from a meeting of the UNAIDS Reference Group on Estimates, Modelling, and Projections held in Nairobi, Kenya, April 20-21st 2009. 2009.
2. Hudson CP. Concurrent partnerships could cause AIDS epidemics. *Int J STD AIDS*. 1993;4:249-253.
3. Morris M, Kretzschmar M. Concurrent partnerships and the spread of HIV. *AIDS*. 1997;11:641-648.
4. Watts CH, May RM. The influence of concurrent partnerships on the dynamics of HIV/AIDS. *Math Biosci*. 1992;108:89-104.
5. Morris MM, Goodreau SM, Moody J. Sexual networks, concurrency, and STD/HIV. In: Holmes KK, Sparling PF, Stamm WE, et al, eds. *Sexually Transmitted Diseases.* 4th ed. New York: McGraw-Hill; 2008:109-125.
6. Pilcher CD, Tien HC, Eron JJ,Jr, et al. Brief but efficient: acute HIV infection and the sexual transmission of HIV. *J Infect Dis*. 2004;189:1785-1792.
7. Potterat JJ, Zimmerman-Rogers H, Muth SQ, et al. Chiamydia Transmission: Concurrency, Reproduction Number, and the Epidemic Trajectory. *Am J Epidemiol*. 1999;150:1331.
8. 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;28:497.
9. Helleringer S, Kohler HP, Kalilani-Phiri L. The association of HIV serodiscordance and partnership concurrency in Likoma Island (Malawi). *AIDS*. 2009;23:1285-1287.
10. 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;14:34.
11. Lurie MN, Rosenthal S. Concurrent partnerships as a driver of the HIV epidemic in Sub-Saharan Africa? The evidence is limited. *AIDS and Behavior*. 2010;14:17-24.
12. Sawers L, Stillwaggon E. Concurrent sexual partnerships do not explain the HIV epidemics in Africa: a systematic review of the evidence. *Journal of the International AIDS Society*. 2010;13.
13. Doherty IA, Shiboski S, Ellen JM, Adimora AA, Padian NS. Sexual bridging socially and over time: a simulation model exploring the relative effects of mixing and concurrency on viral sexually transmitted infection transmission. *Sex Transm Dis*. 2006;33:368-373.
14. Bauch C, Rand DA. A moment closure model for sexually transmitted disease transmission through a concurrent partnership network. *Proc Biol Sci*. 2000;267:2019-2027.
15. Aral SO. Partner concurrency and the STD/HIV epidemic. *Current Infectious Diseases Reports*. 2010.
16. Morris M, Wawer MJ, Podhisita C, Sewankambo N. The thailand and ugandan sexual network studies. In: Morris M, ed. *Network Epidemiology: A Handbook for Survey Design and Data Collection.* Oxford: Oxford University Press; 2004:42.
17. 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;11:822-830.
18. 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;39:295-308.
19. 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;34:731-736.
20. Adimora AA, Schoenbach VJ, Doherty IA. Concurrent sexual partnerships among men in the United States. *Am J Public Health*. 2007;97:2230-2237.
21. Gupta GR. Gender, sexuality, and HIV/AIDS: the what, the why, and the how. *Can HIV AIDS Policy Law Rev*. 2000;5:86-93.

22. Blum RW. Youth in Sub-Saharan Africa. *Journal of Adolescent Health*. 2007;41:230-238.
23. Romer D, Black M, Ricardo I, et al. Social influences on the sexual behavior of youth at risk for HIV exposure. *Am J Public Health*. 1994;84:977-985.
24. Rai AA, Stanton B, Wu Y, et al. Relative influences of perceived parental monitoring and perceived peer involvement on adolescent risk behaviors: an analysis of six cross-sectional data sets. *Journal of Adolescent Health*. 2003;33:108-118.
25. Smith KKP. Social Networks and Health. *Annual review of sociology*. 2008;34:405-429.
26. Luke DA, Harris JK. Network Analysis in Public Health: History, Methods, and Applications. *Annu Rev Public Health*. 2007;28:69-93.
27. Latkin CA, Forman V, Knowlton A, Sherman S. Norms, social networks, and HIV-related risk behaviors among urban disadvantaged drug users. *Soc Sci Med*. 2003;56:465-476.
28. Helleringer S, Kohler HP. Social networks, perceptions of risk, and changing attitudes towards HIV/AIDS: new evidence from a longitudinal study using fixed-effects analysis. *Popul Stud (Camb)*. 2005;59:265-282.
29. Barrington C, Latkin C, Sweat MD, Moreno L, Ellen J, Kerrigan D. Talking the talk, walking the walk: Social network norms, communication patterns, and condom use among the male partners of female sex workers in La Romana, Dominican Republic. *Soc Sci Med*. 2009;68:2037-2044.
30. Montgomery MR, Casterline JB. Social Learning, Social Influence, and New Models of Fertility. *Population and Development Review*. 1996;22:151-175.
31. Yamanis T, Maman S, Mbwambo J, Earp JA, Kajula L. Social venues that protect against and promote HIV risk for young men in Dar es Salaam, Tanzania. *Social Science & Medicine*. 2010;71:1601-1609.
32. Tanzania Research on Poverty Alleviation. Tanzania Poverty and Human Development Report. 2005.
33. National Bureau of Statistics, Tanzania. 2002 Population and Housing Census.
34. McCurdy SA, Ross MW, Kilonzo GP, Leshabari MT, Williams ML. HIV/AIDS and injection drug use in the neighborhoods of Dar es Salaam, Tanzania. *Drug Alcohol Depend*. 2006;82 Suppl 1:S23-7.
35. Dar es Salaam City Council. City Profile for Dar Es Salaam, United Republic of Tanzania. Dar es Salaam: Dar es Salaam City Council; 2004.
36. Weir SS, Pailman C, Mahlalela X, Coetzee N, Meidany F, Boerma JT. From people to places: focusing AIDS prevention efforts where it matters most. *AIDS*. 2003;17:895-903.
37. Modelling, and Projections: Working Group on Measuring Concurrent Sexual Partnerships,UNAIDS Reference Group on Estimates. HIV: consensus indicators are needed for concurrency. *The Lancet*. 2010;375:621-622.