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Assessing the Validity of Sexual Network Degree Among Men Who Have Sex with Men Using Prospective Cohort Data

By

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Master of Public Health

Global Epidemiology

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The University of Texas at Austin

2016

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Abstract

Assessing the Validity of Sexual Network Degree Among Men Who Have Sex with Men using Prospective Cohort Data

By Stephen Uong

Background: Sexual network degree (count of ongoing partners) plays a critical role in HIV/STI transmission dynamics. It is typically measured using cross-sectional data, which may result in biased estimates because of uncertainty about future predictions about partnerships.

Methods: We evaluated the validity of a cross-sectional degree measure with a prospective cohort study of men who have sex with men (MSM). At baseline, men were asked about recent sexual partnerships, and the ongoing status of those partnerships was reevaluated at 6-month follow-up. With Poisson regression, we quantified the confirmed degree as a function of baseline degree. With logistic regression, we assessed the overall probability and predictors of agreement between degree measured at these two time points.

Results: Baseline degree of all partnership types was over-predictive of confirmed degree reported at 6-month follow-up for values of 1 up to 5 for baseline degree and under-predictive for values of 0 for baseline degree in stratified and unstratified models. Confirmed degree was predicted to be 0.28, 0.59, and 1.25 with a baseline degree of 0, 1, and 2 among main partnerships, respectively. Confirmed degree was predicted to be 0.26, 0.44, 0.74, 1.24, 2.09, and 3.51 with a baseline degree of 0, 1, 2, 3, 4, and 5 among casual partnerships, respectively. The odds of reported ongoing status agreement were 1.41 (95% CI, 0.96, 2.07) and 1.85 (95% CI, 1.06, 3.21) times as that in white-white compared to black-black partnerships and in those who had agreement of partnership exclusivity compared to those who had no agreement, respectively.

Conclusion: Network degree may be overestimated in most cases if measured with cross-sectional study designs. Future studies and prevention interventions depending on degree measures should account for this bias through adjustment of their estimates.

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INTRODUCTION

There were estimated to be 1.1 million persons in the United States living with HIV in 2015 (1). Of the 39,720 incident cases that year, 67% were transmitted by male-to-male sexual contact, and 44% were in black compared to 26% of white persons in the same year (1). From 2006 to 2009, the incidence of HIV in the U.S. increased significantly by 48% in young black men who have sex with men (YBMSM) (2). The incidence of HIV infection was higher in black compared to white MSM (6.5 infections/100 PY compared to 1.7 infections/100 PY) in a longitudinal cohort of MSM that was followed from 2010 to 2012 in Atlanta, Georgia (3). A variety of factors have been found to be associated with risk of HIV infection, including multiple partnerships, unprotected anal intercourse, alcohol and drug use, and depression symptoms (4). Sexual network characteristics also put MSM at HIV risk, and are increasingly used as targets for prevention strategies. Assortative mixing by race among black MSM due to racial sexual preferences and HIV stigma promotes within-race partnerships among black MSM. This causes black MSM to experience more sustained prevalence of HIV infection (5). Multiple partnerships may occur as serial monogamy (multiple sequential) or concurrent (multiple overlapping) partnerships. Modeling studies have demonstrated the importance of the distinguishing concurrent partnerships from multiple sequential partnerships by demonstrating the ability of concurrent partnerships to amplify the speed of HIV transmission (5, 6). The 2014 U.S. Public Health Service Clinical Practice Guidelines for Pre-Exposure Prophylaxis (PrEP) recommend PrEP may be indicated for MSM with a “high number of sex partners”, with non-monogamy as a specific indicator (7).

Network degree more broadly is the number of ongoing partners, with concurrency equal to a degree of two or more. Network-based mathematical models commonly use momentary degree measures when estimating HIV transmission and prevalence in sexual networks (8-10). These studies also critically depend on assessments of ongoing partnerships in estimation of average partnership durations, which is based on valid measures of relational start and end dates. Measures of degree are typically based on cross-sectional studies in which persons are asked about the number of ongoing partners on the day of interview ("momentary degree"), which requires a prediction about whether those partnerships will continue.

Because degree measures the anticipated rather than actual future sexual contact with partners, cross-sectional measures of degree may not be an accurate indicator of true degree. To date, there have been no validation studies about degree reported in cross-sectional studies. If partnerships are systematically overpredicted cross-sectionally, for example, estimates for degree and partnership duration would be biased upwards. Previous studies have evaluated agreement in degree measures within sexual dyads and in retrospective partnerships using different degree measurements, but there is a current lack of understanding of the agreement of momentary degree measures with actual degree measured later in time (11, 12). Assessment of the validity of cross-sectional measures of momentary degree would require longitudinal data in which persons would be inquired at a later date to confirm whether the partnerships reported as ongoing truly were ongoing and whether those reported as not ongoing truly were not. Stratification of these biases by partnership type are particularly important, as HIV risk occurs within different partnership types (13, 14). Previous analyses of cross-sectional data have indicated that

the ongoing status of casual (non-main) MSM partnerships are often unknown (15). Validation of degree measures may have important implications for both HIV/STI prevention efforts that use network-based targets and for mathematical modeling studies that incorporate these measures in their parameters.

In this study, we validated a cross-sectional degree measure with longitudinal data that queried on previously reported partnerships. The primary research question was how well the longitudinally validated degree was predicted by the reported degree at baseline (measured cross-sectionally). To maximally inform prevention efforts and modeling activities, we evaluated these associations on different stratifications of baseline degree, by both individual-level and partnership-level attributes. Our goal was to evaluate whether and by how much disagreement between baseline and validated degree measures occurred in order to provide specific bias adjustment factors for future empirical research studies and HIV intervention efforts.

METHODS

Study Design. This analysis used data from InvolveMENt, a prospective cohort study conducted 2010–2012 designed to investigate multilevel factors of HIV incidence among non-Hispanic black and white MSM in Atlanta. Study procedures includes a standardized survey and HIV/STI diagnostic testing results measuring the sociodemographic, biological, and sexual network features hypothesized to influence HIV risk. Study participants were recruited through time-location sampling of sites where MSM congregated in Atlanta and convenience sampling of Facebook visitors. Locations and

time periods were purposefully selected to increase enrollment of black MSM to ensure a balanced cohort.

Enrollment eligibility criteria were male sex, age between 18 and 40, non-Hispanic black or white race, residence in the Atlanta Metropolitan Statistical Area, at least one male sex partner within the past three months, and not being in a mutually monogamous relationship with a man. As shown in Table 1, 560 of the 803 participants (69.7% of study subjects at baseline) who tested as HIV-negative at baseline were enrolled into the study for follow-up visits at 3, 6, 12, 18, and 24 months after enrollment. At each follow-up visit, participants received additional HIV and bacterial STI tests and completed behavioral surveys. Previous reports have described sampling, recruitment, and enrollment protocols in further detail (3, 16). The Emory University Institutional Review Board approved this study.

Measures. Our analyses included measures at baseline and the month 6 follow-up visit. In a sexual partnership module at baseline, subjects reported on up to their 5 most recent partners over the 6 months prior, including whether they perceived these partnerships to be ongoing. Partnerships categorized as ongoing were those with whom subjects expected to have sexual contact again. At the Month 6 (M6) visit, subjects were asked again about the same partners they reported on at baseline. Subjects reported on any sexual activity that occurred with those partners over the interval between baseline and that M6 follow-up visit. In this way, the ongoing status of those partnerships as defined at baseline could be confirmed with this M6 data. Baseline degree was the number of reported ongoing partnerships at the baseline survey. Confirmed degree was the baseline degree confirmed with M6 data. The agreement between the ongoing status at baseline and M6 data could

therefore be evaluated. Confirmed degree would be lower than baseline degree if some partnerships categorized as ongoing at baseline were not truly ongoing after reevaluation at M6. Confirmed degree would be higher than baseline degree if some partnerships categorized as not ongoing at baseline were truly ongoing after reevaluation at M6.

For these analyses, we excluded partnerships with women, missing ongoing partnership measures at baseline or month 6 follow-up, and partners with unknown ongoing status at follow-up. Subjects were allowed to report the ongoing status of any partnership as "Don't Know" at baseline, and we retained this three-level classification (Yes, No, Unknown) in our analyses. We evaluated several predictors for degree agreement, including baseline measurements of HIV status from rapid HIV tests, age, race, total number of male sex partners, and number of condomless male sex partners. Partner-level covariates included partnership type, frequency of sexual contact, race mixing, age mixing, perceived concordant HIV status, and agreement about outside sexual partnerships. Main partnerships were defined as repeated sexual contacts considered as a primary partnership, casual partnerships had repeated sexual contacts without a primary partnership designation, and one-time had (at baseline) no assumed repeated sexual contact.

Statistical Analysis. We compared baseline and month-6 degree by fitting Poisson regression models for main and casual partnership types with baseline degree as the primary predictor, confirmed degree as the outcome, and race and age as covariates. We assessed the effect of various factors of interest on agreement of anticipated ongoing partnerships at baseline and confirmed ongoing partnerships at M6 by fitting partnership-level logistic regression models for main, casual, and one-time partnerships with the

agreement of anticipated and actual ongoing partnerships as the outcome and race-mixing, age-mixing, and frequency of anal and oral sex, perception of concordant HIV status, and agreement of outside sexual partnerships as covariates. For the Poisson and logistic regression models, we fitted separate models that categorized unknown baseline ongoing status as either not ongoing or missing (dropped observations). We reported the full and untransformed regression coefficients for the individual-level Poisson regression models and odds ratios for partner-level logistic regression models. Sandwich variance estimators for robust standard errors were used to calculate 95% confidence intervals for partner-level models to account for nesting of partnerships within individuals. All analyses were conducted using R 3.4.3.

RESULTS

Study subjects in the analytic subset were younger, more white, had better perceived access to hospital or medical care, less likely to test positive for drugs, engaged with more sex male partners but less that were unprotected in the past six months compared to all study participants at baseline (Table 1). In terms of partner-level characteristics, those in the analytic subset reported a higher percentage of repeated partnerships at M6 follow-up, main or casual partnerships compared to one-time partnerships, concordant HIV status with their partner and reported a lower percentage of unprotected anal intercourse as the receptive or insertive partner at last anal intercourse and lower mean absolute difference in age in their partnerships.

Table 2 shows the descriptive agreement between baseline reported degree and confirmed degree at follow-up. Overall, there was agreement and disagreement in the

baseline reported ongoing status and confirmed degree at follow-up in 63.2% and 36.8% of partnerships with known baseline ongoing status, respectively. Of the 1397 total partnerships, 454 (32.5%) had unknown responses for baseline ongoing status. Main partnerships tended to have greater agreement in reports of ongoing partnership across time compared to casual partnerships (68.60% vs. 58.13%). There were higher percentages of one-time and casual partnerships compared to main partnerships that participants reported as unknown for their ongoing status at baseline but as not ongoing as 6-month follow-up (83.3% and 86.3% vs. 60.9%, respectively).

Table 3 displays results of Poisson regression models estimating the association of baseline degree and with confirmed degree. A positive value of the regression coefficient indicates an positive change by a multiplicative factor. For example, confirmed degree increases by a factor of 1.58 times on average with an increase in one baseline degree. In all types of partnerships modeled, when unknown degree at baseline was recoded as missing or not ongoing, and in unstratified and stratified models, increases in the baseline mean degree mean degree resulted in multiplicative increases in confirmed degree. The multiplicative effect and uncertainty in the estimates were greater when unknown baseline degree was coded as missing compared to not ongoing. For example, the confidence intervals in the coefficient comparing white and black participants among main or casual partnerships were larger when unknown baseline degree was coded as missing compared to not ongoing (95% CI, 0.08, 0.85 vs. 0.13, 0.70) as a result of reducing the analytic sample size.

To assess the predictive ability of the mean baseline degree on the mean confirmed degree, we display plots comparing mean baseline degree with the difference

between the baseline and confirmed degrees that consider coding of unknown baseline degree, partnership type, race, and age. In Figure 1, when comparing mean baseline degree with the mean confirmed degree, values below or above the horizontal line indicates that the baseline degree was over-predictive or under-predictive of confirmed degree, respectively. Only degrees of 0 to 2 were included for main partnerships, as that was the range of empirical data, and similarly 0 to 5 for degree of casual partnerships. Confirmed degree was predicted to be 0.28, 0.59, and 1.25 with a baseline degree of 0, 1, and 2 among main partnerships, respectively. Confirmed degree was predicted to be 0.26, 0.44, 0.74, 1.24, 2.09, and 3.51 with a baseline degree of 0, 1, 2, 3, 4, and 5 among casual partnerships, respectively. When ongoing partnerships were coded as not ongoing, baseline degree under-predicts confirmed degree when it is greater than 0 (1-5 degrees for casual partnerships and 1-2 for main partnerships), but baseline degree over-predicts confirmed degree when it is equal to 0 for main and casual partnerships. There were larger uncertainties in confirmed degree prediction when baseline degree was larger due to sparsity in the data. Among casual partnerships, only three study participants had 4 ongoing partnerships, and one study participant had 5 ongoing partnerships.

In Figure 2, we show the results of the stratified model including age and race of the study subject for both main and casual partners when unknown ongoing status at baseline was recoded as not ongoing. In those aged 18-29 in casual or main-partnerships, confirmed degree was predicted to be 0.38, 0.60, 0.94, 1.48, 2.34, and 3.64 among white participants compared to 0.26, 0.41, 0.65, 1.02, 1.61, and 2.54 among black participants with a baseline degree of 0, 1, 2, 3, 4, and 5, respectively. In black participants aged 30-39 in casual or main-partnerships, confirmed degree was predicted to be 0.32, 0.50, 0.79,

1.25, 1.79, 3.11 with a baseline degree of 0, 1, 2, 3, 4, and 5, respectively. Confirmed degree was over-predicted by baseline degree for all baseline degrees above one, but the over-prediction was stronger for black compared to white MSM and younger MSM (those aged 18-29 compared to those aged 30-39).

Table 4 presents results of logistic regression models of association of various factors on agreement of concurrency reporting among MSM at baseline and 6-month follow-up. The odds of reported ongoing status agreement were 2.42 (95% CI, 1.26, 4.66) and 1.61 (95% CI, 1.07, 2.44) times more in white-white partnerships compared to black-black partnerships in main partnerships and one-time partnerships, respectively, when unknown baseline degree was recoded as not ongoing. The odds of reported degree agreement were 1.85 (95% CI, 1.06, 3.21) and 0.97 (95% CI, 0.95, 1.00) times greater in those who had an agreement of no sex with outside partners compared to those who had no agreement across all partnerships and less among those who were one year older on average across all partnerships and in casual partnerships, respectively, when unknown baseline degree was recoded as not ongoing. The odds of reported ongoing status agreement were 2.31 (95% CI, 1.20, 4.81) and 1.71 (95% CI, 1.05, 2.78) times more in white-white partnerships compared to black-black partnerships in main partnerships and one-time partnerships, respectively, when unknown baseline degree was recoded as missing. The odds of reported degree agreement were 2.59 (95% CI, 1.40, 4.80), 1.03 (95% CI, 1.01, 1.04), and 0.97 (95% CI, 0.94, 1.00) times greater in those who had an agreement of no sex with outside partners compared to those who had no agreement across all partnerships and those who had one more oral or anal sex partner within the past six months on average in main partnerships and less among those who were one year

older on average across all partnerships and in casual partnerships, respectively, when unknown baseline degree was recoded as missing.

DISCUSSION

In this study, we found that a cross-sectional measurement of sexual network degree was mostly under-predictive of true network degree as confirmed by follow-up data. These results held across different outcome formulations, regardless of stratification for race and age and recoding of unknown baseline ongoing status (as not ongoing or missing). For men with a baseline degree of 0, baseline degree was over-predictive of confirmed degree across the various partnership types, adjustment, and coding of unknown baseline ongoing status. Over-prediction was stronger for black compared to white MSM and younger MSM (those aged 18–29 compared to those aged 30-39). These findings have important implications for how network degree is measured with cross-sectional study designs, as is most common.

Partnership concurrency has been continuously assessed for its effects in HIV transmission in MSM (13, 17, 18). Previous studies assessing the validity of network-based degree measures were lacking in that they did not assess validity of the same measure across time. The validity of concurrency has been assessed by comparing previous concurrency and dates of partnerships in a survey distributed to MSM.(19) The measures were cross-sectional, and we present a validation of the degree measure across time. Such study designs may substantially overestimate network degree in many cases, and overestimation may differ according to race, agreement of monogamy, and age. Across various partnership types, the odds of agreement in reported ongoing status were greater from those in white-white partnerships compared to black-black partnerships,

those in partnerships with agreement of no sex with outside partners compared to those with no agreement, and less from those who were older among various models when unknown baseline ongoing status recoded as not ongoing.

Network-based studies evaluate momentary degree to model HIV prevalence and transmission when predicting the drivers of HIV and opportunities for prevention. Traditional structures used for network-based models may have poor fit due to the right-skewed distribution of degree sexual networks (20). Adjusting momentary degree measures may provide an opportunity to better understand the actual distribution of degree in order to properly fit network-based models of STIs. Network-based models often use the summary measure of mean degree, which overlooks the heterogeneity of number of contacts by attributes of people in the network that may affect disease transmission (21). Our differential results in agreement of report of ongoing partnership status across two time points for race, agreement of monogamy, and age further suggest that the validity in degree measures may differ by population. In modeling heterogeneous degree measures, our findings suggest that degree measures may be stratified by attribute and identify possible attributes in which degree measures may differ. For example, a network-based model that estimated HIV disparities in race may provide more accurate estimates after differential adjustment of degree measures based on race (22). Modeling studies have incorporated degree measures in understanding the effectiveness of HIV prevention efforts.

These degree adjustments may also have important implications for predictions of the effectiveness of HIV prevention interventions like PrEP. This plays out for both modeling and clinical practice. One example are recent modeling studies for the

effectiveness of HIV PrEP in different contexts and identifying coverage and adherence targets of PrEP (9, 23-25). Potential overestimation of actual degree measures by using reported mean momentary degree measures may result in overestimation of estimated coverage and adherence of PrEP necessary to control HIV epidemics. The empirical effectiveness of implementing PrEP from network-based models may be increased if momentary degree measures were stratified for overestimation. Adjustment of degree measures may have implications not only for PrEP through mathematical modeling but also through clinical practice.

Network degree is often implicit in clinical practice of PrEP prescriptions. Clinicians stereotypes of patients by race were shown to affect whether or not they would decide to prescribe PrEP due to perceived likelihood in engaging in increased unprotected sex after prescription (26). We provide an adjustment factor to account for the number of ongoing partnerships when assessing PrEP prescription for patients and provide an objective method in measuring HIV risk. The use of on-demand pre-exposure prophylaxis (PrEP), in which participants were instructed to take combined doses of tenofovir disoproxil fumarate (TDF) and emtricitabine (FTC) before and after anticipated sex, has been shown to be to be protective against HIV among MSM with frequent sexual activity (27). Assessment of the validity of momentary degree measures would inform possible future analyses on the reliability of momentary degree measures in the decision to prescribe on-demand PrEP for patients. The study was conducted in men with high number of sexual partners (median of 8 partners with an IQR of 5 to 17) and study results cannot be extrapolated to MSM with fewer sexual partners. Another study suggests that on-demand PrEP may be plausibly effective for individuals who may hesitate to use PrEP

due to lower perceived exposure to HIV (28). Initial interventions may include degree as an indicator for potential on-demand PrEP use, and as recommendations for on-demand PrEP related to degree measures are being developed, we recommend that adjusting for measured degree would provide a more accurate assessment of HIV risk.

Limitations. This study had several limitations. First, we excluded 16% of individuals and 21% of partnerships among those enrolled due to the inability to assess the validity of report of ongoing partnerships introduces selection bias as individuals and partnerships who were excluded in the model may be systematically different from those who were included in the analysis. This may have introduced bias in the comparisons of degree measures and agreement of report of ongoing partnerships and may have influenced our results and recommendations. Also, the nicknames that study participants in the InvolveMENt study developed for their partners included names that may have been nondescript (such as single letters) and may have limited the ability of study participants to recall the history of their previous partners at 6-month follow-up. We suggest validating momentary degree using prospective data but acknowledge that given constraints of a study or health intervention, prospective data may not be available and there may be resource and time limitations in collecting such data.

Conclusions. Using prospective cohort data, we show that report of momentary degree measures is under-predictive of actual degree measurement with degrees of 1 to 5 and over-predictive with a degree of 0, and agreement differ by various risk factors. To increase the validity of sexual partnership network degree, we recommend alternative approaches in incorporating degree measures in network-based mathematical models and prevention efforts. If possible, we recommend validating momentary degree reported at

baseline with actual degree measured at follow-up in order to adjust for degree appropriately for use in network-based mathematical models and prevention efforts.

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TABLES

Table 1. Individual-Level and Partnership-Level Characteristics of Baseline Sample, Enrolled Cohort, and Analytic Subset

	Baseline Sample		Enrolled Cohort		Analytic Subset	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**
Individual-Level		*N = 803*		*N = 560*		*N = 469*
Age						
18-19	43	5.35	40	7.14	32	6.82
20-24	247	30.76	189	33.75	150	31.98
25-29	242	30.14	165	29.46	140	29.85
30-39	246	30.64	152	27.14	135	28.78
40 or greater	25	3.11	14	2.5	12	2.56
Race						
Black/African American	454	56.54	257	45.89	205	43.71
White/Caucasian	349	43.46	303	54.11	264	56.29
Sexual Partners in Past 6 Months						
Total Partners (Mean ± SD, Median)		5.54 ± 8.40, 4		5.66 ± 8.29, 3.5		5.77 ± 8.58, 5
Unprotected Partners (Mean ± SD, Median)		2.41 ± 4.61, 1		1.85 ± 3.42, 1		1.80 ± 3.52, 1
HIV Status						
Positive	243	30.26				
Negative	560	69.74				
Partner-Level			*N = 1758*		*N = 1397*	
Ongoing Partnership Reported at Baseline						
Yes			526	35.14	500	35.79
No			482	32.2	443	31.71
Don't know			489	32.67	454	32.50
Repeated Partnership at 6-Month Follow-up			1497	261		
Yes			325	19.83	314	22.48
No			1314	80.17	1083	77.52
Type of Partner						
More than once, main			267	15.30	253	18.11
More than once, casual			533	30.54	494	35.36
Once			945	54.15	650	46.53
Race-mixing						
Black-Black			557	39.62	449	39.04
Black-White			95	6.76	73	6.35
White-White			754	53.63	628	54.61
Age-mixing						
Absolute Difference in Age			8.1	1.91	8.09	1.69
Perceived Concordant HIV Status						
Concordant			965	57.89	814	60.57
Discordant			702	42.11	530	39.43
Oral or Anal Sex with Partner in Past 6 Months						
Total Frequency				12.58 ± 18.38, 4		12.73 ± 18.48, 4
Outside Partnership Agreement						
No Agreement			565	71.61	527	71.6
No Sex with Outside Partners			112	14.2	103	13.99
Sex with Outside Partners with Conditions			43	5.45	40	5.43
Sex with Outside Partners without Conditions			69	8.75	66	8.97

Everyone at baseline includes everyone who met the initial behavioral criteria completed the baseline survey. Those enrolled in the cohort includes only HIV-negative men. The final analytic subset includes only men with same-sex partnerships, no missingness in report of baseline and 6-month degree and no unknown responses for 6-month degree.

Table 2. Baseline versus 6-Month Agreement of Ongoing Status by Partnership Type

Partnership Type	Baseline Ongoing	6-Month Ongoing	
		Yes	**No**
Main (N = 253)	Yes	73 (57.5%)	54 (42.5%)
	No	11 (13.8%)	69 (86.3%)
	Unknown	18 (39.1%)	28 (60.9%)
Casual (N = 494)	Yes	92 (42.4%)	125 (57.6%)
	No	9 (8.7%)	94 (91.3%)
	Unknown	29 (16.7%)	145 (83.3%)
One-Time (N = 650)	Yes	29 (18.6%)	127 (81.4%)
	No	21 (8.1%)	239 (91.9%)
	Unknown	32 (13.7%)	202 (86.3%)
Overall (N = 1397)	Yes	194 (38.80%)	306 (61.20%)
	No	41 (9.26%)	402 (90.74%)
	Unknown	79 (17.40%)	375 (82.60%)

Agreement between baseline and 6-month confirmed degree is compared in the table above. Partnerships with missing baseline and 6-month degree measures, and partnerships with unknown 6-month degree measures are excluded. Percentages of degree cross-tabulations are calculated by partnership type.

Table 3. Individual-Level Poisson Regression Models of Degree at Baseline and Follow-Up

	Partnership Type (Coefficient, 95% CI)*		
	Main or Casual (n = 405)	*Main (n = 220)*	*Casual (n = 299)*
Don't Know = No**			
Unstratified Model			
Intercept	-1.04 (-1.24, -0.85)	-1.28 (-1.65, -0.94)	-1.35 (-1.60, -1.11)
Baseline Mean Degree	0.48 (0.34, 0.56)	0.75 (0.38, 1.13)	0.52 (0.38, 0.65)
Stratified Model			
Intercept	-1.33 (-1.90, -0.75)	-1.73 (-2.63, -0.84)	-1.74 (-2.52, 0.97)
Baseline Mean Degree	0.46 (0.34, 0.57)	0.79 (0.41, 1.19)	0.53 (0.39, 0.67)
Age (Per 5 years)	0 (-0.10, 0.10)	0.03 (-0.13, 0.18)	0.03 (-0.11, 0.16)
Race			
Black	ref	ref	ref
White	0.41 (0.13, 0.70)	0.42 (0, 0.86)	0.34 (-0.04, 0.73)
Don't Know = Missing**			
Unstratified Model			
Intercept	-1.20 (-1.49, -0.93)	-1.55 (-2.05, -1.08)	-1.49 (-1.87, -1.13)
Baseline Mean Degree	0.48 (0.34, 0.61)	0.97 (0.51, 1.44)	0.56 (0.38, 0.72)
Stratified Model			
Intercept	-1.45 (-2.19, -0.71)	-1.97 (-3.01, -0.94)	-1.74 (-2.77, -0.71)
Baseline Mean Degree	0.48 (0.34, 0.63)	1.05 (0.57, 1.55)	0.57 (0.39, 0.74)
Age (Per 5 years)	-0.01 (-0.14, 0.12)	0 (-0.18, 0.17)	0.01 (-0.18, 0.18)
Race			
Black	ref	ref	ref
White	0.46 (0.08, 0.85)	0.56 (0.08, 1.06)	0.31 (-0.19, 0.84)

* Poisson regression models were fitted with the mean degree of individuals at 6-month follow-up as the outcome and baseline mean degree as an exposure. Only individuals in main and casual relationships were modeled.
** Responses for unknown baseline degree were coded as No and Missing when fitting these models.

Table 4. Partner-Level Logistic Regression Models of Concurrency Agreement at Baseline versus 6-Months

	Partnership Type (Odds Ratio, 95% CI)*		
	All (n = 1397)	**Main (n = 253)**	**Casual (n = 494)**
Don't Know = No**			
Age Difference (Per 5 years)	0.91 (0.81, 1.02)	0.91 (0.72, 1.15)	0.90 (0.79, 1.04)
Race-mixing			
Black-Black	ref	ref	ref
Black-White	1.10 (0.50, 2.41)	2.23 (0.43, 11.50)	0.94 (0.37, 2.38)
White-White	1.41 (0.96, 2.07)	2.42 (1.26, 4.66)	0.99 (0.61, 1.61)
Perceived Concordant HIV Status			
Discordant	ref	ref	ref
Concordant	0.82 (0.55, 1.21)	1.10 (0.54, 2.26)	0.73 (0.45, 1.19)
Oral or Anal Sex with Partner in Past 6 Months (Per 5 acts)			
Total Frequency	1.00 (0.95, 1.06)	1.05 (0.97, 1.13)	0.92 (0.84, 1.00)
Outside Partnership Agreement			
No Agreement	ref	ref	ref
No Sex with Outside Partners	1.85 (1.06, 3.21)	1.88 (0.90, 3.94)	0.91 (0.15, 5.59)
Sex with Outside Partners with Conditions	0.58 (0.28, 1.20)	0.37 (0.12, 1.18)	0.79 (0.28, 2.23)
Sex with Outside Partners without Conditions	1.15 (0.59, 2.23)	0.98 (0.40, 2.40)	1.03 (0.29, 3.68)
Don't Know = Missing**			
Age Difference (Per 5 years)	0.87 (0.76, 0.99)	0.88 (0.69, 1.12)	0.86 (0.73, 0.97)
Race-mixing			
Black-Black	ref	ref	ref
Black-White	1.11 (0.45, 2.77)	3.82 (0.54, 26.79)	0.89 (0.31, 2.56)
White-White	1.54 (0.99, 2.40)	2.31 (1.11, 4.81)	1.12 (0.63, 1.98)
Perceived Concordant HIV Status			
Discordant	ref	ref	ref
Concordant	0.83 (0.52, 1.31)	1.03 (0.46, 2.30)	0.73 (0.42, 1.28)
Oral or Anal Sex with Partner in Past 6 Months (Per 5 acts)			
Total Frequency	1.06 (0.99, 1.12)	1.14 (1.04, 1.25)	0.95 (0.87, 1.04)
Outside Partnership Agreement			
No Agreement	ref	ref	ref
No Sex with Outside Partners	2.59 (1.40, 4.80)	2.04 (0.86, 4.79)	1.37 (0.21, 9.10)
Sex with Outside Partners with Conditions	0.75 (0.32, 1.73)	0.39 (0.11, 1.31)	1.01 (0.26, 3.94)
Sex with Outside Partners without Conditions	1.47 (0.73, 2.97)	0.89 (0.32, 2.46)	1.46 (0.41, 5.22)

* Logistic regression models were fitted with agreement of degree reported at baseline and 6-month follow-up as the outcome. Sandwich variance estimators were used to calculate confidence intervals to account for correlation within individuals. Frequency of oral or anal sex and outside partnership agreement were excluded for one-time partnerships due to missingness.

** Responses for unknown baseline degree were coded as No and Missing when fitting these models.

FIGURES

Figure 1. Unstratified Mean Degree Comparison. Responses for unknown ongoing partnership at baseline were coded as No when fitting these models. We calculated mean degree at baseline by averaging the sum of report of ongoing partnerships at baseline. The polygons display the 95% confidence intervals of the difference between the predicted and baseline degree estimates.

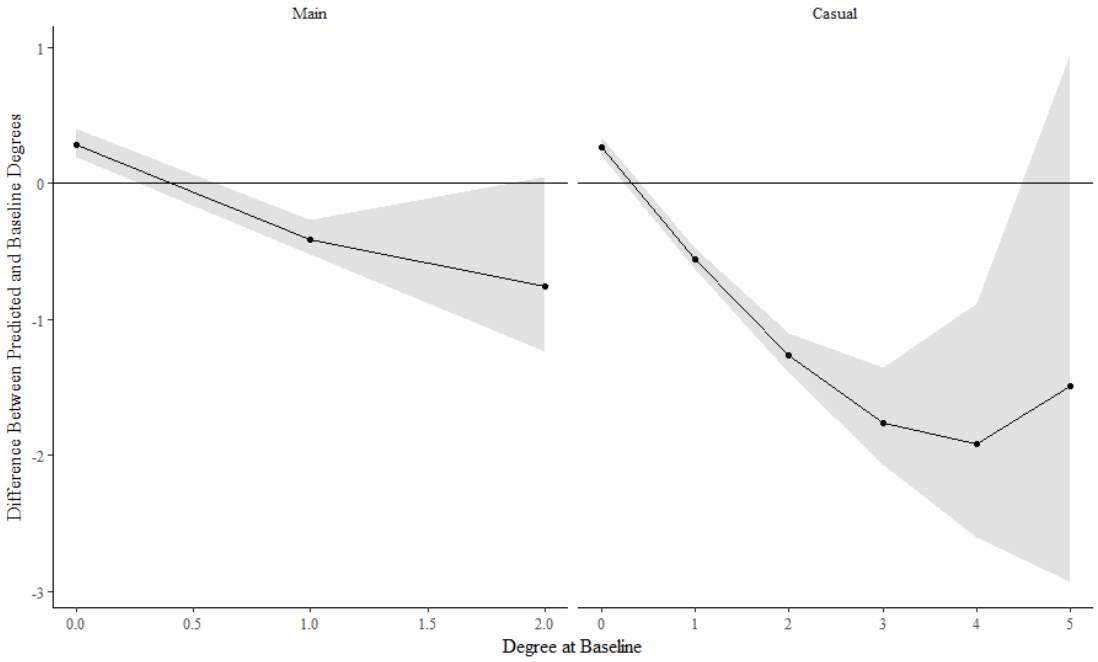

Figure 2. Stratified Mean Degree Comparison. The stratified models accounted for race, partnership type, age category, and responses for unknown ongoing partnership at baseline were coded as No. The plot includes comparisons of degree at baseline and predicted degree at 6-month follow-up for only casual or main partnerships. The polygons display the 95% confidence intervals of the predicted degree estimates.