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Risk factors associated with repeated HIV testing among internet-using men who have sex with men

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Abstract

Background—Men who have sex (MSM) with men represent a disproportionately impacted risk group for HIV incidence among at-risk U.S. populations. Few studies have identified risk factors associated with HIV testing frequency both within and outside of traditional healthcare setting.

Methods—MSM enrolled in a prospective cohort, were mailed at-home specimen collection kit and followed for a year. Incidence density rate ratios (IDRR) of testing were calculated and generalized estimating equations were used to analyze the association between HIV testing and behavioral factors.

Results—The incidence rate of testing was higher among black MSM, compared to white MSM (IDRR: 1.3, 95% confidence interval (CI): 1.1–1.5) and among MSM who reported 3+ condomless anal intercourse partners (CAI), compared to MSM who reported no CAI (IDRR: 1.6, 95% CI: 1.3–2.0).

Conclusion—Increasing availability of HIV testing outside traditional healthcare settings, including at-home testing kits, in conjunction with targeted behavioral interventions and biomedical treatment preventions is needed.

Keywords

HIV Testing; Home HIV Testing; Online HIV Prevention; MSM

Introduction

Men who have sex with men (MSM) represent a disproportionately impacted risk group for HIV within the United States (U.S), accounting for most (61%) new infections annually.¹ Further, in contrast to other risk groups in which HIV incidence rates have declined or

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remained stable, new diagnoses among MSM have continued to increase since 2001.² Among MSM, certain sub-groups are disproportionately affected by the epidemic; young MSM accounted for 72% of new infections in 2010 but comprise only 21% of the U.S. population.³ Further, the estimated number of new infections among young black MSM increased by 20% from 2008 to 2010.³

Recent advances to reduce HIV incidence among MSM can be grouped into three broad categories: biomedical, behavioral, and testing interventions. Testing is an important prevention intervention because HIV-infected individuals aware of their HIV status substantially reduce high-risk sexual behaviors, compared to those unaware of their HIV status.^{4–8} Knowledge of HIV serostatus and associated reductions in high-risk sexual behaviors can decrease HIV transmission by over 30% per year.⁹ In 2012, an estimated 13% of all HIV-infected individuals were unaware of their HIV status.¹⁰ People living with HIV who were unaware of their serostatus accounted for 30% of the approximately 45,000 HIV transmissions that occurred in 2009.¹¹ Specifically, among MSM 66% of the HIV transmissions that occurred within this group, were a result of MSM unaware of their HIV status, highlighting the importance of HIV testing for those at highest-risk.¹¹ Despite its importance, increasing the frequency at which MSM get tested has been challenging.¹²

Currently, the Centers for Disease Control and Prevention (CDC) recommends annual HIV testing for high-risk persons, but suggest that sexually-active MSM could benefit from more frequent testing (3–6 months).^{13,14} However, barriers to HIV testing among MSM still exist, and include the fear associated with a positive diagnosis, privacy concerns, and potential rejection by friends and family members.¹⁵ As a result, there continues to be low rates of annual testing.^{12,15–18} One solution is HIV testing outside of traditional healthcare settings, including at-home testing.

Despite concerns regarding ability to conduct self-tests and test accuracy on the part of participants, oral fluid (OF) and dried blood spot (DBS) collection kits have been successfully incorporated into research studies with majority of high-risk participants returning their biological specimens to a laboratory for HIV testing.^{19–21} Moreover, at-home testing is acceptable among internet-using MSM: a study of 6,163 MSM recruited online found that 62% of participants reported being very likely and 20% likely to accept a free anonymous at-home HIV test as part of future online prevention studies.¹²

Given these trends, it is of substantial public health importance to identify current patterns of HIV testing among MSM, and their relationship to risk behaviors. We sought to identify factors associated with HIV testing among a national prospective cohort of internet-using MSM from the *Checking In* study.²³

Methods

Checking-In

The recruitment details^{22,23} and methods²³ of the *Checking In* study have been previously described. Briefly, *Checking In* was a randomized study to investigate whether making study assessments available through SMS versus online surveys resulted in higher retention of

MSM in a national, “virtual” cohort. Participants were recruited online through selective placement of banner advertisements on social networking sites such as MySpace, Facebook, Adam4Adam, and Black Gay Chat. Eligible men who identified as male were between 18 and 35 years of age; reported at least one male sex partner in the past 12 months; reported non-Hispanic white, non-Hispanic black or Hispanic race/ethnicity; and were willing to participate in an online randomized study over a 12-month follow-up period, which included HIV testing through self-collection and returning a DBS specimen. Men who did not own a mobile phone or had plans of moving out of the U.S. within the next year were excluded. Participants were first administered a baseline online survey. Those who did not report being HIV- at the end of the study were sent an at-home HIV specimen collection kit (Home Access Health Corporation, Hoffman Estates, IL); only men who returned a specimen from the baseline kit were enrolled in the prospective follow-up period. Participants were then randomized to one of two conditions for prospective collection of behavioral data at months 2, 4, 6, 8, and 10: follow-up surveys via SMS or follow-up surveys online. All participants completed a 12-month survey online and were sent another at-home HIV specimen collection kit.

The baseline survey included questions on demographic characteristics; sexual risk behaviors including number of men they engaged in anal or oral sex with, condomless anal intercourse (CAI), and serosorting; as well as their HIV testing history and opinions regarding HIV testing. Follow-up surveys included questions regarding sexual risk behaviors, HIV testing since last survey, and if relevant, questions regarding positive diagnosis, such as disclosure and seeking care. The research study was reviewed and approved by Emory University Institutional Review Board (IRB00031326).

HIV testing

HIV testing questions were asked at both baseline and follow-up. At baseline, HIV testing history was collected from participants, as was the date of their most recent test, where that test was performed, and the result. Because at-home test kits were mailed out to participants who did not report being HIV-positive at the end of the baseline survey, questions regarding HIV testing on follow-up surveys were asked two ways, since your last survey, have you been tested and since you took the at-home test kit, have you been tested. Additionally, participants were asked the result of their most recent HIV test.

While participants had the opportunity to test multiple times in the 2 months between surveys, testing more than once within a 2-month interval has limited prevention value. Therefore, for the purposes of our analysis we assessed testing as a dichotomous variable- either having tested in the 2-month interval or not.

Condomless anal intercourse (CAI)

CAI was asked multiple ways in the survey. Participants who reported only one sex partner either at baseline or at follow-up, were prompted about CAI with that partner, while participants who reported multiple sexual partners either at baseline or at follow-up, were asked with how many of those sex partners they had CAI. Additionally, with respect to their most recent sex partner, participants were asked about condom use for both receptive and

insertive anal intercourse. CAI was coded as a categorical variable, with three categories: (1) no CAI; (2) 1–2 CAI partners; and (3) 3+ CAI partners. For MSM who reported no CAI with partners or whose CAI variable was missing, we confirmed CAI with their responses for condom use (both receptive and insertive) with their most recent sex partner. For MSM who reported no CAI partners or whose CAI was missing, but reported using a condom part of the time; not using a condom; or using a condom, but it broke with respect to their most recent sex partner (both insertive and receptive), we considered those men to have had CAI with their most recent sex partner and were therefore placed in the 1–2 CAI group.

Analysis

Data were analyzed using SAS 9.4 (SAS Institute, Cary, NC, USA) and R 3.2.5 (R Foundation for Statistical Computing, Vienna, Austria). Person-time and number of tests over the course of follow-up were calculated for each stratum of race, education, age, and number of CAI partners. Using person-time and number of HIV tests reported in the 2-month follow-up intervals, incidence density rate ratios (IDRRs) were calculated for each stratum of variables previously listed.

We considered two different classes of statistical models to summarize participant-level risk factors associated with HIV testing: one class models the odds of testing while the second class models the rate of testing. The latter method accounts for elapsed time from baseline to HIV testing times, while the former method summarizes associations between risk factor and testing at the time points of data collection, and then averaged over time.

To examine risk factors associated with testing over six consecutive 2-month intervals of a 12-month study period, we fit a marginal model of the longitudinal binary testing outcome as a function of risk factors (race, education, age, and CAI partners) using generalized estimating equations (GEE). We used GEE to estimate the association between testing and risk factors in the same interval and, in a separate analysis, risk factors in the prior interval (i.e., lagged associations). For both GEE models, we specified an unstructured working correlation model for the repeated testing events; other working correlation models (independence, exchangeable, and first-order auto-regressive) were considered as part of our sensitivity analyses. Intervals missing any of the independent or dependent variables were removed from the regression analysis.

We modeled the testing rate as a function of baseline and time-dependent risk factors (race, education, age, and CAI partners) using statistical methods for the analysis of recurrent event data and, in particular, the Anderson-Gill (AG) model.²⁴ The AG model adopts an ordinary Cox proportional hazards model and disregards the serial order of an event and treats each testing event from a participant as independent.^{24, 25} The AG model was chosen because it makes relatively mild assumptions about the testing event process while still allowing one to draw valid statistical inference about the testing rate, and it is easily fit in standard software. Further, in order to draw the correct statistical inference and compute valid 95% confidence intervals (CI) for hazard ratio (HR) estimates, a robust sandwich covariance was utilized.^{26–28} Data records missing values for any variable were removed during the analysis procedure.

Results

A total of 3,474 men were eligible and consented for the *Checking In* study; however, only 1,489 (43%) men provided valid contact information and initiated a baseline survey. Of those, 716 MSM were HIV-negative after receipt of the at-home test kit and were sent bi-monthly follow-up surveys for 12 months. 443 (62%) men completed all follow-up assessments. Overall, 279 (39%) men reported not testing for HIV at all during their follow-up; 219 (31%) reported testing one time during follow-up, and 218 (30%) reported testing for HIV two or more times during follow-up (Table 1). Person-time, number of HIV tests, HIV testing rates per 100 person-years, and IDRRs by race, education, age, and number of CAI are presented in Table 2. Black MSM had a higher rate of testing, compared to white MSM. There were no differences in HIV testing rate by education or age. Men who reported 3 CAI partners during the 2-month follow-up period reported a higher rate of testing compared to MSM who report no CAI.

Results from the GEE analysis measuring the association of testing in an interval and the risk factors in the same interval and the interval prior are shown in Table 3. Patterns for the odds ratio (OR) estimates mirrored IDRR estimate patterns presented in Table 2. While none of the risk factors were associated with testing in the prior interval, we found the odds of testing in the current interval as CAI were 60% higher among black MSM compared to white MSM. Further, MSM who reported 3+ CAI partners had 2.1 times the odds of testing in the current interval, compared to MSM who reported no CAI (adjusted OR: 2.1, CI: 1.4–3.1).

Finally, results from the AG model measuring the rate of testing are presented in Table 4. Again, patterns seen in the estimates for HRs mirror those seen in both the IDRR and OR estimates (Tables 2 and 3, respectively). Specifically, the rate of testing was 40% higher among black MSM compared to white MSM (adjusted HR: 1.4, CI: 1.2–1.8) and the rate of testing was 80% higher among men who reported 3+ CAI partners compared to MSM who reported no CAI (aHR: 1.8, CI: 1.4–2.4).

Discussion

We sought to measure the rate and identify factors of HIV testing among internet-using MSM in the U.S. over a 12-month period. Results from our study show that black MSM had a higher incidence, rate, and odds of testing, compared to white MSM. Further high-risk MSM, who reported 3 or more CAI partners had a higher incidence, rate, and odds of testing, compared to MSM who reported no CAI.

Our study failed to find some associations with HIV testing that have been reported in other studies. For example, in our data, HIV testing was not significantly related to age. Findings from other studies with regard to this association have been mixed.^{29–32} Lower frequency of testing among young MSM reported in some studies may reflect a generally lower level of healthcare utilization, less testing offered by providers, lower perceived risk of HIV infection, and, for some, lack of medical insurance.³⁰ We also observed no relationship between education and rates of HIV testing among MSM. This association has been reported

in prior studies.^{31–36} In a study of alternative testing strategies, MSM with lower education have higher rates of testing at alternative venues, such as gay pride events, than higher educated MSM, highlighting the fact that alternative testing strategies, such as testing outside of traditional healthcare settings, is feasible for this high-risk group.³¹ One reason we may have failed to demonstrate associations between age and education and HIV testing frequency has to do with the design of our study. In order to join the study, men were required to submit a DBS sample for HIV testing, and were returned the result of that test. Thus, we artificially set a common date of last HIV test for men in the cohort. For men who usually test less frequently, this might have delayed testing that otherwise would have occurred in the months following their enrollment. While this offers some advantage to understanding temporal patterns of testing, it might also tend to bias toward the null for between-group differences in that few men were likely to test in the months immediately after they received an HIV test at study start, regardless of their propensity to test.

Contrary to results from some studies,^{30, 37, 38, 39} identifying as being black in our study was associated with higher frequency and rate of testing. This may be reflected of targeted testing campaigns to this high-risk group. Other studies have shown similar rates of testing among black MSM, compared to white MSM.^{12,40–42} Further, black MSM have been shown to have higher testing rates outside of traditional healthcare settings,³¹ which may be reflective of their access to healthcare and medical insurance, compared to white MSM.^{37,38} White MSM may also experience less discrimination when interacting with healthcare providers, compared to black MSM, increasing their willingness to receive HIV testing through traditional healthcare services.³⁹ Therefore, black MSM may be a more suitable group to target for HIV testing outside of the healthcare system.

However, in order to make a significant impact on the HIV epidemic, there are important considerations for testing outside of traditional settings. For example, persons diagnosed with HIV in non-traditional settings such as mobile clinics, have been shown to be less likely linked to care.^{43,44} While creating awareness is an important first step in the HIV care continuum, individuals need to be linked to care with the goal of achieving viral suppression. Therefore, HIV testing outside of traditional settings needs to be coupled with social support, in an effort to increase linkage to care among those newly diagnosed.

Results from our study suggest MSM who report a higher number of CAI partners have a higher frequency of testing. In studies, higher frequency of testing is associated with perceived risk for HIV infection.^{29,37} In a cohort study of MSM living in San Diego, California, MSM who reported more than 10 male partners and condomless receptive anal intercourse was associated with higher rates of repeat testing.⁴⁵ Testing associated with a high-risk sexual behavior such as CAI may lead to justification of that behavior by the individual if the test results are continuously negative, increasing the risk of HIV transmission.³⁶ This is especially important when considering offering high-risk MSM self-tests such as OraQuick, which has a large window period.^{46,47} Therefore, offering MSM who perceive themselves at high-risk for HIV a variety of testing mechanisms and coupling testing with risk reduction counseling, may help reduce transmission.

Another consideration for high-risk MSM is PrEP, a highly efficacious HIV prevention strategy that has the potential to curtail new HIV infections among MSM in the U.S.^{48,49} In 2014 the Centers for Disease Control and Prevention (CDC) released the first clinical guidelines for the use of PrEP to prevent HIV acquisition among high-risk individuals.⁵⁰ Increasing the number of high-risk MSM on PrEP will also increase the number of these men who regularly test for HIV, as PrEP requires quarterly screening of HIV. However, in order to achieve a higher number of MSM on PrEP, important barriers to PrEP would need to be addressed, such as cost.^{51–54}

Our study is not without limitations. We selected participants from a convenience sample and therefore cannot generalize results to all internet-using MSM in the U.S. Banner advertisements were displayed only to men who self-reported being interested in men in their online profiles, therefore, our findings may be affected by the selection biases inherent in online behavioral research, such as sampling, click-through, and questionnaire dropout biases.⁵⁵ We were unable to verify participants' self-reported demographic and behavioral characteristics, and although some questions in our survey involved a short 2-month recall period, our results could be subjected to recall bias. Although our results point to a clear positive association between numbers of CAI partners and the number of self-reported HIV tests, even after having adjusted for age, race, and education, rates of testing should be interpreted with caution. It is entirely possible that some participants tested in clusters, quite possibly within the same 2-month interval. Our marginal models via GEE only assessed whether the participant tested at least once during the interval or not. Testing more than once within a 2-month interval has limited prevention value, and so we considered multiple HIV tests within an interval as a single test for these analyses. This shortcoming highlights the need for new statistical methods that can overcome the potential biases in cluster testing. However, we did calculate the IDRR, a function of the total number of tests per person-time.

We conducted a number of sensitivity analyses meant to indirectly assess the effect of statistical assumptions on our scientific conclusions. In our marginal models using GEE, we explored other working correlation models that placed more structure on within-participant testing probabilities. Interestingly, when we used exchangeable and first-order autoregressive correlation models, CAI in the prior interval was no longer associated with HIV testing in the current interval but CAI in the same interval remained statistically significant. A possible explanation for this change is that the exchangeable and autoregressive models offer poorer summaries of the within-participant correlation compared to the unstructured correlation model and, therefore, lead to less precise confidence intervals. For modeling the rate of testing from recurring test data, we also considered marginal and conditional models²⁵ in addition to the Anderson-Gill model. Each of these different modeling strategies led to similar estimates of the log relative rates and exactly the same conclusions. Thus, heuristically, these other statistical analyses suggest that the parameter estimates and subsequent conclusions are somewhat robust to statistical modeling assumptions.

Finally, because the *Checking In* study followed participants for 12 months, we could have defined our endpoint as the cumulative sum of HIV tests by the end of follow-up and either regarded the sum as the annual rate or dichotomized the 12-month total (1 or ≥ 1 HIV test) and regarded it as a surrogate measure of repeated HIV testing. [CITE Hoenigl et al.]

However, we wanted to take advantage of the repeated measures design and we were interested in estimating the association between HIV testing and modifiable risk behaviors, both of which may vary longitudinally. Therefore, it was most appropriate to use GEE and Anderson Gill model to measure the odds of testing and the rate of testing, respectively. Our statistical analyses made no attempt to summarize the patterns of HIV testing nor did we consider the regularity of HIV testing across risk strata. There are no methods for summarizing patterns or regularity of HIV testing and this would be another interesting research direction to pursue in the future.

High-risk MSM are not meeting testing recommendations set forth by the CDC,^{17,56} leading to an increase in unawareness of HIV status and an increased probability of HIV transmission, and poor health outcomes.^{16–18} Testing done as a part of routine health care should be supplemented with testing outside of traditional healthcare settings. Alternative testing approaches, including outreach testing and distribution of self-testing kits, also have the potential of overcoming real and perceived barriers to traditional testing approaches faced by MSM in the U.S.⁵⁷ However, scale-up of alternative testing alone will not reduce the incidence of HIV.⁵⁸ Testing services should be coupled with targeted behavioral and education tools, referral to PrEP when appropriate and, for those living with HIV, linkage to care and viral suppression are key to improving health outcomes and reducing the number of HIV transmissions.⁵⁸

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Selected demographic and behavioral characteristics and number of HIV tests during follow-up among 716 MSM in a randomized prevention study, United States, 2010–2012.

Table 1

Characteristic	N	Zero N (%)	One N (%)	Two N (%)	Three N (%)	Four + N (%)
Race						
White	530	182 (38.6)	146 (31)	84 (17.8)	35 (7.4)	24 (5.1)
Black	134	42 (39.3)	26 (24.3)	22 (20.6)	8 (7.5)	9 (8.4)
Hispanic	147	54 (40)	45 (33.3)	18 (13.3)	12 (8.9)	6 (4.4)
Education						
Some HS	13	14 (56)	10 (40)	0 (0)	1 (4)	0 (0)
HS Grad.	101	49 (46.7)	27 (25.7)	21 (20)	4 (3.8)	4 (3.8)
Some College	349	123 (38.8)	104 (32.8)	51 (16.1)	22 (6.9)	17 (5.4)
College Grad.	350	93 (34.6)	78 (29)	52 (19.3)	28 (10.4)	18 (6.7)
Age (years)						
<20	92	43 (45.3)	28 (29.5)	14 (14.7)	7 (7.4)	3 (3.2)
21–24	165	75 (44.1)	47 (27.6)	34 (20)	8 (4.7)	6 (3.5)
25–29	194	61 (37)	49 (29.7)	33 (20)	13 (7.9)	9 (5.5)
30–39	199	53 (33.1)	58 (36.2)	25 (15.6)	14 (8.8)	10 (6.2)
40–49	110	31 (38.3)	25 (30.9)	7 (8.6)	8 (9.9)	10 (12.3)
50+	53	16 (35.6)	12 (26.7)	11 (24.4)	5 (11.1)	1 (2.2)
CAI partners/interval [‡]						
0	565	137 (30.7)	152 (34.1)	93 (20.9)	41 (9.2)	23 (5.2)
1–2	654	167 (32.2)	171 (32.9)	108 (20.8)	43 (8.3)	30 (5.8)
3+	186	21 (20.4)	31 (30.1)	22 (21.4)	16 (15.5)	13 (12.6)

HS: High school; CAI: condomless anal intercourse

* Column percents

[‡] Row percents

Table 2

HIV tests, person-months of follow time, and HIV testing rates among 716 MSM participating in a prospective cohort study, United States, 2010–2012

Characteristic	Person-months of follow-up	Number of HIV tests	HIV testing rate Tests/100 person months (95% CI)	IDRR (95% CI)
Race				
White	4778	530	11.1 (10.2–12.0)	–
Black	948	134	14.0 (11.9–16.4)	1.3 (1.1–1.5)
Hispanic	1306	147	11.3 (9.6–13.1)	1.0 (0.9–1.2)
Education				
Some HS	164	13	7.9 (4.3–13.2)	–
HS Grad.	920	101	11.0 (9.0–13.2)	1.4 (0.8–2.4)
Some College	3138	349	11.1 (10.0–12.3)	1.4 (0.8–2.4)
College Grad.	2816	350	12.4 (11.2–13.7)	1.6 (0.9–2.6)
Age (years)				
<20	878	92	10.5 (8.5–12.7)	0.9 (0.7–1.1)
21–24	1590	165	10.4 (8.9–12.0)	1.0 (0.8–1.2)
25–29	1658	194	11.7 (10.2–13.4)	1.0 (0.8–1.2)
30–39	1674	199	11.9 (10.4–13.5)	–
40–49	814	110	13.5 (11.2–16.1)	1.1 (0.9–1.4)
50+	424	53	12.5 (9.5–16.0)	1.1 (0.8–1.4)
CAI partners/interval				
0	2484	293	11.8 (10.6–13.1)	–
1–2	3230	358	11.1 (10.0–12.2)	0.9 (0.8–1.1)
3+	380	72	19.0 (15.1–23.3)	1.6 (1.3–2.0)

HS: High school; CAI: condomless anal intercourse

Table 3

Time-averaged associations[†] from marginal model where testing is modeled as a function of race, education, age, and CAI partners in the same interval and the interval prior among 638 MSM in a prospective cohort study, United States, 2010–2012.

Characteristic	Same interval		Interval Prior	
	Unadjusted OR 95% CI	Adjusted OR 95% CI	Unadjusted OR 95% CI	Adjusted OR 95% CI
Race				
White	Reference	–	–	–
Black	1.4 (1.1 – 1.9)	1.6 (1.2 – 2.1)	1.3 (0.9 – 1.8)	1.2 (0.9 – 1.7)
Hispanic	1.0 (0.8 – 1.4)	1.2 (0.9 – 1.5)	1.0 (0.8 – 1.3)	1.0 (0.8 – 1.4)
Education				
Some HS	Reference	–	–	–
HS Grad.	1.5 (0.8 – 2.9)	1.5 (0.8 – 3.0)	2.4 (0.9 – 6.6)	2.7 (0.9 – 7.9)
Some College	1.5 (0.8 – 2.8)	1.5 (0.8 – 2.7)	2.2 (0.8 – 5.9)	2.5 (0.9 – 7.1)
College Grad.	1.7 (0.9 – 3.2)	1.7 (0.9 – 3.1)	2.7 (1.0–7.2)	2.8 (0.9–8.1)
Age (years)				
<20	0.9 (0.6 – 1.2)	0.9 (0.6 – 1.3)	0.8 (0.5 – 1.1)	0.8 (0.5 – 1.2)
21–24	0.9 (0.6 – 1.2)	0.8 (0.6 – 1.1)	0.8 (0.6 – 1.1)	0.8 (0.6 – 1.1)
25–29	1.0 (0.7 – 1.3)	0.9 (0.7 – 1.3)	1.0 (0.7 – 1.3)	0.9 (0.7 – 1.3)
30–39	Reference	–	–	–
40–49	1.2 (0.8 – 1.8)	1.1 (0.8 – 1.7)	1.1 (0.8 – 1.7)	1.0 (0.7 – 1.5)
50+	1.1 (0.7 – 1.6)	1.1 (0.7 – 1.6)	0.9 (0.6 – 1.4)	0.9 (0.6 – 1.4)
CAI partners/interval				
0	Reference	–	–	–
1–2	0.9 (0.7 – 1.1)	0.9 (0.8 – 1.1)	1.0 (0.8 – 1.2)	1.0 (0.8 – 1.2)
3+	2.1 (1.4 – 3.0)	2.1 (1.4 – 3.1)	1.6 (1.0 – 2.5)	1.6 (1.0 – 2.5)

HS: High school; CAI: condomless anal intercourse

[†]All time-averaged associations adjust for time main effect in the marginal model

Table 4

Adjusted rates of testing from proportional hazards model where time-to-test is modeled as a function of race, education, age, and time-dependent CAI among 638 MSM in a prospective cohort study, United States, 2010–2012.

Characteristic	Unadjusted HR	95% CI	Adjusted HR	95% CI
Race				
White	Reference	–	–	–
Black	1.3	1.1 – 1.6	1.4	1.2 – 1.8
Hispanic	1.0	0.8 – 1.2	1.1	0.9 – 1.4
Education				
Some HS	Reference	–	–	–
HS Grad.	1.4	0.8 – 2.5	1.4	0.8 – 2.6
Some College	1.4	0.8 – 2.4	1.4	0.8 – 2.4
College Grad.	1.6	0.9 – 2.8	1.5	0.9 – 2.7
Age (years)				
<20	0.9	0.7 – 1.1	0.9	0.7 – 1.2
21–24	0.9	0.7 – 1.1	0.9	0.8 – 1.1
25–29	1.0	0.8 – 1.2	1.0	0.8 – 1.2
30–39	Reference	–	–	–
40–49	1.2	0.9 – 1.5	1.1	0.9 – 1.4
50+	1.1	0.8 – 1.4	1.1	0.8 – 1.5
CAI partners/interval				
0	Reference	–	–	–
1–2	0.9	0.8 – 1.1	1.0	0.8 – 1.1
3+	1.8	1.4 – 2.3	1.8	1.4 – 2.4

HS: High school; CAI: condomless anal intercourse