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Jenna Zagoren April 16th, 2020

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Factors that may explain lower HIV testing among young MSM as compared to older MSM

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Abstract

Factors that may explain lower HIV testing among young MSM as compared to older MSM

By Jenna Zagoren

HIV testing is an important first step in identifying, diagnosing, and treating those who are HIV infected. HIV testing prevalence has increased for the general population of men who have sex with men (MSM). However, progress in testing among younger MSM has lagged, leading to a disproportionate amount of missed diagnoses among this subpopulation. In this study, we analyzed a population of MSM living in the United States who participated in the 2016 American Men's Internet Survey (AMIS) in order to explore factors that may explain the difference in HIV testing between younger and older MSM. We analyzed data on 10,052 participants, 2,684 of whom were 15-24 years old. We conducted univariate and bivariate analyses, as well as logistic regression modeling to estimate effect modification by age for factors associated with the outcome of lack of HIV testing. Among 15-24 year old MSM, the crude odds ratio of never having been HIV tested for those that reported lack of STI testing in the past 12 months (OR = 31.07, 95% Confidence Interval: 22.25, 43.39) was statistically stronger (interaction β p-value = 0.007) compared to the unadjusted odds ratio among those 25 years or older (OR = 13.76, 95% CI: 9.90, 19.11). A statistically significant effect modification was also observed for the factor of reporting that a healthcare provider did not offer an HIV test in the past 12 months (OR among 15-24 year old MSM 28.52 95% CI: 20.69, 39.29; OR among 25 years or older MSM: 9.45, 95% CI: 7.01, 12.75; β p-value = <.0001). Our findings echo earlier research on the importance of future exploration of patient-provider relationships and stigma regarding HIV testing among younger MSM. While our study is not generalizable to MSM who did not take the online survey, our study directly compared younger MSM and older MSM, allowing us to gain improved insight on factors that may have exacerbated effects on testing among younger MSM. Future research should continue to compare younger and older MSM to understand the specific differences in testing associated factors that may impact the success of testing interventions.

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Background/Literature Review

HIV infection has been a nationally recognized epidemic in the United States for several decades. HIV continues to be a complex issue facing at-risk populations. It is an epidemic that is not purely biomedical, but also encompasses economic factors, race/ethnicity factors, and societal beliefs and stigma. Despite targeted prevention methods, it continues to disproportionately affect certain populations in the United States, such as men who have sex with men (MSM) (1, 2). As of 2016, MSM made up nearly 70% of HIV diagnoses, despite only making up 2% of the US population (3). Moreover, HIV incidence decreased by nearly 15% from 2008-2015 among all risk groups except for MSM (3). Based on recent surveillance research, there is a particularly disproportionate effect on younger MSM, stemming from a lack of interventional progress in this sub-population (4). CDC defines HIV youth as 13-24 year old men and women regardless of sexual identity (5). However, 93% of cases of HIV in youth were caused by male-to-male sexual contact (5). Younger MSM are at an increased risk of HIV diagnosis due to related issues such as substance use, unprotected sex, and mental health burden (6).

HIV testing is a critical component of HIV intervention and benefits include earlier infection diagnosis and timely initiation of treatment (1, 3, 7). High rates of undiagnosed infection, due to low rates of testing, are associated with a higher risk of HIV transmission to others through sexual contact or injection drug use (5). In 2015, 17% of the 632,300 MSM living with HIV in the United States were estimated to be undiagnosed and have a greater likelihood of transmitting to sexual partners (8). In 2006, the CDC began recommending that all persons aged 13-64 years be tested for HIV at

least once, and persons at higher risk for HIV infections, including MSM, be screened annually (3, 9). This recommendation is part of CDC's overall approach to increasing HIV awareness in order to reduce the number of undiagnosed infections in the US (8). This recommendation was echoed by multiple organizations, including the US Preventative Services Task Force (4). HIV testing technology has improved, including higher sensitivity and detecting HIV as early as one week after infection (9, 10). Despite improved testing, low HIV testing rates still exist among MSM and other at-risk populations (11).

Income, race, and sexual identity have been found to be associated with the utilization of HIV testing services (2). However, more recent research points to age as another factor associated with HIV testing rates. Several studies found low HIV testing rates as well as high undiagnosed HIV infection rates among younger MSM (2, 8, 12). In one study, 52.2% of MSM aged 13-25 years had undiagnosed HIV infections (3). The 2016 American Men's Internet Survey (AMIS) further confirmed this notion that younger MSM are more likely not to be HIV tested. Approximately 45% of those in the AMIS study aged 15-24 years had been HIV tested in the past 12 months, compared to 56-66% in older age groups of MSM (13). Several qualitative interviews noted potential reasons why younger MSM may not be utilizing HIV testing. These reasons include HIV-related stigma and perception of risk (1, 14). Younger MSM may be facing barriers such as lack of accessibility to HIV testing services, health care, and insufficient sexual health and HIV knowledge (4). Not only is perception of risk underestimated in younger populations, but also many in these studies said they would rather live in the state of not knowing their status than know if they were positive (1, 4). It is not sufficient to create

more HIV testing services for younger MSM if they are not even aware of the need for HIV testing. In order to created effective interventions to improve HIV testing among younger MSM, there needs to be a better understanding of factors explaining lower HIV testing in this target population.

Previous research points to younger MSM as a group that should be highly considered for testing-focused interventions. The more focus put on younger MSM, from survey data analysis to targeted intervention analysis, the better understood the issue regarding lower HIV testing among young MSM will be. Datasets used in previous research may not be as generalizable to younger MSM. A meta-analyses of HIV research concluded that young MSM may be harder to reach through traditional approaches of community or venue-based research/outreach (2). Therefore, the internet may be the most effective way to reach this age group in interventional approaches, as well surveys and data collection. Many HIV testing-related studies used Youth Risk Behavioral Surveillance System data (YRBSS), the Behavioral Risk Factor Surveillance System (BRFSS) data for testing among younger populations, as well as the National Survey of Family Growth (NSFG) data for looking at testing behaviors of MSM across all age groups (4, 7, 11). The YRBSS is limited to survey data on high school students, and the BRFSS data is collected solely through telephone recruitment and interviews (4). The NSFG interview is a face-to face interview (11). The American Men's Internet Survey conducts recruitment and the actual survey through online mediums (13). By conducting analysis on the AMIS dataset, collected by a method effective in reaching younger populations, results may be more generalizable to younger MSM.

There is recent research on reasons why younger populations and MSM do not receive nor use HIV testing (1, 2, 11, 14). However, most of these studies did not assess potential associations with compounding issues related to HIV testing, such as substance use and sexual risk behaviors. In order to address younger MSM HIV testing rates in an impactful way, research must expand analysis on a range of factors that are potentially associated with low rates of HIV testing among this population.

Using data from the 2016 American Men's Internet Survey, this study investigated why younger MSM (aged 15-24) are less likely to be tested for HIV compared to older MSM, by examining potential risk indicators including substance use, sexual behaviors, geographic setting, STI testing, and experiences in a healthcare setting. The purpose of this study is to understand risk factors affecting lower testing rates, with the long-term goal of creating targeted interventions to improve HIV testing among younger MSM.

Methods

We analyzed the 2016 American Men's Internet Survey (AMIS), an annual online behavioral survey of men who have sex with men living in the United States. The survey reflected data collected from September 2016 to February 2017. Participants were eligible if they consented to the study, were at least 15 years of age, considered themselves male, reside in the United States, and reported anal or oral sex with another man.

Participants were recruited from websites using advertisements and email blasts. Those who participated in AMIS 2015 and consented to being contacted for future studies were also emailed to complete the AMIS 2016 survey. The survey was not incentivized. More information on recruiting and data collection methods for AMIS 2016 can be found elsewhere (13).

Almost all variables of interest were dichotomous. For univariate and some bivariate analyses, we used the original categorization of age groups. For logistic regression modeling, we condensed age into two groups: 15-24 year old MSM, and MSM 25 years or older as the reference group. For the outcome, participants had either never been tested for HIV or had been tested for HIV in their life at least once. For demographic variables, we used the original categorization of race/ethnicity. We divided the NCHS classification variable for where participants resided into six variables for descriptive statistical analyses and then condensed this variable into "metro" and "non-metro" categories for bivariate and logistic regression modeling analyses. In the AMIS survey, some questions were answered as "prefer not to answer" or "don't know",

although this was infrequent. We set these answers to missing for the purpose of this study to keep variables dichotomous.

We conducted all analyses in SAS 9.4. We reported the prevalence of participants who had never been HIV tested and those who had been HIV tested. We assessed overall prevalence, as well as across different demographic variables including age, race/ethnicity, education, and 2013 NCHS classification of residence. We conducted statistical analyses estimating the association between various risk factors and the outcome of never receiving HIV testing. We assessed risk factors including demographic variables, risky sexual behaviors, drug use, and variables related to healthcare provider experiences. We selected risk factors for analyses based on literature and availability of data. We conducted chi-square tests to identify whether these characteristics differed significantly between those who had and had not received HIV testing. We applied statistical analyses to both the whole eligible dataset and specifically among 15-24 year old participants.

We used logistic regression models to determine significant predictors of never receiving HIV testing. For predictors such as drug use and risky sexual behaviors, the reference group was those who answered “no” to such behaviors. For predictors such as seeing a health care provider or discussing sensitive topics or health with a provider, the reference group was those who answered “yes”. We then modeled these predictors testing for significant effect modification by age for the outcome of never receiving HIV testing, adjusting for race/ethnicity, education, and NCHS classification of residency when applicable. We reported the estimated odds ratios among 15-24 year old MSM and

among those 25 years or older, their 95% confidence intervals, and the p-value for the β of the interaction term (risk factor*age group).

Results

There were 10,152 eligible men who reported in their 2016 AMIS survey they had sexual interactions with other men. Among this group, 10,052 completed the part of the AMIS survey indicating whether they had ever or never been tested for HIV (Table 1). The 100 who did not report information on testing were excluded from any further analysis. The final eligible sample was 15-88 years old (Table A.1) The majority were non-Hispanic White (69.50%), reported having either a college or post graduate degree (51.48%), and resided in a large central metro classified area (42.29%) (Table 1). Of those who reported they had never been tested for HIV, the average age was 28 years (Table A.1) and 64.04% were 15-24 years. 71.57% were non-Hispanic White, 34.38% had some college or technical degree education, and over 80% lived in a NCHS classified urban area (Table 1).

There were 2,684 eligible 15 to 24 year old MSM. Among this age group sample, the prevalence of HIV testing significantly differed by multiple factors (Table 2). The prevalence of HIV testing differed by demographics including race/ethnicity and NCHS classification of residence. Those who reported unprotected anal sex in the past 12 months (risk ratio = 0.61, 95% confidence interval: 0.55, 0.66) and reported any drug use ((unprescribed injection0 drug use RR = 0.50, 95% CI: 0.27, 0.92) (illicit drug use RR = 0.70, 95% CI: 0.63, 0.78) (marijuana use RR = 0.73, 95% CI: 0.66, 0.81) (other drug use RR = 0.55, 95% CI: 0.47, 0.64)) were less likely to report they had never been tested for HIV. Among 15 to 24 year old MSM, reporting never receiving any STI tests in the past 12 months (RR = 12.94, 95% CI: 9.74, 17.10), lack of seeing a healthcare provider in the

past 12 months (RR = 1.52, 95% CI: 1.37, 1.68), and lack of telling a healthcare provider they were attracted to or had sex with men (RR = 3.85, 95% CI: 1.78, 2.57) were positively associated with reporting they had never been tested for HIV.

Table 3 includes the results of logistic regression models for the outcome of never tested for HIV. Factors relating to lack of testing services and health conversations at healthcare provider visits were generally associated with a higher likelihood of never being tested for HIV. Among 15-24 year old MSM, the crude odds of never having been HIV tested for those that reported lack of STI testing in the past 12 months (OR = 31.07, 95% CI: 22.25, 43.39) was statistically stronger (interaction β p-value = .007) compared to the unadjusted odds ratio among those 25 years or older (OR = 13.76, 95% CI: 9.90, 19.11). This same statistically significant effect modification was observed for the factor of reporting that a healthcare provider did not offer an HIV test in the past 12 months (OR among 15-24 year old MSM 28.52 95% CI: 20.69, 39.29; OR among 25 years or older MSM: 9.45, 95% CI: 7.01, 12.75; β p-value = <.0001). There was an association between lack of HIV testing and lack of telling a healthcare provider that they were attracted to/had sex with men that was a greater value among 15-24 year old MSM (OR = 8.82, 95% CI: 7.27, 10.71) compared to older MSM (7.91, 95% CI: 6.44, 9.72), however the difference between these odds ratios was not of statistical significance.

Reported risky sexual behaviors and drug use were generally associated with a decreased likelihood of participants reporting they had never been tested for HIV. There were no factors under this category that showed a statistically significant stronger association with lack of HIV testing among younger MSM compared to older MSM. Among 15-24 year old MSM, the several high-risk behavior factors had a statistically

significant inverse association with lack of HIV testing (Table 3), including unprotected anal sex in the past 12 months (OR = 0.48, 95% CI: 0.45, 0.53), any injection drug use ever (OR = 0.26, 95% CI: 0.17, 0.40), and other drug use in the past 12 months (OR = 0.52, 95% CI: 0.45, 0.61).

Confounders considered for the adjusted logistic regression models included race, education, and 2013 NCHS classification. Confounders were chosen based on previous literature and associations with risk factors of interest. In general, the odds ratios between the unadjusted versus adjusted models were not meaningfully different. The same factors that were found to have strong crude associations among 15-24 year old MSM, as well as those that saw statistically significant effect modification in which the stronger association was among 15-24 year old MSM, aligned with the results among the adjusted associations.

Discussion

In our study, we found that there are several factors that impact completion of HIV testing more so in younger MSM than older MSM. Since testing is a critical step in treatment and prevention, there is a strong need to identify these factors in order to create appropriately designed and targeted testing interventions. While there has been successful interventions in diverse populations of MSM, previous research has noted a lag in success among younger MSM, noting a higher undiagnosed HIV rate and lower testing rates among adolescent and young adult MSM (11). There is evidence that younger populations have a misperception of risk experience staggering rates of societal stigma, and a greater lack of accessibility to sexual health education and services (4, 15-17). The AMIS dataset provides us the opportunity to conduct exploratory research on risk factors based on previous studies. Previous research commonly studied MSM as a whole population or studied a younger population regardless of gender and sexual orientation. Thus, perhaps most importantly, our study was able to directly compare younger MSM and older MSM sub-populations to highlight potential differences in risk factors, making our results more generalizable to this specific age group of MSM compared to previous studies. Identifying and gathering strong evidence on these risk factors strongly impacting young MSM with regards to testing is a critical first step in designing targeted interventions for this at risk sub-population.

Our study found that lack of any STI testing in the past 12 months and reporting that a healthcare provider did not offer an HIV test at a visit in the past year was statistically significantly more associated with never being HIV tested among younger MSM compared to older MSM. Our findings are consistent with other studies regarding

lack of healthcare providers offering HIV/STI testing to MSM during visits (18, 19). However, our study analyzed these factors directly with whether the participant had ever been HIV tested or not as compared to these previous studies which evaluated these factors' associations with disclosure of sexual orientation. MSM's ambivalence towards seeking information, screening, and care related to sexual health and HIV is well-known as a barrier to HIV diagnosis among all MSM (16-19). However, this is most likely a complex series of factors relating to education, perception of risk, stigma, as well as provider practices and perceptions of their MSM patients. Our findings raise questions related to the previously mentioned issues revolving around healthcare provider visits. Since all eligible participants had been sexually active, it is critical that they receive standard sexual health information and care, including recommendations of STI and HIV testing. These offers are important in increasing HIV diagnoses to protect and treat these vulnerable populations. Some studies have considered that healthcare providers may assume sexual orientations and conduct heteronormative practices among younger MSM, including not offering testing or sexual health information (16, 18). Others believe that young MSM misperceive their risk, fear being outed by their family, and would rather not know their diagnosis as a reason for not being offered HIV or STI testing (1, 4, 17, 19). In order to understand why there is a lack of these critical healthcare services offered to MSM, we must learn more about healthcare provider visits from both the patient and provider perspectives. Moreover, we need further research on younger MSM as a specific high-risk subgroup, as the factors that impact HIV/STI testing could vary greatly from older MSM (20).

Logistic regression did not indicate a statistically significant difference between younger MSM and older MSM for sexual or drug-related risk factors. However, our bivariate analysis determined that among 15-24 year old MSM in our dataset, those who engaged in risky behaviors such as unprotected sex or any type of drug use had a lower likelihood of reporting they had never been tested for HIV. These results are consistent with previous research, however reasons explaining these associations has yet to be solidified (11, 14). Some researchers conclude that prevalence of these risk behaviors may be underestimated among those who do not get HIV tested due to a variety of factors(2, 14). Some note evidence such as misperception of risk of HIV despite engaging in risky behaviors and evidence of a significant lag time between sexual debut and first test for HIV (4, 16). However, with the evidence that younger MSM lack HIV and sexual health knowledge, misperceive their risk of HIV, and fear breach of confidentiality of sexual orientation and potential positive diagnoses, we must consider the possibility that reasons explaining these associations may differ for this MSM subgroup (4, 15, 17). Many questions in the 2016 AMIS are sensitive, asking for questions regarding illicit drug use and sexual behaviors. Younger MSM may not be comfortable disclosing such information even in an anonymous online survey, similar to their discomfort with disclosing information to healthcare providers (16, 17). This discomfort and fear of potential HIV diagnoses may also influence response bias: younger MSM who are aware they are not tested for HIV may be less likely to report that they engage in risk behaviors that would prompt testing in a healthcare environment. As noted in previous studies, education and available information on HIV can mitigate many of these fears (4, 17). However, future research should consider these fears and misperceptions among younger

MSM when deciding on data collection methods, and whether recruitment, surveys, or interviews may exacerbate these issues among younger MSM leading to stronger response biases.

There were several factors that there were not statistically significantly associated with younger MSM, although we do feel they should still be considered for future studies and targeting testing interventions for this age group. These are: lack of telling a healthcare provider they are attracted to or had sex with men, no discussion of HIV health with a healthcare provider, and no discussion of sexual health with a healthcare provider. These findings not only echo earlier research, but they also echo the same questions and future directions mentioned in this study (16, 17, 19). We need to study the reasons behind why patients are not disclosing sexual orientation to providers, and in turn why providers are not normalizing sexual health education and recommendations for all patients, MSM or otherwise. There is evidence that these factors and their impact on testing could be widely variable among subgroups of MSM, and thus interventions that work for older MSM may not work for younger MSM (20). Although we did not find stronger associations among young MSM for these factors, previous research has found strong associations between disclosing sexual orientation/history to a provider and HIV testing among younger MSM (17, 19). Moreover, these factors are related to factors we found to be statistically significant in our study, indicating they should still be considered important to future research directions. Many studies evaluated these factors for MSM and younger populations without expanding among different subgroups. Our study was able to directly compare younger and older MSM, providing direct comparisons of risk factors for HIV testing between these two populations. Future studies with similar

modeling and comparison of these populations will continue to increase insight into how we can tailor research and interventions targeting younger MSM HIV testing rates.

Strengths and Weaknesses

There were several limitations to our study. Since this is an online survey, there is no way to ascertain the accuracy of participants' responses. However, given the nature of anonymity of an online survey as opposed to an in-person interview, this may mitigate some response bias many participants may feel towards more sensitive questions. In our eligible dataset, the majority of participants were non-Hispanic White and there was relatively little representation of minorities (Table 1). Thus, we were unable to evaluate any differences in our estimated associations between races/ethnicities. Since there is evidence that there are racial disparities in HIV testing and diagnoses based on previous research, future studies may want to consider ways to collect a more racially diverse sample (21). AMIS data is not generalizable to all MSM in the United States or MSM online (13). However, this study was able to compare younger MSM to older MSM within the same study, making results more generalizable to younger MSM ages 15 to 24 as opposed to similar studies that look at less-specific populations. Our study serves to be a preliminary analyses and hypothesis generating approach to exploring risk factors related to HIV testing among younger MSM. Although we were able to control for several commonly-known confounders in our modeling, interpretation of our results should be made with caution. It is more important to continue this type of study to create reproducibility and validity than to interpret our results as they are.

Future Directions

Based on our study, there should be a deeper exploration of patient-provider relationships in regard to HIV testing. We were able to estimate risk factors of lower testing for younger MSM, such as lack of STI testing and lack of a healthcare provider offering an HIV test at a visit, but these estimates raise further questions about these potential barriers to HIV testing. It is unknown whether these risk factors result from a young MSM's misperception of risk, discomfort disclosing sexual information and seeking health information from a professional, or if healthcare providers are limiting their efforts and tests due to heteronormative or age assumptions about a patient. Only further research – both studying younger MSM as well as healthcare providers who see younger patients – will help us answer these questions. Also, while our study was able to analyze a large sample of young MSM in the United States, a more racially representative sample may give us deeper insight to risk factors of lower testing. More diverse populations will allow us to assess these same risk factors among different sub-groups in order to better understand sociodemographic disparities. Continuing to compare younger MSM and older MSM in the same study will allow us to compare risk factors and provide evidence of disproportionate effects by age on HIV testing. Even among risk factors that did not show statistical significance or a stronger effect on testing rates among younger MSM, it is important that these factors continue to be assessed in future studies. These factors may indicate to be significant in future studies and future design of targeted testing interventions for younger MSM.

Testing is the first step in the HIV treatment cascade, making it a critical practice for the prevention and control of HIV diagnosis. Not only is HIV a complex, multi-

disciplinary issue, it disproportionately affects a series of high risk sub-populations. The more specific we can be in researching and studying younger MSM, the more effective future interventions will be in increasing testing rates among this high-risk group. It is imperative that we further explore factors related to patient-provider experiences, accessibility to healthcare settings, and high-risk behaviors among younger MSM compared to older MSM in order to better understand how such factors and barriers are disproportionately affecting different sub-populations of MSM.

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Tables

Table 1. Demographic Characteristics of a Cohort of U.S. MSM participating in the 2016 AMIS Survey, by HIV Testing Status

	All MSM (N = 10052)[a]	**Never Tested (N=1713)**	**Ever Tested (N= 8339)**
	n (%)	**n (%)**	**n (%)**
Age (in years)			
15-24	2674 (26.60)	1097 (64.04)	157 (18.91)
25-29	1685 (16.76)	196 (11.44)	1489 (17.86)
30-39	1406 (13.99)	91 (5.31)	1315 (15.77)
40 or older	4287 (42.65)	329 (19.21)	3958 (47.46)
Race/Ethnicity			
White	6986 (69.50)	1226 (71.57)	5760 (69.07)
African American	873 (8.68)	63 (3.68)	810 (9.71)
Asian/Native Hawaiian/Other PI	251 (2.50)	47 (2.74)	204 (2.45)
American Indian/Alaskan Native	66 (0.66)	13 (0.76)	53 (0.64)
Hispanic/Latino	1299 (12.92)	253 (14.77)	1046 (12.54)
Other/Multi	419 (4.17)	77 (4.50)	342 (4.10)
Missing	158 (1.57)	34 (1.98)	124 (1.49)
Education			
< HS diploma	372 (3.70)	233 (13.60)	139 (1.67)
HS Diploma or equivalent	1038(10.33)	339 (19.79)	699 (8.38)
Some college or technical degree	3316 (32.99)	589 (34.38)	2727 (32.70)
College degree or postgraduate	5175 (51.48)	496 (28.96)	4679 (56.11)
Missing	151(1.50)	56 (3.27)	95 (1.14)
NCHS Rural/Urban Classification			
Large Central Metro	4250 (42.28)	469 (27.38)	3781 (45.34)
Large Fringe Metro	2177 (21.66)	405 (23.64)	1772 (21.25)
Medium metro	1922 (19.12)	406 (23.58)	1518 (18.20)
Small metro	834 (8.30)	192 (11.09)	644 (7.72)
Micropolitan	593 (5.90)	164 (9.57)	429 (5.14)
Non-Core	272 (2.71)	81 (4.73)	191 (2.29)
Missing	4 (0.04)	0(0.00)	4 (0.05)

[a]100 MSM who did not report yes or no for testing were ineligible for analysis

Table 2. Distribution and unadjusted risk ratio estimates of potential indicators for never receiving HIV testing in cohort of US MSM aged 15-24 (N=2684) participating in the 2016 AMIS Survey

	Total N	Not HIV Tested N	HIV Tested N	RR (95% CI)	*p*[a]
Race/Ethnicity					0.002
White	1737	753	984	ref	
African American	140	38	102	0.63 (0.47, 0.83)	
Asian/Native Hawaiian/Other PI	96	34	62	0.82 (0.62,1.08)	
American Indian/Alaskan Native	16	8	8	1.15 (0.70, 1.88)	
Hispanic	481	181	300	0.87 (0.76, 0.99)	
Other/Multi	151	59	92	0.90 (0.73, 1.11)	
Urban/rural classification[d]					<0.001
Metro	2361	928	1433	ref	
Non-Metro	312	169	143	1.38 (1.23, 1.54)	
Unprotected anal sex P12M[b]					<0.001
No	945	520	425	ref	
Yes	1729	577	1152	0.61 (0.55, 0.66)	
Unprotected discordant anal sex P12M					0.036
No	2241	939	1302	ref	
Yes	433	158	275	0.87 (0.76, 1.00)	
Any STI Test P12M					<0.001
yes	979	47	932	ref	
no	1695	1050	645	12.90 (9.74, 17.10)	
Unprescribed injection drug use					
No	2623	1085	1538	ref	0.009
Yes	39	8	31	0.50 (0.27, 0.92)	
Illicit drug use P12M					<0.001
No	1640	761	879	ref	
Yes	1034	336	698	0.70 (0.63, 0.78)	
Marijuana use P12M					<0.002
No	1772	799	973	ref	
Yes	902	298	604	0.73	

				(0.66, 0.81)	
Other drug use P12M					<0.001
no	2109	956	1153	ref	
yes	565	141	424	0.55 (0.47, 0.64)	
Told HCP they were attracted to/had sex with men					<0.001
yes	1236	204	1032	ref	
no	1106	703	403	3.85 (3.37, 4.40)	
Saw HCP P12M					<0.001
Yes	1996	749	1247	ref	
No	400	228	172	1.52 (1.37, 1.68)	
Discussed sexual health at HCP visit P12M[c]					<0.001
yes	887	174	713	ref	
no	1088	561	527	2.63 (2.27, 3.04)	
Discussed HIV health at HCP visit P12M[c]					<0.001
Yes	450	95	355	ref	
No	2136	965	1171	2.14 (1.78, 2.57)	
Offered HIV test at HCP visit P12M[c]					<0.001
Yes	855	46	809	ref	
No	1114	689	425	11.45 (8.65, 15.28)	
Received free condoms P12M					<0.001
Yes	1434	427	1007	ref	
No	1194	652	542	1.83 (1.68, 2.02)	

[a]Chi-square test for differences in risk factors between HIV testing groups
[b]Past 12 Months
[c]Among those who saw a Healthcare Provider in past 12 months
[d]NCHS Classifications categorized as: Metro = Large Central Metro, Large Fringe metro, Medium metro, small metro. Non-Metro = Micropolitan, Non-core.

Table 3. Logistic regression modeling summary measures for sample of US MSM 2016 AMIS participants (Outcome = Has Not Been Tested for HIV).

	Crude Model		**Crude Model w/Interaction by Age[a]**			**Adjusted Model w/ Interaction by Age[b]**		
	OR (95% CI)	**p-value**	**$OR_{age=1}$ (95% CI)**	**$OR_{age=0}$ (95% CI)**	**β_1 p-value[h]**	**$OR_{age=1}$ (95% CI)**	**$OR_{age=0}$ (95% CI)**	**β_1 p-value[h]**
NCHS rural/urban classification								
metro	ref	--	ref	ref	--	ref	ref	--
non-metro	2.08 (1.77, 2.43)	<.0001	1.82 (1.44, 2.31)	1.85 (1.43, 2.40)	0.93	1.39 (1.08, 1.79)	1.59 (1.22, 2.07)	0.49
Unprotected anal sex P12M								
no	ref	--	ref	ref	--	ref	ref	--
yes	0.48 (0.43, 0.53)	<.0001	0.41 (0.35, 0.49)	0.51 (0.43,0.60)	0.07	0.42 (0.35, 0.50)	0.50 (0.42, 0.59)	0.16
Unprotected discordant anal sex P12M								
no	ref	--	ref	ref	--	ref	ref	--
yes	0.75 (0.65, 0.86)	<.0001	0.80 (.64, 0.99)	0.75 (0.60, 0.95)	0.72	0.78(0.62, 0.98)	0.76 (0.60, 0.96)	0.85
Any STI test P12M								
yes	ref	--	ref	ref	--	ref	ref	--
no	20.30 (16.27, 25.32)	<.0001	32.28 (23.70, 43.97)	14.81 (10.67, 20.55)	0.0007	31.07 (22.25, 43.39)	13.76 (9.90, 19.11)	0.0007
Unprescribed injection drug use								
no	ref	--	ref	ref	--	ref	ref	--
yes	0.26 (0.17, 0.40)	<.0001	0.37 (0.17, 0.80)	0.40 (0.23, 0.70)	0.87	0.31 (0.13, 0.71)	0.35 (0.20, 0.61)	0.80
Illicit drug use P12M								
no	ref	--	ref	ref	ref	ref	ref	--
yes	0.75(0.66,0.84)	<.0001	0.56(0.47, 0.65)	0.55(.45, 0.68)	0.92	0.61(0.51, 0.72)	0.55(0.45, 0.69)	0.51
Marijuana drug use P12M								
no	ref	--	ref	ref	--	ref	ref	--
yes	0.83 (0.73, 0.94)	0.0027	0.60 (0.51, 0.71)	0.55(0.44, 0.70)	0.58	0.65 (0.55, 0.78)	0.56 (0.44, 0.70)	0.28
Other drug use P12M								
no	ref	--	ref	ref	--	ref	ref	--
yes	0.52 (0.45, 0.61)	<.0001	0.40	0.50	0.18	0.44	0.51 (0.40, 0.67)	0.34

			(0.33, 0.49)	(0.39, 0.65)		(0.35, 0.54)		
Told HCP they were attracted to/had sex with men[c]								
yes	ref	--	ref	ref	--	ref	ref	--
no	10.85 (9.50,12.40)	<.0001	8.82 (7.27, 10.71)	7.91 (6.44, 9.72)	0.45	7.80 (6.47, 9.55)	7.64 (6.19, 9.42)	0.89
Saw HCP P12M[d]								
yes	ref	--	ref	ref	--	ref	ref	--
no	3.10 (2.69, 3.57)	<.0001	2.21 (1.78, 2.74)	3.56 (2.86, 4.43)	0.002	2.17 (1.73, 2.73)	3.29 (2.63, 4.10)	0.01
Discussed sexual health at HCP visit P12M[e]								
yes	ref	--	ref	ref	--	ref	ref	--
no	3.94 (3.39, 4.58)	<.0001	4.36 (3.56, 5.34)	4.99 (3.81, 6.54)	0.44	4.37 (3.54, 5.42)	4.64 (3.54, 6.09)	0.73
Discussed HIV health at HCP visit P12M[f]								
yes	ref	--	ref	ref	--	ref	ref	--
no	3.08 (2,53, 3.76)	<.0001	3.08 (2.42, 3.92)	6.32 (3.98, 10.02)	0.07	3.32 (2.56, 4.30)	6.63 (4.12, 10.68)	0.01
Offered HIV test at HCP Visit P12M								
yes	ref	--	ref	ref	--	ref	ref	--
no	15.84 (12.78, 19.61)	<0.0001	28.52 (20.69, 39.29)	9.45 (7.01, 12.75)	<.0001	24.58 (17.70, 34.15)	8.85 (6.53, 11.99)	<.0001
Received free condoms P12M[g]								
yes	ref	--	ref	ref	--	ref	ref	--
no	2.09 (1.87, 2.33)	<0.0001	2.84 (2.42, 3.33)	2.78 (2.31, 3.35)	0.88	2.33 (1.97, 2.76)	2.62 (2.16, 3.17)	0.37

[a]Age variable dichotomized 15-24, 25 or older (ref. group)

[b]Conducted for Models where interaction term was statistically significant according to interaction assessment

[c]adjusted for race, sti testing P12M

[d]adjusted for sti testing p12m, NCHS classification

[e]adjusted for sti testing p12m, NCHS classification, Saw HCP P12M

[f]adjusted for sti testing p12m, education level

[g]adjusted for race, NCHS classification, education level

[h] β_1 is the p-value for interaction term risk factor*age

Appendix

Table A1. Summary Statistics on Age for All Eligible MSM, Stratified on HIV Testing Outcome[a]

		HIV Testing Outcome	
	All	**Not tested**	**yes tested**
n	10052	1713	8339
mean	38.00	28.12	40.04
standard deviation	16.04	15.38	15.42
median	33	21	38
25th tile	24	18	26
75th tile	52	29	53
min	15	15	15
max	88	80	88
# missing	0	0	0
Skewness	0.46	1.58	0.35
Kurtosis	-1.03	1.27	-1.08
Statistic[b]	0.15	0.26	0.14
P-value[b]	<0.010	<0.010	<0.010

[a]Only MSM with HIV testing information were eligible.
[b]Kolmogrov-Smirnov Test for Normality.