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Trends in Testing Behavior Among Young MSM in the United States from 2013-2018

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TRENDS IN TESTING BEHAVIOR AMONG YOUNG MSM IN THE UNITED STATES FROM 2013-2018

By

JUSTIN JOHNSON

ABSTRACT

According to the Centers for Disease Control (CDC), in 2017 of the 27,000 new HIV diagnoses among the men who have sex with men (MSM) population, individuals between the ages of 13 to 34 made up 64% (17,194) of new HIV diagnoses. But according to CDC's Atlas Plus data tool, the number of HIV diagnoses among MSM aged 13-24 years has been declining since 2014. The aim of this study was to assess changes over time in HIV testing among young MSM, as change in testing behavior is one potential reason for declining HIV diagnoses. Using survey data collected by the PRISM Health Research Team at the Emory University Rollins School of Public Health, HIV testing behaviors of young MSM between the ages of 15-29 from the years 2013 to 2018 were analyzed. The age group and year group was broken down into two groups of 15-24 and 25-29 year olds and 2013-2015 and 2016-2018. A logistic regression model was used to test whether covariates confounded on or had an effect modification on the exposure (year) and outcome (HIV test) of interest. The major finding was that testing behavior among 15-24 year olds remained unchanged across time, but an increase in past year testing was observed in the 25-29 year old group (p-value <0.05). Increased testing among 25–29 year olds was observed at a similar magnitude after accounting for potential confounders and effect modifiers. For the 15-24 year olds, it was found that as the level of educational increased so did the odds of reporting an HIV test in the past year (p-value <0.05).

TRENDS IN TESTING BEHAVIOR AMONG YOUNG MSM IN THE UNITED STATES FROM 2013-2018

BY

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Author's Statement Page

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INTRODUCTION

Men who have sex with men (MSM) are the population that is most impacted by HIV in the United States. According to the Centers for Disease Control (CDC) in 2017, MSM made up approximately 70% (27,000) of the 38,739 new HIV diagnoses in the United States (CDC, 2019) Of the 27,000 new HIV diagnoses among the MSM population, individuals between the ages of 13 to 34 made up 64% (17,194) of new HIV diagnoses in 2017. It is also estimated by the CDC that approximately 492,000 sexually active MSM individuals are at high risk for HIV. The CDC defined the sexually active MSM population as high risk for two reasons. The first reason was that the CDC reports that 1 in 6 gay and bisexual men with HIV do not know that they have HIV. This puts the individual with HIV and their partners at increased risk due to the infected individual not being linked to care thus increasing their probability of transmission due to the disease not being virally suppressed. The second reason that the CDC states the MSM community as individuals are at high risk for HIV is due to socioeconomic factors such as limited access to health care, low income, low educational levels, and higher rates of unemployment which the CDC quotes as greatly increasing these individuals chances of getting or transmitting HIV (CDC, 2019).

A major part of HIV prevention is testing and a 2006 CDC recommendation concluded that all persons aged 13-64 years old should be screened for HIV at least once a year. The CDC recommendation also stated that individuals at higher risk of HIV infection such as those in the MSM community should be rescreened at least once annually totaling in at least two test a year (Branson, 2006).With MSM being the group that is disproportionally impacted by HIV diagnosis, understanding MSM testing behaviors, especially among young MSM, could be crucial to understanding what groups within the MSM community are testing the least and are in need of a potential HIV testing intervention.

According to CDC's Atlas Plus data tool, the number of HIV diagnoses among MSM aged 13 – 24 years has been declining since 2014. The number of HIV diagnoses decreased from 7,334 diagnoses among 13-24 years old to 6,536 diagnoses to 2017, which is approximately a 10.9% decrease in diagnoses over that time period.

When individuals are tested for HIV, if they are found to be HIV positive they can be linked to care sooner and begin taking anti-retroviral treatment in an attempt to virally suppress the virus. This is very important because in a paper written by Dailey et al. "Viral suppression not only preserves immune function, decreasing a person's risk for morbidity and mortality, but also profoundly reduces risk for sexual transmission to others" (Dailey et al., 2017). This emphasizes the importance of individuals being tested for HIV, especially those in the high risk MSM community so that they can be linked to care and become virally suppressed. As stated earlier, the CDC reported that there has been a decline in diagnoses since 2014. However, this decline in diagnoses may be due to either lower prevalence of disease in the MSM population or less HIV testing within the population. The reason that it is difficult to discern between the true meaning behind the decline of HIV diagnosis is due to the fact that diagnoses are reported as counts. Without knowing how many HIV test are administered, it is hard to determine if HIV prevalence is decreasing in the young MSM community or if HIV testing is decreasing in this community. The literature on young MSM and HIV testing addresses some factors that may attribute to HIV testing and diagnosis rates in the United States but the gap in the literature lies in how these factors may have impacted testing over time. Therefore, this analysis will explore

trends and factors potentially associated with changes in HIV testing over time among the young MSM community in the United States.

METHODS

Data Source

The data used in this research were survey data collected by the PRISM Health Research Team at the Emory University Rollins School of Public Health. This research team oversees the annual online cross sectional HIV behavioral survey of men who have sex with men (MSM) in the United States, the American Men's Internet Survey (AMIS). The data were assembled and analyzed using the statistical software SAS. The AMIS survey is an annual online cross-sectional HIV behavioral survey of MSM in the United States. AMIS participants were recruited through convenience sampling from a variety of websites and apps using banner advertisements or email blasts to website members. Men that provided a valid U.S. zip code, resided in the United States, were at least 15 years of age, and reported ever having sex with a man or identified as gay or bisexual were eligible to participate in the study. The AMIS 2016 round of data collection resulted in 10,166 completed surveys from MSM representing every U.S. state, Puerto Rico, Guam, and the US Virgin Islands. The online survey consists of a core questionnaire, including questions that collect basic demographic information and that also pertain to the proposed thesis topic such as: "How old are you" and "Have you ever been tested for HIV." The covariates of interest included race, income, insurance, age, education, and region. Categories for each covariate were as follows: Age [*15-24 and 25-29*] Income [*$0 - $19,999 / $20,000 - $39,999 / $40,000 - $74,999 / $75,000+*], Education *[<HS Diploma, HS Diploma or Equivalent, Some College, College or Post Grad*] Region [*Northeast, Midwest, South, West]* Insurance [*None, Private Only, Public Only, Other/Multiple*], and Race [*White, Black, Hispanic/Latino, Other*]. To define the levels within the insurance covariate, public only would include individuals who only have Medicare or Medicaid healthcare coverage, private only would represent individuals who have only private healthcare coverage such as Kaiser or UnitedHealthcare, and Other/Multiple insurance coverage would be individuals who obtain healthcare services through the Veterans Administration or have multiple forms of insurance coverage types. These covariates would be tested to see whether they had a confounding or effect modifying effect on the relationship between the outcome of interest of reporting to have had HIV test in the past 12 months and the exposure variable of time.

Data Analysis

I examined AMIS survey results from 2013 to 2018 which totaled to over 60,000 study participants across the six collected surveys. Additional inclusion criteria were implemented in the dataset to only include individuals between the ages of 15 to 29 years old. The reason this age range was chosen was due to the fact that it falls within the range that the CDC used in its studies mentioned previously to describe young MSM in the United States. Once the data were restricted to only include study participants between the ages of 15 to 29 years old, the dataset included 24,367 observations. The final two steps of cleaning the data included dividing the year and age variable into two groups (2013-2015 and 2016-2018) and (15-24 and 25-29) respectively. A Chi-square was used to determine statistical significance for all findings in the study.

The aim of this study was to assess testing behavior for young MSM in the United States and analyze the testing trends from 2013 to 2018. To test this, the relationship between time and HIV testing was tested using a chi square test to determine if there was a statistically significant association between the two variables. To assess if the covariates of interest were potentially confounding or effect modifying the relationship between the outcome and exposure variable, a logistic regression model was built. The first step of building the logistic model involved using a Chi-squared test to test associations between each covariate separately with the outcome of interest and exposure of interest. The second step for building the logistic model required calculating prevalence ratios for HIV testing in each year group for each level of the covariates. The prevalence ratio (PR) was calculated based on HIV testing in the year group 2016-2018 compared to reported HIV testing in year group 2013-2015 for each level of each covariate. These PRs were then compared to the overall PR of HIV testing among the entire study population to determine a magnitude of association between the covariates and their association on the relationship between the exposure and outcome variables of interest. Lastly, based on the magnitude of the association between the covariates and its relationship between the exposure and outcome, a decision was made on whether or not to include that covariate in the final logistic model for analysis. If the covariate had a PR that differed from the PR of the overall population, it would be included in the model as a potential confounder or effect mediator variable**.** All statistical analyses and data cleaning were performed in SAS software version 9.4. With this study using a secondary data source for analysis, IRB approval was sought out and this dataset and study was approved for use.

LITERATURE REVIEW

An individual's HIV testing behavior may be influenced by many factors. Rizza et al. found that "some populations are particularly burdened by HIV and account for a disproportionate number of cases owing to social, economic, and demographic factors such as stigma, discrimination, income, education, and geographic region." (Rizza et al., 2012). In populations that are already disproportionately impacted by HIV, any barriers that may deter an individual from getting an HIV test may be amplified in these populations such as young MSM in the United States.

Income

When trying to encourage testing for HIV within a population that is as susceptible to spreading infection, as the young MSM population is in the United States, understanding the underlying issues that have an influence on their testing behavior is key. One of the factors that could potentially contribute to influencing an individual to getting an HIV test would be their income. When an individual is living in poverty, they are forced to make decisions that may not be conducive to that individual having good health. Researchers found that even if a person in poverty perceives himself or herself to be at risk for an STD including HIV, he or she may not practice preventive behaviors if there are other risks that appear more imminent, more threatening, or both (Institute of Medicine, 1997). This is a very important point because it highlights the fact that individuals experiencing low income are forced to make decisions in their lives that they perceive to be the most important at the time. For example, if an individual of low income has to decide between spending their last few dollars on groceries or to pay a copay for an HIV test that individual will more than likely choose paying for groceries for the week. This

decision is especially easier for that individual to make if they are not experiencing any symptoms of HIV.

Insurance

In a report by the Institute of Medicine, the researchers stated that "Health insurance coverage enables individuals to obtain professional assistance in order to prevent potential exposures to sexually transmitted infections and to seek care for suspected STDs." (Institute of Medicine, 1997). However, in the United States there are different types of insurance that usually fall into the category of having private or public insurance. Private insurance is any type of health insurance plan that is not funded by the federal or state government, with public health insurance being the opposite and is ran by the federal or state government with the two main types being Medicare or Medicaid.

Naturally, individuals that are not insured at all delay seeking any form of care for any health problems including HIV in comparison to individuals that have some sort of insurance, whether it be private or public insurance. Insurance coverage is important because it allows those with coverage to be able to be linked to HIV care more efficiently. The reason this linkage to care is important is because it allows individuals to become virally suppressed thus reducing HIV transmission within the MSM community. A study by Marks et al. looked at health insurance as a barrier to PrEP use. PrEP is a drug used in HIV prevention and the study found that for young MSM between the ages of 18-24, " lack of health insurance coverage and limited or no engagement with the healthcare system have been identified as barriers to PrEP implementation." (Marks et al., 2017). This barrier of not having insurance and not being able to be linked to care to receive medicine not only puts the individual at risk but also the entire young MSM community.

The literature also shows that that even process of having insurance and knowing where to get testing services that is covered by that insurance is something that has been found to be difficult for young MSM. A study by Rhodes and Wong found that "Access to and retention in HIV testing, treatment, and care may be challenging as clinics are places that require "adult" skills. YMSM may lack the skills necessary to negotiate clinical policies and procedures (e.g., payment, insurance, and residency documentation)." (Rhodes & Wong, 2016). This point establishes the fact that even for young MSM in the United States that may have some form of insurance coverage, they lack the proper knowledge and experience to be able to navigate the healthcare system. To receive the treatment that they need, it may require more than just having health insurance but additional skills that young MSM may not have. Therefore, this scenario creates another potential barrier for young MSM to receive HIV testing in the United States.

Race

A study conducted by Millett et al., compared disparities and risks of HIV infection among different races in the United States and Canada. Structural barriers were defined as an individual experiencing at least one of the following variables: low income, low education, incarceration, unemployment, and lack of health insurance. The study took these structural barriers into consideration and tried to determine its impact in different races reporting any preventive behavior against HIV, which was defined as seeking HIV testing among other qualifying definitions. The study found that "Black MSM were more likely than other MSM to report any preventive behavior against HIV infection and more likely to report testing for HIV in the past year (Millett et al., 2012). Once the researchers looked into the MSM population and stratified it by age, they found that young black MSM (age 13-29) "were reported to have their

first HIV test too late (median 2 years after sexual debut) compared with other young MSM" (Millet et al., 2012). All of the findings listed from this study were found to be statistically significant and it shows that even though the initial results reported testing behaviors that were encouraging, once the study population was stratified by age, the disparity of testing behavior by race was shown to be statistically significant when comparing across different racial groups.

Education

Another variable that may contribute to an individual to get an HIV test is the level of educational attainment that person has. A study conducted by Guo & Sims found that "African-American, Hispanic, male, with public insurance and higher levels of education and a history of having same sex sexual behavior were more likely to be tested for HIV" (Guo & Sims, 2017). This finding of the minority groups with the following characteristics being more likely to be tested for HIV than the same individuals without insurance and high levels of education is interesting. It can be interpreted in a way that individuals that obtain higher levels of education are in positions in which they have greater economic opportunities to seek out an HIV test. Another study analyzed knowledge about HIV testing as it relates to an individual's educational level. The study stratified their results by race and concluded that "the knowledge gap among blacks compared to whites decreased with increasing income and education." (Ebrahim et al., 2004). This finding highlights a key point in the educational variable as it not only gives an individual the opportunity to have a well-paying career to afford quality healthcare, but it also shows that these individuals tend to be knowledgeable about health care practices such as getting annual HIV test.

Region

When looking at the United States new HIV diagnoses, as a result of HIV testing, varies from region to region in the United States. The CDC reports that in 2017 the South made up 52% (19,968) of the new HIV diagnoses in the US, followed by the West 19% (7,270), the Northeast 16% (6,011), and the Midwest 13% (5,032). When looking at how new HIV diagnoses have changed over time, from 2012 to 2016 the two regions that have had the greatest decrease in diagnoses was the Northeast (17%) and the Midwest (6%) while the South and West remained stable over the same time period (CDC, 2019). Research studies have also shown that based on the region, different factors may exist that may have an association between an individual and that individual seeking HIV testing. Research conducted by Rebeiro et al. found that "Social stressors and structural factors that may limit the ability of individuals to access care (e.g., poverty, housing instability, discrimination, etc.) may also play an outsize role in the observed disparity of care between the South and Northeast" (Rebeiro et al., 2017). In the context of young MSM in the United States, particularly in the south, some of the social stressors that may deter young MSM may include the negative social stigma that comes with being a part of the MSM community in the south. Therefore, identifying as being a part of the MSM community in a region that is not conducive to that individual seeking HIV care, could be an important variable to analyzing when assessing the decline in HIV diagnosis of young MSM in the United States.

RESULTS

Demographics

Once the AMIS dataset was restricted to the age range of 15-29 year olds and to include the study years of 2013-2018, the dataset included 24,367 observations. Demographic

characteristics for the population are described in Table 1. This table shows who was participating in the internet survey and the demographic results were stratified by age to be able to be compared across the two age groups. Nearly 67% of 15-24 year olds were white in 2013-2015, compared to 61% in 2016-2018. Similarly, 67% of 25-29 year olds were white in 2013-201, compared to 66% in 2016-2018.

Table 1. Demographic Characteristcs of 15-29 Year Old MSM stratified by age group, AMIS 2013-2018

	15-24 Year Olds		
	Study Year and Race Association		
RACE	**2013-2015**	**2016-2018**	**TOTAL**
American Indian/ Alaska Native	0.74%	0.57%	99
Asian/Native Hawaiian/Other Pacific Islander	3.19%	3.48%	522
Black	4.56%	5.03%	752
Hispanic/Latino	25.03%	29.70%	4326
White	66.47%	61.22%	9817
TOTAL	6049	9467	15516

	25-29 Year Olds		
	Study Year and Race Association		
RACE	**2013-2015**	**2016-2018**	**TOTAL**
American Indian/ Alaska Native	0.69%	0.74%	60
Asian/Native Hawaiian/Other Pacific Islander	4.20%	4.00%	344
Black	6.64%	8.13%	619
Hispanic/Latino	21.38%	21.36%	1792
White	67.09%	65.76%	5570
TOTAL	4214	4171	8385

Testing Behaviors

Table 2.1 Testing Behavior of 15-29 year olds stratified by year group, AMIS 2013-2018

	Testing Among Entire Study Population		
	Tested in Past 12 Months		
YEAR	**NO**	**YES**	**TOTAL**
2013-2015	47.87%	52.13%	10446
2016-2018	49.84%	50.16%	13921
TOTAL	8683	7151	24367
PR	0.96		

Table 2.1 illustrates the testing behaviors for all study participants that were between the ages of 15 and 29 years old. The percentage of study participants that reported to have had an HIV test in the past 12 months dropped from 52.13% in study years 2013-2015 to 50.16% in study years 2016-2018 with a p-value of 0.002. When comparing the prevalence ratio (PR) of HIV testing in 2016-2018 to 2013-2015, there was a reported PR of 0.96 (p-value <0.05). This value of 0.96

was used as reference point to determine the magnitude of association that the covariates of interest had on the exposure of year and outcome of reporting a HIV test in the past year.

When stratified by age, this decrease in testing across the two study year groups is only observed in the young age group. Among the 15-24 year olds, 47.60% of survey participants reported to have had a HIV test in the past 12 months compared to 43.61% in 2016-2018 (P-value <0.05). For the older age group of 25-29 year olds, there was an observed increase in reporting HIV testing across the two study years. For study years 2013-2015, 58.63% of 25-29 year olds reported to have had an HIV test and this value increased to 65.08% of survey participants reporting to have had an HIV test in the past 12 months (P-value <0.05). In regards to PR, 15-24 year olds had a PR of 0.916 and 25-29 year olds had a HIV testing PR of 1.11. These two PR had opposite magnitudes of associations as it relates to the reference PR of 0.96, which is a sign of age being an effect modifier. It is also important to note that the survey participants are mostly a part of the 15-24 year old group with 64.9% of the 24,367 belonging to that population overall. The population also gotten progressively younger with 6,160 15-24 year olds participating in the survey from 2013-2015 and this population grew to 9,674 study participants between the ages of 15-24 in 2016-2018. This growth in the younger MSM survey participants are shown in Tables 2.2 and 2.3, which also shows the testing prevalence of the two age groups for the AMIS survey cycle of 2013-2018.

Table 2.2 Testing Behavior of 15-24 Year Olds

Testing Among 15-24 Year Olds			
Tested in Past 12 Months			
YEAR	NO	YES	TOTAL
2013-2015	52.40%	47.60%	6160
2016-2018	56.39%	43.61%	9674
TOTAL	8683	7151	15834

Table 2.3 Testing Behavior of 25-29 Year Olds

Tested Among 25-29 Year Olds			
Tested in Past 12 Months			
YEAR	NO	YES	TOTAL
2013-2015	41.37%	58.63%	4286
2016-2018	34.92%	65.08%	4247
TOTAL	3256	5277	8533

Covariates of Interest

Table 3 shows the prevalence ratio for each level for the other covariates of interest included in this study. For a majority of the covariates the magnitude of association between the covariates and its association with the outcome and exposure of interest was one that seemed to have a confounding relationship. The reason that it was believed that these covariates had a confounding relationship is that the calculated PR for each level of each covariate have PRs that differ from the overall population of 0.96. Based on the findings illustrated in Table 3, and after each covariate was tested individually to determine their association on the outcome and exposure separately, a decision was made to include all of the covariates of interest in the final logistic model to test the effect, if any, these covariates had on the exposure and outcome of interest.

Table 3. Prevalence Ratio for Covariates of Interest Stratified by Study Year, AMIS 2013-2018

COVARIATE	HIV TESTING % (2013-2015)	HIV TESTING% 2016-2018)	PREVALENCE RATIO	P-VALUE
INCOME				
0-19,999	49.31%	51.94%	1.05	0.02
20,000 - 39,999	52.53%	56.90%	1.08	<.0001
40,000 - 74,999	52.69%	58.53%	1.11	<.0001
75,000+	51.25%	58.35%	1.05	<.0001
RACE				
Black	58.00%	62.37%	1.07	0.009
Hispanic/Latino	55.49%	55.38%	0.99	0.9
White	49.74%	55.18%	1.1	<.0001
Other	62.03%	62.22%	1.12	0.18
INSURANCE				
None	45.03%	53.85%	1.19	<.0001
Private Only	52.44%	59.67%	1.13	<.0001
Public Only	48.48%	51.30%	1.05	0.02
Other/Multiple	50.91%	54.65%	1.07	0.006
EDUCATION				
< HS Diploma	29.18%	21.78%	0.74	0.0004
HS Diploma or Equivalent	43.36%	41.96%	0.96	0.258
Some College or Technical Degree	49.02%	55.72%	1.13	<.0001
College or Postgrad Education	55.02%	65.53%	1.19	<.0001
REGION				
Northeast	49.88%	56.18%	1.12	<.0001
Midwest	47.79%	52.84%	1.1	<.0001
South	52.35%	56.06%	1.07	<.0001
West	53.66%	57.97%	1.08	<.0001

Analysis of 15-24 Year Old MSM Testing (Unadjusted and Adjusted)

For both the unadjusted and adjusted models, the year variable was deemed to not be statistically significant. This can be interpreted as the year not having any statistically significant association between 15-24 year old MSM that participated in the survey and their likeliness to have reported to have had a HIV test in the past 12 months. When looking at the covariates of interest (year, income, race, insurance type, education, and region) and their relationship between time and HIV, the results varied when looking at the unadjusted and adjusted models.

When looking at the unadjusted odds ratio variables for 15-24 year olds, the three variables that had statistically significant findings across all levels of the variables were the race, insurance, and education variables. For the race variable, Black survey participants had 1.593 (p-value <0.05) times the odds of reporting to have had a HIV test in the past 12 months in comparison to White study participants. These reported odds were the highest odds within the race variable. For insurance type, survey participants that reported to have had Other/Multiple forms of insurance were 1.243 (p-value <0.05) times more likely to have reported an HIV test in the past 12 months. Lastly, 15-24 year olds that reported to have had College or Postgrad Education were 4.5 times more likely to have reported an HIV test in the past 12 months, in comparison to survey participants that reported only having a High School diploma.

Once the variables were adjusted using a logistic regression model, the relationship that the covariates had between HIV testing and time yielded interesting results. For example, the association between insurance and HIV testing was statistically significant in the adjusted model, and young MSM without insurance were less likely to test for HIV during the past year than those with public insurance (p-value <0.05). Education was another covariate that had a strong association between the relationship of HIV testing and time for MSM between the ages of 15-24 years old. MSM between the ages of 15-24 who an HS diploma were 2.07 times more likely to report an HIV test in the past year than those with less than a HS diploma (p-value <0.05). It was also observed as the reported educational attainment increased, so did the odds of a 15-24 year old MSM reporting to have had an HIV test in the past year (p-value <0.05). Table 3.1 shows the full results from the logistic model ran for 15-24 with both adjusted and unadjusted odds ratios for each covariate of interest included in the table.

Table 4.1 Variable Characteristics 15-24 Year Olds

15-24 Year Olds				
VARIABLE	**UNADJUSTED ODDS RATIO**		**ADJUSTED ODDS RATIO**	
	Odds Ratio (95% CI)	**P-value**	**Odds Ratio (95% CI)**	**P-value**
Year (Ref=2013-2015)				
2013-2015				
2016-2018	0.97 (0.896, 1.051)	0.46	1.069 (0.984, 1.162)	0.11
Income (Ref=$75,000+)				
0-19,999	1.079 (0.970, 1.199)	0.25	1.093 (0.974, 1.225)	0.96
20,000 - 39,999	1.259 (1.128, 1.405)	0.0006	1.195 (1.065, 1.341)	0.009
40,000 - 74,999	1.157 (1.032, 1.297)	0.37	1.084 (0.962, 1.220)	0.86
75,000+				
Race (Ref=White)				
Other	1.518 (1.241, 1.856)	0.03	1.48 (1.202, 1.822)	0.18
Black	1.593 (1.309, 1.940)	0.005	1.75 (1.427, 2.146)	0.0006
Hispanic/Latino	1.117 (1.021, 1.221)	0.002	1.198 (1.089, 1.317)	0.02
White				
Insurance (Ref=Public Only)				
None	0.955 (0.805, 1.133)	0.009	0.847 (0.710, 1.011)	0.005
Private Only	1.21 (1.096, 1.410)	<.0001	1.041 (0.906, 1.196)	0.11
Public Only				
Other/Multiple	1.243 (1.025, 1.428)	0.04	1.063 (0.894, 1.264)	0.13
Education (Ref=< HS Diploma)				
< HS Diploma				
HS Diploma or Equivalent	2.111 (1.746, 2.553)	0.004	2.076 (1.174, 2.514)	0.001
Some College or Technical Degree	3.374 (2.826, 4.029)	<.0001	3.397 (2.837, 4.067)	<.0001
College or Postgrad Education	4.507 (3.757, 5.405)	<.0001	4.491 (3.726, 5.414)	<.0001
Region (Ref=Midwest)				
Northeast	1.245 (1.1, 1.41)	0.013	1.199 (1.055, 1.363)	0.03
Midwest				
South	1.132 (1.019, 1.258)	0.97	1.087 0.975, 1.212)	0.65
West	1.16 (1.034, 1.301)	0.47	1.137 (1.008, 1.282)	0.42

Analysis of 25- 29 Year Old MSM Testing (Unadjusted and Adjusted)

For the unadjusted and adjusted model, "year" was shown to have a statistically significant association between the likeliness that a 25-29 year old having a HIV test in the past year and time. For the year variable, the odds an individual reporting to have had a HIV test in the past 12 months in the study years of 2016-2018 was 1.35 times the odds of a person reporting to have had a HIV test in 2013-2015 (p-value <0.0001 / CI 95% 1.225, 1.489). For the income variable, survey participants that reported to have earned between $40,000 - $74,999 a year reported to have 1.027 the odds of reporting to have had an HIV test in the past year in comparison to an individual to an individual that makes over $75,000 a year (p-value 0.006 / CI 95% 0.894, 1.179). Likewise, 25-29 year olds that reported on the survey as making anywhere between $0 - $19,999 per year had an inverse relationship of reporting if they have had a HIV test in the past year with having 0.77 or seven tenths times the odds of having a HIV test in the past year in comparison to an individual that makes over $75,000 a year.

Once the model was adjusted to include all interested covariates, just as the case was for the model for the 15-24 year old MSM population, the association between the covariates and their relationship on the exposure and outcome of interest yielded interesting results. The study year variable remained relatively unchanged with a reported AOR of 1.35 (p-value <0.0001 / 95% CI 1.225, 1.493). This finding is interpreted as the covariates having no type of confounding or effect mediating impact on the likeliness that a 25-29 year having a HIV test and time. The income covariate yielded some statistically significant results with survey participants that reported to have earned $0 – $19,999 a year about eight tenths or 0.86 times the odds having a HIV test in the past year in comparison to a survey participant earning more than $75,000 a year. Also, black study participants were reported to have 1.483 times the odds of reporting to have had a HIV test in the past 12 months in comparison to White survey participants among 25-29 year old MSM (p-value <0.05). Table 3.2 shows the full results from the logistic model ran for 15-24 with both adjusted and unadjusted odds ratios for each covariate of interest included in the table.

Table 4.2 Variable Characteristics 25-29 Year Olds

25-29 Year Olds				
VARIABLE	**UNADJUSTED ODDS RATIO**		**ADJUSTED ODDS RATIO**	
	Odds Ratio (95% CI)	**P-value**	**Odds Ratio (95% CI)**	**P-value**
Year (Ref=2013-2015)				
2013-2015				
2016-2018	1.351 (1.225, 1.489)	<.0001	1.352 (1.225, 1.493)	<.0001
Income (Ref=$75,000+)				
0-19,999	0.772 (0.658, 0.907)	0.0005	0.864 (0.723, 1.032)	0.02
20,000 - 39,999	0.9 (0.783, 1.034)	0.59	1 (0.865, 1.156)	0.56
40,000 - 74,999	1.027 (0.894, 1.179)	0.006	1.05 (0.912, 1.209)	0.08
75,000+				
Race (Ref=White)				
Other	1.335 (1.053, 1.693)	0.53	1.247 (0.978, 1.588)	0.86
Black	1.404 (1.154, 1.709)	0.17	1.483 (1.213, 1.815)	0.05
Hispanic/Latino	1.346 (1.189, 1.524)	0.24	1.392 (1.224, 1.584)	0.10
White				
Insurance (Ref=Public Only)				
None	0.602 (0.481, 0.752)	<.0001	0.557 (0.442, 0.702)	<.0001
Private Only	0.91 (0.752, 1.1)	0.09	0.768 (0.623, 0.948)	0.81
Public Only				
Other/Multiple	0.937 (0.721, 1.219)	0.19	0.853 (0.651, 1.119)	0.24
Education (Ref=< HS Diploma)				
< HS Diploma				
HS Diploma or Equivalent	1.118 (0.623, 2.008)	0.07	1.12 (0.619, 2.026)	0.07
Some College or Technical Degree	1.449 (0.826, 2.542)	0.33	1.474 (0.833, 2.608)	0.27
College or Postgrad Education	1.975 (1.130, 3.451)	<.0001	1.984 (1.122, 3.506)	<.0001
Region (Ref=Midwest)				
Northeast	1.225 (1.075, 1.465)	0.17	1.175 (1.003, 1.376)	0.38
Midwest				
South	1.2 (1.052, 1.369)	0.57	1.145 (1.001, 1.310)	0.66
West	1.263 (1.093, 1.459)	0.09	1.192 (1.027, 1.384)	0.21

DISCUSSION

When looking at HIV testing behavior as it relates to year, for the younger age group of 15-24 year olds, testing behavior remained unchanged across time, but a statistically significant change was observed in the 25-29 year old group. However, when looking at the year covariate for the older age group of 25-29 year the odds of reporting a HIV test in the past year remained unchanged in both the adjusted and unadjusted logistic model. A possible explanation for this lack of change could be that the additional variables that were included in the model do not have a strong effect on the year variable. This would mean that even with statistically significant results within different levels of the other variables included in the model, the association between these variables and the year variable itself was not strong enough to change the odds of the year variable.

When comparing which variables that seem to have the strongest impact for the youngest age group of MSM survey participants, education was a variable that was strongly associated with the outcome of reporting to have had an HIV test. Every level of education had statistically significant results and as the level of educational attainment increased, so did the odds of that individual reporting to have had an HIV test. When looking into the 15-24 year olds and the distribution of educational attainment for this group, 15.38% of this group only reported to have had an HS Diploma as their highest level of education. As a comparison, the older MSM group of 25-29 year olds only had 0.85% of survey participants reporting a HS diploma as their highest education level. This finding accompanied with the finding in the literature which states as educational attainment increase so does the knowledge of the importance of getting tested for HIV. Researchers have highlighted the association between education and HIV testing in research conducted by Wagenaar et al. which found that compared to MSM men in the United States who reported to have over 12 years of education, men with less than 12 years of education or less than a HS diploma were 2.7 times more likely to score "low" on HIV knowledge which includes knowledge about the importance of getting a HIV test (Wagenaar et al., 2012) The findings in the literature were similar to the results from the model results as it relates to the association between education and HIV testing for MSM between the ages of 15-24. Lower educational attainment among 15-24 year olds compared to the older group may partially explain their lower prevalence of HIV testing across the two study year groups. An explanation for this difference in reported educational attainment could be that the 15-24 year old group were not of age to obtain higher education due to them still being HS or college aged at the time of the survey. With the older group being 25 to 29 years old, they have simply been alive longer thus allowing this population to have a greater proportion of its survey respondents be over the age of 18 or 22 which is the age most students graduate from HS and college respectively.

The scenario that applies to the educational variable is also applicable to all of the variables in this study that were shown to have an impact on testing behaviors. For the entire young MSM population analyzed in this study, 64.98% (15,834) of the survey participants were a part of the younger MSM age group of 15-24 years old out of the 24,367 total survey participants between the ages of 15-29. As stated previously, this age distribution was also seen across the two study year groups of interest with the survey participants not only being majority younger for both year groups, but also got progressively younger with 6,160 15-24 year olds participating in the survey from 2013-2015 and this population grew to 9,674 study participants between the ages of 15-24 in 2016-2018. Therefore, since the variables that are associated with increasing an individual's odds of having an HIV test in the past year are more likely to be

obtained by an older individual, the decrease in testing observed amongst this population may not entirely be due to factors included in the study but rather the observed study population getting younger overall, thus driving down the HIV testing numbers.

Some limitations of this study include that this population included mostly white survey participants, and some variables that may also have an impact on an individual's testing behavior were not asked on the original questionnaire such as religion of the study participant. Recall bias is another potential limitation as is the case with any dataset that relies on self-reported data. For example, survey participants that could have possibly gotten an HIV test at a blood drive may not have known this test has taken place thus, they could of incorrectly responded "No" when asked about their HIV testing status on the survey. Religion could have been a great question to ask study participants especially as it relates to some religions views on pre-marital sex so if an individual may think they may have been infected with HIV, fear of stigma or judgment may have swayed that individual to not have gotten a test done. Lastly, social desirability bias is a potential limitation of this study. With survey participants taking a survey about HIV behavior, they may be hesitant to report their HIV status or sexual history.

In conclusion, the adjusted model shows that education has an association with young MSM between the ages of 15-24 years old having a HIV test. Proper next steps would include educating young MSM, especially those between the ages of 15-24 about the importance of following the CDCs guideline and getting at least one HIV test annually. This increase in knowledge about the disease should supplement their lack of educational attainment which was shown to be strongly associated with reporting a HIV test in the past year. Similarly, for the older MSM age group of 25-29 year olds, it was found that there was a statistically significant change over time but the covariates that were included on the model showed no association on the relationship between HIV testing and time. This could mean that there could be other possible confounding or effect modifying variables that could account for change in testing behavior among the 25-29 year old MSM in this survey group. Therefore, further analysis could be done on the 25-29 year old MSM group to determine if there are any additional covariates that may be associated with the relationship between HIV testing and time.

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