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COVID-19 Vaccine Uptake and Correlates Among Men Who Have Sex with Men in the United States

By

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Master of Public Health

Epidemiology

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B.A.
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2020

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An abstract of
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Abstract

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By Benjamin Goldberg

Many studies have analyzed COVID-19 vaccine uptake and correlates in the general population. However, to date, there has not been a study looking at these correlates among men who have sex with men (MSM) who are both living with HIV and not living with HIV. To examine this relationship, the 2021 cycle of the American Men's Internet Survey (AMIS) added questions about receipt of the COVID-19 vaccine, such as which vaccine an individual received and how many doses they received if they had been vaccinated. Men were recruited for AMIS through email and banner ads on websites. Men could participate if they were aged at least 15 years, resided in the United States, provided a valid United States ZIP code, and reported ever having sex with a man or identified as gay or bisexual. Polytomous logistic regression models were used to evaluate the relationship between COVID-19 vaccination status and various demographic and health characteristics. An individual could have one of four different vaccination statuses: unvaccinated, incomplete initial series, fully vaccinated, and boosted, where each status was compared against the unvaccinated group. We found that identifying as Black was associated with being less likely to have received a booster dose (aOR 0.51, 95% CI 0.36-0.72), while identifying as Hispanic was associated with being more likely to have received a booster dose (aOR 1.60, 95% CI 1.05-2.42) when compared to MSM who identified as White. We also found that having any health insurance was associated with being more likely to have received a booster dose compared to those who were uninsured. Additionally, compared to individuals with a high school diploma or less, MSM with a complete college degree or more were more likely to both be fully vaccinated and have received a booster dose (aOR 2.47 95% CI 1.72-3.55 and aOR 4.10 95% CI 2.78-6.06 respectively). Given that these findings were not always consistent with findings on other preventative health behaviors among MSM, further research is needed to understand how the COVID-19 pandemic impacted these factors.

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Introduction

Since the start of the HIV Epidemic, men who have sex with men (MSM) have been disproportionately burdened by HIV.[1] MSM who bare this burden of HIV also suffer from health inequities that were exacerbated throughout the 2019 Novel Coronavirus (COVID-19) pandemic. During the COVID-19 pandemic, People Living with HIV (PLWH), including MSM living with HIV, were found to be no more likely than those without HIV to become infected with COVID-19 or suffer from severe COVID-19 once infected.[2,3] Additionally, PLWH had a greater risk of mortality associated with COVID-19 than those without HIV.[2-4] Furthermore, among PLWH hospitalized for COVID-19, older age and decreasing CD4 lymphocyte count were associated with increased length of hospital stay.[5]

In December 2020, the first COVID-19 vaccine was authorized for use in the United States under the Food and Drug Administration's (FDA) emergency use authorization (EUA).[6] In the first two months after receiving the second dose of the vaccine, an individual was significantly less likely to get COVID-19, suffer from severe illness due to COVID-19 if they were diagnosed, or die due to COVID-19.[7, 8] After two months vaccine effectiveness began to decline with immunity against infection waning by nearly 25% seven months after vaccination, protection against death remained steady between 89% - 94% for each of the two-dose vaccines after seven months.[7] For PLWH and individuals who are at higher risk for HIV, including MSM, vaccination is a necessary step to help curb the excess risk of death seen in this population before vaccines were available.

Current research suggests there are multiple factors associated with an individual's decision to get vaccinated. Black and Hispanic/Latinx individuals were more likely to be vaccine-hesitant with the COVID-19 vaccine than other racial groups.[9, 10] They were also less likely to be trusting of the vaccine overall compared to other racial and ethnic groups.[9] Possible explanations for this include inadequate representation of racial and ethnic groups in vaccine clinical trials, a lack of education regarding the vaccine development process in minority communities with past and experiences with racial inequalities, lack of engagement during the process of the vaccine trials and post approval vaccination campaigns.[11]

Other potential drivers of decreased vaccine uptake among these racial and ethnic groups are socioeconomic status and access to healthcare and health insurance.[12] Additionally, those with more mistrust towards COVID-19 overall were more likely to have more vaccine hesitancy.[13] Finally, in a small study on COVID-19 perceptions conducted in Arkansas, individuals who reported they were less afraid of COVID-19 infection were five times more likely to report vaccine hesitancy than those who feared COVID-19 infection the most.[9]

To date, most research looking at factors associated with COVID-19 vaccination uptake has been in the general population, with one study being specifically in PLWH (Bogart et al.). Due to the disparities in COVID-19 outcomes among PLWH and the fact that MSM bare a disproportionate risk of getting HIV, findings in these studies may not be generalizable to this subset of the United States population. Using data from the American Men's Internet Survey (AMIS), which collects demographic and behavioral characteristics exclusively in MSM, factors associated with COVID-19 vaccine uptake among MSM will be explored further.

Methods

Study Population:

AMIS is an institutional review board approved study conducted annually with the goal of having at least 10,000 eligible MSM complete surveys each year. The methods for recruitment and study eligibility had previously been reported in detail.[14, 15, 16] Briefly, participants were recruited through convenience sampling from sources such as website banner ads and emails to website members. Those who clicked on the ad were taken to the survey. In addition to the ads and emails from websites, additional participants were recruited by emailed participants from previous years. The survey was self-administered and could be taken on any electronic device with access to a web browser and an internet connection. The survey was comprised of questions on demographics, sexual behaviors, substance use, HIV and STI testing and diagnosis, and use of HIV prevention services. Starting with the 2020 AMIS cycle, questions about

COVID-19 began being asked, and beginning with the 2021 AMIS cycle, questions about one's COVID-19 vaccination status began being asked.

Participants were eligible to participate if they were assigned male sex at birth, resided in the United States at the time of taking the survey, and reported any type of sex with another man at least once at any time previously. Participants also had to be at least 15 years old at the time of taking the survey. Participants who refused to answer any of these questions or did not fall into any of these criteria were deemed ineligible and were not asked further questions.

Measures:

The dependent measure presented in this study was COVID-19 vaccination status at the time of completing the survey. Vaccination status was classified into four categories: Unvaccinated, incomplete initial series, fully vaccinated, and boosted. Unvaccinated individuals were those who had not received any dose of any COVID-19 vaccine. Incomplete initial series were those who received only one dose of an mRNA vaccine, and if the vaccine received was not specified, it was assumed they received an mRNA vaccine. Fully vaccinated individuals were those who received one dose of the Johnson and Johnson COVID-19 vaccine or two doses of an mRNA vaccine, and if a vaccine was not specified, it was assumed they received a two-dose mRNA vaccine. Individuals who were classified as boosted were those who received at one dose of the Johnson and Johnson vaccine and at least one mRNA booster dose or those who received three doses of an mRNA vaccine. A series of demographic characteristics as well as general health and COVID-19-related characteristics, were exposures of interest to determine what variables are correlated with COVID-19 vaccine uptake among the MSM community in the United States. The two primary exposures of interest within the multivariable analysis were HIV status among all individuals and the perceived risk of being diagnosed with HIV within the next five years among those who are presently not living with HIV. HIV status was determined using self-reported data.

Statistical Analyses:

Eligible consenting participants were included in the analyses if they were unduplicated by IP address, completed the survey, and reported a COVID-19 vaccination status. Overall odds ratios, confidence intervals, and p-values for each bivariate analysis between vaccination status and participant characteristics were reported. For the multivariate regression model, the primary exposure of interest was included, and all demographic characteristics and all health-related characteristics were included if its inclusion would not reduce the number of observations in the model by over 1,000. In the multivariate models, only those with a known reported HIV status (positive or negative) were included. Further, any individuals who did not answer every question included in the multivariate model were excluded from that model.

Results

About sixty-six percent of the individuals who completed the 2021 AMIS survey reported their vaccination status and were eligible for this analysis (n=5938). Of these, 5376 (90.5%) were either fully vaccinated or fully vaccinated and had a booster dose (Table 2). A majority of all participants were 40 years or older (57.8%), and a majority were also White, non-Hispanic (64.3%) (Table 1). Additionally, our sample was highly educated, with 5608 (62.1%) participants having a college degree or higher.

An association was seen between age and vaccination status with those who were older being most likely to have had a booster dose. Race was also associated with vaccination levels. Those who identifying as Black were less likely to be fully vaccinated with or without a booster and more likely to be partially vaccinated (Table 3). After adjusting for all covariates of interest, age was no longer significantly associated with vaccination status; however, identifying as Black remained associated with being less likely to have received a booster dose or more likely to have an incomplete vaccination series (Table 4). When examining vaccination status by age among race/ethnicity groups, differences were also seen. Across all races and ethnicities, as individuals got older, individuals were more likely to be fully vaccinated and to have received a booster dose (Figure 1). Young Black individuals were least likely to be

vaccinated, while more than 90% of White or Hispanic MSM in age categories 25-29 years, 30-39 years, and 40 years and older had completed their primary series with or without a booster dose (Figure 1).

HIV status was not associated with any level of COVID-19 vaccination status (Table 4). No differences were seen by age and vaccination status or race and vaccination status when examining these associations by HIV status (Table 4). In the bivariate analysis, individuals who believed their risk of getting HIV within the next five years was more than minimal were more likely to receive a booster dose than those who thought their risk was very unlikely (Table 4). However, after adjusting for covariates of interest, this association dissipated (Table 5).

Having a previous COVID-19 diagnosis was negatively associated with being fully vaccinated or having received a booster dose (Tables 3 and 4). MSM who ask about COVID-19 symptoms with a new male sex partner before engaging in sex were more likely to be vaccinated. This difference persisted across all age groups. Additionally, if individuals ask their sex partners about COVID-19 symptoms before engaging in sex they are more likely to be vaccinated than those who do not, although there were no differences in vaccination status by age among those who do ask about COVID-19 symptoms (Figure 2).

Discussion

Previous studies have evaluated factors associated with COVID-19 vaccine uptake. This study provides insight into factors associated with COVID-19 vaccine uptake among MSM, including those living with HIV. Overall, participants in AMIS were highly vaccinated, with 90.5% completing at least the initial vaccine series, a much higher rate than the general US population.[17]

COVID-19 Vaccinate Uptake and Correlates:

We found that Black MSM were less likely to have received a booster dose of the COVID-19 vaccine compared to White MSM while also being more likely to have an incomplete COVID-19 vaccination series. This is consistent with other health behaviors of MSM prior to the COVID-19 pandemic. Studies have found that Black MSM were less likely to use PrEP than their White counterparts.[18,19,20] While Black

MSM were less likely to have received a booster dose if fully vaccinated, Hispanic MSM were more likely to have received a booster dose of the COVID-19 vaccine compared to White MSM. This is inconsistent with other health behaviors of Hispanic MSM previously seen. A study by Hoots et al. found Black and Hispanic MSM were less likely to use PrEP compared to White MSM.[20] While this trend is consistent for Black MSM, the higher rates of vaccination among Hispanic MSM in this analysis suggests there are additional factors impacting COVID-19 vaccine uptake beyond previous health-seeking behaviors. One possible explanation is access to the COVID-19 vaccine. Previous studies have shown the Black individuals tend to live further than Non-Hispanic White individuals from traditional vaccination sites which decreases the accessibility of vaccines.[21] Furthermore, one study of MSM across multiple countries during the COVID-19 pandemic found that racial and ethnic minorities were less confident in their ability to have easy access to condoms or HIV testing.[22] This coincides with the finding that individuals who previously were not satisfied with their level of access to care were more vaccine hesitant than those who were satisfied.[23] While this explanation is not precisely consistent with our findings because Hispanic MSM are also an ethnic minority in the United States, it provides insight into additional factors that may impact COVID-19 vaccine uptake beyond demographic characteristics.

Having insurance, higher levels of education and higher levels of income were all associated with increased COVID-19 vaccine uptake. People with insurance and those with a college degree were more likely to have received a COVID-19 vaccine booster dose. The association between having insurance and having more preventative health behaviors is also seen when looking at PrEP use. Those who have private or public insurance are more likely to use PrEP.[24] While insurance was not a requirement to receive a COVID-19 vaccine during the US Public Health Emergency, it does still seem to be associated with more preventive care behaviors while uninsured MSM experienced a greater disruption in HIV-related care services during the pandemic.[22,25]

Previous analyses have not found similar relationships between income and education and health behaviors. One study found that insurance was associated with PrEP use, and income was not.[25]

Furthermore, another study of young PrEP naïve MSM in California found that a higher income was negatively associated with the likelihood of future PrEP use.[26] Finally, another study of young MSM in California did find income was associated with PrEP use, but education level was not.[27] Although these trends did not mimic what would be expected if COVID-19 vaccination uptake and PrEP use followed the same trends, two of these studies focused on young MSM, possibly limiting the comparison.

MSM who ask potential new male sex partners questions about their COVID-19 status and vaccination were more likely to be vaccinated. This aligns with studies regarding the perceived benefits of the vaccine and the risks of COVID-19. Prior to the COVID-19 vaccine being authorized under the EUA, a study found that individuals will a high perceived susceptibility to COVID-19 and high perceived benefits of the vaccine were more likely to plan on getting the vaccine compared to those with lower perceived susceptibility and lower perceived benefits.[28] Furthermore, those who were not concerned about getting infected with COVID-19 were less likely to plan on getting the vaccine.[29]

Perceived risk of being diagnosed with HIV within the next five years was not associated with COVID-19 vaccine uptake. While this perceived risk is not the same as perceived risk of COVID-19, it was still interesting that those who perceive themselves at increased risk for HIV were not more likely to use all preventive behaviors including COVID-19 vaccinations. It is possible that perceived risk for HIV is more a marker of less protective behaviors rather than a marker of being concerned about risk. No differences were seen in COVID-19 uptake among MSM living with HIV compared to those not living with HIV. This finding should be investigated further given that the Centers for Disease Control and Prevention (CDC) has specific guidance for vaccination for those with immune-compromising conditions, such as HIV.[30]

In both crude and adjusted analyses, having previously been diagnosed with COVID-19 was associated with being less likely to be fully vaccinated or boosted. This finding is possibly tied to the timing of the data in this analysis. Individuals completed this survey from September 2021 – December 2021, less than one year after the vaccine became available. Vaccinations did not become widely available to younger

adults until Spring of 2021. Additionally, during this time in the pandemic, individuals who recently had COVID-19 were not yet advised to get the vaccine due to supply and uncertainty regarding how long natural immunity would last.

Limitations:

One of the primary limitations of this study is that convenience sampling was used for recruitment which means the individuals who enrolled saw advertisements or received an email for the survey and chose to take it. As a result, this study may not be generalizable to the United States MSM population as a whole or even to the United States MSM population with internet access. Additionally, in this survey, 57% of participants were over 40 years old. In the 2017 – 2019 AMIS cycles, 25.9% - 44.6% of the population were over 40 years of age, suggesting those aged 40 years and older took this survey at a greater rate than usual, further restricting the external validity of the study.[31,32,33]

Implications:

This is the first known study to examine factors associated with COVID-19 vaccine uptake among MSM living with and without HIV in the United States. Many studies have examined factors associated with COVID-19 vaccine uptake in the general population, and the findings of these studies were similar to those among MSM in this analysis. New potential associations were also assessed such as HIV status, perceived risk of HIV infection, and PrEP use, though none of these were associated with COVID-19 vaccine uptake among MSM in this cohort in 2021.

Furthermore, the CDC recommends individuals currently living with immunocompromising conditions such as HIV are a higher priority for being fully vaccinated and receiving a booster dose for the COVID-19 vaccine compared to MSM not living with HIV due to the increased risk of death from COVID-19 for individuals living with HIV.[2-4]. Because immunocompromised individuals may not have a sufficient response to the COVID-19 vaccine after two doses, the CDC recommends a third primary dose, which in our analysis would have been classified as receiving a booster dose.[30] While this guidance should have

been relayed from health professionals to individuals living with HIV, our analysis did not find any difference in vaccination status by HIV status for this time in the pandemic. It is possible that data from later in the pandemic will find differences in uptake by HIV status though it is also possible that the CDC guidance was not well followed, implying the need for enhanced efforts to support vaccination uptake among people living with HIV.

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Table 1. Demographic characteristics of MSM participants in the 2021 American Men's Internet Survey

Participant Characteristics	N (%)
Age Group	
15-24	725 (8.0)
25-29	903 (10.0)
30-39	2198 (24.3)
40+	5235 (57.8)
Race	
Any Black	1277 (14.1)
Non-Hispanic White	5828 (64.3)
Non-Black Hispanic	1186 (13.1)
Other	770 (8.5)
Region	
Northeast	1675 (18.5)
Midwest	1745 (19.3)
South	3533 (39.0)
West	2093 (23.1)
U.S. dependent areas	15 (0.1)
NHBS City Resident	
Yes	3268 (36.1)
No	5793 (63.9)
Health Insurance	
None	572 (6.4)
Private Only	6156 (69.1)
Public Only	1630 (18.2)
Other	554 (6.2)
Population Density	
Large Central Metro	4190 (46.4)
Large Fringe Metro	1876 (20.8)
Medium Metro	1666 (18.4)
Small Metro and Smaller	1307 (14.5)
Education Level	
< HS diploma	142 (1.6)
HS diploma or equivalent	839 (9.3)
Some college or technical degree	2445 (27.1)
College degree or postgraduate education	5608 (62.1)
Income (USD)	
<20,000	830 (9.7)
20,000-39,999	1397 (16.4)
40,000-74,999	2013 (23.6)
≥75,000	4291 (50.3)

Table 2. Health characteristics of MSM participants in the 2021 American Men's Internet Survey

Participant Characteristic	N (%)
HIV Status	
Positive	1301 (15.0)
Negative	6552 (75.3)
Unknown	843 (9.7)
Perceived HIV Infection Risk (among those not living with HIV)	
Very unlikely	4792 (75.0)
Somewhat unlikely	1220 (19.1)
Very or somewhat likely	375 (5.9)
Previous COVID-19 Diagnosis	
Yes	1225 (17.9)
No	5611 (81.8)
Before having sex with a new male partner do you check if they have COVID symptoms	
Yes	1597 (24.6)
No	4884 (75.4)
Before having sex with a new male partner do you check if they've been near others who had COVID in the past 10-14 days	
Yes	2096 (32.3)
No	4385 (67.7)
Before having sex with a new male partner do you discuss COVID precautions with them	
Yes	2553 (39.4)
No	3928 (60.6)
Before having sex with a new male partner do you get tested for COVID-19	
Yes	503 (7.8)
No	5978 (92.2)
Before having sex with a new male partner do you request they get tested for COVID-19	
Yes	248 (3.8)
No	6233 (96.2)
Before having sex with a new male partner do you ask if they've been vaccinated against COVID-19	
Yes	3507 (54.1)
No	2974 (45.9)
COVID Vaccination Status	
Unvaccinated	500 (8.4)
Incomplete Initial Series (1 dose of an mRNA vaccine)	62 (1.0)
Completed Initial Series	2666 (44.9)
Boosted	2710 (45.6)

Table 3. Bivariate Analysis of COVID-19 Vaccination status among MSM participants in the American Men's Internet Survey in 2021

Participant Characteristic	N	Unvaccinated n (%)	Incomplete Initial Series n (%)	Fully Vaccinated n (%)	Boosted n (%)	Crude Odds Ratio (Unvaccinated vs Incomplete) (95% CI)	p-value	Crude Odds Ratio (Unvaccinated vs Fully Vaccinated) (95% CI)	p-value	Crude Odds Ratio (Unvaccinated vs Boosted) (95% CI)	p-value
Age											
15-24	476	61 (12.8)	28 (5.9)	240 (50.4)	147 (30.9)	Reference	Ref	Reference		Reference	
25-29	674	6 (9.9)	37 (5.5)	332 (49.3)	238 (35.3)	0.55 (0.19, 1.59)	0.27	1.24 (0.84, 1.82)	0.28	1.48 (0.99, 2.21)	0.05
30-39	1662	145 (8.7)	93 (5.6)	803 (48.3)	621 (37.4)	0.88 (0.39, 1.98)	0.76	1.29 (0.92, 1.80)	0.14	**1.78 (1.26, 2.53)**	**0.001**
40+	4046	227 (5.6)	221 (5.5)	1994 (49.3)	1604 (39.6)	0.67 (0.31, 1.47)	0.32	**1.76 (1.28, 2.41)**	**0.0005**	**2.91 (2.10, 4.04)**	**<0.0001**
Race											
Non-Hispanic White	3890	304 (7.8)	29 (0.8)	1699 (43.7)	1858 (47.8)	Reference	Ref	Reference	Ref	Reference	Ref
Any Black	761	103 (13.5)	25 (3.3)	403 (53.0)	230 (30.2)	**2.55 (1.43, 4.55)**	**0.002**	**0.70 (0.55, 0.90)**	**0.005**	**0.37 (0.28, 0.48)**	**<0.0001**
Non-Black Hispanic	772	50 (6.5)	3 (0.4)	341 (44.2)	378 (49.0)	0.63 (0.19, 2.14)	0.46	1.22 (0.89, 1.68)	0.22	1.24 (0.90, 1.70)	0.19
Other	440	32 (7.2)	2 (0.5)	192 (43.6)	214 (48.6)	1.22 (0.45, 3.32)	0.70	0.93 (0.66, 1.32)	0.67	0.93 (0.93, 1.31)	0.67
Region											
Northeast	1109	72 (6.5)	9/1109 (0.8)	463/1109 (41.8)	565/1109 (51.0)	Reference	Ref	Reference	Ref	Reference	Ref
Midwest	1123	112 (10.0)	11 (1.0)	510 (45.4)	490 (43.6)	0.79 (0.31, 1.99)	0.61	**0.70 (0.51, 0.97)**	**0.03**	**0.55 (0.40, 0.76)**	**0.0003**
South	2271	223 (9.8)	34 (1.5)	1032 (45.4)	982 (43.2)	1.22 (0.56, 2.67)	0.62	**0.72 (0.54, 0.95)**	**0.02**	**0.55 (0.42, 0.74)**	**<0.0001**
West	1424	93 (6.5)	8 (0.6)	657 (46.1)	666 (46.8)	0.69 (0.25, 1.87)	0.46	1.09 (0.78, 1.52)	0.61	0.90 (0.65, 1.25)	0.53
NHBS City Resident											
Yes	2159	127 (5.9)	20 (0.9)	958 (44.4)	1054 (48.8)	1.40 (0.79, 2.47)	0.25	**1.65 (1.33, 2.05)**	**<0.0001**	**1.87 (1.51, 2.32)**	**<0.0001**
No	3779	373 (9.9)	42 (1.1)	1708 (45.2)	1656 (43.8)	Reference	Ref	Reference	Ref	Reference	
Health Insurance											
None	365	88 (24.1)	13 (3.6)	182 (49.9)	82 (22.5)	Reference	Ref	Reference	Ref	Reference	Ref

Private Only	4122	245 (5.9)	33 (0.8)	1858 (45.1)	1986 (48.2)	0.91 (0.46, 1.81)	0.79	**3.67 (2.75, 4.89)**	**<0.0001**	**8.70 (6.26, 12.09)**	**<0.0001**
Public Only	1029	130 (12.6)	13 (1.3)	454 (44.1)	432 (42.0)	0.68 (0.30, 1.53)	0.35	**1.69 (1.23, 2.33)**	**0.001**	**3.57 (2.49, 5.11)**	**<0.0001**
Other/Multiple	360	25 (6.9)	1 (0.3)	145 (40.3)	189 (52.5)	0.27 (0.03, 2.17)	0.22	**2.80 (1.71, 4.60)**	**<0.0001**	**8.11 (4.85, 13.57)**	**<0.0001**
Population Density											
Large Central Metro	2758	162 (5.9)	24 (0.9)	1236 (44.8)	1336 (48.4)	Reference	Ref	Reference	Ref	Reference	Ref
Large Fringe Metro	1217	113 (9.2)	18 (1.5)	553 (45.4)	533 (43.8)	1.08 (0.56, 2.07)	0.83	**0.64 (0.49, 0.83)**	**0.0008**	**0.57 (0.44, 0.74)**	**<0.0001**
Medium Metro	1100	98 (8.9)	12 (1.1)	503 (45.7)	487 (44.3)	0.83 (0.40, 1.73)	0.61	**0.67 (0.51, 0.88)**	**0.004**	**0.60 (0.46, 0.79)**	**0.0003**
Small Metro and Smaller	849	126 (14.8)	8 (0.9)	369 (43.5)	346 (40.8)	**0.43 (0.19, 0.99)**	**0.046**	**0.38 (0.30, 0.50)**	**<0.0001**	**0.33 (0.26, 0.43)**	**<0.0001**
Education Level											
HS diploma or equivalent or less	579	128 (22.1)	18 (3.1)	274 (47.3)	159 (27.5)	Reference	Ref	Reference	Ref	Reference	Ref
Some college or technical degree	1559	204 (13.1)	21 (1.4)	774 (49.7)	560 (35.9)	0.73 (0.38, 1.43)	0.36	**1.78 (1.37, 2.30)**	**<0.0001**	**2.21 (1.67, 2.93)**	**<0.0001**
College degree or postgraduate education	3785	168 (4.4)	23 (0.6)	1612 (42.6)	1982 (52.4)	0.97 (0.50, 1.88)	0.94	**4.48 (3.45, 5.83)**	**<0.0001**	**9.50 (7.17, 12.58)**	**<0.0001**
Income (USD)											
<20,000	538	91 (16.9)	9 (1.7)	247 (45.9)	191 (35.5)	Reference	Ref	Reference	Ref	Reference	Ref
20,000-39,999	887	122 (13.8)	14 (1.6)	460 (51.9)	291 (32.8)	1.16 (0.48, 2.80)	0.74	**1.39 (1.02, 1.90)**	**0.04**	1.14 (0.82, 1.58)	0.44
40,000-74,999	1312	106 (8.1)	18 (1.4)	651 (49.6)	537 (40.9)	1.72 (0.74, 4.01)	0.21	**2.26 (1.65, 3.11)**	**<0.0001**	**2.41 (1.74, 3.34)**	**<0.0001**
≥75,000	2875	139 (4.8)	13 (0.5)	1161 (40.4)	1562 (54.3)	0.95 (0.39, 2.30)	0.90	**3.08 (2.29, 4.15)**	**<0.0001**	**5.36 (3.95, 7.26)**	**<0.0001**
HIV Status											
Positive	790	55 (7.0)	10 (1.3)	354 (44.8)	371 (47.0)	1.51 (0.71, 3.20)	0.28	1.05 (0.77, 1.43)	0.76	1.08 (0.80, 1.47)	0.62
Negative	4481	332 (7.4)	40 (0.9)	2036 (45.4)	2073 (46.3)	Reference	Ref	Reference	Ref	Reference	Ref
Previous COVID-19 Diagnosis											
Yes	1099	109 (9.9)	15 (1.4)	517 (47.0)	458 (41.7)	0.89 (0.64, 1.26)	0.51	**0.86 (0.78, 0.94)**	**0.002**	**0.76 (0.68, 0.85)**	**<0.0001**

No	4811	384 (8.0)	46 (1.0)	2137 (44.4)	2244 (46.6)	Reference	Ref	Reference	Ref	Reference	Ref
Before having sex with a new male partner:											
Do you check if they have COVID symptoms?											
Yes	1073	62 (5.8)	8 (0.8)	468 (43.6)	535 (49.9)	1.04 (0.46, 2.34)	0.93	**1.37 (1.02, 1.84)**	**0.03**	**1.72 (1.28, 2.30)**	**0.0003**
No	3367	289 (8.6)	36 (1.1)	1590 (47.2)	1452 (43.1)	Reference	Ref	Reference	Ref	Reference	Ref
Do you check if they've been near others who had COVID in the past 10-14 days?											
Yes	1418	68 (4.8)	14 (1.0)	650 (45.8)	686 (48.4)	1.94 (0.98, 3.86)	0.06	**1.92 (1.45, 2.54)**	**<0.0001**	**2.19 (1.66, 2.91)**	**0.0001**
No	3022	283 (9.4)	30 (1.0)	1408 (46.6)	1301 (43.1)	Reference	Ref	Reference	Ref	Reference	Ref
Do you discuss COVID precautions with them?											
Yes	1785	63 (3.5)	13 (0.7)	799 (44.8)	910 (51.0)	1.92 (0.95, 3.87)	0.07	**2.90 (2.18, 3.86)**	**<0.0001**	**3.86 (2.90, 5.14)**	**<0.0001**
No	2655	288 (10.9)	31 (1.2)	1259 (47.4)	1077 (40.6)	Reference	Ref	Reference	Ref	Reference	Ref
Do you get tested for COVID-19?											
Yes	326	19 (5.8)	6 (1.8)	151 (46.3)	150 (46.0)	**2.76 (1.04, 7.33)**	**0.04**	1.38 (0.85, 2.26)	0.20	1.43 (0.87, 2.33)	0.16
No	4114	332 (8.1)	38 (0.9)	1907 (46.4)	1837 (44.7)	Reference	Ref	Reference	Ref	Reference	Ref
Do you request they get tested for COVID-19?											
Yes	152	10 (6.6)	1 (0.7)	52 (34.2)	89 (58.6)	0.79 (0.10, 6.35)	0.83	0.88 (0.45, 1.76)	0.72	1.60 (0.82, 3.10)	0.17
No	4288	341 (8.0)	43 (1.0)	2066 (46.8)	1898 (44.3)	Reference	Ref	Reference	Ref	Reference	Ref
Do you ask if they've been vaccinated against COVID-19?											
Yes	2478	38 (1.5)	12 (0.5)	1161 (46.9)	1267 (51.1)	**3.09 (1.47, 6.50)**	**0.003**	**10.66 (7.53, 15.09)**	**<0.0001**	**14.49 (10.22, 20.54)**	**<0.0001**
No	1962	313 (16.0)	32 (1.6)	897 (45.7)	720 (36.7)	Reference	Ref	Reference	Ref	Reference	Ref

Table 4. Multivariate Logistic Regression Models of COVID-19 vaccination status among MSM participants in the American Men's Internet Survey in 2021

Participant Characteristic	Adjusted Odds Ratio (Unvaccinated vs Incomplete) (95% CI)	p-value	Adjusted Odds Ratio (Unvaccinated vs Fully Vaccinated) (95% CI)	p-value	Adjusted Odds Ratio (Unvaccinated vs Boosted) (95% CI)	p-value
HIV Status						
Positive	1.02 (0.42, 2.48)	0.97	1.15 (0.82, 1.63)	0.42	1.36 (0.96, 1.93)	0.09

Negative	Reference	Ref	Reference	Ref	Reference	Ref
Age						
15-24	Reference	Ref	Reference	Ref	Reference	
25-29	1.66 (0.30, 9.13)	0.56	1.07 (0.62, 1.84)	0.81	0.95 (0.54, 1.68)	0.86
30-39	1.56 (0.31, 7.72)	0.59	1.00 (0.62, 1.62)	0.99	0.95 (0.57, 1.58)	0.85
40+	1.82 (0.38 8.78)	0.46	1.19 (0.74, 1.91)	0.47	1.17 (0.72, 1.91)	0.53
Race						
Non-Hispanic White	Reference	Ref	Reference	Ref	Reference	Ref
Any Black	**2.24 (1.04, 4.83)**	0.04	0.87 (0.62, 1.20)	0.06	**0.51 (0.36, 0.72)**	**0.0001**
Non-Black Hispanic	0.58 (0.13, 2.68)	0.49	1.48 (0.98, 2.23)	0.54	**1.60 (1.05, 2.42)**	**0.03**
Other	0.84 (0.18, 3.85)	0.82	0.87 (0.55, 1.37)	0.54	0.90 (0.57, 1.43)	0.66
Region						
Northeast	Reference	Ref	Reference	Ref	Reference	Ref
Midwest	0.31 (0.08, 1.28)	0.11	0.84 (0.56, 1.26)	0.39	0.73 (0.48, 1.10)	0.13
South	1.14 (0.44, 2.92)	0.79	0.77 (0.53, 1.10)	0.15	0.70 (0.49, 1.01)	0.06
West	0.63 (0.18, 2.20)	0.47	0.94 (0.62, 1.43)	0.77	0.78 (0.51, 1.18)	0.24
NHBS City Resident						
Yes	1.08 (0.46, 2.56)	0.86	**1.52 (1.11, 2.09)**	**0.01**	**1.80 (1.30, 2.48)**	**0.0004**
No	Reference	Ref	Reference	Ref	Reference	Ref
Health Insurance						
None	Reference	Ref	Reference	Ref	Reference	Ref
Private Only	0.88 (0.34, 2.29)	0.79	**2.42 (1.67, 3.51)**	**<0.0001**	**4.40 (2.87, 6.75)**	**<0.0001**
Public Only	0.92 (0.34, 2.52)	0.87	1.28 (0.86, 1.90)	0.23	**2.61 (1.66, 4.11)**	**<0.0001**
Other/Multiple	Insufficient Data*	N/A	1.80 (0.99, 3.29)	0.06	**4.64 (2.46, 8.77)**	**<0.0001**
Population Density						
Large Central Metro	Reference	Ref	Reference	Ref	Reference	Ref
Large Fringe Metro	0.84 (0.36, 1.97)	0.68	**0.58 (0.42, 0.80)**	**0.0008**	**0.51 (0.37, 0.71)**	**<0.0001**
Medium Metro	1.22 (0.47, 3.14)	0.68	0.90 (0.63, 1.30)	0.57	0.93 (0.64, 1.34)	0.68
Small Metro and Smaller	0.41 (0.12, 1.39)	0.15	**0.62 (0.43, 0.88)**	**0.007**	**0.64 (0.44, 0.92)**	**0.02**
Education Level						
HS diploma or equivalent or less	Reference	Ref	Reference	Ref	Reference	Ref

Some college or technical degree	0.49 (0.20, 1.19)	0.11	1.20 (0.85, 1.69)	0.31	1.43 (0.98, 2.08)	0.06
College degree or postgraduate education	0.84 (0.34, 2.08)	0.70	**2.47 (1.72, 3.55)**	**<0.0001**	**4.10 (2.78, 6.06)**	**<0.0001**
Income (USD)						
<20,000	Reference	Ref	Reference	Ref	Reference	Ref
20,000-39,999	1.20 (0.40, 3.55)	0.74	1.21 (0.83, 1.76)	0.32	0.95 (0.64, 1.42)	0.81
40,000-74,999	2.29 (0.80, 6.58)	0.12	1.36 (0.92, 2.02)	0.12	1.32 (0.87, 1.99)	0.19
≥75,000	0.94 (0.27, 3.33)	0.93	**1.62 (1.08, 2.44)**	**0.02**	**2.38 (1.55, 3.63)**	**<0.0001**
Previous COVID-19 Diagnosis						
Yes	0.95 (0.62, 1.46)	0.81	**0.78 (0.70, 0.92)**	**0.003**	**0.75 (0.63, 0.89)**	**0.0008**
No	Reference	Ref	Reference	Ref	Reference	Ref

*After adjusting for other variables the number of individuals who had other/multiple health insurance was insufficient to calculate a confidence interval.

**Health Characteristics that excluded an additional 1,000 individuals were removed from the model

Table 5. Bivariate Analysis of COVID-19 Vaccination status among MSM participants in the American Men's Internet Survey in 2021 who are not living with HIV.

Participant Characteristic	N	Unvaccinated n (%)	Incomplete Initial Series n (%)	Fully Vaccinated n (%)	Boosted n (%)	Crude Odds Ratio (Unvaccinated vs Incomplete) (95% CI)	p-value	Crude Odds Ratio (Unvaccinated vs Fully Vaccinated) (95% CI)	p-value	Crude Odds Ratio (Unvaccinated vs Boosted) (95% CI)	p-value
Age											
15-24	295	35 (11.9)	5 (1.7)	147 (49.8)	108 (36.6)	Reference	Ref	Reference	Ref	Reference	Ref

25-29	500	39 (7.8)	5 (1.0)	247 (49.4)	209 (41.8)	0.90 (0.24, 3.36)	0.87	1.51 (0.92, 2.49)	0.11	**1.74 (1.04, 2.90)**	**0.03**
30-39	1202	91 (7.6)	11 (0.9)	540 (44.9)	560 (46.6)	0.85 (0.27, 2.61)	0.77	1.41 (0.92, 2.17)	0.12	**1.99 (1.28, 3.10)**	**0.002**
40+	2484	167 (48.2)	19 (0.8)	1102 (44.4)	1196 (48.2)	0.80 (0.28, 2.28)	0.67	**1.571 (1.05, 2.35)**	**0.03**	**2.32 (1.53, 3.51)**	**<0.0001**
Race											
Non-Hispanic White	3022	231 (7.1)	19 (0.6)	1337 (44.2)	1453 (48.1)	Reference	Ref	Reference	Ref	Reference	Ref
Any Black	477	58 (12.2)	17 (3.6)	253 (53.0)	149 (31.2)	**3.29 (1.61, 6.72)**	**<0.0001**	**0.70 (0.51, 0.96)**	**<0.0001**	**0.38 (0.27, 0.53)**	**<0.0001**
Non-Black Hispanic	581	29 (5.0)	1 (0.2)	273 (47.0)	278 (47.9)	0.39 (0.05, 3.00)	0.36	1.50 (0.996, 2.26)	0.05	1.41 (0.93, 2.12)	0.10
Other	350	24 (6.9)	2 (0.6)	153 (43.7)	171 (48.9)	1.05 (0.29, 3.75)	0.94	0.86 (0.58, 1.29)	0.47	0.88 (0.59, 1.32)	0.55
Region											
Northeast	853	52 (6.1)	6 (0.7)	351 (41.2)	444 (52.1)	Reference	Ref	Reference	Ref	Reference	Ref
Midwest	873	70 (8.0)	4 (0.5)	407 (46.6)	392 (44.9)	0.50 (0.13, 1.85)	0.30	0.86 (0.58, 1.26)	0.44	**0.65 (0.44, 0.95)**	**0.03**
South	1656	146 (8.8)	24 (1.5)	758 (45.8)	728 (44.0)	1.43 (0.55, 3.68)	0.46	0.77 (0.55, 1.08)	0.13	**0.58 (0.41, 0.81)**	**0.001**
West	1093	64 (5.9)	6 (0.6)	519 (47.5)	504 (46.1)	0.81 (0.25, 2.67)	0.73	1.20 (0.81, 1.77)	0.36	0.91 (0.62, 1.34)	0.64
NHBS City Resident											
Yes	1612	73 (4.5)	13 (0.8)	715 (44.4)	811 (50.3)	1.71 (0.84, 3.48)	0.14	**1.92 (1.46, 2.53)**	**<0.0001**	**2.28 (1.73, 3.00)**	**<0.0001**
No	2869	259 (9.0)	27 (0.9)	1321 (46.0)	1262 (44.0)	Reference	Ref	Reference	Ref	Reference	Ref
Health Insurance											
None	283	63 (22.3)	9 (3.2)	147 (51.9)	64 (22.6)	Reference	Ref	Reference	Ref	Reference	Ref
Private Only	3285	171 (5.2)	20 (0.6)	1504 (45.8)	1590 (48.4)	0.82 (0.35, 1.89)	0.64	**3.77 (2.70, 5.27)**	**<0.0001**	**9.15 (6.25, 13.41)**	**<0.0001**
Public Only	630	75 (11.9)	10 (1.6)	272 (43.2)	273 (43.3)	0.93 (0.36, 2.44)	0.89	**1.55 (1.05, 2.30)**	**0.03**	**3.58 (2.33, 5.52)**	**<0.0001**
Other/Multiple	250	18 (7.2)	0 (0.0)	99 (39.6)	133 (53.2)	Not enough data*	N/A	**2.36 (1.32, 4.22)**	**0.004**	**7.27 (3.98, 13.29)**	**<0.0001**
Population Density											
Large Central Metro	2084	99 (4.8)	13 (0.6)	942 (45.2)	1030 (49.4)	Reference	Ref	Reference	Ref	Reference	Ref
Large Fringe Metro	928	80 (8.6)	12 (1.3)	433 (46.7)	403 (43.4)	1.14 (0.49, 2.64)	0.76	**0.57 (0.42, 0.78)**	**0.0005**	**0.48 (0.35, 0.66)**	**<0.0001**

Medium Metro	827	66 (8.0)	9 (1.1)	380 (46.0)	372 (45.0)	1.04 (0.42, 2.57)	0.93	**0.61 (0.43, 0.85)**	**0.003**	**0.54 (0.39, 0.76)**	**0.003**
Small Metro and Smaller	633	86 (13.6)	6 (9.5)	279 (44.1)	262 (41.4)	0.53 (0.19, 1.46)	0.22	**0.34 (0.25, 0.47)**	**<0.0001**	**0.29 (0.21, 0.40)**	**<0.0001**
Education Level											
HS diploma or equivalent or less	358	68 (19.0)	13 (3.6)	176 (49.2)	101 (28.2)	Reference	Ref	Reference	Ref	Reference	Ref
Some college or technical degree	1060	135 (12.7)	13 (1.2)	538 (50.8)	374 (35.3)	0.50 (0.22, 1.15)	0.10	**1.54 (1.10, 2.16)**	**0.01**	**1.87 (1.30, 2.69)**	**0.0008**
College degree or postgraduate education	3053	129 (4.2)	14 (0.5)	1318 (43.2)	1592 (52.2)	0.57 (0.25, 1.28)	0.17	**3.95 (2.83, 5.51)**	**<0.0001**	**8.31 (5.82, 11.86)**	**<0.0001**
Income (USD)											
<20,000	340	51 (15.0)	4 (1.2)	155 (45.6)	130 (38.2)	Reference	Ref	Reference	Ref	Reference	Ref
20,000-39,999	601	79 (13.1)	9 (1.5)	325 (54.1)	188 (31.3)	1.45 (0.43, 4.97)	0.55	1.35 (0.91, 2.02)	0.14	0.93 (0.62, 1.42)	0.75
40,000-74,999	972	72 (7.4)	13 (1.3)	482 (49.6)	405 (41.7)	2.30 (0.71, 7.47)	0.16	**2.20 (1.48, 3.29)**	**0.0001**	**2.21 (1.47, 3.33)**	**0.0002**
≥75,000	2341	99 (4.2)	9 (0.4)	973 (41.6)	1260 (53.8)	1.16 (0.34, 3.95)	0.81	**3.24 (2.22, 4.72)**	**<0.0001**	**5.00 (3.41, 7.33)**	**<0.0001**
Perceived Risk of Getting HIV within the next 5 years											
Very unlikely	3356	228 (6.8)	26 (0.8)	1490 (44.4)	1612 (48.0)	Reference	Ref	Reference	Ref	Reference	Ref
Somewhat unlikely	854	73 (8.6)	11 (1.3)	415 (48.6)	355 (41.6)	1.32 (0.62, 2.81)	0.47	0.87 (0.65, 1.16)	0.34	**0.69 (0.52, 0.92)**	**0.01**
Very or somewhat likely	215	24 (20.9)	3 (2.6)	111 (51.6)	77 (35.8)	1.10 (0.31, 3.89)	0.89	0.71 (0.45, 1.12)	0.14	**0.45 (0.28, 0.73)**	**0.001**
Previous COVID-19 Diagnosis											
Yes	849	80 (9.4)	12 (1.4)	399 (47.0)	358 (42.2)	0.99 (0.70, 1.39)	0.93	**0.85 (0.75, 0.98)**	**0.02**	**0.75 (0.65, 0.88)**	**0.0002**
No	3613	249 (6.9)	27 (0.8)	1628 (45.1)	1709 (47.3)	Reference	Ref	Reference	Ref	Reference	Ref
Before having sex with a new male partner:											
Do you check if they have COVID symptoms?											
Yes	861	40 (4.7)	5 (0.6)	381 (44.3)	435 (50.5)	1.11 (0.40, 3.09)	0.84	**1.60 (1.12, 2.29)**	**0.01**	**2.05 (1.43, 2.92)**	**<0.0001**
No	2523	204 (8.1)	23 (0.9)	1212 (48.0)	1084 (43.0)	Reference	Ref	Reference	Ref	Reference	Ref

Do you check if they've been near others who had COVID in the past 10-14 days?											
Yes	1133	45 (4.0)	11 (1.0)	525 (46.3)	552 (48.7)	**2.86 (1.26, 6.53)**	**0.01**	**2.17 (1.55, 3.05)**	**<0.0001**	**2.52 (1.80, 3.55)**	**<0.0001**
No	2251	199 (8.8)	17 (0.8)	1068 (47.5)	967 (43.0)	Reference	Ref	Reference	Ref	Reference	Ref
Do you discuss COVID precautions with them?											
Yes	1435	42 (2.9)	10 (0.7)	652 (45.4)	731 (50.9)	**2.67 (1.15, 6.19)**	**0.02**	**3.33 (2.35, 4.71)**	**<0.0001**	**4.46 (3.15, 6.31)**	**<0.0001**
No	1949	202 (10.4)	18 (0.9)	941 (48.3)	788 (40.4)	Reference	Ref	Reference	Ref	Reference	Ref
Do you get tested for COVID-19?											
Yes	258	11 (4.3)	5 (1.9)	120 (46.5)	122 (47.3)	**4.61 (1.47, 14.41)**	**0.009**	1.73 (0.92, 3.25)	0.09	1.85 (0.98, 3.48)	0.06
No	3126	233 (7.5)	23 (0.7)	1473 (47.1)	1397 (44.7)	Reference	Ref	Reference	Ref	Reference	Ref
Do you request they get tested for COVID-19?											
Yes	122	4 (3.3)	1 (0.8)	44 (36.1)	73 (59.8)	2.22 (0.24, 20.60)	0.48	1.70 (0.61, 4.79)	0.31	**3.03 (1.10, 8.36)**	**0.03**
No	3262	240 (7.4)	27 (0.8)	1549 (47.5)	1446 (44.3)	Reference	Ref	Reference	Ref	Reference	Ref
Do you ask if they've been vaccinated against COVID-19?											
Yes	1960	25 (1.3)	6 (0.3)	925 (47.2)	1004 (51.2)	2.39 (0.88, 6.44)	0.09	**12.1 (7.92, 18.55)**	**<0.0001**	**17.07 (11.13, 26.16)**	**<0.0001**
No	1424	219 (15.4)	22 (1.5)	668 (49.9)	515 (36.2)	Reference	Ref	Reference	Ref	Reference	Ref
Currently Taking PrEP											
Yes	1678	66 (3.9)	9 (0.5)	769 (45.8)	834 (49.7)	0.82 (0.16, 4.26)	0.81	1.59 (0.83, 3.05)	0.16	1.70 (0.89, 3.25)	0.11
No	191	12 (6.3)	2 (1.1)	92 (48.2)	85 (44.5)	Reference	Ref	Reference	Ref	Reference	Ref

*There were 0 individuals with who had an incomplete vaccination series with other/multiple health insurance

Table 6. Multivariate Logistic Regression Models among MSM not living with HIV of COVID-19 vaccination status among MSM participants in the American Men's Internet Survey in 2021.

Participant Characteristic	Adjusted Odds Ratio (Unvaccinated vs Incomplete) (95% CI)	p-value	Adjusted Odds Ratio (Unvaccinated vs Fully Vaccinated) (95% CI)	p-value	Adjusted Odds Ratio (Unvaccinated vs Boosted) (95% CI)	p-value
Perceived risk of getting HIV within the next 5 years						
Very unlikely	Reference	Ref	Reference	Ref	Reference	Ref
Somewhat unlikely	1.70 (0.74, 3.89)	0.21	0.94 (0.68, 1.29)	0.71	0.82 (0.59, 1.14)	0.24

Very or somewhat likely	1.53 (0.39, 6.01)	0.54	1.01 (0.59, 1.70)	0.99	0.77 (0.44, 1.35)	0.36
Age						
15-24	Reference	Ref	Reference	Ref	Reference	Ref
25-29	1.97 (0.34, 11.48)	0.45	1.31 (0.74, 2.32)	0.36	1.12 (0.62, 2.03)	0.71
30-39	1.37 (0.26, 7.21)	0.71	1.08 (0.66, 1.79)	0.76	1.04 (0.62, 1.75)	0.89
40+	2.10 (0.43 10.30)	0.36	1.24 (0.77, 2.01)	0.78	1.12 (0.68, 1.85)	0.65
Race						
Non-Hispanic White	Reference	Ref	Reference	Ref	Reference	Ref
Any Black	2.24 (0.95, 5.27)	0.07	0.75 (0.52, 1.08)	0.13	**0.43 (0.29, 0.63)**	**<0.0001**
Non-Black Hispanic	0.36 (0.04, 2.87)	0.33	**1.60 (1.01, 2.53)**	**0.05**	**1.65 (1.03, 2.63)**	**0.04**
Other	0.87 (0.18, 4.13)	0.86	0.77 (0.48, 1.25)	0.29	0.85 (0.52 1.38)	0.50
Region						
Northeast	Reference	Ref	Reference	Ref	Reference	Ref
Midwest	0.29 (0.05, 1.54)	0.15	1.03 (0.67, 1.59)	0.88	0.82 (0.53, 1.27)	0.78
South	1.27 (0.46, 3.56)	0.65	0.90 (0.61, 1.33)	0.60	0.76 (0.51, 1.12)	0.17
West	0.81 (0.22, 3.01)	0.76	1.06 (0.68, 1.66)	0.79	0.77 (0.49, 1.21)	0.26
NHBS City Resident						
Yes	1.18 (0.44, 3.14)	0.74	**1.48 (1.03, 2.13)**	**0.03**	**1.88 (1.30, 2.71)**	**0.0008**
No	Reference	Ref	Reference	Ref	Reference	Ref
Health Insurance						
None	Reference	Ref	Reference	Ref	Reference	Ref
Private Only	0.74 (0.27 2.02)	0.56	**2.69 (1.81, 4.01)**	**<0.0001**	**4.57 (2.90, 7.19)**	**<0.0001**
Public Only	0.95 (0.33, 2.76)	0.92	1.29 (0.83, 2.00)	0.25	**2.53 (1.54, 4.13)**	**0.0002**
Other/Multiple	Not enough data*	N/A	**2.27 (1.14, 4.50)**	**0.02**	**5.15 (2.51, 10.58)**	**<0.0001**
Population Density						
Large Central Metro	Reference	Ref	Reference	Ref	Reference	Ref
Large Fringe Metro	0.86 (0.33, 2.27)	0.76	**0.56 (0.39, 0.80)**	**0.001**	**0.47 (0.32, 0.67)**	**<0.0001**
Medium Metro	1.12 (0.38, 3.27)	0.84	0.76 (0.51, 1.13)	0.17	0.79 (0.53, 1.19)	0.26
Small Metro and Smaller	0.46 (0.13, 1.65)	0.23	**0.54 (0.36, 0.79)**	**0.002**	**0.57 (0.38, 0.85)**	**0.006**
Education Level						
HS diploma or equivalent or less	Reference	Ref	Reference	Ref	Reference	Ref

Some college or technical degree	0.53 (0.20, 1.40)	0.20	1.11 (0.75, 1.64)	0.59	1.29 (0.84, 1.97)	0.24
College degree or postgraduate education	0.60 (0.21 1.70)	0.34	**2.25 (1.50, 3.36)**	**<0.0001**	**3.83 (2.48, 5.90)**	**<0.0001**
Income (USD)						
<20,000	Reference	Ref	Reference	Ref	Reference	Ref
20,000-39,999	1.84 (0.49, 6.89)	0.37	1.13 (0.73, 1.74)	0.59	0.76 (0.48 1.21)	0.24
40,000-74,999	3.13 (0.86, 11.36)	0.08	1.28 (0.82, 2.01)	0.28	1.13 (0.71 1.81)	0.60
≥75,000	1.69 (0.40 7.15)	0.48	1.52 (0.96, 2.41)	0.07	**1.87 (1.17 3.01)**	**0.01**
Previous COVID-19 Diagnosis						
Yes	0.95 (0.61, 1.49)	0.83	**0.79 (0.66, 0.94)**	**0.007**	**0.75 (0.62, 0.90)**	**0.003**
No	Reference	Ref	Reference	Ref	Reference	Ref

*There were 0 individuals with who had an incomplete vaccination series with other/multiple health insurance

**Health Characteristics that excluded an additional 1,000 individuals were removed from the model

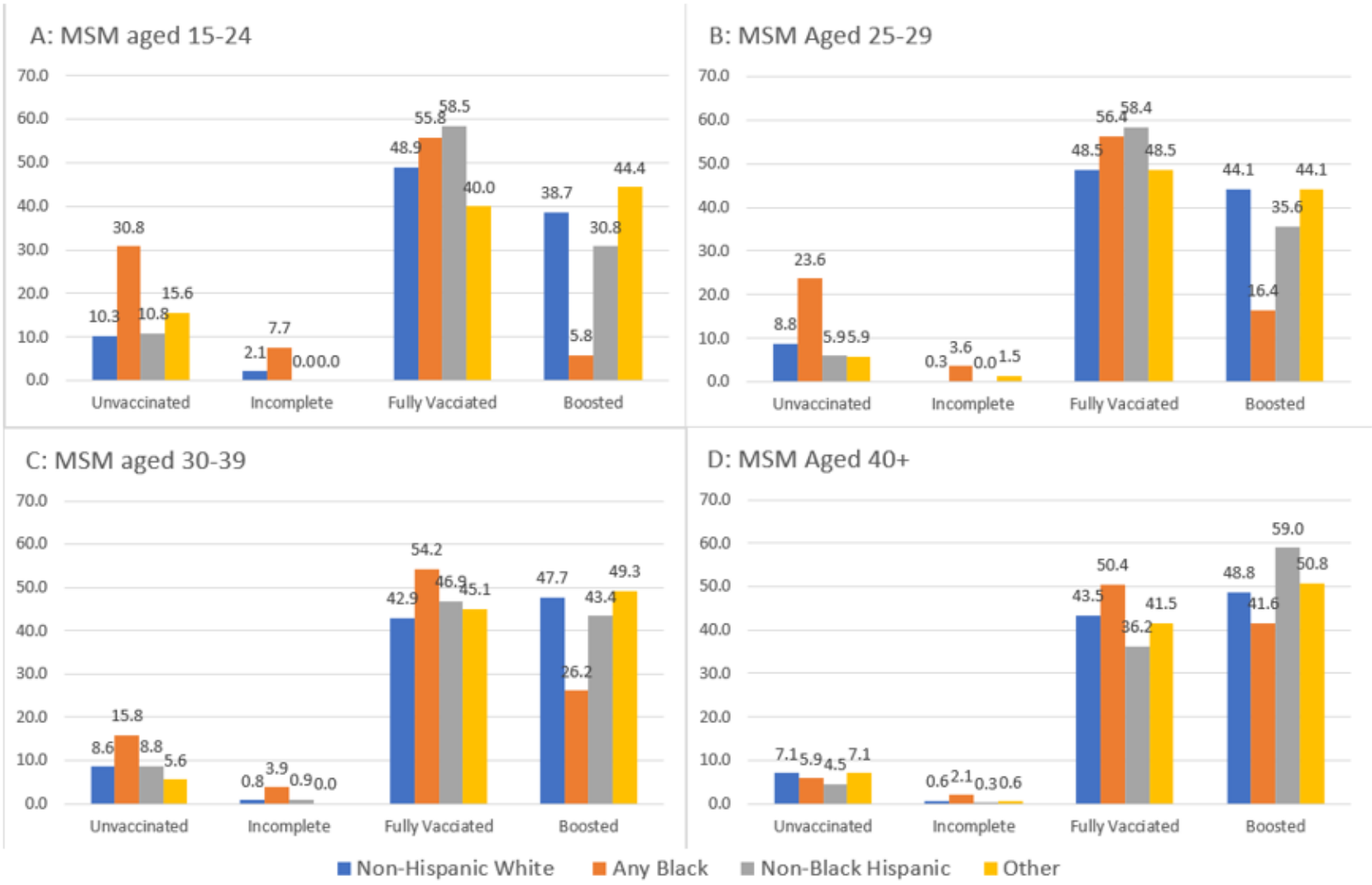

Figure 1. The proportion of MSM in each category of vaccination status stratified by age. Panel A represents individuals aged 15-24 years. Panel B represents individuals aged 25-29 years. Panel C represents individuals aged 30-39 years. Panel D represents individuals 40 years and older.

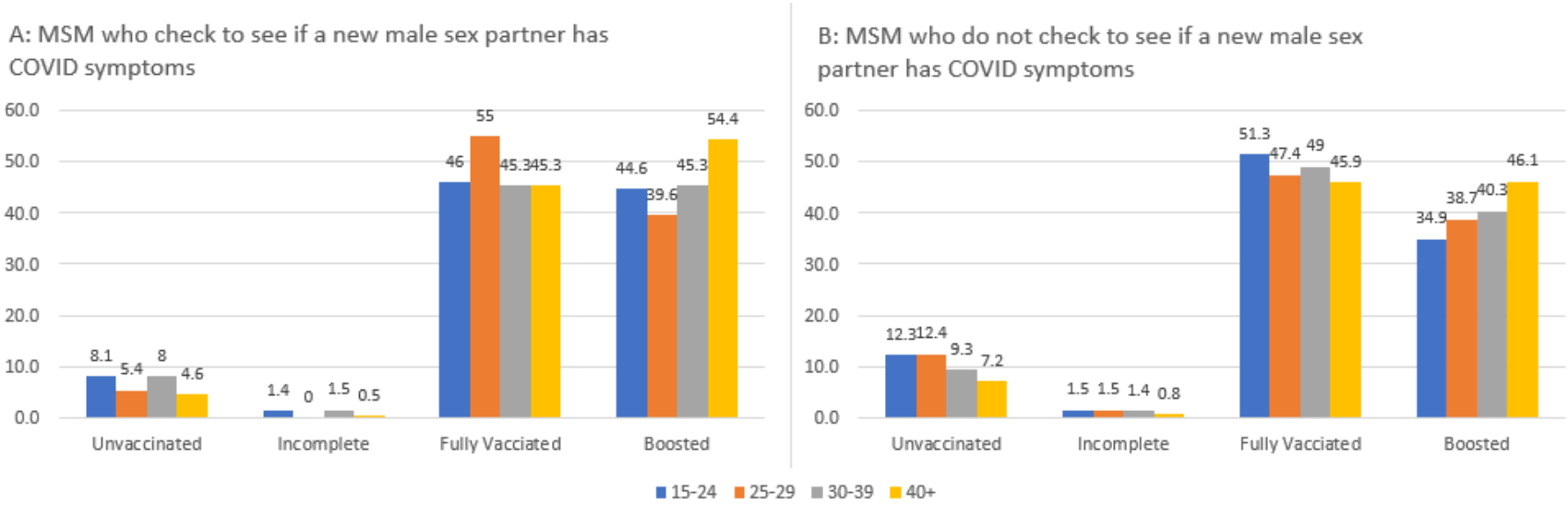

Figure 2. The proportion of MSM in each category of vaccination status stratified by the answer to the question, “Before having sex with a new male partner do you check if they have COVID symptoms?” Panel A represents a “Yes” and Panel B represents a “No” answer.