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Assessing the Impact of the COVID-19 Pandemic on Sexual Behaviors of Men Who Have Sex with Men in the United States

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Introduction

The ongoing COVID-19 pandemic has quickly become one of the most devastating global pandemics of the modern era. With a global case count of more than 600 million and more than 90 million cases in the United States alone, nearly every population in the world has been impacted by the pandemic in some way [1]. Men who have sex with men (MSM) are one community that was severely impacted by the COVID-19 pandemic. For many MSM, COVID-19 acted as a significant barrier for access to HIV preventative care and treatment, especially among MSM who identify as a racial or ethnic minority [2]. Sexual minorities such as MSM are at increased risk of prevalent conditions such as heart disease, obesity, and asthma, among others, that are associated with severe health outcomes as a result of COVID-19 infection [3].

The exact nature of the impact of COVID-19 on the health of sexual minorities requires further research, but it is known that many MSM and those within the larger lesbian, gay, bisexual, transgender, queer, and other sexual and gender identities (LGBTQ+) community, are at an increased risk of negative outcomes associated with COVID-19 [4]. As a response to this perceived elevated risk, many MSM report changing their sexual behaviors as a result of the ongoing pandemic in order to avoid being infected with and potentially spreading SARS-Cov-2 [5, 6, 7, 8]. These studies report on perceived changes in behavior as a result of the COVID-19 pandemic but do not look at changes and trends in actual behaviors.

As the COVID-19 pandemic persists, it is important to recognize the current burdens the US MSM population continues to experience. The MSM population accounts for 68% of new HIV infections and 58% of people living with HIV in the US today [9, 10]. Within the MSM community, different populations experience different levels of this burden. For example, black MSM 13-24 years old account for 51% of new HIV diagnoses in comparison to white MSM in the same age group, who only account for 14% of new HIV diagnoses [11]. MSM are also at increased risk of sexually transmitted infections (STI) [12]. The rate of reported gonorrhea is 42 times higher among MSM than heterosexual men and MSM account for more than half of all cases of reported syphilis in the US [12].

Many of the studies that have identified changes in the sexual behavior of MSM utilize only self-reported cross-sectional data from a single timepoint. As of yet, there have not been any studies to look for evidence of these changes in sexual behavior trends as related to the COVID-19 pandemic. Understanding these changes in sexual behavior trends is crucial in order for current programs and policies to adjust in order to better address the health of the MSM population, especially in regard to HIV/AIDS, STIs, and other sexual health concerns in the wake of the COVID-19 pandemic.

The American Men's Internet Survey (AMIS) is an online behavioral study of US MSM that has collected cross-sectional survey data annually from approximately 10,000 participants since 2013 [13, 14] and has previously been used to investigate changes in many aspects of the MSM community, including sexual behaviors [15]. Another survey that describes the sexual behaviors

of MSM is the Centers for Disease Control and Prevention's National HIV Behavioral Surveillance System (NHBS). This is a survey of MSM residing in the 20 largest cities in the US and their self-reported sexual behaviors for the purpose of HIV surveillance and monitions. Although this data is very useful, it is only collected every 3 years whereas AMIS is conducted annually. In this study, we examined changes in sexual behaviors, during the time period before the COVID-19 pandemic (2017-2019) and during/after the pandemic (2020-2021), utilizing AMIS cycles that correspond to this time period. Additionally, we also evaluated how racial differences in sexual behaviors have changed as a result of the COVID-19 pandemic.

Methods

Study Population

The study complied with federal regulations regarding the protection of human subjects in research and was reviewed and approved by Emory University's institutional review board.

AMIS cycles have been conducted annually since 2013 and eligible MSM are recruited each year. The sampling methods of AMIS cycles have been previously described [13, 14]. In short, recruitment occurred online through digital advertisements and participants were taken to the survey website after clicking on one of the advertisements. Since 2016, previous participants have also been recruited via email. The self-administered online survey asked questions about demographics and a variety of other topics, including sexual behaviors, PrEP use, testing behaviors, and drug use. Additionally, in 2021, participants were asked questions related to the COVID-19 pandemic, including any COVID-19 diagnoses they received in the past year and what COVID-19 vaccines they had received.

The eligibility criteria has remained consistent throughout AMIS cycles included in this analysis. The minimum age of recruitment is 15 years and older and the participants were enrolled if they identified as cisgender men and they reported ever having anal or oral sex with another men. If participants were 15-17 years old and identified as gay or bisexual (without a prior sexual history), they were included in the study. Once identified, eligible participants were immediately asked to provide informed consent and took the self-administered online survey. In order to be included in the analysis, participants must have reported male-male sexual activity within the past 12 months.

Measures

The measures that were included in these analyses were self-reported and occurred in the previous year. Three sexual behaviors were included as part of this analysis: condomless anal sex with any male partner (CAI), condomless anal sex with a male partner of serodiscordant HIV status (discordant CAI), and number of male sex partners (MSP) as categorized into 1 partner or more than 1 partner. The number of MSP was categorized in this way as we were interested in investigating whether the number of MSM engaged in exclusive relationships had changed. For the purpose of this analysis, serodiscordance was defined as when either partner has an unknown HIV status or when one partner was living with HIV and the other was not.

In addition to standard demographic information such as age and race/ethnicity, information about recruitment source was also collected. Each advertisement contained unique links, so we were able to categorize them into different recruitment types, based on where they saw the advertisements. Prior to 2020, participants were categorized into 5 recruitment types: gay social networking, general gay interest, general social networking, geospatial, and previous AMIS participants. However, beginning in 2020, participants were no longer recruited via gay social networking and general gay interest social media. These recruitment sources were discontinued due to the low number of participants that had been recruited previously using them. In order to be emailed to participate in future cycles, participants had to opt in to agree to be contacted for

the next year's cycle. Participants who answered a subsequent year's survey were categorized by their original recruitment type.

ZIP codes were collected from participants so that they could be categorized into what city, state, and geographical region of the US that they resided in, as well as whether they resided in an NHBS city. Additionally, their ZIP codes were used to classify their place of residence into different levels of urbanicity using the National Center for Health Statistics (NCHS) Rural-Urban classification scheme [16] and these levels were then further collapsed into a 4-level scheme: urban, suburban, small/medium metropolitan, and rural. Participants provided self-reported answers to questions such as ever having an HIV test, results of their most recent HIV test, and ever receiving a positive HIV diagnosis, in order to determine their HIV status. Participants who had never received an HIV test or did not know the results of their most recent test were classified as having an unknown status, participants who reported having a most recently negative HIV test were classified as HIV-negative, and participants who reported ever receiving a positive HIV diagnosis were classified as HIV-positive.

Analyses of AMIS 2017-2021 Cycles

Participants were included in the analysis if they completed the survey, reported having sex with another man in the past 12 months, and entered a valid US ZIP code. These inclusion criteria have been reported on previously [13, 14]. In order to assess whether the characteristics of the participants in each cycle were significantly different from each other, Overall Chi square tests were used. Then, linear trends across cycles were evaluated using Poisson models. Each cycle was stratified by HIV-/Unknown status and HIV+ positive status, as well as race/ethnicity and age. All models included age, race, recruitment site type, and urbanicity level (Table 2). Interaction by race/ethnicity and age were evaluated and presented where significant (Alpha=0.05) (Table 2).

Trends across study cycles for sexual behaviors of interest, stratified by HIV status, race/ethnicity, and age were plotted. In order to examine trends across study cycles, we used estimated annual percentage change (EAPC) with 95% confidence intervals (CI). EAPC, instead of multi-variable standardization was used, as established in previous research using AMIS data [15].

Results

Overall, forty-one thousand nine hundred seventy-three AMIS participants were included in the study. Nine thousand four hundred fifty-one participants were censored as they did not report any sexual activity within the last 12 months. The most prevalent age groups among participants were 15-24 and 40 and older (Table 1). Two-thirds of the participants were white, non-Hispanic. The most common method of recruitment was general social networking for all study cycles except 2021, where geospatial was the most common. Slightly less than half of participants live in the Southern United States for each study cycle and most commonly in urban areas. A majority of the participants of each study cycle did not live in NHBS cities. Approximately 9% of participants were living with HIV, ranging between 7-14% across each study cycle, and one-fifth did not know their HIV-status. The characteristics of the participants were significantly different between all study cycles.

During the study period, there was a significant increase in the percentage of participants who reported having more than one male-male sex partner among participants not living with HIV (p-value = 0.0052; EAPC = 1.09 [0.32, 1.86]; Table 3) but among participants living with HIV, there was no significant change. Similarly, a significant increase in the number of participants who engaged in condomless anal intercourse with a male partner occurred among participants not living with HIV (p-value <0.0001; EAPC = 5.60 [4.54, 6.68]) and no significant change occurred among participants living with HIV (Table 3). A larger significant increase in serodiscordant condomless anal sex was detected among participants living with HIV (EAPC 7.81 [5.41, 10.26]) in comparison to those not living with HIV (EAPC = 6.43 [5.12, 7.77]; Table 3). An additional analysis was performed to investigate the changes in the trends of serodiscordant partner coupling. In this analysis, the proportion of participants not living with HIV who reported a sexual partner with an unknown HIV status significantly increased during the study period, from 23.3% to 26.74% (p-value < 0.0001).

Among Black, non-Hispanic MSM, a significant increase in the percentage of participants who reported having more than one male-male sex partner occurred during the study period: 85% in 2017 to 90.2% in 2021 (p-value = 0.024; EAPC = 1.13 [0.15, 2.12]; Table 4a). Among White, non-Hispanic MSM, a decreasing trend of percentage of participants who reported having more than one male-male sex partner was seen throughout the study period, except in 2021 where the prevalence reached levels higher than in 2017: 82.1% in 2017 to 83.2% in 2021 (p-value = 0.0128; EAPC = -0.54 [-0.97, 0.12]; Table 4c). Among Hispanic MSM and MSM of other races, no significant change was detected in the percentage of participants who reported having more than one male-male sex partner. With the exception of Hispanic MSM, all racial/ethnic groups exhibited a significant increase in the percentage of participants who engaged in condomless anal sex, with the largest increase in terms of EAPC occurring among MSM of other races (EAPC = 7.93 [4.37, 11.61]; Table 4d) and the smallest increase among black MSM (EAPC = 1.95 [0.49, 3.43]; Table 3a. A significant increase in the percentage of participants who engaged in condomless anal sex with a serodiscordant partner was detected among all racial/ethnic groups, with the largest increase in terms of EAPC occurring among black MSM (EAPC = 9.05 [5.88,

12.32]; Table 4a) and the smallest occurring among Hispanic MSM (EAPC = 4.56 [1.78, 7.41]; Table 4b).

Participants aged 25-29 y.o. were the only group to exhibit a significant change in the percentage who reported having more than one male-male sexual partner, decreasing from 83.2% in 2017 to 79% in 2021 (p-value = 0.029; EAPC = -1.53 [-2.88, 0.16]; Table 5a). All age groups exhibited a significant increase in the percentage who reported having condomless anal sex, with the largest increase in terms of EAPC occurring among 15-24 y.o. MSM (EAPC = 4.81 [3.55, 6.08]; Table 5a) and the smallest increase occurring among 24-29 y.o. MSM (EAPC = -1.53 [-2.88, 0.16]; Table 5b). With the exception of MSM aged 25-29 y.o., a significant increase in the percentage of participants who engaged in serodiscordant condomless anal sex was detected, with the largest increase in terms of EAPC occurring among MSM aged 40 and older y.o. (EAPC = 10.09 [8.45, 11.76]; Table 5d) and the smallest occurring among participants aged 15-24 y.o. (EAPC = 5.23 [2.53, 8.00]; Table 5a).

Discussion

Our study has identified several significant trends in the sexual behaviors of US MSM during the course of the COVID-19 pandemic, especially the increasing number of MSM who had condomless anal intercourse with a male sex partner, including those who were HIV serodiscordant. Importantly, the COVID-19 pandemic has affected different groups of MSM in different ways, exacerbating pre-existing disparities in terms of risk of HIV acquisition between racial/ethnic groups and age groups. These trends are of most concern to HIV prevention efforts, especially among black MSM where the majority of new HIV infections are occurring. This study also identified an increase in individuals who do not know their HIV status which is likely indicative of HIV testing interruptions as a result of the COVID-19 pandemic. In these ways, it is clear to see how public health emergencies such as COVID-19 have the potential to impact the sexual behaviors of MSM, resulting in changes to health outcomes related to those behaviors

Compared to 2017, our study identified significant changes in the number of black, white, and 25-29 y.o. MSM who reported more than 1 MSP by the end of the study period. MSM aged 25-29 y.o. and white MSM exhibited a significant decrease in the prevalence of more than 1 MSP, whereas black MSM exhibited a significant increase (Figure 3b; Figure 3c). This may be indicative of different sexual networks and interactions between the two racial groups. Previous studies have identified significant differences between the black and white MSM communities-particularly that higher racial homophily exists among the black MSM community than the white MSM community which could explain the opposing trends identified in this study [26]. A previous study of sexual behavior changes as a result of the COVID-19 pandemic in the US identified that younger MSM (18-29 y.o.) decreased their number of sexual partners more than older MSM (30-49 y.o.) [27]. Our results, in conjunction with previous findings, may indicate that younger MSM are more willing than older MSM to change their behavior to reduce their risk of COVID-19 infection [27]. The 2020 cycle reports the lowest percentage of MSM with more than 1 MSP, regardless of HIV status. Additionally, the largest increase in percentage occurs from 2020 to 2021. This trend is thought to be due to MSM reducing their number of sexual partners in the beginning of the COVID-19 pandemic (early to mid-2020) in order to decrease their risk of infection [17, 18]. Though we did see this reduction in the number of sexual partners briefly in the beginning of the pandemic, a continuous decrease did not persist, as the percentage of MSM reporting more than 1 MSP increased in 2021 to the highest levels in the entire study period. This supports findings in previous studies where MSM self-reported as initially reducing their number of sexual partners and/or encounters in the early stages of the pandemic and lockdown, but subsequently increasing in the later stages of the pandemic (late 2020-2021) [19, 20]. In contrast, the number of participants engaging in sexual relationships with only 1 MSP exhibited a reciprocal trend in which the prevalence of these relationships increased during the early stages of the pandemic and decreased during the later stages of the pandemic.

Among participants not living with HIV, including those with an unknown status, there was no decrease at all throughout the study period of CAI prevalence, with a significant increase of 78% to 84% from 2017 to 2021 (Figure 1a). This increase was significant for all racial/ethnic and age subgroups, with the exception of Hispanic MSM (Figure 1b). This supports the continuing trend

of increasing CAI in the MSM community that has been observed previously [21]. In the context of the COVID-19 pandemic, this is a concerning trend because many MSM report experiencing interruptions in their access to PrEP, primarily due to self-perceived barriers in accessing medical care [28, 29].

There was also a significant increase in the prevalence of serodiscordant CAI among participants not living with HIV. This can potentially be explained by the observed increase in the number of HIV Negative Status + Unknown Status CAI. It has been reported that the COVID-19 pandemic negatively impacted access to care for MSM in both the US and abroad, including access to HIV testing [19, 22, 23]. Due to these interruptions in access to HIV testing, it is likely that the number of MSM in the US who did not know their HIV status increased. This would result in more sexual encounters, including CAI, between participants not living with HIV and those who do not know their status. This could explain the increase in serodiscordant CAI that was identified in this study (Figure 2a). The only group to exhibit a significant decrease throughout the study period in the prevalence of serodiscordant CAI was MSM aged 40 y.o. and older (Figure 2c). This could potentially be due to a decrease in sexual activity overall or the implementation of more selective partnering. Among participants living with HIV, there was no definite trend in CAI throughout the study period, although there was a significant increase in the prevalence of serodiscordant CAI (Figure 2a). However, there was no significant increase in the prevalence of HIV Positive Status + HIV Unknown Status CAI encounters, since persons living with HIV are more likely to have partners also living with HIV [30]. This is possibly indicative of the increase in the number of MSM living with HIV who are virally suppressed as well as the increase in the destigmatization of serodiscordant CAI among MSM who are virally suppressed [24, 25].

This study is subject to several notable limitations. AMIS relies entirely on self-reported data and as questions about sexual behavior are included, these data are subject to social desirability bias as participants may not be willing to answer these personal questions honestly. This could potentially result in certain behaviors that are perceived by participants as less desirable being less reported and therefore underestimated in analysis. Additionally, AMIS data are not generalizable to all MSM living in the US or all US MSM who are online. The convenience-based sampling approach that AMIS utilizes is prone to selection and enrollment biases, even though AMIS takes measures to limit these biases as much as possible (use multiple and different types of online platforms in recruitment). AMIS is also subject to significant variation in who participates in the study due to the online-based recruitment, as evident by the fact that all demographics are significantly different between survey cycles. This analysis was limited only to sexual behaviors and so did not include data on PrEP use, testing behaviors, or drug/alcohol use.

Several significant impacts of the COVID-19 pandemic on the sexual behaviors of MSM have been identified in this study. The pandemic initially caused MSM to decrease their number of sexual partners, but this was reversed in the later stages of the pandemic when the prevalence of MSM with more than 1 MSP increased to pre-pandemic levels. The prevalence of CAI and serodiscordant CAI also increased during the pandemic, both of which are concerning trends for HIV prevention campaigns. The potential for the increase in serodiscordant CAI to be due to the

interruption of HIV testing is also very concerning as the COVID-19 pandemic has revealed vulnerabilities in the US's current HIV prevention and care systems. In order to adapt sexual health and HIV prevention/treatment programs more readily, prospective data on MSM (in the form of AMIS data) needs to be continuously analyzed so that changes in the sexual behavior of MSM can be more rapidly detected. This would allow for US HIV prevention programs and other MSM sexual health interventions to respond quicker and implement more effective change in the wake of future public health emergencies. It is critical for the data produced in this analysis to be utilized by public health professionals and policy makers to adjust current US HIV prevention campaigns and efforts to address the vulnerabilities that have been revealed by the COVID-19 pandemic so that potential future public health crises to not produce similar negative effects.

Table 1: Demographic Characteristics of MSM Participants in the American Men's Internet Survey, United States, 2017-2021

Demographic Characteristics	Total	AMIS-2017[a]	AMIS-2018[b]	AMIS-2019[c]	AMIS-2020[d]	AMIS-2021[e]	p-value[f]
		N (%)	N (%)	N (%)	N (%)	N (%)	
Total	41973	6745	8272	8236	11100	7620	
Age (years)							< 0.0001
15-24	13923 (33.2%)	1922 (28.5%)	3327 (40.2%)	3398 (41.3%)	4681 (42.2%)	595 (7.8%)	
25-29	7332 (17.5%)	938 (13.9%)	1155 (14.0%	1557 (18.9%)	2903 (26.2%)	779 (10.2%)	
30-39	6862 (16.3%)	1134 (16.8%)	1312 (15.9%)	1274 (15.5%)	1219 (11.0%)	1923 (25.2%)	
40 and older	13856 (33.0%)	2751 (40.8%)	2478 (30.0%)	2007 (24.4%)	2297 (20.7%)	4323 (56.7%)	
Race/Ethnicity[g]							< 0.0001
Hispanic	7003 (16.7%)	1076 (16.0%)	1349 (16.3%)	1294 (15.7%)	2278 (20.5%)	1006 (13.2%)	
Black, non-Hispanic	4450 (10.6%)	441 (6.5%)	457 (5.5%)	1236 (15.7%)	1391 (12.5%)	925 (12.1%)	
White, non-Hispanic	27131 (64.6%)	4736 (70.2%)	5857 (70.8%)	5021 (61.0%)	6574 (59.2%)	4943 (64.9%)	
Other	3389 (8.1%)	492 (7.29%)	609 (7.36%)	685 (8.32%)	857 (7.72%)	746 (9.8%)	
Recruitment Type[h]							< 0.0001
Gay social networking[i]	1131 (2.7%)	793 (11.8%)	304 (3.7%)	34 (0.4%)	0	0	
General gay interest[j]	92 (0.2%)	57 (0.9%)	20 (0.2%)	15 (0.2%)	0	0	
General social networking	24572 (58.5%)	2521 (37.4%)	5098 (61.6%)	5676 (68.9%)	9453 (85.2%)	1824 (23.9%)	
Geospatial	12791 (30.5%)	2517 (37.3%)	2037 (24.6%)	1720 (20.9%)	1046 (9.4%)	5471 (71.8%)	
Previous AMIS participants	3387 (8.1%)	857 (12.7%)	813 (9.8%)	791 (9.6%)	601 (5.4%)	325 (4.27%)	
Region[k]							< 0.0001
Northeast	7190 (17.1%)	1211 (18.0%)	1312 (15.9%)	1387 (16.8%)	1854 (16.7%)	1426 (18.7%)	
Midwest	8385 (20.0%)	1289 (19.1%)	1785 (21.6%)	1651 (20.1%)	2228 (20.1%)	1432 (18.8%)	
South	16808 (40.0%)	2581 (38.3%)	3187 (38.5%)	3534 (42.9%)	4537 (40.9%)	2969 (39.0%)	
West	9590 (22.8%)	1664 (24.7%)	1988 (24.0%)	1664 (20.2%)	2481 (22.4%)	1793 (23.5%)	
NHBS City Resident							< 0.0001
Yes	14824 (35.3%)	2698 (40.0%)	2626 (31.8%)	2937 (35.7%)	3830 (34.5%)	2733 (25.9%)	
No	27149 (64.7%)	4047 (60.0%)	5646 (68.3%)	5299 (64.3%)	7270 (65.5%)	4887 (64.1%)	
Population Density[l]							< 0.0001
Urban	16738 (39.9%)	2863 (42.5%)	3041 (36.7%)	3075 (37.3%)	4211 (37.9%)	3548 (46.6%)	
Suburban	8785 (20.9%)	1441 (21.4%)	1696 (20.5%)	1773 (21.5%)	2335 (21.0%)	1540 (20.2%)	
Small/medium metropolitan	12614 (30.0%)	1913 (28.4%)	2725 (32.9%)	2570 (31.2%)	3458 (31.2%)	1948 (25.6%)	
Rural	3836 (91.4%)	528 (7.8%)	810 (9.79%)	818 (9.9%)	1096 (9.9%)	584 (7.66%)	
Self-Reported HIV Status							< 0.0001
Positive	3868 (9.2%)	650 (9.6%)	540 (6.5%)	749 (9.1%)	816 (7.4%)	1113 (14.6%)	
Negative	29411 (70.1%)	4953 (73.4%)	5788 (70.0%)	5609 (68.1%)	7447 (67.1%)	5614 (73.7%)	
Unknown	8694 (20.7%)	1142 (16.9%)	1944 (23.5%)	1878 (22.8%)	2837 (25.6%)	893 (11.7%)	

MSM men who sex with men, NHBS National HIV Behavioral Surveillance

[a]Data collected between July and Novemeber 2017

[b]Data collected between September and December 2018

[c]Data collected between September 2019 and January 2020

[d]Data collected between October 2020 and January 2021

[e]Data collected between September 2021 and March 20222

[f]Chi square test for difference in characteristics between AMIS cycles

[g]867 participants missing Race/Ethnicity information

[h]159 participants missing Recruitment Type infromation

[i]Gay social networking was not utilized as a recruitment method for 2020 and 2021 cycles

[j]General gay interest was not utilized as a recruitment method for 2020 and 2021 cycles

[k]No participants reported living in U.S.-dependent areas

[l]90 participants missing Population Density information

Table 2: Model and Interaction Assessment				
Participants not living with HIV				
Model	Estimate	P-value	Interaction	P-value
CAI = Study Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type * Study Year*Age * Study Year*Race/Ethnicity	0.0545 (0.0444, 0.0647)	<0.0001	Hispanic: -0.0192 (-0.0315, -0.0068) Black, non-Hispanic: -0.0243 (-0.0425, -0.0061 Other: 0.0028 (-0.0143, 0.0198) 25-29: -0.0202 (-0.0338, -0.0065) 30-39: -0.0310 (-0.0438, -0.0182) 40+: -0.0449 (-0.0572, -0.0327)	Hispanic: 0.0024 Black, non-Hispanic: 0.0087 Other: 0.7507 25-29: 0.0037 30-39: <0.0001 40+: <0.0001
Discordardant CAI = Study Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type	0.0623 (0.0499, 0.0748)	<0.0001	N/A	N/A
More Than 1 MSP = Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type * Year*Age	0.0108 (0.0032, 0.0184)	0.0052	25-29: 0.0028 (-0.0094, 0.015) 30-39: -0.0121 (-0.0232, -0.0009) 40+: -0.0247 (-0.034, -0.0154)	25-29: 0.6541 30-39: 0.0342 40+: <0.0001
Participants living with HIV				
Model	Estimate	P-value	Interaction	P-value
CAI = Study Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type	0.0052 (-0.0043, 0.0147)	0.2823	N/A	N/A
Discordardant CAI = Study Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type * Study Year*Race/Ethnicity	0.0752 (0.0527, 0.0977)	<0.0001	Hispanic: 0.0091 (-0.0468, 0.065) Black, non-Hispanic: 0.0516 (0.0022, 0.1009) Other: 0.0754 (-0.0047, 0.155)	Hispanic: 0.7502 Black, non-Hispanic: 0.0405 Other: 0.0650
More Than 1 MSP = Year * Age * Race/Ethnicity * Urbanicity * Recruitment Type	-0.0033 (-0.0115, 0.0049)	0.4321	N/A	N/A

Table 3: Sexual Behaviors of MSM Participants in the American Men's Internet Survey by serostatus and survey cycle, United States, 2017-2021							
Participants not living with HIV							
Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	4990 (81.9%)	6025 (77.9%)	5806 (77.6%)	7777 (75.6%)	5329 (83.0%)	0.0052	1.09 (0.32, 1.86)
Condomless anal intercourse (CAI)	4750 (77.9%)	6154 (79.6%)	5974 (79.8%)	8343 (81.1%)	5468 (84.0%)	<0.0001	5.60 (4.54, 6.68)
CAI with partner of serodiscordant or unknown HIV status	1680 (27.6%)	2010 (26.0%)	1971 (26.3%)	2527 (24.6%)	2131 (32.8%)	<0.0001	6.43 (5.12, 7.77)
Participants living with HIV							
Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	
More than 1 sexual partner	569 (87.5%)	469 (86.9%)	662 (88.4%)	672 (82.4%)	998 (91.1%)	0.4321	-0.33 (-1.14, 0.49)
Condomless anal intercourse (CAI)	583 (89.7%)	473 (87.6%)	654 (87.3%)	699 (85.7%)	1000 (89.9%)	0.283	0.52 (-0.43, 1.48)
CAI with partner of serodiscordant or unknown HIV status	402 (61.9%)	332 (61.5%)	504 (67.3%)	501 (61.4%)	811 (72.9%)	<0.0001	7.81 (5.41, 10.26)

Table 4: Sexual Behaviors of MSM Participants in the American Men's Internet Survey by race/ethnicity and survey cycle (2017-2021), United States

Table 4a: Sexual Behaviors of Black MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	375 (85.0%)	369 (80.7%)	1110 (89.8%)	1163 (83.6%)	834 (90.2%)	0.024	1.13 (0.15, 2.12)
Condomless anal intercourse (CAI)	336 (76.2%)	346 (75.7%)	970 (78.5%)	1075 (77.3%)	749 (81.0%)	0.0086	1.95 (0.49, 3.43)
CAI with partner of serodiscordant or unknown HIV status	164 (37.2%)	167 (36.5%)	556 (45.0%)	508 (36.5%)	454 (49.1%)	<0.0001	9.05 (5.88, 12.32)

Table 4b: Sexual Behaviors of Hispanic MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	890 (82.7%)	1073 (79.4%)	1018 (78.7%)	1787 (78.5%)	833 (82.8%)	0.2592	-0.50 (-1.35, 0.37)
Condomless anal intercourse (CAI)	840 (78.1%)	1065 (79.0%)	1026 (79.3%)	1830 (80.3%)	802 (79.7%)	0.1556	0.75 (-0.29, 1.81)
of serodiscordant or unknown HIV status	336 (31.2%)	404 (30.0%)	412 (31.8%)	654 (28.7%)	354 (35.2%)	0.0012	4.56 (1.78, 7.41)

Table 4c: Sexual Behaviors of White MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	3886 (82.1%)	4578 (78.2%)	3786 (75.4%)	4832 (73.5%)	4113 (83.2%)	0.0128	-0.54 (-0.97, 0.12)
Condomless anal intercourse (CAI)	3791 (80.1%)	4757 (81.2%)	4092 (81.5%)	5463 (83.1%)	4301 (87.0%)	<0.0001	2.82 (2.33, 3.32)
CAI with partner of serodiscordant or unknown HIV status	1444 (30.5%)	1592 (27.2%)	1296 (25.8%)	1659 (25.2%)	1856 (37.6%)	<0.0001	7.93 (6.49, 9.40)

Table 4d: Sexual Behaviors of Unknown/Other MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	408 (82.9%)	474 (77.8%)	554 (88.9%)	667 (77.8%)	633 (84.9%)	0.737	0.21 (-1.00, 1.42)
Condomless anal intercourse (CAI)	366 (74.4%)	459 (75.4%)	540 (78.8%)	674 (78.7%)	616 (82.6%)	<0.0001	7.93 (4.37, 11.61)
CAI with partner of serodiscordant or unknown HIV status	138 (28.1%)	179 (29.4%)	211 (30.8%)	207 (24.2%)	278 (37.3%)	0.0025	6.07 (2.11, 10.19)

Table 5: Sexual Behaviors of HIV-Negative and Unknown Status MSM Participants in the American Men's Internet Survey by age and survey cycle (2017-2021), United States

Table 5a: Sexual Behaviors of 15-24 MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	1548 (79.3%)	2597 (76.4%)	2716 (78.5%)	3712 (77.8%)	469 (78.8%)	0.2827	-0.588 (-1.63, 0.48)
Condomless anal intercourse (CAI)	1448 (74.2%)	2568 (75.6%)	2646 (76.5%)	3796 (79.6%)	474 (79.7%)	<0.0001	4.81 (3.55, 6.08)
CAI with partner of serodiscordant or unknown HIV status	489 (25.1%)	816 (24.0%)	853 (24.7%)	1176 (24.6%)	166 (27.9%)	0.0001	5.23 (2.53, 8.00)

Table 5b: Sexual Behaviors of 25-29 MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	792 (83.2%)	850 (72.5%)	1216 (76.9%)	2248 (76.0%)	615 (79.0%)	0.0292	-1.53 (-2.88, 0.16)
Condomless anal intercourse (CAI)	748 (78.6%)	983 (83.8%)	1352 (85.5%)	2511 (84.9%)	655 (84.1%)	0.0017	1.92 (0.72, 3.14)
CAI with partner of serodiscordant or unknown HIV status	271 (28.5%)	314 (26.8%)	464 (29.4%)	775 (26.2%)	234 (30.0%)	0.2613	1.78 (1.32, 4.94)

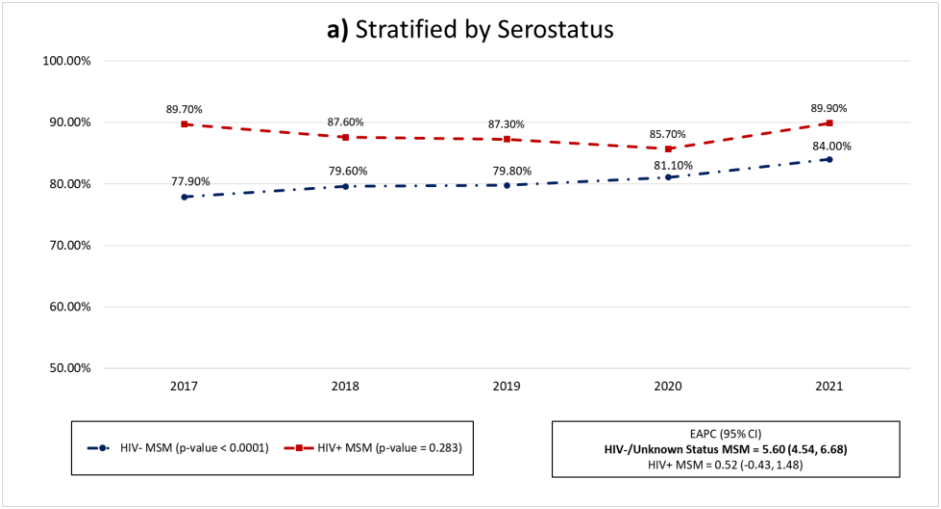
Table 5c: Sexual Behaviors of 30-39 MSM

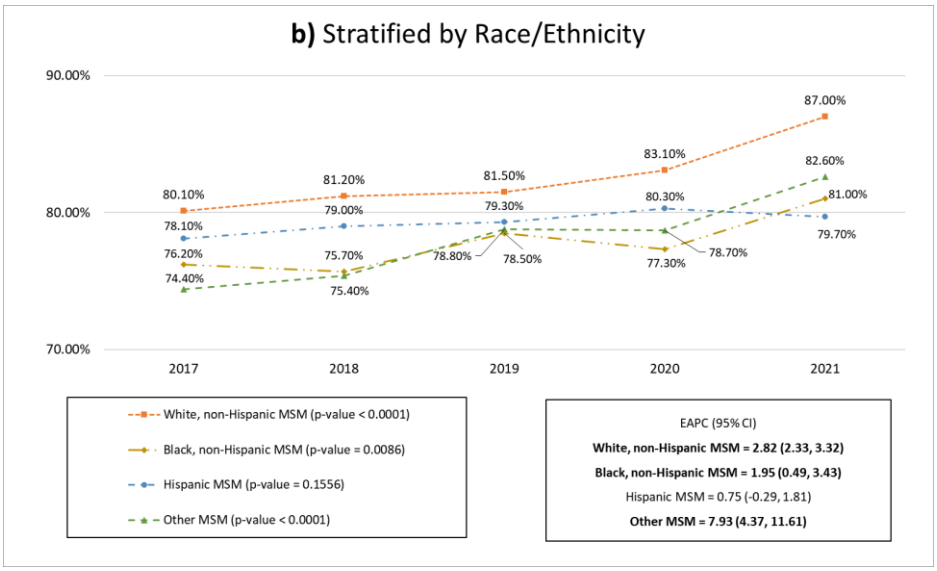
Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	970 (83.1%)	1004 (75.0%)	997 (76.7%)	948 (76.1%)	1580 (82.2%)	0.3167	-0.588 (-1.72, 0.56)
Condomless anal intercourse (CAI)	951 (81.5%)	1133 (84.7%)	1075 (82.8%)	1014 (81.5%)	1687 (87.7%)	<0.0001	2.18 (1.20, 3.18)
CAI with partner of serodiscordant or unknown HIV status	392 (33.6%)	368 (27.5%)	450 (34.7%)	357 (28.7%)	724 (37.7%)	<0.0001	6.05 (3.54, 8.62)

Table 5d: Sexual Behaviors of 40+ MSM

Sexual behaviors in past 12 months	AMIS-2017 N (%)	AMIS-2018 N (%)	AMIS-2019 N (%)	AMIS-2020 N (%)	AMIS-2021 N (%)	p-value	EAPC
More than 1 male-male sex partner	2341 (83.9%)	2152 (85.8%)	1665 (81.2%)	1714 (73.3%)	3749 (86.7%)	0.289	-0.29 (-0.82, 0.23)
Condomless anal intercourse (CAI)	2263 (81.1%)	2055 (81.9%)	1674 (81.6%)	1878 (80.3%)	3652 (84.5%)	<0.0001	2.54 (1.82, 3.27)
CAI with partner of serodiscordant or unknown HIV status	961 (34.4%)	881 (35.1%)	753 (36.7%)	774 (33.1%)	1818 (42.1%)	<0.0001	10.09 (8.45, 11.76)

Figure 1: Prevalence of Condomless Anal Sex Among MSM Participants in the American Men's Internet Survey, 2017-2021





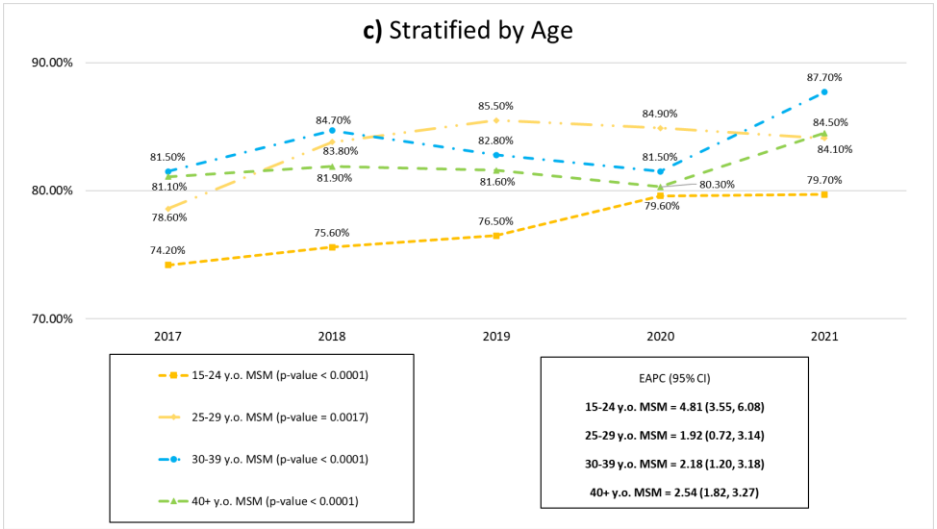
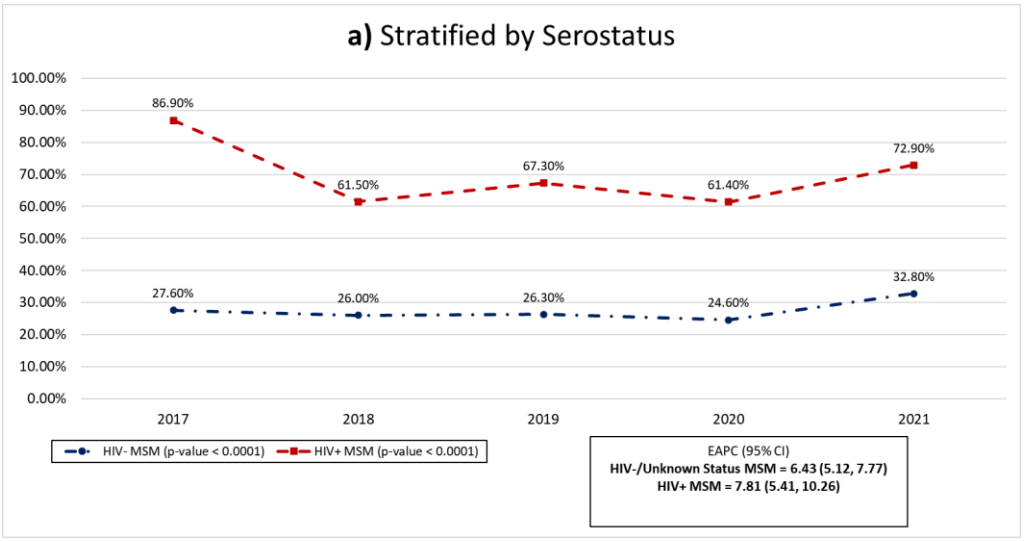
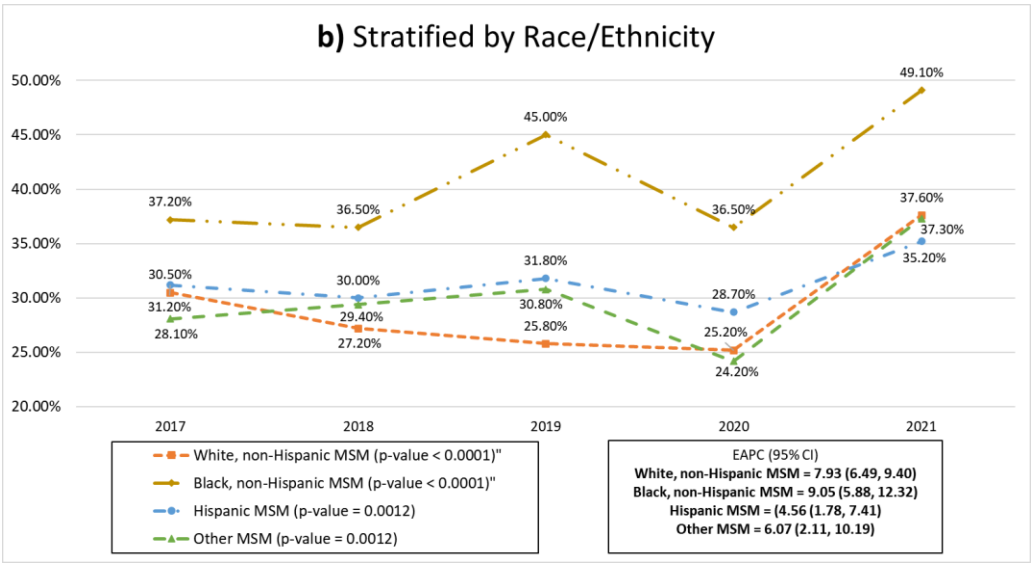


Figure 2: Prevalence of Serodiscordant Condomless Anal Sex Among MSM Participants in the American Men's Internet Survey, 2017-2021





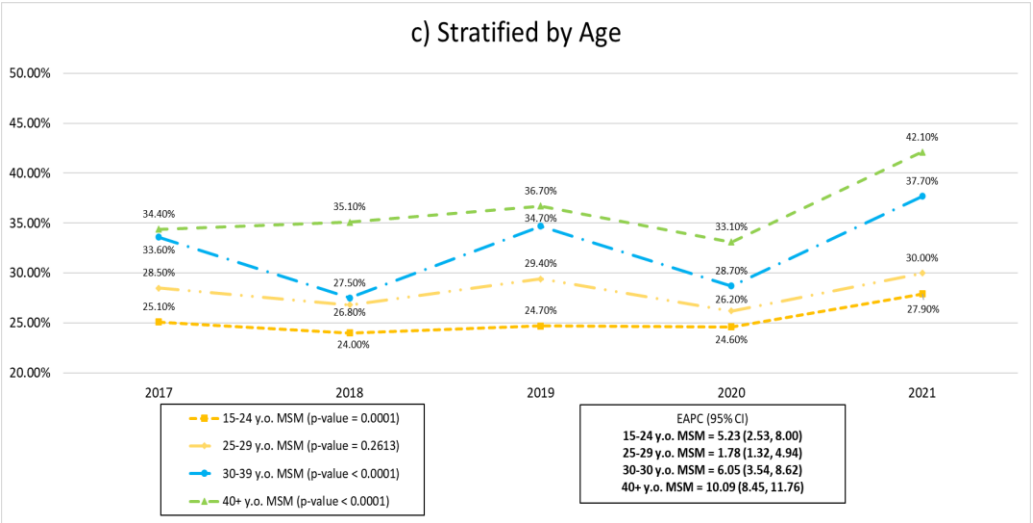
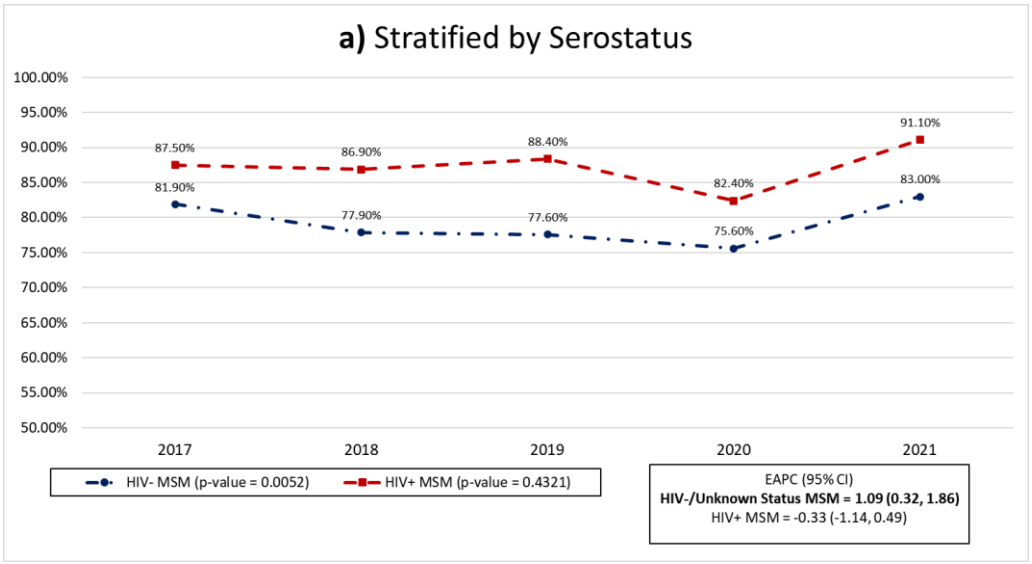
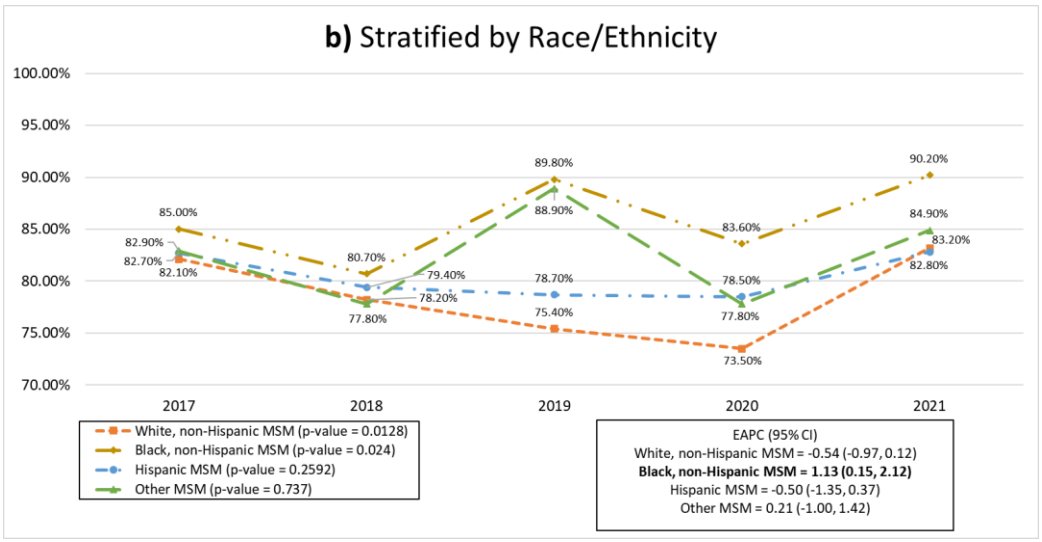
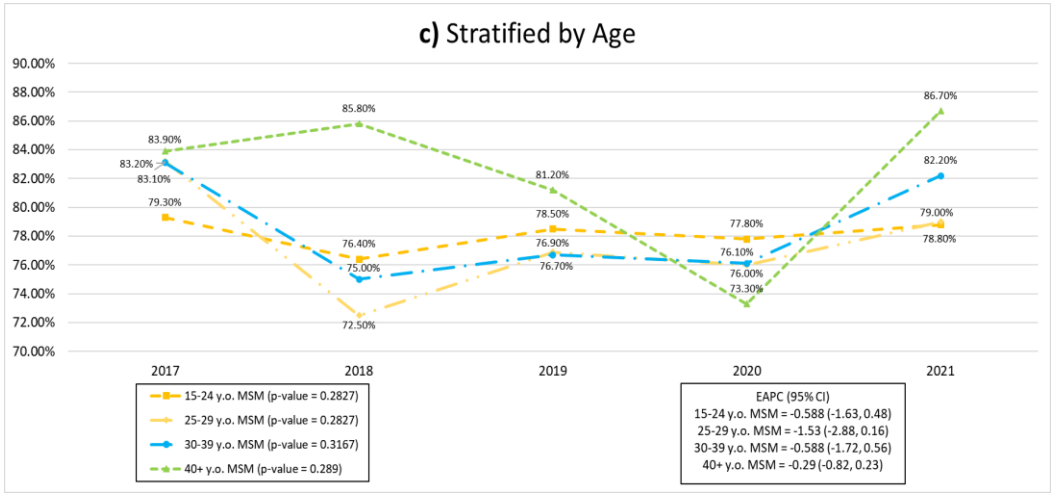


Figure 3: Prevalence of More than 1 Male Sex Partner in the American Men's Internet Survey, 2017-2021







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