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Correlates of Condomless Anal Intercourse (CAI) with a Partner of Unknown HIV Status Among the 2019 American Men's Internet Survey (AMIS) Participants

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Master of Public Health

Global Epidemiology

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2019

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An abstract of

A thesis submitted to the Faculty of the
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Abstract

Correlates of Condomless Anal Intercourse (CAI) with a Partner of Unknown HIV Status Among the 2019 American Men's Internet Survey (AMIS) Participants

By Ciara J. Michel

Introduction: HIV continues to be a significant issue in both public and LGBTQ+ health, especially among gay, bisexual, and other men who have sex with men (MSM) in the United States. Condom use during sex is an important mechanism of HIV prevention among MSM as condomless anal intercourse (CAI) is a main pathway to HIV transmission. A second significant prevention mechanism is disclosure of HIV statuses between partners. This study aims to determine which correlates are associated with and are more common among those with the outcome of interest, CAI with a partner of unknown (versus known) HIV status in the past 12 months, among MSM in the US.

Methods: Data from the 2019 American Men's Internet Survey (AMIS) were used for this study. AMIS is a large cross-sectional online HIV behavioral survey of MSM in the US and has been IRB-approved at Emory University. Bivariate unadjusted log binomial regression models were used to obtain unadjusted prevalence ratios (PR). Multivariate adjusted log binomial regression models were used to obtain adjusted prevalence ratios (aPR). SAS statistical software was used to perform both the bivariate and multivariate analyses.

Results: Statistically significant increased likelihoods of CAI with a partner of unknown HIV status in the past 12 months were found with the following correlates: being in the lowest income level, identifying as Black non-Hispanic, identifying as Hispanic, identifying as other, multiple, or unknown race/ethnicity, living with HIV, PrEP use, experiencing depressive symptoms, heavy alcohol use, various substance use, having more than 0 or 1 male anal sex partners, and worrying about a partner's HIV status.

Discussion: This study identified numerous important factors that may play a role in engaging in CAI with a partner of unknown HIV status among MSM in the US. The findings of this study can be used to inform and shape future research investigating the correlates and relationships associated with CAI with a partner of unknown HIV status among MSM partners. Additionally, these findings can be used to elucidate factors that could inform prevention and educational strategies and identify target populations for prevention and educational programming.

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Introduction

HIV continues to be a significant issue in both public and LGBTQ+ health; gay, bisexual, and other men who have sex with men (MSM) accounted for 69% of the 37,968 new HIV diagnoses in the United States in 2018 (1). About 492,000 sexually active MSM remain at high risk for HIV (1). Factors that contribute to this disparity and higher risk among MSM include higher chances of having a partner who has HIV, stigma, discrimination, unknown HIV status, condomless anal intercourse (CAI), low pre-exposure prophylaxis (PrEP) use, increased risk for other sexually transmitted infections (STIs), and socioeconomic factors (1–5). Black MSM made up 37% of the new HIV diagnoses among all MSM and 26% of the total 37,968 new HIV diagnoses in the United States in 2018 (1,6). This disproportionate burden of new HIV diagnoses among Black MSM further demonstrates the racial disparities that exist between Black and white MSM (1,6–9). These racial disparities are complex and are likely due to numerous factors faced by Black MSM such as racism, social barriers, structural barriers, incarceration rates, delay in linkage to HIV medical care, lower PrEP use, lower percentages of viral suppression, and socioeconomic factors (1,6–11). These complex factors work in tandem with the HIV-related risk factors faced by the overall MSM population in the US.

Aside from the aforementioned HIV-related racial disparities among MSM, an additional factor to consider among this population is depression. In the United States, major depression is one of the most common mental health disorders and can lead to severe impairments and major life disruptions (12). In comparison to the general United States population, MSM have higher rates of depression and may face other health-related issues stemming from depression and other mental health conditions (13–15). The increased rate of depression among MSM and the demonstration that depression is highly co-morbid with HIV, may contribute to higher HIV risk, increased

probability of sexual risk behaviors, influence disclosure status, and reduce adherence to antiretroviral therapy (15–20).

Using condoms during sex is a highly effective method of preventing HIV and other sexually transmitted infections (STIs) and can be used in combination with other prevention methods (21). Condom use during sex is an especially important mechanism of prevention among MSM as condomless anal intercourse (CAI) is a main pathway to HIV transmission (1,3,21); in terms of risk surrounding anal sex, receptive anal sex carries 13 times the risk for getting HIV in comparison to insertive anal sex (1). In addition to condom use, disclosure of one's HIV status to partners is an important protective factor that can lead to better health outcomes and communication on safer sex practices with partners (1,19). Despite the current research and prevention work surrounding HIV and HIV prevention methods, the relationship between and the important correlates of HIV disclosure status and condom use is not entirely clear, and the findings are not always consistent (3,4,19,22–28). Informed by existing literature, several of the important correlates that will be investigated in this study include age, education level, income level, healthcare access, PrEP and/or ART use, HIV status, alcohol or drug use before sex, and number of partners (3,4,14,19,25–28).

This study aims to determine which correlates are statistically significantly associated with and which are more common among those with the outcome of interest, CAI with a partner of unknown (versus known) HIV status in the past 12 months among MSM populations in the US. Sub-aims for this study include investigating the roles that both race and ethnicity, and, therefore, racial disparities, and depression among MSM play in the relationship of CAI with a partner of unknown (versus known) HIV status in the past 12 months as the implications of depression and racial disparities among MSM are not fully understood (7–9,14,15,18,20). Data for this study come from

The American Men's Internet Survey (AMIS), an annual cross-sectional online HIV behavioral survey of MSM in the US.

Methods

Study Population

The American Men's Internet Survey (AMIS) is a large cross-sectional online HIV behavioral survey of men who have sex with men (MSM) in the United States and has been IRB-approved at Emory University. AMIS is supported by funding from the MAC AIDS Fund. AMIS is conducted annually in cycles with the goal of at least 10,000 completed surveys of MSM every year. Data used in this study come from the seventh cycle of AMIS, which was completed in December 2019. The core of the survey collects a range of information including demographics, sexual behavior, HIV and STI testing and diagnosis history, drug and alcohol use, PrEP use and knowledge, and HIV prevention services, while additional subsets of the survey collect specific questions that vary by cycle. AMIS seeks to improve public health services and outreach in HIV prevention by monitoring trends in HIV risk behavior, use of HIV testing, and access to prevention services among gay and bisexual men in the US.

Study participants are recruited online through convenience sampling with the use of banner ads on social networks, websites, and geospatial networking apps. Participants are screened for eligibility by clicking on ads placed on a variety of websites and apps. Men are eligible to participate in the study if they are at least 15 years old, are a US resident, have a history of oral or anal sex with men or identify as gay or bisexual, and are able to complete the survey in English.

Correlates Considered

Out of the 10,130 overall participants in the 2019 AMIS cohort, 6,534 participants who reported either condomless anal intercourse (CAI) with at least one male partner of known (n=4,341) or CAI with at least one male partner of unknown (n=2,193) HIV status in the past 12 months were included in the study analysis. Demographic variables and other correlates of interest were selected and included in this study based on a previous literature and DAGS. 17 individual-related correlates and 7 partner-related correlates were considered in the bivariate analyses and 12 individual-related correlates and 6 partner-related correlates were considered in the multivariate analyses based on results from the bivariate analysis.

The 17 individual-related correlates were age category, race/ethnicity, sexual identity, income level, educational attainment, insurance category, healthcare provider visit in the past 12 months, HIV testing in the past 12 months, HIV status, current ART use for HIV infection, PrEP use in the past 12 months, experiencing depressive symptoms in the past 30 days, alcohol use in the past 12 months, heavy alcohol use in the past 12 months, illicit drug use in the past 12 months, marijuana use in the past 12 months, and other drug use in the past 12 months. The 7 partner-related correlates were: use of a social network website in the past 12 months to meet or socialize with gay men, use of a dating website in the past 12 months to meet or socialize with gay men, use of a mobile phone app in the past 12 months to meet or socialize with gay men, use of none of the aforementioned sites in the past 12 months to meet or socialize with gay men, use of an app to meet a partner in person in the past 12 months, number of male anal sex partners in the past 12 months, and ever worrying about a partner's HIV status.

All correlates reported in Table 1 and subsequently used in the statistical analyses were categorical variables. Age was broken into categorical quartiles and race and ethnicity were combined for

participants and categorized into the following categories: (1) Black non-Hispanic, (2) Hispanic, (3) white non-Hispanic, and (4) other, multiple, or unknown.

Statistical Analyses

The total study population analyzed in this study was n=6,534 participants who reported either condomless anal intercourse (CAI) with at least one male partner of known (n=4,341) or CAI with at least one male partner of unknown (n=2,193) HIV status in the past 12 months; 66.44% reported CAI with a person of known HIV status (n=4,341) while 33.56% reported CAI with MSM of unknown HIV status (n=2,193). These participants were compared with respect to demographic characteristics and other correlates of interest. Individual-related correlates and partner-related correlates were included in bivariate unadjusted log binomial regression models with the outcome of interest to obtain unadjusted prevalence ratios (PR) and determine statistical significance comparing those who reported condomless anal intercourse with at least one male partner in the past 12 months of known vs. unknown HIV status. Correlates that were found to be statistically significantly associated with the outcome at the 5% significance level in the bivariate analysis were included in the multivariate adjusted log binomial regression models. The multivariate adjusted log binomial regression models allow the relevant correlates to be considered together and are used to provide adjusted prevalence ratios (aPR) and determine statistical significance comparing those who reported condomless anal intercourse (CAI) with at least one male anal sex partner in the past 12 months of known vs. unknown HIV status. Separate multivariate adjusted log binomial regression models were used for both individual-related and partner-related correlates of interest. Results from the bivariate and multivariate analyses are reported in Tables 2, 3a, and 3b. All data viewing, management, and analyses were completed using SAS version 9.4 between November 2020 and April 2021.

Results

The data used for this study and analysis comes from participants of the 2019 American Men's Internet Survey (AMIS). Descriptive statistics obtained and presented in Table 1 describe the characteristics of the participants in the 2019 AMIS. These characteristics are presented both for the overall 2019 AMIS cohort (n=10,130) and for the subsets of participants included in this analysis who had condomless anal intercourse (CAI) with a male partner in the past 12 months (Table 1). Participant age ranged widely with the average overall age being 32.2 years with a standard deviation of 14.8 years. Overall, participants were mostly non-Hispanic white (60.6%) and identified as gay or homosexual (77.7%). The income level among participants varies widely, with the most common level (34.0%) being $75,000 or more. The overall level of education obtained was quite high with 43.2% being a college graduate or beyond and 34.7% with some college or a technical degree.

CAI in the previous 12 months was common in the 2019 AMIS cohort (n=6,534, 64.5%). Among MSM who had CAI in the previous 12 months, 33.56% did not know the HIV status of their partner (n=2,193). These groups are comparable in terms of demographics, though the men with CAI with a partner of known HIV status were slightly younger (mean of 31.6 vs. 32.9 years) and more likely to be non-Hispanic white (66.3% vs. 53.1%) in comparison to the group who had CAI with a partner of unknown HIV status.

Bivariate Analysis Results

The results of the bivariate analysis using bivariate unadjusted log binomial regression models examining the association between various correlates of interest and outcome of interest, condomless anal intercourse (CAI) with a partner of unknown HIV status vs. known HIV status in the past 12 months are presented in Table 2. Many of the bivariate associations were significant at a

level of $\alpha = 0.05$ and are denoted as such in Table 2. Correlates found to be significantly associated with the outcome and those previously identified as important correlates to the outcome of interest were included in the final multivariate log binomial regression analyses; these included age, race/ethnicity, income, education, one's HIV status, and depressive symptoms.

Some important and statistically significant results from the bivariate analysis that found increased likelihoods of CAI with a partner of unknown HIV status in the past 12 months from the bivariate analysis included age 40+, identifying as Black non-Hispanic, identifying as Hispanic, identifying as other multiple, or unknown race/ethnicity, the lowest income level, living with an HIV positive status, PrEP use, experiencing depressive symptoms, heavy alcohol use, various substance use, using social media, dating sites, and dating apps, having more than 0 or 1 male anal sex partners, and worrying about a partner's HIV status.

Those who were less than 40 years old were all found to have lower likelihoods of CAI with a partner of unknown HIV status, suggesting that those who are 40 and older have an increased likelihood. Participants who identified as Black, non-Hispanic were 68% more likely (PR=1.68, 95% CI: 1.51, 1.88) to have CAI with a partner of unknown HIV status in the past 12 months while those who identified as Hispanic were 29% more likely (PR=1.29, 95% CI: 1.15, 1.46) and those who identified as other, multiple, or unknown were 26% more likely (PR=1.26, 95% CI: 1.08, 1.47). Participants who are in the lowest annual income level ($0-19,999) were 18% more likely (PR=1.18, 95% CI: 1.03, 1.35) to report CAI with a partner of unknown HIV status in the past 12 months. Those living with HIV were 67% more likely (PR=1.67, 95% CI: 1.45, 1.92) to report CAI with a partner of unknown HIV status in the past 12 months. Participants who reported PrEP use in the past 12 months were 35% more likely (PR=1.35, 95% CI: 1.22, 1.49) to report CAI with a partner of

unknown HIV status in the past 12 months. Those who reported experiencing depressive symptoms in the past 30 days were 14% more likely (PR=1.14, 95% CI: 1.03, 1.26) to report CAI with a partner of unknown HIV status in the past 12 months. Participants who reported heavy alcohol use, defined as 7+ drinks during a typical day of drinking, were 28% more likely (PR=1.28, 95% CI: 1.08, 1.51), illicit drug users were 29% more likely (PR=1.29, 95% CI: 1.19, 1.40), marijuana users were 20% more likely (PR=1.20, 95% CI: 1.10, 1.30), and other drug users were 47% more likely (PR=1.47, 95% CI: 1.34, 1.61) to have reported CAI with a partner of unknown HIV status in the past 12 months.

Participants who reported using the following sites to meet or socialize with gay men were found to have increased likelihoods of CAI with a partner of unknown HIV status in the past 12 months: social networking site users were 21% more likely (PR=1.21, 95% CI: 1.11, 1.32), dating website users were 46% more likely (PR=1.46, 95% CI: 1.34, 1.59), and mobile phone app users were 114% more likely (PR=2.14, 95% CI: 1.89, 2.42); those who used a mobile app to meet a partner in person in the past 12 months were 56% more likely (PR=1.56, 95% CI: 1.13, 2.15) to report CAI with a partner of unknown HIV status in the past 12 months. In terms of number of male anal sex partners in the past 12 months, those who reported 2 to 4 partners were 39% more likely (PR=1.39, 95% CI: 1.17, 1.65) and those who reported 5 or more partners were 125% more likely (PR=2.25, 95% CI: 1.91, 2.66) to report CAI with a partner of unknown HIV status in the past 12 months. Finally, participants who reported ever worrying about a partner's HIV status were 68% more likely (PR=1.68, 95% CI: 1.33, 2.11) to report CAI with a partner of unknown HIV status in the past 12 months.

Multivariate Analyses Results

Multivariate adjusted log binomial regression models were created and run for both individual-level correlates and for partner-related correlates; the results of which are presented in Tables 3a-b. In terms of individual-level correlates, age, race/ethnicity, income level, an individual's reported HIV status, PrEP use in past 12 months, experiencing depressive symptoms in past 30 days, heavy alcohol use, and other drug use were all statistically significantly associated with having CAI with a male partner of unknown HIV status in the past 12 months (Table 3a). While looking at partner-related variables, none of the correlates included in the multivariate adjusted log binomial regression were statistically significantly associated with having CAI with a male partner of unknown HIV status in the past 12 months (Table 3b).

In terms of race/ethnicity, participants who identify as Black, non-Hispanic were 48% more likely (aPR=1.48, 95% CI: 1.29, 1.68), those who identify as Hispanic were 28% more likely (aPR=1.28, 95% CI: 1.12, 1.47), and those who identify as other, multiple, or unknown were 17% more likely (aPR=1.17, 95% CI: 0.98, 1.40) to report CAI with a partner of unknown HIV status. In terms of income level, those in the lowest annual income level of $0-19,999 were 18% more likely (aPR=1.18, 95% CI: 1.00, 1.38) to report CAI with a partner of unknown HIV status. Participants who are living with HIV were 33% more likely (aPR=1.33, 95% CI: 1.07, 1.65) and those who reported using PrEP in the past 12 months were 50% more likely (aPR=1.50, 95% CI: 1.32, 1.70) to report CAI with a partner of unknown HIV status in the past 12 months. Furthermore, participants who reported experiencing depressive symptoms in the past 30 days were 16% more likely (aPR=1.16, 95% CI: 1.03, 1.31), heavy alcohol users in the past 12 months were 21% more likely (aPR=1.21, 95% CI: 1.08, 1.51), and other drug users in the past 12 months were 37% more likely (aPR=1.37, 95% CI: 1.16, 1.61) to report CAI with a partner of unknown HIV status in the past 12 months. Participants in the younger age categories were all less likely to report CAI with a partner of unknown HIV

status in the past 12 months compared to the oldest age category, 40+, suggesting that those who are 40 or older are more likely to report (age 15-24 aPR=0.76, 95% CI: 0.65, 0.88; age 25-29 aPR=0.75, 95% CI: 0.65, 0.87; age 30-39 aPR=0.84, 95% CI: 0.72, 0.97).

The use of social network sites, dating sites, or mobile phone apps to meet or socialize with gay men in the past 12 months, use of an app to meet a partner in person in the past 12 months, number of male anal sex partners in the past 12 months, and reporting of ever worrying about a partner's HIV status were not found to be statistically significantly associated with CAI with a male partner of unknown HIV status in the past 12 months when considered together in the multivariate log binomial regression.

Discussion

Study Aims and Importance

The overall aim of this study was to determine correlates associated with having CAI with a male partner of unknown HIV status in the past 12 months, with a particular focus on the roles that race/ethnicity and depression play in the association. These findings can be used to elucidate factors that could inform prevention and educational strategies and identify target populations for prevention and educational programming. These findings are of particular importance as two of the factors that contribute to the HIV disparities and higher risk among MSM populations include CAI and unknown HIV status (1–5). Furthermore, the current literature suggests that the relationship between and the important correlates of HIV disclosure status and condom use is not entirely clear and the findings are not always consistent (3,4,19,22–28). Previous literature suggests condom use among MSM is generally low or remains a concern and several studies found that factors like younger age, lower education, not identifying as white, having a lower income level, PrEP use,

alcohol use, substance use, experiencing negative psychological and/or depressive symptoms, depression, higher number of partners or non-main partners, partner-related barriers to condom use, and worrying about partner HIV statuses or about partner beliefs regarding HIV and condoms may play roles in increased reports of CAI with partners and unknown HIV statuses among MSM populations (3,4,14,19,25–28). This study topic is especially important to investigate as common alternatives to condom use among MSM are serosorting and seropositioning which would not be effective prevention methods when used among MSM who are engaging in CAI with partners of unknown HIV statuses nor are they effective at preventing the spread of other sexually transmitted infections (STIs) and because CAI with partners of unknown HIV status is significantly associated with HIV acquisition (4,11).

Many of these literature findings were consistent with the findings of this study in that statistically significant increased likelihoods of CAI with a partner of unknown HIV status in the past 12 months were found from the analyses with the following correlates: being in the lowest income level, identifying as Black non-Hispanic, identifying as Hispanic, identifying as other multiple, or unknown race/ethnicity, living with HIV, PrEP use, experiencing depressive symptoms, heavy alcohol use, various substance use, having more than 0 or 1 male anal sex partners, and worrying about a partner's HIV status. However, the findings of this study did not find statistically significant increased likelihoods of CAI with a partner of unknown HIV status in the past 12 months among younger age categories, across all income levels below the highest income level (other than the lowest income level), nor across all educational levels below the highest educational level, in contrast to the literature findings.

Findings and Related Commentary

The three younger age quartiles, collectively ranging from 15 to 39 years of age, were are all statistically significantly less likely to report CAI with a partner of unknown HIV status in the past 12 months in comparison to the oldest age quartile, age 40+ years. This finding was inconsistent with numerous literature findings that either found no significant associations or a significant contrasting association with age and CAI and/or unknown HIV status and is inconsistent with an overall finding that younger MSM are generally at higher risk of HIV acquisition and of risky sexual behaviors (4,11,24,26). This suggests that more prevention strategies and educational outreach should be aimed at MSM populations who are 40+ years and might be due to a birth cohort effect of not discussing one's HIV status. Additionally, this finding could suggest that current HIV education and prevention programming aimed at younger cohorts are working well in increasing condom use and/or knowing one's and one's partner's HIV status before engaging in sexual activities.

The findings for income and education were not consistent and not all statistically significant. Participants who were in the lowest annual income level ($0-19,999) were consistently statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months compared to the highest annual income level ($75,000 or more); the other two income levels were also more likely to report compared to the highest, but these findings were not statistically significant. Relatedly, there was a trend of decreasing likelihood of CAI with a partner of unknown HIV status in the past 12 months as education level increased, but only in the bivariate analysis were high school graduates or those with a GED statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months compared to those with the highest education level of a college degree or postgraduate education. The statistically significant finding of those with the lowest income being at an increased likelihood are consistent with the majority of the current

literature, but these findings on all other income levels and on education levels were not consistent with the majority of the current literature in terms of their statistical significance. Despite the lack of statistical significance, the findings were in general alignment with the current literature with those of lower income and lower education, respectively, being at overall higher risk populations for HIV acquisition, being higher risk of unknown HIV status, and being at higher risk of engaging in higher risk sexual behaviors, such as the one investigated in this study, engaging in CAI with a partner of unknown HIV status (24,26,27). These findings support the need to have targeted outreach to those with lower income and lower education and the need to address socioeconomic disparities alongside HIV prevention and education among MSM in the US in order to reduce overall risk and improve the related health inequities.

Participants who identified as Black non-Hispanic, Hispanic, or other, multiple, or unknown race/ethnicity were all statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months in comparison to those who identified as white non-Hispanic. These findings should be considered alongside the context of racial disparities and, more specifically, anti-Black racism that exist in the US overall and among MSM populations (1,6–9). Numerous factors like racism, social barriers, structural barriers, incarceration rates, delays in linkage to HIV medical care, lower PrEP use rates, and other socioeconomic factors should be considered as they may play a role in explaining the both disparities in HIV infection and unknown HIV status as well as in the finding here of higher likelihood of CAI with a partner of unknown HIV status among Black and all other non-white MSM compared to white MSM (1,2,6–10,26). These factors should be investigated further in future studies in relation to their role in CAI with partners of varying HIV disclosure statuses as well as in relation to HIV transmission overall. These findings further demonstrate the need for equitable services, prevention strategies, and educational outreach aimed

specifically at respective racial/ethnic groups in order to address the racial disparities that exist among MSM.

Participants who are living with HIV were statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months in comparison to those who have never been tested for HIV. There may be several reasons for this finding among those living with HIV in this study population. Some of these reasons could be previously identified factors related to low condom use among MSM like complacency about one's and one's partner's sexual risk, a desire for greater sexual pleasure, and fatigue around condom messaging (4). Other factors more specific to this finding include the optimism about HIV being both managed well with ART and other medications and being preventable with PrEP/PEP and, therefore, presenting less of a risk for both those living with and without HIV (4). This aforementioned factor may also be a reason for this study finding that participants who reported using PrEP in the past 12 months were statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months in comparison to those who have not reported using PrEP. These findings suggest a need to reframe prevention and educational efforts when working both with people living with HIV and with those who report regular use of PrEP, especially in terms of explaining the risks that remain related to HIV and other STIs when condoms are not used regularly.

Participants who reported depressive symptoms, which including feeling depressed, worthless, and/or hopeless, in the previous 30 days were more likely to have CAI with a partner of unknown HIV status in the past 12 months. This is consistent with the current literature which suggests that depression and depressive or negative psychological symptoms among MSM can contribute to higher HIV risk, an increased probability of sexual risk behaviors, and reduced adherence to ART as

well as being negatively associated with disclosing one's own HIV status (3,15–20,23). Thus, addressing and managing depression and depressive symptoms among MSM populations should be a secondary goal in HIV educational and prevention programming. Additionally, HIV educational and prevention programming should include specific, tailored materials for those living with depression or experiencing depressive symptoms.

Heavy use of alcohol, illicit drug use, marijuana use, and other drug use in the past 12 months were all, respectively, statistically significantly associated with being more likely to have reported CAI with a partner with an unknown HIV status in the past 12 months. These findings are consistent with most literature findings that alcohol and substance use are typically associated with risky sexual behaviors and CAI compared to those who are sober and/or who don't use alcohol and other substances via pathways like altered decision-making skills and altered ability to perform an accurate personal risk assessment (2,3,14,27). These findings suggest the need to increase prevention and educational efforts among MSM populations who are heavy drinkers and/or use any of the aforementioned substances; discussions surrounding safer alcohol and substance use should be included within these prevention and educational efforts.

Participants who reported 2 to 4 male anal sex partners in the past 12 months were more statistically significantly more likely to report CAI with a partner of unknown HIV status in the past 12 months, in comparison to those who reported 0-1 partners. This increased likelihood becomes much higher among participants who reported 5 or more male anal sex partners in the past 12 months. Number of partners is an important correlate to investigate as an increased number of partners can be considered a risky sexual behavior, can increase risk of HIV and other STI acquisition, and is associated with a lower HIV disclosure status among anal sex partners (2,11,24); having anal sex

with an increased number of partners in conjunction with CAI with partners of unknown HIV status leads to an even higher level of risk. This finding highlights the importance of prevention programming centering the safer sex practices of limiting number of sexual partners, ensuring condoms are used with each partner during every act of sex, and knowing and discussing one's own HIV status as well as knowing and discussing each partner's HIV status.

Limitations

AMIS and the data used in this analysis are cross-sectional and, therefore, provide the weakest evidence of association between the correlates considered here and the outcome of interest and cannot provide clarification on causality due to the lack of built-in temporality. Additionally, AMIS is an online survey that uses convenience sampling, and the 2019 cohort may not be entirely reflective of the total US MSM population. The 2019 AMIS cohort is disproportionally white, well-educated, and generally of middle- or upper-level income levels. Given that non-white race and ethnicity groups as well as lower incomes levels were associated with increased risk of having CAI with a person with an unknown HIV status, this is likely underestimate of MSM who have CAI without knowing the partner's HIV status.

Future Directions

The findings of this study can be used to inform and shape future research investigating the correlates and relationships associated with CAI with a partner of unknown (versus known) HIV status among MSM partners. Future research should be conducted to better understand the roles that race, ethnicity, and racial disparities and depression play in the outcome of CAI with a partner of unknown (versus known) HIV status among MSM partners and in the relationships various correlates have with this outcome. These findings can be used to guide and inform prevention

programming and educational efforts in terms of identifying both key target populations and key topics to include and cover. Prevention programming and educational efforts should be pursued at the individual, partner, and population levels among MSM populations in the US in order to effectively address the many correlates associated with both CAI with partners of varying HIV disclosure statuses and HIV transmission overall.

Table 1. Characteristics of 2019 American Men's Internet Survey (AMIS) participants. Overall characteristics (n=10,130) are shown as well as stratifications by the outcome of interest, condomless anal intercourse (CAI) with a male partner of known (n=4,341) vs. unknown (n=2,193) HIV status in the past 12 months.

Characteristic	Overall (n = 10,130)*	CAI with a partner of known HIV status (n = 4,341)*	CAI with a partner of unknown HIV status (n = 2,193)*
Age			
Mean (SD)	32.2 (14.8)	31.6 (13.5)	32.9 (14.2)
15-24	4,209 (41.6%)	1,727 (39.8%)	810 (36.9%)
25-29	1,817 (17.9%)	926 (21.3%)	401 (18.3%)
30-39	1,482 (14.6%)	688 (15.9%)	363 (16.6%)
40+	2,622 (25.9%)	1,000 (23.0%)	619 (28.2%)
Race/Ethnicity			
Black, non-Hispanic	1,508 (15.2%)	482 (11.3%)	451 (21.0%)
Hispanic	1,557 (15.7%)	620 (14.5%)	367 (17.1%)
White, non-Hispanic	6,020 (60.6%)	2,831 (66.3%)	1,142 (53.1%)
Other, multiple, or unknown	845 (8.5%)	335 (7.9%)	191 (8.9%)
Sexual Identity			
Gay or homosexual	7,626 (77.7%)	3,453 (81.1%)	1,715 (80.5%)
Bisexual	2,111 (21.5%)	784 (18.43%)	401 (18.8%)
Straight or heterosexual	84 (0.9%)	20 (0.5%)	14 (0.7%)
Income Level			
$0-19,999	1,433 (15.9%)	569 (14.3%)	333 (16.6%)
$20,000-39,999	1,935 (21.4%)	842 (21.2%)	449 (22.4%)
$40,000-74,999	2,589 (28.7%)	1,156 (29.1%)	578 (28.9%)
$75,000 or more	3,069 (34.0%)	1,410 (35.5%)	641 (32.0%)
Educational Attainment			
Less than high school graduate	602 (6.0%)	169 (3.9%)	106 (4.9%)
High school graduate or GED	1,624 (16.1%)	596 (13.8%)	349 (16.0%)
Some college or technical degree	3,495 (34.7%)	1,574 (36.4%)	766 (35.1%)
College degree or postgraduate education	4,357 (43.2%)	1,990 (45.97%)	962 (44.1%)
Insurance Category			
None (uninsured)	853 (8.7%)	374 (8.8%)	216 (10.1%)
Private only	7,089 (71.9%)	3,134 (73.5%)	1,519 (70.8%)

Public only	1,346 (13.7%)	535 (12.5%)	302 (14.1%)
Other or multiple	573 (5.8%)	223 (5.2%)	109 (5.1%)
Healthcare provider visit in past 12 months	8,706 (86.5%)	3,719 (86.1%)	1,917 (87.9%)
HIV tested in past 12 months	5,420 (53.5%)	2,484 (57.2%)	1,336 (60.9%)
HIV status			
Negative	6,602 (66.6%)	3.188 (74.6%)	1,358 (63.1%)
Positive	903 (9.1%)	273 (6.4%)	364 (16.9%)
Indeterminate	8 (0.1%)	2 (0.1%)	5 (0.2%)
Never got results	52 (0.5%)	22 (0.5%)	15 (0.7%)
Never tested	2,356 (23.8%)	789 (18.5%)	411 (19.1%)
Current ART use for HIV infection	835 (93.2%)	254 (93.4%)	335 (92.8%)
PrEP used in past 12 months	1,406 (13.9%)	649 (15.0%)	484 (22.1%)
Depressive symptoms (in past 30 days, felt depressed, worthless, and/or hopeless)	7,530 (74.3%)	3,208 (73.9%)	1,698 (77.4%)
Alcohol use in past 12 months	8,651 (85.5%)	3,852 (88.8%)	1,923 (87.7%)
Heavy alcohol use in past 12 months (7+ drinks during typical day of drinking)	546 (6.3%)	210 (5.5%)	151 (7.9%)
Illicit drug use in past 12 months	3,464 (34.2%)	1,476 (34.0%)	947 (43.2%)
Marijuana use in past 12 months	3,123 (30.8%)	1,361 (31.4%)	822 (37.5%)
Other drug use in past 12 months	2,118 (20.9%)	860 (19.8%)	686 (31.3%)
Use of following sites in past 12 months to meet or socialize with gay men			
Social Network Website	2,842 (28.1%)	1,147 (26.4%)	712 (32.5%)
Dating Website	3,779 (37.3%)	1,429 (32.9%)	1,025 (46.7%)
Mobile Phone App	7,366 (72.7%)	3,025 (69.7%)	1,903 (86.8%)
None of the sites above	1,902 (18.8%)	1,009 (23.2%)	171 (7.8%)
Use of an app to meet a partner in person in past 12 months	1,186 (75.9%)	481 (75.9%)	257 (85.4%)
Number of male anal sex partners in past 12 months			
0 to 1	1,076 (16.6%)	514 (17.2%)	157 (8.0%)
2 to 4	2,983 (46.0%)	1,496 (50.1%)	718 (36.6%)
5+	2,432 (37.5%)	976 (32.7%)	1,089 (55.5%)
Ever worried about a partner's HIV status	1,047 (63.3%)	407 (57.4%)	281 (74.3%)

*Note: values may not sum to the total number of observations due to missing data

Table 2. Bivariate unadjusted log binomial regression models examining the association between various correlates of interest and condomless anal intercourse (CAI) with a partner of unknown (vs. known) HIV status in the past 12 months among men who have sex with men (MSM) surveyed in the AMIS 2019 cohort.

Correlate	PR	95% Confidence Interval	p-value
Age Category			
15-24	0.84	0.75, 0.93	0.0007*
25-29	0.79	0.70, 0.90	0.0002*
30-39	0.90	0.79, 1.03	0.1242
40+	REF	--	--
Race/Ethnicity			
Black, non-Hispanic	1.68	1.51, 1.88	<0.0001*
Hispanic	1.29	1.15, 1.46	<0.0001*
White, non-Hispanic	REF	--	--
Other, multiple, or unknown	1.26	1.08, 1.47	0.0028*
Sexual Identity			
Gay or homosexual	0.81	0.48, 1.36	0.4214
Bisexual	0.82	0.48, 1.40	0.4704
Straight or heterosexual	REF	--	--
Income Level			
$0-19,999	1.18	1.03, 1.35	0.0137*
$20,000-39,999	1.11	0.99, 1.26	0.0824
$40,000-74,999	1.07	0.95, 1.19	0.2612
$75,000 or more	REF	--	--
Educational Attainment			
Less than high school graduate	1.18	0.97, 1.45	0.1009
High school graduate or GED	1.13	1.00, 1.28	0.0453*
Some college or technical degree	1.00	0.91, 1.10	0.9260
College degree or postgraduate education	REF	--	--
Insurance Category			
None (uninsured)	1.12	0.89, 1.40	0.3538
Private only	0.99	0.82, 1.21	0.9544
Public only	1.10	0.88, 1.37	0.3983
Other or multiple	REF	--	--
Healthcare provider visit in past 12 months	1.12	0.98, 1.27	0.0914
HIV tested in past 12 months	1.11	1.02, 1.21	0.0196*
HIV status			

Negative	0.87	0.78, 0.97	0.0151*
Positive	1.67	1.45, 1.92	<0.0001*
Indeterminate	2.09	0.86, 5.04	0.1023
Never got results	1.18	0.71, 1.98	0.5212
Never tested	REF	--	--
Current ART use for HIV infection	0.96	0.65, 1.43	0.8512
PrEP used in past 12 months	1.35	1.22, 1.49	<0.0001*
Depressive symptoms (in past 30 days, felt depressed, worthless, and/or hopeless)	1.14	1.03, 1.26	0.0112*
Alcohol use in past 12 months	0.93	0.82, 1.06	0.2904
Heavy alcohol use in past 12 months (7+ drinks during typical day of drinking)	1.28	1.08, 1.51	0.0036*
Illicit drug use in past 12 months	1.29	1.19, 1.40	<0.0001*
Marijuana use in past 12 months	1.20	1.10, 1.30	<0.0001*
Other drug use in past 12 months	1.47	1.34, 1.61	<0.0001*
Use of following sites in past 12 months to meet or socialize with gay men			
Social Network Website	1.21	1.11, 1.32	<0.0001*
Dating Website	1.46	1.34, 1.59	<0.0001*
Mobile Phone App	2.14	1.89, 2.42	<0.0001*
None of the sites above	0.38	0.33, 0.45	<0.0001*
Use of an app to meet a partner in person in past 12 months	1.56	1.13, 2.15	0.0065*
Number of male anal sex partners in past 12 months			
0 to 1	REF	--	--
2 to 4	1.39	1.17, 1.65	0.0002*
5+	2.25	1.91, 2.66	<0.0001*
Ever worried about a partner's HIV status	1.68	1.33, 2.11	<0.0001*

* Indicates significance at $\alpha = 0.05$

Table 3a. Multivariate adjusted log binomial regression model examining the association between select individual-related correlates and condomless anal intercourse (CAI) with a partner of unknown (vs. known) HIV status in the past 12 months among men who have sex with men (MSM) surveyed in the AMIS 2019 cohort. Correlates included in the final adjusted model were selected based on a previously completed literature review and statistical significance in the bivariate analysis.

Correlate	aPR	95% Confidence Interval	p-value
Age Category			
15-24	0.76	0.65, 0.88	0.0003*
25-29	0.75	0.65, 0.87	0.0001*
30-39	0.84	0.72, 0.97	0.0173*
40+	REF	--	--
Race/Ethnicity			
Black, non-Hispanic	1.48	1.29, 1.68	<0.0001*
Hispanic	1.28	1.12, 1.47	0.0003*
White, non-Hispanic	REF	--	--
Other, multiple, or unknown	1.17	0.98, 1.40	0.0860*
Income Level			
$0-19,999	1.18	1.00, 1.38	0.0461*
$20,000-39,999	1.11	0.97, 1.28	0.1391
$40,000-74,999	1.05	0.93, 1.19	0.4063
$75,000 or more	REF	--	--
Educational Attainment			
Less than high school graduate	1.02	0.72, 1.45	0.9269
High school graduate or GED	1.11	0.94, 1.30	0.2163
Some college or technical degree	1.05	0.93, 1.17	0.4376
College degree or postgraduate education	REF	--	--
HIV tested in past 12 months	1.14	0.99, 1.29	0.0519
HIV status			
Negative	0.75	0.63, 0.90	0.0020*
Positive	1.33	1.07, 1.65	0.0094*
Indeterminate	1.53	0.62, 3.75	0.3580
Never got results	0.98	0.52, 1.87	0.9599
Never tested	REF	--	--
PrEP used in past 12 months	1.50	1.32, 1.70	<0.0001*
Depressive symptoms (in past 30 days, felt depressed, worthless, and/or hopeless)	1.16	1.03, 1.31	0.0144*
Heavy alcohol use in past 12 months (7+ drinks during	1.21	1.08, 1.51	0.0406*

typical day of drinking)			
Illicit drug use in past 12 months	1.20	0.92, 1.56	0.1776
Marijuana use in past 12 months	0.83	0.67, 1.03	0.0955
Other drug use in past 12 months	1.37	1.16, 1.61	0.0002*

* Indicates significance at $\alpha = 0.05$

Table 3b. Multivariate adjusted log binomial regression model examining the association between select partner-related correlates and condomless anal intercourse (CAI) with a partner of unknown (vs. known) HIV status in the past 12 months among men who have sex with men (MSM) surveyed in the AMIS 2019 cohort. Correlates included in the final adjusted model were selected based on a previously completed literature review and statistical significance in the bivariate analysis.

Correlate	aPR	95% Confidence Interval	p-value
Use of following sites in past 12 months to meet or socialize with gay men			
Social Network Website	1.07	0.51, 2.23	0.8529
Dating Website	0.98	0.45, 2.15	0.9613
Mobile Phone App	1.95	0.24, 15.95	0.5314
Use of an app to meet a partner in person in past 12 months	1.54	0.54, 4.43	0.4213
Number of male anal sex partners in past 12 months			
0 to 1	REF	--	--
2 to 4	1.13	0.40, 3.15	0.8194
5+	2.04	0.74, 5.65	0.1703
Ever worried about a partner's HIV status	1.02	0.52, 1.99	0.9483

* Indicates significance at $\alpha = 0.05$

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