Associations between adverse childhood experiences and HIV risk behavior among adults in the United States toward the end of the COVID-19 Pandemic

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Abstract

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Background: Adverse Childhood Experiences (ACEs) have been linked to HIV risk behaviors in adulthood and have not been explored after the start of the COVID-19 pandemic. **Purpose:** This study investigates the contemporary relationship between ACEs and HIV risk behaviors. **Methods:** This study used cross-sectional data from the 2022 Behavioral Risk Factor Surveillance System and included a sample of 51,168 individuals (26,769 females and 24,399 males). Analyses included multivariable logistic regressions using a 13-item, 8-item, and individual ACE exposure variables, and a test for interaction between ACEs and race/ethnicity on HIV risk behavior in adulthood. **Results:** In adjusted analyses and compared with no reported ACEs, increasing number of reported ACEs was associated with progressively higher odds of HIV risk behaviors: 1 (OR = 1.76, 95% CI: 1.26, 2.47), 2 (OR = 1.76, 95% CI: 1.28, 2.41), 3 (OR = 2.22, 95% CI: 1.62, 3.04), and 4 or more (OR = 3.82, 95% CI: 2.94, 4.97). **Conclusion:** This study reveals a significant association between ACEs and HIV risk behavior, with a marked increase in risk among individuals reporting three or more ACEs, underscoring the cumulative impact of trauma.

INTRODUCTION

Adverse childhood experiences (ACEs) are defined by the Centers for Disease Control and Prevention (CDC) as potentially traumatic events that occur between 0 and 17 years of age (1). This includes experiencing violence, abuse, or neglect; witnessing violence in the home or community, or having a family member attempt or die by suicide (1). Additionally, environmental factors such as substance use, mental health problems in the household, or instability due to parental separation are considered ACEs (1). It is important to note that ACEs encompass a broad spectrum of traumatic experiences, extending beyond this abbreviated list. The CDC estimates that in the United States (US), 64% of adults report experiencing at least one ACE, with 17.3% reporting four or more ACEs (1). Previous literature has linked ACEs to chronic health issues, mental illness, and substance abuse in adulthood, with high-risk human immunodeficiency (HIV) behaviors among the health concerns associated with ACEs (1-5).

HIV is a virus targeting the immune system and is the cause of acquired immunodeficiency syndrome (AIDS). HIV/AIDS left untreated can lead to severe opportunistic infections and death (6,7). HIV/AIDS has been endemic in the US for over four decades, and the CDC estimates that about 1.2 million people in the US had HIV at the end of 2021 (8). HIV is most commonly transmitted through HIV risk behaviors. The most common HIV risk behaviors include risky sex practices, including unprotected sex and having numerous sexual partners, and the sharing of needles during intravenous drug use (9). Considering that a cure currently does not exist, there is an emphasis on the prevention of HIV transmission through behavioral changes (6). While prevention strategies include the promotion of using condoms, needle exchange programs, and HIV testing, another research approach involves the identification of populations at high risk of acquiring HIV. ACEs exposure has been identified as one such risk factor, suggesting that the prevention of ACEs may play a role in reducing HIV risk behavior in

adulthood. Additioanlly, it It also allows identification of those at higher risk who may be targeted to greater prevention efforts.

Two studies using Behavioral Risk Factor Surveillance System (BRFSS) survey data from 2011 and 2012 both found an association between ACEs and HIV risk behaviors, however, the study samples involved were limited to five US States (2,3). A more recent study using BRFSS data from 2019 explored the relationship between HIV risk and HIV testing, moderated by ACEs. They found that ACEs were positively associated with HIV risk and negatively associated with HIV testing, while HIV risk and HIV testing were negatively associated. Additionally, they found that a higher number of ACEs was more strongly negatively associated with HIV testing (4). A similar study using BRFSS data from 2019 and 2020 that explored the association between ACEs and HIV testing specifically also found a strong negative association between ACEs and HIV testing (5).

Researchers have explored the relationship between ACEs and HIV risk behavior among a number of different study populations and have consistently found positive associations. These study populations have included US men who have sex (MSM) with men in the US, youth living with HIV in the Southern region of the US, youth in rural South Africa, and adult men in Eswatini, South Africa, and Malawi (11-15). Prior research has also found a positive associations between ACEs and high-risk sexual behavior, which is considered an HIV risk behavior. These studies were conducted among MSM and a history of childhood sexual abuse in Boston, MA and Miami, FL; young adults from Cote d'Ivoire, Lesotho, Kenya, Namibia, and Mozambique; and adolescents and young adults in Malawi (16-19).

While the relationship between ACEs and HIV risk behaviors has been investigated in various studies, it is also important to understand the relationship of ACEs with HIV risk behavior in a more recent context, considering that this relationship has not been explored in

the wake of the COVID-19 pandemic. Differences in reported behavior may exist considering pre- and intra-COVID-19 societal factors that occurred in response to the pandemic. Moreover, the relationship between ACEs and HIV risk behavior has not been explored using the BRFSS dataset since 2012; over a decade ago (3). The 2012 study exploring ACEs and HIV risk behavior involved a limited number of states and data on fewer ACEs (3).

We conducted an analysis using BRFSS data collected during 2022; thus participants experienced the 2020 and 2021 COVID-19-related restrictions. The present study included data from 8 states and is thus more generalizable findings to the US as a whole. This study also explored more ACEs, as the optional ACEs module has been expanded to 13 questions since 2012, capturing a wider range of ACEs, each of which was explored individually. Finally, while similar studies have explored how sex and gender alter this relationship, none of the studies have explored whether race and ethnicity moderate this relationship. This is particularly important to consider because health inequities have been established between different racial and ethnic groups, including differences in the prevalence of ACEs and HIV risk behaviors (12,13).

SPECIFIC AIMS

Specific Aim 1. To investigate the association between the number of ACEs (from among all 13 ACEs inquired about) and HIV risk behavior in adulthood in a context post-COVID-19. This study hypothesizes that a higher number of ACEs will be associated with HIV risk behavior.

Specific Aim 2. Using an alternate categorization of ACEs, to investigate the association between the number of ACEs and HIV risk behavior in adulthood, where the number of ACEs includes the 8 ACEs (3). This study hypothesizes that a higher number of ACEs will be associated with greater HIV risk behavior.

Specific Aim 3. To investigate the association between each individual ACE and HIV risk behavior in adulthood. This study hypothesizes that each ACE will be associated with greater HIV risk behavior.

Specific Aim 4. To investigate whether the association between the number of ACEs and HIV risk behavior in adulthood is moderated by racial and ethnic group identity. This study hypothesizes that racial and ethnic group identity will elevate the associations found in Specific Aim 1 among people of color.

METHODS

Study Setting. Data for this study was collected in the United States. Only the states of Arizona, Arkansas, Florida, Iowa, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, and Virginia collected data on ACEs and therefore were the only states included in this study.

Study Subjects. This study included 51,168 respondents to the 2022 BRFSS with complete responses to the questions regarding ACEs and HIV risk behavior. Participants had to be non-institutionalized adults (18 years of age and older) residing in the US, and speak either English or Spanish (20). Participants who responded “Don’t Know,” “Don’t Know/Not Sure,” “Refused,” or had missing responses for questions related to all 13 ACEs, HIV risk behavior, or selected covariates were excluded.

Data Collection. This study utilized cross-sectional data from the 2022 BRFSS. The BRFSS is an annual telephone survey that collects data on health-related risk behaviors, medical conditions, and individual exposures. The BRFSS uses core questions consistent across states and territories, however, individual state departments of health may opt to include additional optional modules, one of which is the ACE module. The BRFSS is currently offered in English and Spanish. The CDC has published full details of the BRFSS methodology (20). The University of Washington Institutional Review Board has determined that using BRFSS data for

research is accepted as exempt from requiring human subjects review given the data is anonymized.

Exposure. The primary exposure of this study was the number of ACEs experienced before age 18 among those who lived in the same household during childhood. The 13 ACE questions are listed in Table 1. For questions 1 through 11, responses of “Yes,” “Once,” or “> Once,” to any of the questions were categorized as having experienced an ACE. For questions 12 and 13, responses of “Never” were categorized as having experienced an ACE. The number of ACEs was categorized as 0, 1, 2, 3, and >4. The primary analysis of this study (Specific Aim 1) included all 13 ACEs in the 2022 BRFSS ACEs Questionnaire. The analysis for Specific Aim 2 included only the 8 ACE items studied by Fang and colleagues, who used 2012 BRFSS data (denoted by asterisks (*,**, and ***)) (3). While the 2012 BRFSS ACEs Questionnaire had 11 items, Fang and colleagues combined the two questions on alcohol and drug abuse into one item (denoted by **), and the three questions on sexual abuse into one item (denoted by ***).

Table 1. 2022 BRFSS Questionnaires used to create exposure and outcome variables.

2022 BRFSS ACEs Questionnaire		
Item	Question	
1.	Did you live with anyone who was depressed, mentally ill, or suicidal?	*
2.	Did you live with anyone who was a problem drinker or alcoholic?	**
3.	Did you live with anyone who used illegal street drugs or who abused prescription medications?	**
4.	Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	*
5.	Were your parents separated or divorced?	*
6.	How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	*

7.	Not including spanking, (before age 18), how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Was it—	*
8.	How often did a parent or adult in your home ever swear at you, insult you, or put you down?	*
9.	How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	***
10.	How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	***
11.	How often did anyone at least 5 years older than you or an adult, force you to have sex?	***
12.	For how much of your childhood was there an adult in your household who made you feel safe and protected? Would you say never, a little of the time, some of the time, most of the time, or all of the time?	
13.	For how much of your childhood was there an adult in your household who tried hard to make sure your basic needs were met? Would you say never, a little of the time, some of the time, most of the time, or all of the time?	

2022 BRFSS HIV Risk Behavior Questionnaire

Item	Question
1.	I am going to read you a list. When I am done, please tell me if any of the situations apply to you. You do not need to tell me which one. You have injected any drug other than those prescribed for you in the past year. You have been treated for a sexually transmitted disease or STD in the past year. You have given or received money or drugs in exchange for sex in the past year.

Outcome. The primary outcome of this study was HIV risk behavior using the question in Table 1. Responses to this question include “Yes” or “No.”

Covariates. Sex assigned at birth, age at the time of the interview, and race/ethnicity were selected as confounders based on theoretical considerations and prior research suggesting their influence on HIV risk behaviors. Confounders were identified *a priori* using a directed acyclic graph (DAG). Age was categorized as follows: 18 to 24, 25 to 34, 35 to 44, 45

to 54, 55 to 64, and 65 years or older. Race/ethnicity was categorized as White, Non-Hispanic; Black, Non-Hispanic; Asian, Non-Hispanic; American Indian/Alaskan Native, Non-Hispanic; Hispanic, and other race, Non-Hispanic.

Education level, annual household income, health care access, and mental health reported at the time of the interview were selected as potential mediators based on theoretical considerations and prior research and were identified *a priori* using a DAG. Education level was categorized as: "Did not graduate High School, Graduated High School," "Attended College or Technical School," and "Graduated from College or Technical School." Annual household income was based on reported household income at the time of the interview and categorized as <$15,000, $15,000 to <$25,000, $25,000 to <$35,000, $35,000 to <$50,000, $50,000 to <$100,000, $100,000 to <$200,000, and $200,000 or more. Health care access was assessed based on the availability of health insurance, categorized as "Have some form of health insurance" and "Do not have some form of health insurance." Mental health was based on a variable that reported any diagnosis of a depressive disorder.

Data Analysis. All analyses were performed using Stata 18. Logistic regression was used to analyze the association between the number of ACEs and HIV risk behavior, considering that the HIV risk behavior outcome variable is binary. The threshold for statistical significance was set at $p<0.05$. Because the outcome is rare (<10%), the odds ratio provided a reasonable estimate of the risk ratio in this study. The exposure, reported number of ACEs, was categorized as 0, 1, 2, 3, and 4 or more ACEs.

For each Specific aim, the regression models included adjustment for age, sex, and race/ethnicity and the four potential mediators: education level, SES, health care access, and mental health. The analyses for Specific Aim 4 also included a multiplicative interaction term for race/ethnicity by 4 or more ACEs (binary) to examine moderation by race/ethnicity of the

ACE-HIV risk behavior relationship.Survey design and weighting were accommodated through Stata's svy suite of commands following BRFSS guidelines (21).

Study Power. Based on previous publications, the sample size of this study was large enough to detect an association between the number of ACEs and HIV risk behavior; therefore, formal study power calculations were not conducted.

RESULTS

Figure 1 shows the flow diagram of participants included in the analysis. We required complete data on covariates and the outcome variable of HIV risk behavior. In the primary analysis, we also required that participants have provided answers to at least 4 of the 13 ACE questions, yielding a final primary analytic sample of 51,168 individuals (26,769 females and 24,399 males). In a sensitivity analysis, we further restricted the analytic sample to those who had answered all 13 ACE questions (n=46,489).

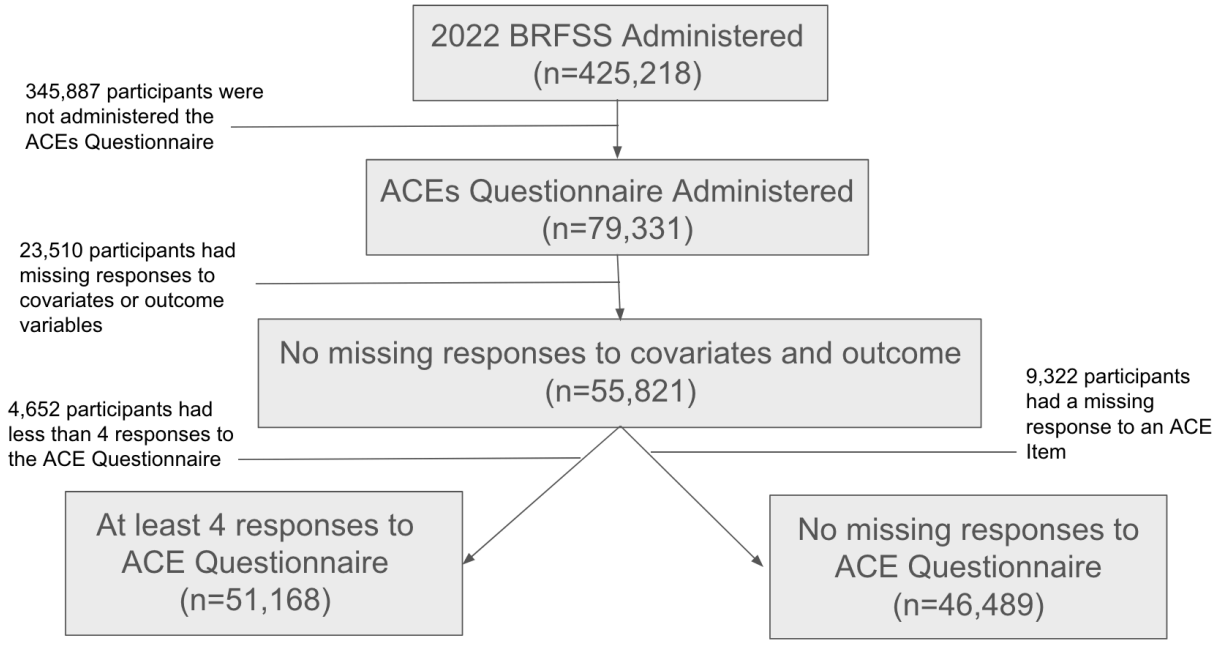

Figure 1. Flow diagram depicting subpopulation selection used in analyses

Participant characteristics in relation to number of reported ACEs. Information about participants' demographic characteristics, socioeconomic status, and mental health in relation to the number of reported ACEs is presented in Table 2. Individuals with higher ACEs tended to be younger, with a greater proportion of the 18 to 24 age group having four or more ACEs compared to those with no ACEs. Females represented 59.5% of those reporting four or more ACEs while males represented 40.5%. Higher ACEs were more common among Black, Non-Hispanic; Hispanic; and American Indian/Alaska Native, Non-Hispanic individuals when compared to their White, Non-Hispanic counterparts.

Educational attainment decreased as the number of ACEs increased, with fewer individuals who had four or more ACEs having graduated from college or technical school. Annual household income also showed considerable variation, with those reporting higher ACEs more likely to have lower income levels. Health insurance coverage was also less prevalent among individuals with higher ACEs. A history of depressive disorders was strongly associated with a larger number of ACEs, with 39.4% of those with four or more ACEs having a history of depressive disorder compared to only 10.3% of those with no ACEs.

Table 2. Demographic and mental health characteristics of 51,168 respondents by number of ACEs of the 2022 BRFSS data from Arizona, Arkansas, Florida, Iowa, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, and Virginia.

	Number of Adverse Childhood Experiences				
	0	1	2	3	4+
Total, n	15938	10542	6692	4511	13458
Demographics, n (%)					
Age					
18 to 24	424 (2.7)	396 (3.8)	307 (4.6)	239 (5.3)	866 (6.4)
35 to 34	1022 (6.4)	886 (8.4)	636 (12.9)	480 (9.5)	1923 (14.3)
35 to 44	1629 (10.2)	1253 (11.9)	849 (12.7)	643 (14.3)	2,467 (18.3)

45 to 54	2038 (12.8)	1532 (14.5)	1033 (15.4)	689 (15.3)	2453 (18.2)
55 to 64	3059 (19.2)	2038 (19.3)	1323 (19.8)	901 (20.0)	2658 (19.7)
65 or older	7766 (48.7)	4437 (42.1)	3544 (38.0)	1559 (34.6)	3118 (23.1)
Sex					
Female	8143 (51.1)	5148 (48.8)	3205 (47.9)	2253 (49.9)	8020 (59.5)
Male	7795 (48.9)	5394 (51.2)	3487 (52.1)	2258 (50.1)	5465 (40.5)
Race/Ethnicity					
White, Non-Hispanic	13799 (86.6)	8672 (82.3)	5339 (79.8)	3559 (78.9)	10343 (76.7)
Black, Non-Hispanic	737 (4.6)	671 (6.4)	432 (6.5)	332 (7.4)	815 (6.0)
Asian, Non-Hispanic	215 (1.4)	143 (1.4)	118 (1.8)	68 (1.5)	112 (0.8)
American Indian/ Alaska Native, Non-Hispanic	291 (1.8)	300 (2.9)	198 (3.0)	131 (2.9)	552 (4.1)
Hispanic	697 (4.4)	587 (5.6)	472 (7.0)	331 (7.3)	1149 (8.5)
Other race, Non-Hispanic	199 (1.3)	169 (1.6)	133 (2.0)	90 (2.0)	514 (3.8)
Education					
Did not graduate High School	581 (3.7)	462 (4.4)	392 (5.9)	237 (5.3)	844 (6.3)
Graduated High School	3609 (22.6)	2592 (24.6)	1734 (25.9)	1179 (26.1)	3553 (26.4)
Attended College or Technical School	4338 (27.2)	2975 (28.2)	1892 (28.3)	1382 (30.6)	4567 (33.9)
Graduated from College or Technical School	7410 (46.5)	4513 (42.8)	2674 (40.0)	1713 (38.0)	4521 (33.5)
Annual Household Income (US$)					
Less than 15,000	580 (3.6)	464 (4.4)	312 (4.7)	291 (6.5)	1142 (8.5)
15,000 to <25,000	1343 (8.43)	976 (9.3)	659 (9.9)	463 (10.3)	1609 (11.9)

25,000 to <35,000	1835 (11.5)	1254 (11.9)	891 (13.3)	621 (13.8)	1892 (14.0)
35,000 to <50,000	2334 (14.6)	1507 (14.3)	1019 (15.2)	663 (14.7)	1985 (14.7)
50,000 to <100,000	5446 (34.2)	3518 (33.4)	2135 (31.9)	1398 (31.0)	3952 (29.3)
100,000 to <200,000	3346 (21.0)	2174 (20.6)	1334 (19.9)	824 (18.3)	2302 (17.1)
200,000 or more	1054 (6.6)	649 (6.2)	342 (5.1)	251 (5.6)	603 (4.5)
Have any health insurance					
Do not have some form of insurance	504 (3.2)	407 (3.9)	3917 (4.7)	243 (5.4)	900 (6.7)
Have some form of insurance	15434 (96.8)	10135 (96.1)	6375 (95.3)	4268 (94.6)	12,585 (93.3)
Mental Health, n (%)					
History of a depressive disorder					
No	14297 (89.7)	8965 (85.0)	5378 (80.4)	3427 (76.0)	8169 (60.6)
Yes	1641 (10.3)	1577 (15.0)	1314 (19.6)	1084 (24.0)	5316 (39.4)

Association of number of ACEs with HIV risk behavior. In multivariable logistic regression analysis (Table 3), compared with the 0 ACE reference group, increasing number of reported ACEs was associated with progressively higher odds of HIV risk behaviors: 1 ACE (OR = 1.76, 95% CI: 1.26, 2.47), 2 ACEs (OR = 1.76, 95% CI: 1.28, 2.41), 3 ACEs (OR = 2.22, 95% CI: 1.62, 3.04), and 4 or more ACEs (OR = 3.82, 95% CI: 2.94, 4.97). In the sensitivity analysis restricted to the 46,489 participants who answered all 13 ACEs questions, results were nearly identical.

Table 3. Multivariable Logistic Regression Results: Association Between ACEs (13-Item) and HIV Risk Behavior

Number of ACEs	OR	95% CI
0	1.00	Referent
1	1.76	1.26–2.47

2	1.76	1.28–2.41
3	2.22	1.62–3.04
4 or more	3.82	2.94–4.97

Note. Model adjusted for participant age, sex, race/ethnicity, educational level, annual household income, health insurance status, and history of depressive disorder.

The results of the multivariable logistic regression analysis using a replication of Fang and colleagues' 8-item ACE Questionnaire closely mirrored those of the primary analysis with increasingly elevated odds for 2, 3, and 4 or more ACEs, respectively (Table 4).

Table 4. Multivariable Logistic Regression Results: Association Between ACEs (8-Item) and HIV Risk Behavior

Number of ACEs	OR	95% CI
0	1.00	Referent
1	1.76	1.29–2.42
2	2.08	1.55–2.80
3	2.54	1.86–3.47
4 or more	4.30	3.29–5.62

Note. Model adjusted for participant age, sex, race/ethnicity, educational level, annual household income, health insurance status, and history of depressive disorder.

The associations between exposure to individual ACEs and engaging in HIV risk behaviors are shown in Table 5. After adjusting for socio-demographic characteristics and mental health status, each of the ACEs were significantly associated with HIV risk behavior. The odds of engaging in HIV risk behavior were the highest among those who had an adult force them to have sex (OR = 2.86), were made to touch an adult sexually (OR = 2.45), were ever touched sexually by an adult (OR = 2.44), lived with anyone who used illegal street drugs or who abused prescription medications (OR = 2.21), or lived with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility (OR = 2.11).

Table 5. Prevalence of individual ACEs and their association with odds of engaging in HIV risk behavior.

Type of ACE	%	OR	95% CI
Live With Anyone Depressed, Mentally Ill, Or Suicidal?	19.8	2.02	1.66–2.43
Live With a Problem Drinker/Alcoholic?	25.2	1.99	1.68–2.35
Live With Anyone Who Used Illegal Drugs or Abused Prescriptions?	10.8	2.21	1.82–2.68
Live With Anyone Who Served TIme in Prison or Jail?	7.8	2.11	1.71–2.60
Parents were separated or divorced	26.9	1.44	1.20–1.74
Parents or adults in your home ever slap, hit, kick, punch or beat each other up	17.1	2.30	1.93–2.75
Parent or adult in your home ever hit, beat, kick, or physically hurt respondent in any way	25.8	1.95	1.65–2.32
Parent or adult in your home ever swear at you, insult respondent, or put respondent down	36.1	2.08	1.74–2.50
Anyone at least 5 years older than you or an adult, ever touch respondent sexually	12.6	2.44	1.98–3.02
Anyone at least 5 years older than you or an adult, try to make respondent touch them sexually	9.4	2.45	1.96–3.06
Anyone at least 5 years older than you or an adult, force respondent to have sex	5.5	2.86	2.21–3.70
An adult in respondents' household who made respondent feel safe and protected was not present	28.6	1.29	1.09–1.54

Adult in respondents' household who tried hard to make sure respondents' basic needs were met was not present	16.9	1.38	1.14–1.68

Note. Model adjusted for participant age, sex, race/ethnicity, educational level, annual household income, health insurance status, and history of depressive disorder.

The logistic regression analysis conducted to attend to Specific Aim 4 examined whether race/ethnicity moderated the relationship between exposure to four or more ACEs and HIV risk behavior (Table 6). The interaction term between ACE exposure and race/ethnicity was significant consistent with moderation of the ACE-HIV risk association by race/ethnicity. As illustrated in Table 3, the odds of HIV risk behavior associated with 4 or more ACEs was significantly elevated for those who identified as Asian, Non-Hispanic; Hispanic; and Other race, Non-Hispanic relative to those who identified as White, Non-Hispanic participants (Table 6, p for interaction 0.05).

Table 6. Association of 4 or more reported ACEs with HIV risk behavior in subgroups defined by race/ethnicity.

Race/Ethnicity	OR	95% CI
White, Non-Hispanic	1.00	Referent
Black, Non-Hispanic	1.58	0.92–2.73
Asian, Non-Hispanic	3.40	1.11–10.44
American Indian/ Alaska Native, Non-Hispanic	2.23	0.82–6.07
Hispanic	2.97	1.82–4.85
Other race, Non-Hispanic	15.17	6.97–32.99

Note. Model adjusted for participant age, sex, race/ethnicity, educational level, annual household income, health insurance status, and history of depressive disorder.

DISCUSSION

This study examined the association between ACEs and HIV risk behavior among adults using data from the 2022 BRFSS across several US states. The findings reveal that individuals with a higher number of ACEs demonstrate increased odds of engaging in HIV risk behaviors, suggesting a dose-response effect where the risk escalates significantly with three or more ACEs. This relationship continues to exist following the implementation of COVID-19 pandemic policies. Fang and colleagues conducted a similar analysis, where the associations between ACEs and HIV risk behavior were investigated for each sex and found the following ORs for males, with no reported ACEs as the reference group: 1.94, 2.29 3.30, and 3.95 for 1, 2, 3, and 4 or more ACEs, respectively. For females, the ORs were 0.88, 1.62, 2.26, and 3.27 (3). The observed persistence of this association post-COVID-19 pandemic highlights the ongoing need for targeted interventions addressing both ACEs and their effects in the midst of socio-economic disruptions.

It was found that individuals with a higher number of ACEs had significantly increased odds of engaging in HIV risk behaviors. Specifically, when compared to individuals with no ACEs, those with 1, 2, 3, and 4 or more ACEs had progressively higher odds of HIV risk. These results align with previous research, such as the systematic review by Hughes et al., which indicated that ACEs are robust predictors of various adverse health outcomes, including risky sexual behaviors and substance use, which contribute to HIV risk (22). Interestingly, in our analysis, the OR was similar for 1 or 2 ACEs and increased when respondents reported 3 or more ACEs, a relationship that Fang and colleagues found with an 8-item ACE variable (3). This pattern suggests a dose-response effect where the accumulation of ACEs beyond a certain point exacerbates the risk of engaging in HIV-related behaviors (23).

One explanation for the similar odds observed between 1 and 2 ACEs may be rooted in resilience. Previous research by Bethell et al., suggests that individuals with fewer ACEs might be better equipped with coping mechanisms that mitigate the impact of early adversities (24). Resilience, defined as the ability to recover from or adapt to significant stress or adversity, can play a crucial role in how individuals respond to early life challenges. Protective factors such as social support, positive relationships, and personal strengths might buffer the negative effects of ACEs, preventing a proportional increase in HIV risk behaviors until a higher threshold of ACEs is reached (24, 25). Beyond resilience, other factors like access to mental health resources, socioeconomic status, and community support systems might also influence how individuals with lower numbers of ACEs manage their risk behaviors (24, 25).

Furthermore, the escalation in HIV risk behaviors observed with three or more ACEs is consistent with the more profound adverse consequences of cumulative trauma that overwhelms an individual's adaptive capacities. With an increasing number of ACEs, the compounded stress may lead to maladaptive coping strategies such as substance abuse and unsafe sexual practices, which are directly linked to higher HIV risk. Merrick et al. support this cumulative stress hypothesis, highlighting the importance of early interventions aimed at preventing ACEs and fostering resilience, as well as providing comprehensive support for individuals with multiple ACEs to mitigate their long-term health risks (26).

Future research should delve deeper into the mechanisms underlying the relationship between ACEs and HIV risk behaviors, exploring the interplay of resilience, coping strategies, and social and environmental factors. factors. Additionally, mixed methods approaches incorporating qualitative research may provide nuanced insights into the lived experiences of individuals with ACEs, informing targeted interventions and support systems. Integrating trauma-informed approaches into public health initiatives can address the root causes of ACEs

and foster environments conducive to resilience, ultimately reducing HIV risk and promoting overall well-being.

The findings of the primary analysis were largely confirmed in our analysis that emulated the work of Fang and colleagues by using 8 ACE items, rather than 13 (3). We found that individuals with a higher number of ACEs had significantly increased odds of engaging in HIV risk behaviors both with using the 13-item and 8-item versions measuring ACEs exposure. Specifically, when compared to individuals with no ACEs, those with 1, 2, 3, and 4 or more ACEs had progressively higher odds of HIV risk.

Factors such as increased isolation, economic hardship, and disruptions to routine healthcare services could have heightened vulnerability among those with multiple ACEs. This highlights the need for targeted interventions that address the heightened vulnerabilities during the height of the COVID-19 pandemic and in the post-COVID-19 landscape, underscoring the importance of socio-economic and healthcare disruptions in public health strategies.

Examining each ACE individually, we found that each ACE was significantly linked to HIV risk behavior. The strongest predictors included being forced into sex by an adult, being made to touch an adult sexually, being sexually touched by an adult, living with someone who used illegal drugs or abused prescriptions, or living with someone incarcerated. Interestingly, these ACEs were amongst the least prevalent in this sample. However, these findings are in line with the existing literature where HIV-uninfected MSM with CSA histories report higher rates of HIV sexual risk behavior (16, 27).

These ACEs highlight the profound effects of traumatic experiences on HIV risk behaviors. This aligns with Fang et al.'s research, which also found significant links between individual ACEs and HIV risk in adulthood, especially those related to childhood sexual abuse. Additionally, living with an incarcerated individual presented increased point estimates in HIV

risk behavior since Fang and colleagues' findings in 2012, which may suggest that the impact of this ACE has increased (3). Unlike Fang et al., this study did not find participants who had lived with individuals with depression, mental illness, or suicidality in childhood to be among those most at risk factors for HIV risk behavior, though the point estimates have increased since 2012, which may suggest that the impact of these ACEs have also increased (3).

Future research may delve into specific HIV risk behaviors associated with each ACE, offering insights into their unique vulnerabilities and informing tailored interventions and preventive strategies.

This study also examined the interaction between exposure to four or more ACEs and race/ethnicity on HIV risk behavior and revealed significant and nuanced differences across racial groups. Compared with White, Non-Hispanic participants, the point estimates for Black, Non-Hispanic and American Indian/Alaska Native, Non-Hispanic participants were higher but were not statistically significant. The same analysis found a significant association between experiencing four or more ACEs and heightened HIV risk behavior among Asian, Non-Hispanic; Hispanic; and Other Race, Non-Hispanic participants. This underscores the imperative for culturally sensitive interventions tailored to the distinct experiences and vulnerabilities within these communities considering that elevated risk levels may stem from socio-cultural dynamics or stressors. Thus, culturally appropriate strategies are critical to effectively mitigate risk of ACEs and HIV risk behavior among these populations.

The most striking finding was the OR of 15.17 for participants that identified as Other race, Non-Hispanic, indicating an exceptionally high HIV risk behavior associated with 4 or more ACE exposures. This level of risk underscores the urgency of understanding and addressing the factors contributing to such a pronounced effect. The heterogeneity within the Other race,

Non-Hispanic race category suggests that diverse and intersectional factors may be at play, necessitating a nuanced approach to intervention and research.

Future research should delve deeper into understanding the mechanisms underlying these observed associations, exploring the interconnected dynamics of race/ethnicity, ACEs, and HIV risk behavior. Additionally, investigations into the effectiveness of tailored interventions targeting specific racial/ethnic groups are warranted to address these disparities effectively. The significant interaction effects observed in our study highlight the critical need for race- and ethnic-specific approaches in addressing the impact of ACEs on HIV risk. These findings suggest that the adverse effects of childhood experiences on health are not necessarily uniform across racial groups. Therefore, public health strategies must be tailored to account for these differences, ensuring that interventions are both culturally relevant, equitable, and effective. By recognizing and addressing the diverse vulnerabilities within each racial group, considering factors such as socio-economic status, cultural differences, and historical experiences, we can better mitigate the long-term health consequences of ACEs and tailor interventions to reduce HIV risk across varied populations.

Limitations. This study, while offering valuable insights, should be interpreted in consideration of several limitations inherent to its methodology. Firstly, the use of cross-sectional does not allow for temporal sequencing of exposure and outcome. Additionally, the restriction of data to a single year might overlook long-term trends in the variables under scrutiny. However, by conducting analyses comparable to previous studies predating COVID-19 policies, such as the research by Fang et al. in 2012, this study elucidates the evolving relationship between ACEs and HIV risk behavior, enriching our understanding over time (3).

Telephone surveys inherently introduce sampling bias, as participation is restricted to individuals with access to either landline or cellphone services, potentially excluding those without such access. Additionally, the linguistic scope of the BRFSS is confined to English and Spanish, which may result in the omission of responses from individuals who speak other languages, thereby limiting the inclusivity of certain demographic groups. However, it is important to note that to address these limitations, the BRFSS employs complex weighting techniques to mitigate sampling bias and ensure that the survey results are representative of the US population (21).

The reliance on self-reported data within the BRFSS poses additional concerns, including social desirability and recall biases, which may distort the accuracy of responses, particularly when recalling childhood experiences. However, the study also benefits from several strengths that bolster the robustness of its findings. The utilization of a large, nationally representative sample size enables a comprehensive analysis across diverse populations, enhancing the study's generalizability. Moreover, the use of established, validated survey instruments contributes to the reliability of the data collected.

Conclusion. The findings of this study underscore the profound impact of ACEs on HIV risk behavior among adults, using data from the 2022 BRFSS across multiple US states. These findings reveal a clear dose-response relationship between the number of ACEs and the likelihood of engaging in HIV risk behavior. Thse results highlight the cumulative burden of trauma and its role in exacerbating HIV-related risk behaviors. This study provides compelling evidence for the ongoing need to address ACEs in public health strategies aimed at reducing HIV risk behaviors. Public health policies must prioritize these comprehensive, intersectional approaches to effectively reduce HIV risk and support those most affected by ACEs. However, moving forward, longitudinal studies are critical for further understanding the complex interplay

between ACEs, HIV risk behavior, and long-term health outcomes, informing more targeted and effective interventions.

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