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Trends in prevalence of adverse childhood experiences by sociodemographic factors in the United States: Behavioral Risk Factor Surveillance System 2009–2022

Shivani Kumar¹, Jennifer A. Campbell^{2*}, Xuemeng Wang², Yilin Xu², Sneha Nagavally³ and Leonard E. Egede²

Abstract

Background Limited data exists on trends in prevalence of adverse childhood experiences (ACE) at the national level and sociodemographic correlates of having ACEs. This study examined trends in ACE prevalence and sociodemographic correlates in US adults over 14 years using nationally representative data.

Methods Data on 447,162 adults from the Behavioral Risk Factor Surveillance System (BRFSS) across four timepoints (2009–2010; 2011–2012; 2019–2020; 2021–2022) was analyzed and weighted for population estimates. The primary outcome was ACEs with 3 groups used (0 vs. 1+ ACEs; <4 vs. 4+ ACEs; 0 vs. 1 vs. 2 vs. 3 vs. 4+ ACEs). Sociodemographic factors included age, sex, race/ethnicity, employment, education, marital status, income and insurance status. Prevalence trends were examined by estimating prevalence of ACE groupings (0/1+; <4/4+; 0,1,2,3,4+) across the four timepoints and trend analysis was performed to determine if the differences over time were statistically significant. Unadjusted and adjusted prevalence ratios were estimated using log-binomial regression models with ACE groupings as the outcome and timepoints as the primary independent variable with sociodemographic factors as covariates.

Results Across the four time points, prevalence of ACEs was higher across groupings of ACEs by time. For ACEs 1+, prevalence was 62.2% (2009–2010); 62.2% (2011–2012); 64.5% (2019–2020); and 67.2% (2021–2022). For ACEs 4+, prevalence was 17.4% (2009–2010); 18.1% (2011–2012); 20.4% (2019–2020); and 22.6% (2021–2022). Prevalence of ACE 1+ was higher for older adults, Non-Hispanic Black adults, Non-Hispanic Other adults, and those with higher education. Prevalence of 4+ ACEs was higher for females, and lower for those with higher education and those with higher annual incomes.

Conclusion This study shows an increased prevalence of having ACEs over a 14-year period and identified independent sociodemographic correlates of having ACEs in a nationally representative study. Targeted interventions are needed to reduce burden of ACEs using population-based approaches.

Keywords Adverse childhood experiences, Trends, Adults, Sociodemographic factors

*Correspondence:
Jennifer A. Campbell
jcampbe@buffalo.edu

¹Internal Medicine Residency Program, Department of Medicine, Lewis Katz School of Medicine, Temple University, Philadelphia, PA, USA

²Division of Population Health, Department of Medicine, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, NY, USA

³Center for Advancing Population Science, Medical College of Wisconsin, Milwaukee, WI, USA



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Introduction

Adverse childhood experiences (ACEs), as originally examined [1] are traumatic events that occur at the individual level during childhood, and include abuse at the emotional, physical, and sexual level, as well as experiences of neglect, and household dysfunction [1]. Recent expansion of ACEs has led to additional categories that include financial hardship at the household level, experiences of discrimination, living in foster care, as well as experiencing bullying prior to the age of 18 [2]. ACEs are highly prevalent with 2023 data from the Centers for Disease Control and Prevention (CDC) showing 64% of US adults reporting exposure to at least one ACE using traditional ACE categories from the Behavioral Risk Factor Surveillance System (BRFSS) [3]. It is estimated that ACEs have an estimated lifetime cost of approximately \$210,000 per person per year, with the total economic burden in the US being approximately \$124 billion annually in both direct and indirect costs for adults who have experienced ACEs [4].

ACEs remain a public health concern due to their known association with and increased risk of morbidity, mortality and decreased quality of life in adulthood [5–10]. Specifically, ACEs are shown to increase risk for diabetes [6, 11–13], hypertension [14], and kidney disease [15]. Evidence also shows that once an individual with a history of ACEs develops a chronic disease, risk of early mortality is amplified, specifically for those with diabetes [16] and kidney disease [15], compared to those with a history of ACEs with no chronic disease. Individuals with a history of ACEs are also more likely to engage in risky health behavior [6], experience higher rates of depression, anxiety, and other mood disorders compared to those who have never experienced an ACE [17, 18].

While the detrimental effects that ACEs have on health during childhood and adulthood have been well established, there remain gaps in prevention strategies, with limited work done to first establish trends in ACEs over time at the national level, and second to identify key sociodemographic factors associated with increased odds of ACEs over time. Specifically, very few studies have examined trends in ACEs in the US, with one study in 2020 summarizing existing data in the form of a review to establish trends [19] and a more recent study using autoregressive integrated moving average (ARIMA) to forecast ACEs into 2030 [20]. However, assessment of trends in prevalence using national data over time is limited. In addition, understanding the sociodemographic factors associated with trends in prevalence is highly needed.

Taken together, while the body of work examining the impact of ACEs on adult health is robust, there is a need to understand current trends in ACE prevalence at the national level and to understand key sociodemographic factors associated with increased odds of ACEs.

This understanding will provide evidence needed to better inform screening, primary, and secondary prevention methods for adults who have experienced ACEs. Therefore, the purpose of this study is to examine the trends in prevalence of ACEs and to identify the sociodemographic factors associated with increased odds of ACEs. Using data from the nationally representative BRFSS, this study will look at trends in ACEs across four time points from 2009 to 2022 (2009–2010; 2011–2012; 2019–2020; 2021–2022) and identify the independent sociodemographic correlates of having ACEs over time.

Methods

Data source

The current study used data from the Behavioral Risk Factor Surveillance System (BRFSS) for the years 2009–2012 and 2019–2022 and created four timepoints (2009–2010; 2011–2012; 2019–2020; 2021–2022). BRFSS is primarily administered as a state-based, random-digit-dialed telephone survey on non-institutionalized adults aged 18 years or older in the United States [21]. This survey collects information on a range of health-related behaviors and conditions, including Adverse Childhood Experiences (ACEs). The ACE questions asked about experiences of abuse, neglect, and household dysfunction during childhood. The BRFSS ACE module is optional, and each state can elect to include. The study sample included adults aged 18 years or older who participated in the BRFSS surveys for the years 2009–2010; 2011–2012; 2019–2020; 2021–2022 and who answered the ACE questions. A total sample of $N=447,162$ was included from the eight years of data from the following 37 states: Alabama; Arizona; Arkansas; Delaware; District of Columbia; Florida; Georgia; Hawaii; Idaho; Indiana; Iowa; Kentucky; Louisiana; Michigan; Minnesota; Mississippi; Missouri; Montana; Nevada; New Hampshire; New Mexico; North Carolina; North Dakota; Oregon; Pennsylvania; Rhode Island; South Carolina; South Dakota; Tennessee; Texas; Utah; Vermont; Virginia; Washington; West Virginia; Wisconsin; Wyoming. For this analysis, ACE responses were unique and not influenced by repeat participants across timepoints, standard BRFSS procedures which utilize a cross-sectional design ensuring that participants are not tracked over time were followed. Complex sampling weights were applied using BRFSS recommended weights for analysis among optional modules [22]. Specifically, when combining BRFSS data from multiple years, the weighting procedures are adjusted proportionally to account for different sample sizes across the years. The procedure involves calculating the sample size for each year, determining the proportion of the total combined sample size for each year, and then multiplying the original weight variable for each year by the corresponding proportion [22].

Outcome variable

The outcome variable in this study was the presence of Adverse Childhood Experiences (ACEs). The ACE module in BRFSS categorizes ACEs according to the foundational ACE study conducted by the CDC and Kaiser Permanente [1]. The following list of eleven questions were considered to identify ACEs among the participants:

ACE Category – Household Dysfunction: Mental Illness.

- Did you live with anyone who was depressed, mentally ill, or suicidal?

ACE Category – Household Dysfunction: Substance Abuse.

- Did you live with anyone who was a problem drinker or alcoholic, or who used street drugs?
- Did you live with anyone who used illegal street drugs or who abused prescription medications?

ACE Category – Household Dysfunction: Incarceration.

- Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?

ACE Category – Household Dysfunction: Divorce/Separation.

- Was a biological parent ever lost to you through divorce, abandonment, or other reason?

ACE Category – Household Dysfunction: Violence.

- How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?

ACE Category – Physical Abuse.

- Did a parent or other adult in the household often or very often hit, beat, kick, or physically hurt you in any way?

ACE Category – Verbal Abuse.

- How often did a parent or adult in your home ever swear at you, insult you, or put you down?

ACE Category – Sexual Abuse.

- How often did anyone at least 5 years older than you or an adult, ever touch you sexually?

- How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?
- How often did anyone at least 5 years older than you or an adult, force you to have sex?

ACE grouping variables

Three ACE grouping variables were created based on a count of number of ACEs. First grouping was based on 0 vs. 1+ACEs; second was <4 vs. 4+ACEs; and third was 0 vs. 1 vs. 2 vs. 3 vs. 4+ACEs.

Demographic variables

Demographic variables included age grouped as 18–34, 35–49, 50–64 and ≥ 65 , biological sex (male vs. female), race/ethnicity grouped as Non-Hispanic White, Non-Hispanic Black, Hispanic and Non-Hispanic Other, employment classified as Employed vs. Not Employed, education classified as Less than High School, High School Graduate, Some College, and College Graduate, marital status classified as Married vs. Not Married, income classified as <\$25,000, \$25,000 - \$49,999, \$50,000-\$74,999, \geq \$75,000 and insurance status classified as Insured vs. Not Insured.

Statistical analysis

Chi-square for categorical variables and anova for continuous variables were used to summarize the characteristics of the study sample, including demographics by ACE groupings (0/1+; <4/4+; 0,1,2,3,4+) and by the four study timepoints (2009–2010; 2011–2012; 2019–2020; 2021–2022). Prevalence trends were examined by estimating prevalence of ACE groupings (0/1+; <4/4+; 0,1,2,3,4+) across the four timepoints and trend analysis was performed to determine if the differences over time were statistically significant. Then, to estimate unadjusted prevalence ratios, log-binomial regression models were run with ACE groupings as the outcome and timepoints as the primary independent variable. To identify independent correlates of ACE groupings, log-binomial regression models were run with ACE groupings as the outcome, timepoints as the primary independent variable, and sociodemographic factors including age, sex, race/ethnicity, employment, education level, marital status, and income level as covariates. Unadjusted and adjusted prevalence ratios with 95% confidence intervals (CIs) were estimated from the respective models, and statistical significance was set at $p < 0.05$. All analyses were conducted using R-4.1.3.

Results

Tables 1 and 2 summarize ACE prevalence among adults by sociodemographic factors by ACE groupings (0 vs. 1+ACEs; and <4 vs. 4+ACEs) across each year and by

Table 1 (continued)

	2009–2010 (ACE Prevalence 62.2%)			2011–2012 (ACE Prevalence 62.2%)			2019–2020 (ACE Prevalence 64.5%)			2021–2022 (ACE Prevalence 67.2%)			Overall		
	No ACE (N=90,001)	ACE 1+ (N=147,886)	Total (N=237,887)	No ACE (N=416,475)	ACE 1+ (N=684,043)	Total (N=1,100,518)	No ACE (N=8,187,301)	ACE 1+ (N=14,896,381)	Total (N=23,083,682)	No ACE (N=4,440,692)	ACE 1+ (N=9,080,279)	Total (N=13,520,971)	No ACE (N=13,134,470)	ACE 1+ (N=24,808,589)	Total (N=37,943,059)
	(27.59%)	(28.39%)	(24.88%)	(29.82%)	(28.09%)	(24.82%)	(22.44%)	(24.38%)	(19.76%)	(36.00%)	(35.40%)	(23.66%)	(26.27%)	(27.74%)	(23.66%)
Less than \$25,000	15,886 (20.08%)	32,829 (24.94%)	48,715 (20.48%)	82,957 (23.58%)	183,109 (30.54%)	266,066 (24.18%)	1,552,047 (23.72%)	3,414,373 (26.92%)	4,966,420 (21.52%)	5,19,704 (21.30%)	1,271,262 (23.09%)	1,790,966 (13.24%)	2,170,594 (23.06%)	4,901,573 (25.91%)	6,072,560 (23.06%)
\$25,000–\$49,999	21,830 (27.59%)	37,371 (28.39%)	59,201 (24.88%)	104,886 (29.82%)	168,402 (28.09%)	273,288 (24.82%)	1,468,420 (22.44%)	3,092,328 (24.38%)	4,560,748 (19.76%)	878,277 (36.00%)	1,949,173 (35.40%)	3,198,217 (23.66%)	2,473,413 (26.27%)	5,247,275 (27.74%)	7,440,588 (23.66%)
\$50,000–\$74,999	14,861 (18.78%)	22,333 (16.97%)	37,194 (15.64%)	62,050 (17.64%)	95,765 (15.97%)	157,815 (14.34%)	1,058,664 (16.18%)	2,049,674 (16.16%)	3,108,338 (13.47%)	543,780 (22.29%)	1,266,744 (23.01%)	1,810,524 (13.39%)	1,679,354 (17.84%)	3,434,516 (18.15%)	5,113,840 (13.39%)
\$75,000+	26,535 (33.54%)	39,091 (29.70%)	65,626 (27.60%)	101,866 (28.96%)	152,247 (25.39%)	403,349 (36.65%)	2,464,167 (37.66%)	4,125,417 (32.53%)	10,055,878 (43.58%)	498,003 (20.41%)	1,018,994 (18.51%)	6,721,264 (49.71%)	3,090,572 (32.83%)	5,335,750 (28.20%)	11,427,026 (28.20%)
Insurance Status															
No - Not insured	8,490 (9.46%)	23,640 (16.03%)	32,130 (13.51%)	45,109 (10.89%)	118,162 (17.33%)	163,271 (14.84%)	902,592 (11.08%)	2,234,854 (15.09%)	3,137,446 (13.59%)	290,483 (6.90%)	731,222 (8.43%)	1,021,705 (7.56%)	1,246,674 (9.69%)	3,107,878 (12.78%)	4,128,573 (10.87%)
Yes - insured	81,267 (90.54%)	123,813 (83.97%)	205,757 (86.49%)	369,001 (89.11%)	563,478 (82.67%)	937,247 (85.16%)	7,245,050 (88.92%)	12,577,100 (84.91%)	19,946,236 (86.41%)	3,919,802 (93.10%)	7,945,607 (91.57%)	12,499,266 (92.44%)	11,615,121 (90.31%)	21,209,998 (87.22%)	27,814,486 (73.33%)

sociodemographic factors. Consistently across ACE groups and sociodemographic factors by year, prevalence of ACEs was high. For the ACE grouping of 0 versus 1+, in 2009–2010, prevalence was 62.2%; 2011–2012 62.2%; 2019–2020 64.5%; and 2021–2022 67.2%. For the ACE grouping of <4 vs. 4+, from 2009 to 2010 prevalence for 4+ ACEs was 17.4%, from 2011 to 2012 18.1%, 2019–2020 20.4%, and 2021–2022 22.6%. Also see appendix for additional reporting by ACE groupings.

Table 3 shows the prevalence ratios by ACE group (0 vs. 1+ ACEs) across each year and by sociodemographic factors. Of note, in 2009–2010, compared to those in the 18–34 age group, those in the 50–64 age group had significantly higher prevalence of having at least 1 or more ACE (PR=1.29; CI 1.16; 1.43) as well as those age 65 and older (PR=1.77; CI 1.57; 1.98) from 2009 to 2010. This relationship held across each of the four time points. From 2011 to 2012, those in the age group of 35–49 had significantly lower prevalence (PR=0.93; CI 0.88; 0.99) compared to those in the 18–34 age group. This relationship flipped in the 2019–2020 time point with the 35–49 age group demonstrating a significantly higher prevalence (PR=1.07; CI 1.02; 1.13) compared to the 18–34 age group and increased again in 2021–2022 (PR=1.15; CI 1.02; 1.31). By sex, females had significantly lower prevalence of having at least 1 ACE compared to males in both 2011–2012 (PR=0.95; CI 0.92; 0.98) and 2019–2020 (PR=0.97; CI 0.94; 0.99). When looking at race/ethnicity, from 2009 to 2010 compared to non-Hispanic Whites, those identifying as Non-Hispanic Other had significantly higher prevalence of at least 1 ACE (PR=1.12; CI 1.04; 1.20). This relationship became non-significant in the 2011–2012 time point with Non-Hispanic Black adults having a lower prevalence (PR=0.9; CI 0.84; 0.97) compared to non-Hispanic Whites. In 2019–2020, Non-Hispanic Blacks continued to have a lower prevalence (PR=0.95; CI 0.91; 1.00) with Hispanic adults having significantly higher prevalence (PR=1.18; CI 1.12; 1.26) and Non-Hispanic Other adults also having significantly higher prevalence (PR=1.19; CI 1.13; 1.26), compared to non-Hispanic Whites. In the 2021–2022 time point, only Hispanic adults had a significantly higher prevalence of having at least 1 ACE (PR=1.29; CI 1.14; 1.47) compared to non-Hispanic Whites.

Table 4 shows the prevalence ratios by ACE group (<4 vs. 4+ ACEs) across each year and by sociodemographic factors. Of note, only those aged 35–49 had significantly higher prevalence of having 4+ ACEs (PR=1.1; CI 1.02; 1.19) compared to those in the 18–34 age group in 2011–2012. Those in the 50–64 and 65 and older age group, had significantly lower prevalence of 4+ ACEs compared to the 18–34 age group, consistent across each time point. Females, compared to males consistently had a higher prevalence of 4+ ACEs across each time point. Adults

identifying as Non-Hispanic Other had significantly higher prevalence of 4+ ACEs (PR=1.15; CI 1.03; 1.29) in 2011–2012 compared to Non-Hispanic Whites. In 2019–2020, this relationship flipped (PR=0.87; CI 0.81; 0.93) with Non-Hispanic Other adults having lower prevalence as well as Non-Hispanic Black adults (PR=0.79; CI 0.74; 0.84) and Hispanic adults (PR=0.72; CI 0.67; 0.78) having lower prevalence compared to Non-Hispanic Whites. See appendix for additional reporting across each time period.

Figure 1 shows the trends in prevalence over time by all three ACE groupings (0 vs. 1+ ACEs; <4 vs. 4+ ACEs; and 0 vs. 1 vs. 2 vs. 3 vs. 4+ ACEs.) Consistent across ACE grouping, prevalence in ACEs significantly increased across each time point. Of note, those reporting no ACEs decreased from 2009 to 2022. Those reporting at least 3 ACEs and 4 or more ACEs increased over each time period from 2009 to 2022.

Discussion

Using a nationally representative sample, weighted for population estimates, this study shows that prevalence of ACEs has increased in the US since first being assessed by BRFSS nationally in 2009 to the most recent year of 2022. Specifically, prevalence in ACEs, across groupings of ACEs has significantly increased over time. When looking at the sociodemographic correlates, there is variation by ACE groupings by time point. When only considering the presence of one or more ACE compared to zero ACEs, age is a significant correlate of ACEs. Specifically, compared to those who are 18–34, those aged 50–64 and 65 and older from 2009 to 2010 had a 29% higher prevalence and a 77% higher prevalence of at least 1 ACE, respectively. This significant increased prevalence was seen across each time point, with marked increased prevalence in 2021–2022 for those in the 65 and older age group having a two-fold increased prevalence compared to those aged 18–34. When looking at the prevalence of ACE by sex, females had significantly lower prevalence compared to males in 2011–2012 and 2019–2020. From 2009 to 2010, adults identifying as Non-Hispanic Other had a 12% higher prevalence compared to Non-Hispanic Whites. In 2011–2012, the only significant prevalence was for Non-Hispanic Black adults who had a lower prevalence compared to Non-Hispanic Whites. Non-Hispanic Black adults continued to have a lower prevalence in 2019–2020 with Hispanic adults having an 18% higher prevalence and Non-Hispanic Other adults having a 19% higher prevalence compared to Non-Hispanic Whites. Those who completed college had consistently higher prevalence compared to those with less than a high school diploma. Across each time point, those who were married had significantly higher prevalence compared to those who were not married.

When considering the ACE grouping of 4 or more, compared ACE grouping of 0–3, those aged 50 and older had significantly lower prevalence compared to those aged 18–34 across each of the four time points. When looking at four or more ACEs by sex, females had between 35% and 40% higher prevalence compared to males across each of the four time points. By race/ethnicity, only Non-Hispanic Other adults had a 15% higher prevalence from 2011 to 2012 compared to Non-Hispanic Whites. From 2019 to 2020, each racial/ethnic group had significantly lower prevalence compared to Non-Hispanic Whites. By marital status, those who were married had significantly lower prevalence of ACEs compared to those who were not married from 2011 to 2012; 2019–2020; and 2021–2022. Those who completed college had lower prevalence across each time point compared to those with less than a high school education, and those with incomes over \$25,000 annually had significantly lower prevalence of ACEs over each time point.

This is one of the first studies to our knowledge to examine prevalence of ACEs over time using national data in the US. Existing work examining trends in ACEs have relied primarily on summarizing data sources including vital statistics and published literature to estimate reports over time periods [19]. Findings from this study show that prevalence of ACEs over time has increased as of 2022, however additional surveillance at the population level is needed for a more precise estimate. For example, BRFSS is a robust surveillance mechanism at the national level, however states may opt in to include the ACE module, and availability of the ACE module varies over time [21]. For this reason, the increase in ACEs may be in part due to a greater number of states electing to use the ACE module in their surveillance. To truly understand the prevalence and impact of ACEs, national surveillance programs should consider incorporating required ACE modules to better understand prevalence as well as understand the influence ACEs have on other health behaviors and health promotion activities.

This study also examined the sociodemographic correlates of ACEs and found variation by ACE groupings. Specifically, prevalence of at least one ACE was higher for males, Non-Hispanic Other adults, and those with less than a high school education. Whereas prevalence of four or more ACEs was higher for females, those who have less than a high school education, and those who earn less than \$25,000 annually. Prevalence of four or more ACEs was higher for Non-Hispanic Other adults in 2011–2012 and higher for Non-Hispanic Whites in 2019–2020. While the current literature shows women and racial/ethnic minorities are more likely to experience ACEs compared to men and non-Hispanic Whites [23–30]. This is one of the first studies to examine correlates across sociodemographic factors by year of BRFSS data

Table 2 ACE prevalence among adults 18 years and older by Sociodemographic Factors (ACE grouping < 4 vs. 4+ ACEs)

	2009–2010			2011–2012			2019–2020			2021–2022			Overall		
	ACE 0–3 (N = 196,413)	ACE 4+ (N = 41,474)	2009–2010 Total (N = 237,887)	ACE 0–3 (N = 901,456)	ACE 4+ (N = 199,062)	2011–2012 Total (N = 1,100,518)	ACE 0–3 (N = 18,383,657)	ACE 4+ (N = 4,700,026)	2019–2020 Total (N = 23,083,682)	ACE 0–3 (N = 10,465,419)	ACE 4+ (N = 3,055,553)	2021–2022 Total (N = 13,520,971)	ACE 0–3 (N = 29,946,944)	ACE 4+ (N = 7,996,115)	Overall Total (N = 135,209,971)
Age															
18–34	53,914 (27.45%)	16,527 (39.85%)	70,441 (29.61%)	236,717 (26.26%)	73,631 (36.99%)	310,348 (28.20%)	4,491,261 (24.43%)	1,749,860 (37.23%)	6,241,122 (27.04%)	2,242,087 (21.42%)	1,110,618 (36.35%)	3,352,705 (24.80%)	7,023,978 (23.45%)	2,950,637 (36.90%)	10,974,615 (23.45%)
35–49	51,600 (26.27%)	13,038 (31.44%)	64,638 (27.18%)	222,301 (24.66%)	61,908 (31.10%)	284,209 (25.83%)	3,906,702 (21.25%)	1,308,286 (27.84%)	5,214,988 (22.60%)	2,240,274 (21.41%)	843,255 (27.60%)	3,083,530 (22.80%)	6,420,876 (21.44%)	2,226,487 (27.84%)	9,647,363 (21.44%)
50–64	52,146 (26.55%)	9,237 (22.27%)	61,383 (25.80%)	252,424 (28.00%)	50,223 (25.23%)	302,647 (27.51%)	4,912,502 (26.72%)	1,146,133 (24.39%)	6,058,635 (26.24%)	2,713,129 (25.92%)	733,167 (23.99%)	3,446,295 (25.49%)	7,930,200 (26.48%)	1,938,760 (24.25%)	9,868,960 (26.48%)
>=65	38,754 (19.73%)	2,671 (6.44%)	41,425 (17.41%)	190,014 (21.08%)	13,300 (6.68%)	203,314 (18.46%)	5,073,191 (27.60%)	495,747 (10.55%)	5,568,939 (24.12%)	3,269,929 (31.25%)	368,513 (12.06%)	3,638,441 (26.91%)	8,571,889 (28.62%)	880,231 (11.01%)	9,452,120 (28.62%)
Sex															
Male	99,610 (50.71%)	17,300 (41.71%)	116,910 (49.15%)	450,170 (49.94%)	84,319 (42.36%)	534,489 (48.59%)	9,097,154 (49.49%)	1,939,984 (41.28%)	11,037,138 (47.81%)	5,238,320 (50.05%)	1,262,823 (41.33%)	6,501,143 (48.08%)	14,885,254 (49.71%)	3,304,426 (41.33%)	18,189,680 (49.71%)
Female	96,803 (49.29%)	24,174 (58.29%)	120,977 (50.85%)	451,286 (50.06%)	114,743 (57.64%)	566,029 (51.41%)	9,286,502 (50.51%)	2,760,042 (58.72%)	12,046,544 (52.19%)	5,227,098 (49.95%)	1,792,730 (58.67%)	7,019,828 (51.92%)	15,061,690 (50.29%)	4,691,689 (58.67%)	19,753,379 (50.29%)
Race/Ethnicity															
Non-Hispanic White	145,273 (74.63%)	29,205 (70.87%)	174,477 (73.33%)	736,104 (82.19%)	153,276 (77.68%)	889,380 (80.81%)	12,003,310 (66.44%)	3,036,449 (65.71%)	15,039,759 (65.15%)	6,659,574 (65.35%)	1,938,768 (65.05%)	8,598,343 (63.60%)	19,544,261 (66.60%)	5,157,698 (65.79%)	24,701,959 (66.60%)
Non-Hispanic Black	16,553 (8.50%)	4,370 (10.60%)	20,924 (8.79%)	64,692 (7.22%)	18,291 (9.27%)	82,982 (7.54%)	2,464,002 (13.64%)	637,674 (13.80%)	3,101,677 (13.44%)	1,313,272 (12.89%)	330,300 (11.08%)	1,643,572 (12.15%)	3,858,520 (13.15%)	990,635 (12.64%)	4,849,155 (13.15%)
Hispanic	9,693 (4.98%)	3,109 (7.54%)	12,801 (5.38%)	45,005 (5.03%)	10,977 (5.56%)	55,983 (5.09%)	2,582,991 (14.30%)	681,725 (14.75%)	3,264,716 (14.14%)	1,432,873 (14.06%)	429,872 (14.42%)	1,862,746 (13.78%)	4,070,563 (13.87%)	1,125,684 (14.36%)	5,196,247 (13.87%)
Non-Hispanic Other	23,126 (11.88%)	4,528 (10.99%)	27,654 (11.62%)	49,821 (5.56%)	14,760 (7.48%)	72,173 (6.55%)	1,015,267 (5.62%)	264,835 (5.73%)	1,677,530 (7.27%)	785,662 (7.71%)	281,561 (9.45%)	874,310 (6.47%)	1,873,875 (6.39%)	565,684 (7.22%)	2,439,559 (6.39%)
Employment															
Not Employed	78,146 (39.94%)	16,889 (40.83%)	95,035 (39.94%)	374,438 (41.65%)	84,802 (42.73%)	459,241 (41.73%)	8,394,635 (46.07%)	1,937,596 (41.55%)	10,332,231 (44.77%)	4,825,610 (46.60%)	1,175,017 (38.83%)	6,000,627 (44.37%)	13,672,829 (46.08%)	3,214,304 (40.54%)	16,887,133 (46.08%)
Employed	117,525 (60.06%)	24,475 (59.17%)	142,852 (60.06%)	524,585 (58.35%)	113,667 (57.27%)	641,277 (58.27%)	9,826,168 (53.93%)	2,725,670 (58.45%)	12,751,451 (55.23%)	5,529,515 (53.40%)	1,850,732 (61.17%)	7,520,344 (55.63%)	15,997,792 (53.92%)	4,714,544 (59.46%)	20,712,336 (53.92%)
Education															
Less than HS	12,073 (6.15%)	3,866 (9.33%)	15,940 (6.70%)	97,795 (10.87%)	32,434 (16.30%)	130,228 (11.83%)	2,175,540 (11.87%)	708,281 (15.09%)	2,883,821 (12.49%)	1,097,760 (10.54%)	361,499 (11.85%)	1,459,259 (10.79%)	3,383,168 (11.34%)	1,106,080 (13.85%)	4,489,248 (11.34%)
HS Grad	58,767 (29.94%)	13,694 (33.04%)	72,461 (30.45%)	267,729 (29.75%)	59,166 (29.74%)	326,895 (29.69%)	5,383,605 (29.37%)	1,442,168 (30.73%)	6,825,773 (29.57%)	2,813,367 (27.01%)	910,142 (29.82%)	3,723,508 (27.53%)	8,523,469 (28.56%)	2,425,169 (30.37%)	10,948,638 (28.56%)
Some college	53,483 (27.25%)	13,905 (33.55%)	67,389 (28.33%)	288,931 (32.10%)	72,912 (36.65%)	361,843 (32.88%)	5,704,947 (31.12%)	1,674,984 (35.69%)	7,379,931 (31.96%)	3,243,460 (31.14%)	1,096,491 (32.09%)	4,339,952 (32.09%)	9,290,821 (31.13%)	2,858,292 (35.80%)	12,149,113 (31.13%)
College Grad	71,932 (36.65%)	9,985 (24.09%)	81,917 (34.30%)	245,601 (27.29%)	34,424 (17.30%)	281,552 (25.60%)	5,067,496 (27.64%)	867,296 (18.48%)	5,994,157 (25.99%)	3,261,384 (31.31%)	683,544 (22.40%)	3,998,252 (29.59%)	8,646,413 (28.97%)	1,595,250 (19.98%)	10,241,663 (28.97%)
Marital Status															
Not Married	74,893 (38.23%)	19,172 (46.27%)	94,064 (39.53%)	388,563 (43.21%)	110,434 (55.63%)	498,997 (45.34%)	8,557,598 (46.90%)	2,721,460 (58.20%)	11,279,057 (48.86%)	4,726,482 (45.57%)	1,723,904 (56.79%)	6,450,386 (47.71%)	13,747,535 (46.27%)	4,574,970 (57.54%)	18,322,505 (46.27%)
Married	121,004 (61.77%)	22,259 (53.73%)	143,823 (60.47%)	510,731 (56.79%)	88,092 (44.37%)	601,521 (54.66%)	9,687,563 (53.10%)	1,954,232 (41.80%)	11,804,625 (51.14%)	5,645,726 (54.43%)	1,311,717 (43.21%)	7,070,585 (52.29%)	15,965,023 (53.73%)	3,376,300 (42.46%)	19,341,323 (53.73%)
Household Total Income															
Less than \$25,000	36,117 (20.83%)	12,598 (33.70%)	48,715 (20.48%)	197,347 (25.47%)	68,720 (38.93%)	266,066 (24.18%)	3,676,221 (24.30%)	1,290,199 (31.50%)	4,966,420 (21.52%)	1,251,821 (21.01%)	539,145 (27.14%)	1,790,966 (13.24%)	5,161,505 (23.42%)	1,910,662 (30.35%)	7,072,167 (23.42%)

Table 2 (continued)

	2009–2010			2011–2012			2019–2020			2021–2022			Overall		
	ACE 0-3 (N=196,413)	ACE 4+ (N=41,474)	Total (N=237,887)	ACE 0-3 (N=901,456)	ACE 4+ (N=199,062)	Total (N=1,100,518)	ACE 0-3 (N=18,383,657)	ACE 4+ (N=4,700,026)	Total (N=23,083,682)	ACE 0-3 (N=10,465,419)	ACE 4+ (N=3,055,553)	Total (N=13,520,971)	ACE 0-3 (N=29,946,944)	ACE 4+ (N=7,996,115)	Total (N=37,943,059)
\$25,000 - \$49,999	49,393 (28.49%)	9,807 (26.24%)	59,201 (24.88%)	224,612 (28.99%)	48,676 (27.57%)	273,288 (24.82%)	3,518,765 (23.26%)	1,041,984 (25.44%)	4,560,748 (19.76%)	2,106,371 (35.34%)	721,079 (36.30%)	3,198,217 (23.66%)	5,899,141 (26.77%)	1,821,546 (28.93%)	7,720,687 (23.55%)
\$50,000-\$74,999	31,639 (18.25%)	5,556 (14.86%)	37,194 (15.64%)	133,571 (17.24%)	24,244 (13.73%)	157,815 (14.34%)	2,459,623 (16.26%)	648,715 (15.84%)	3,108,338 (13.47%)	1,408,173 (23.63%)	402,351 (20.25%)	1,810,524 (13.39%)	4,033,005 (18.30%)	1,080,865 (17.17%)	5,114,389 (18.30%)
\$75,000+	56,209 (32.42%)	9,418 (25.20%)	65,626 (27.60%)	219,212 (28.29%)	34,902 (19.77%)	403,349 (36.65%)	5,475,045 (36.19%)	1,114,539 (27.21%)	10,055,878 (43.58%)	1,193,112 (20.02%)	323,885 (16.30%)	6,721,264 (49.71%)	6,943,577 (31.51%)	1,482,744 (23.55%)	8,424,321 (23.55%)
Insurance Status															
No - Not insured	23,476 (11.98%)	8,654 (20.95%)	32,130 (13.51%)	118,841 (13.25%)	44,430 (22.36%)	163,271 (14.84%)	2,276,556 (12.45%)	860,890 (18.42%)	3,137,446 (13.59%)	736,618 (7.41%)	285,087 (9.67%)	1,021,705 (7.56%)	3,155,491 (10.76%)	1,199,061 (15.25%)	4,354,756 (12.61%)
Yes - insured	172,425 (88.02%)	32,655 (79.05%)	205,757 (86.49%)	778,235 (86.75%)	154,244 (77.64%)	937,247 (85.16%)	16,009,358 (87.55%)	3,812,792 (81.58%)	19,946,236 (86.41%)	9,201,221 (92.59%)	2,664,189 (90.33%)	12,499,266 (92.44%)	26,161,238 (89.24%)	6,663,880 (84.75%)	32,825,124 (89.24%)

and adds new findings to our understanding that prevalence may vary by ACE grouping.

Overall, the body of literature examining the prevalence as well as the associated social and health risks of ACEs has been well established [30, 31]. As this study shows, ACEs persist as a major public health concern in the United States with increased prevalence since 2009. These findings add to the field by informing key areas for primary and secondary prevention, namely screening and education to further understand specific vulnerabilities that may exist across populations to prevent the occurrence, as well as mitigate the effects once they have been identified as having occurred [32]. However, as ACEs persist as a public health crisis, the next frontier in the study of ACE prevention is to use a root cause approach to identify structural determinants that allow the incidence of ACEs to increase. Specifically, understanding the societal structures and larger contexts wherein ACEs occur are needed for large scale prevention efforts across populations. For example, recent work within the field of diabetes has identified key factors that increase risk for ACEs and subsequent risk for type 2 diabetes at the community and social level using a qualitative approach [33]. These factors include family instability and poverty [33]. Additional work outlining the Pair of ACEs highlights individual level ACEs as one group of ACEs, and the community/environment as the second group, together forming a detrimental Pair of ACEs [34]. This work conceptually illustrates the root causes of ACEs to include poverty, discrimination, lack of economic mobility, and exposure to violence [34]. While this evidence advances our understanding, the field is still limited in understanding pathways. To effectively use the evidence base to develop prevention strategies, identifying the pathways at a population level are needed to develop and refine interventions to understand structural factors that enable ACEs to persist.

While this study is strengthened by its large sample size, there are limitations that are worth mentioning. First, data on ACEs were self-reported by study participants and may be subject to recall bias. Evidence shows recall for significant life events such as diagnosis with a chronic disease as well as traumatic lived experiences have relatively low recall bias, therefore we do not believe this impacts the findings [35, 36]. Additionally, not all states included the ACE module in their yearly data collection, with a small number of states including the module in the initial time period from 2009 to 2010. While the number of states offering the ACE module increased over time, consideration for inclusion of ACEs as a required BRFSS module would allow for more precise estimates at the population level. No states in BRFSS assessed for ACEs between the years 2013–2018. Furthermore, a significant percentage of the sample population identified

Table 3 Prevalence ratio (PR) by ACE grouping 1 +vs. 0

	2009–2010			2011–2012			2019–2020			2021–2022		
	PR	95% CI	p-value	PR	95% CI	p-value	PR	95% CI	p-value	PR	95% CI	p-value
Age												
18–34 (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
35–49	1.12	(1.00, 1.25)	0.06	0.93	(0.88, 0.99)	0.03	1.07	(1.02, 1.13)	0.01	1.15	(1.02, 1.31)	0.03
50–64	1.29	(1.16, 1.43)	< 0.0001	1.16	(1.10, 1.22)	< 0.0001	1.25	(1.20, 1.31)	< 0.0001	1.48	(1.31, 1.67)	< 0.0001
>=65	1.77	(1.57, 1.98)	< 0.0001	1.68	(1.59, 1.78)	< 0.0001	1.69	(1.61, 1.77)	< 0.0001	2.15	(1.90, 2.43)	< 0.0001
Sex												
Male (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Female	0.98	(0.92, 1.03)	0.37	0.95	(0.92, 0.98)	0.003	0.97	(0.94, 0.99)	0.02	0.95	(0.89, 1.01)	0.1
Race/Ethnicity												
Non-Hispanic White (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Non-Hispanic Black	0.96	(0.89, 1.04)	0.34	0.9	(0.84, 0.97)	0.004	0.95	(0.91, 1.00)	0.04	1.08	(0.98, 1.20)	0.13
Hispanic	0.91	(0.76, 1.08)	0.29	0.95	(0.85, 1.06)	0.37	1.18	(1.12, 1.26)	< 0.0001	1.29	(1.14, 1.47)	0.0001
Non-Hispanic Other	1.12	(1.04, 1.20)	0.003	1.06	(0.98, 1.15)	0.17	1.19	(1.13, 1.26)	< 0.0001	1.01	(0.86, 1.19)	0.91
Employment												
Not Employed (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Employed	0.99	(0.92, 1.06)	0.71	1.07	(1.03, 1.11)	0.001	0.98	(0.95, 1.02)	0.27	1.01	(0.93, 1.09)	0.82
Education												
Less than HS (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
HS Grad	1.06	(0.95, 1.18)	0.31	1.11	(1.03, 1.19)	0.01	1	(0.94, 1.07)	0.92	1.09	(0.96, 1.24)	0.21
Some college	1.03	(0.92, 1.16)	0.61	1.05	(0.97, 1.13)	0.27	0.96	(0.90, 1.02)	0.16	1.06	(0.92, 1.21)	0.42
College Grad	1.2	(1.07, 1.35)	0.003	1.18	(1.09, 1.28)	< 0.0001	1.14	(1.07, 1.22)	< 0.0001	1.21	(1.06, 1.38)	0.005
Marital Status												
Not Married (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Married	1.15	(1.07, 1.23)	< 0.0001	1.16	(1.11, 1.20)	< 0.0001	1.17	(1.13, 1.21)	< 0.0001	1.17	(1.10, 1.25)	< 0.0001
Household Total Income												
< \$25,000 (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
\$25,000 - \$49,999	1.03	(0.95, 1.12)	0.48	1.08	(1.03, 1.13)	0.002	0.99	(0.95, 1.03)	0.7	1.03	(0.94, 1.14)	0.51
\$50,000 - \$74,999	1.09	(0.99, 1.21)	0.09	1.09	(1.03, 1.15)	0.005	1.02	(0.97, 1.07)	0.54	1.01	(0.91, 1.12)	0.82
\$75,000+	1.1	(0.99, 1.21)	0.08	1.11	(1.04, 1.18)	0.001	1.08	(1.03, 1.14)	0.001	1.09	(0.97, 1.22)	0.17
Insurance Status												
No - Not insured (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Yes - insured	1.2	(1.06, 1.35)	0.004	1.14	(1.07, 1.22)	< 0.0001	1.07	(1.01, 1.14)	0.03	0.88	(0.76, 1.03)	0.11

Table 4 Prevalence ratio (PR) by ACE grouping 4+ vs. <4

	2009–2010			2011–2012			2019–2020			2021–2022		
	PR	95% CI	p-value	PR	95% CI	p-value	PR	95% CI	p-value	PR	95% CI	p-value
Age												
18–34 (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
35–49	0.98	(0.86, 1.11)	0.74	1.1	(1.02, 1.19)	0.02	0.97	(0.93, 1.02)	0.23	0.9	(0.84, 0.97)	0.01
50–64	0.68	(0.60, 0.78)	<0.001	0.8	(0.74, 0.86)	<0.001	0.7	(0.67, 0.74)	<0.001	0.68	(0.63, 0.74)	<0.001
>=65	0.24	(0.20, 0.28)	<0.001	0.25	(0.23, 0.28)	<0.001	0.31	(0.29, 0.33)	<0.001	0.3	(0.27, 0.34)	<0.001
Sex												
Male (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Female	1.35	(1.21, 1.52)	<0.001	1.3	(1.22, 1.38)	<0.001	1.35	(1.30, 1.40)	<0.001	1.4	(1.31, 1.48)	<0.001
Race/Ethnicity												
Non-Hispanic White (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Non-Hispanic Black	0.9	(0.77, 1.04)	0.17	0.93	(0.83, 1.04)	0.19	0.79	(0.74, 0.84)	<0.001	0.73	(0.66, 0.81)	<0.001
Hispanic	1.03	(0.80, 1.31)	0.84	0.69	(0.58, 0.80)	<0.001	0.72	(0.67, 0.78)	<0.001	0.79	(0.71, 0.89)	<0.001
Non-Hispanic Other	0.86	(0.74, 1.01)	0.06	1.15	(1.03, 1.29)	0.02	0.87	(0.81, 0.93)	<0.001	0.99	(0.89, 1.10)	0.79
Employment												
Not Employed (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Employed	0.89	(0.79, 1.00)	0.06	0.84	(0.78, 0.89)	<0.001	0.97	(0.93, 1.01)	0.11	0.99	(0.92, 1.05)	0.67
Education												
Less than HS (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
HS Grad	0.84	(0.71, 1.00)	0.05	0.75	(0.67, 0.83)	<0.001	0.84	(0.78, 0.90)	<0.001	0.92	(0.82, 1.04)	0.19
Some college	0.86	(0.72, 1.03)	0.12	0.81	(0.73, 0.90)	<0.001	0.89	(0.83, 0.95)	0.001	0.95	(0.84, 1.06)	0.35
College Grad	0.55	(0.45, 0.67)	<0.001	0.56	(0.50, 0.63)	<0.001	0.64	(0.60, 0.69)	<0.001	0.66	(0.59, 0.75)	<0.001
Marital Status												
Not Married (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Married	0.92	(0.82, 1.04)	0.21	0.82	(0.77, 0.88)	<0.001	0.85	(0.81, 0.88)	<0.001	0.82	(0.77, 0.87)	<0.001
Household Total Income												
< \$25,000 (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
\$25,000 - \$49,999	0.69	(0.59, 0.80)	<0.001	0.82	(0.75, 0.88)	<0.001	0.94	(0.90, 0.99)	0.03	-	-	-
\$50,000 - \$74,999	0.63	(0.52, 0.75)	<0.001	0.73	(0.66, 0.80)	<0.001	0.87	(0.81, 0.92)	<0.001	-	-	-
\$75,000+	0.64	(0.54, 0.76)	<0.001	0.65	(0.58, 0.72)	<0.001	0.73	(0.68, 0.77)	<0.001	-	-	-
Insurance Status*												
No - Not insured (Reference)	-	-	-	-	-	-	-	-	-	-	-	-
Yes - insured	-	-	-	-	-	-	0.92	(0.87, 0.98)	0.005	-	-	-

* Imbalance in the outcome variable leading to convergence issues GLM could not apply

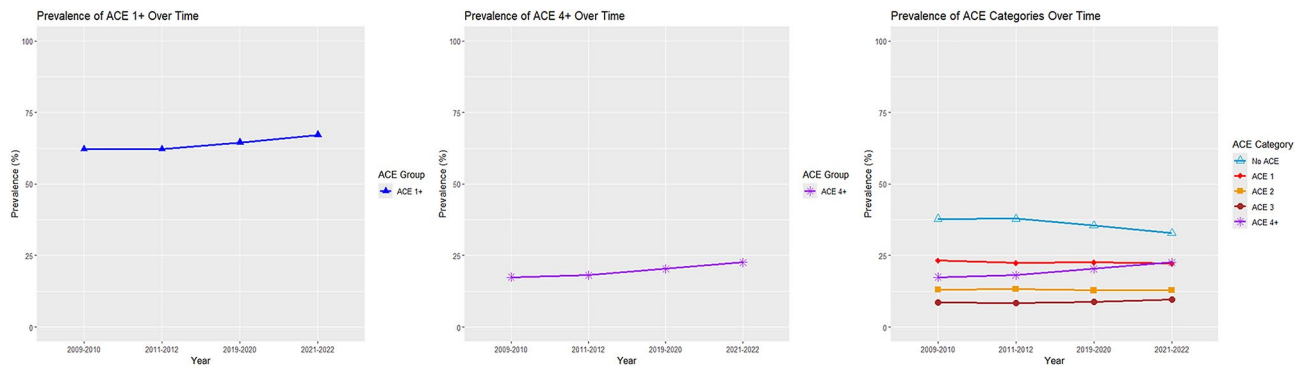


Fig. 1 Prevalence of ACE by ACE groupings over time

as non-Hispanic White (79.4%) and does not adequately represent the racial, ethnic and cultural diversity of these experiences, potentially representing under reported data across the whole population as many communities are not represented here. More importantly, due to the small sample sizes across racial/ethnic groups, racial/ethnic minorities identifying as Asian, Pacific Islander, and Native American were collapsed into Other. Additional research and data collection focusing on the prevalence of ACEs amongst diverse populations should be considered in order to accurately recommend appropriate screening and prevention techniques. BRFSS does not assess timing of ACEs. This may be important information for prevention programs. In addition, BRFSS years 2020–2022 represent COVID-19 years including mandatory shelter in place orders. Some evidence shows that there may have been increased incidence of ACEs during this time. This is an important event that may impact overall prevalence and warrants independent investigation to understand the effect of COVID-19 on ACEs [37]. Finally, the increased public health awareness of ACEs since the original ACEs study may be an important factor in creating space to disclose and self-report experiences. The role of awareness and campaigns in disclosure should be examined as a factor leading to increased reporting that masks as increased prevalence.

Conclusions and implications

The present study provides new information on ACEs over 4 time periods using national data and show that ACEs have significantly increased from 2009 to 2022. To effectively address ACEs from a population health standpoint, incorporating levels of prevention into policy to address the impact on health over time may be an important strategy to adopt at the federal level. Additional work will be needed including more comprehensive surveillance efforts at the state and national level. These include precise estimates at the national level that includes each US state and province. This can be achieved by adopting the expanded ACE module (including individual and

community level ACEs) as a core module in BRFSS. If adopting the ACE module as a part of the BRFSS core is not feasible, funding for a largescale national study or embedding expanded ACE questions into existing national platforms where data is collected such as the Centers for Medicare and Medicaid Services may be warranted. Second, understanding the impact of societal events and trends on reporting and incidence is highly needed. Specifically, little has been done to understand the role of COVID-19 on incidence of ACEs. In addition, since the original ACE study was published in 1998, robust data has become available on the role of ACEs in health over the life course. This has led to public health awareness and educational campaigns [32]. Evaluation of these programs on primary, secondary, and tertiary prevention at the national level are needed. Specifically, understanding if public health campaigns have decreased the occurrence of ACEs (primary), mitigated the detrimental health effects once ACEs have occurred (secondary), and decreased complications after disease and/or mental health conditions have become manifest among those who have experienced ACEs (tertiary) will inform population level approaches to addressing Adverse Childhood Experiences.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-20125-4>.

Supplementary Material 1

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Not Applicable.

Author contributions

LEE and JAC designed the study. LEE and JAC designed the analysis, XW, YX, and SN analyzed the data, LEE interpreted the data. JAC and SK drafted the article. JAC, SK, XW, YX, SN, and LEE critically revised the manuscript for intellectual content. All authors approved the final manuscript.

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Data availability

Data used for this study is available upon request from LEE.

Declarations

Ethics approval and consent to participate

Not Applicable.

Consent for publication

Not Applicable.

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Competing interests

The authors declare no competing interests.

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