Adverse childhood experiences and cognitive disability in the 2019 United States behavioral risk factor surveillance system

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ABSTRACT

A growing number of studies have found associations between adverse childhood experiences (ACEs) and adult well-being, with disparities between subpopulations. Limited research exists about the association between ACEs and cognitive disability, and variations by race and ethnicity. This study reports a cross-sectional analysis of 2019 Behavioral Risk Factor Surveillance System (BRFSS) data (n = 93 692) conducted in 2021. Logistic regression models examined the association between ACEs and cognitive disability (as defined by serious difficulty concentrating, remembering or making decisions because of a physical, mental, or emotional condition) and whether the association varied by race and ethnicity, adjusting for demographics, (age, gender, marital status), socioeconomic factors (income and education), and perceived general health. Exposures to 1, 2, 3, and 4 or more ACEs were associated with elevated odds of cognitive disability; the association varied by race and ethnicity (p for interaction less than 0.05). In stratified analyses, ACEs were positively associated with cognitive disability among the American Indian/Alaskan Native group, though significant only among those reporting 4 ACEs or more (OR: 2.89; 95% CI 1.25, 6.66). A dose response was observed for Black, White and Hispanic groups though the association was larger among Hispanic respondents. The elevated odds of cognitive disability associated with ACEs warrant additional research to understand mechanisms underlying this relationship across racial and ethnic groups. Additionally, interventions to prevent cognitive disability may benefit from considering ACEs across all populations, particularly among those with highest prevalence.

1. Introduction:

Cognitive disability, self-reported difficulty with concentration, memory and/or decision making (Erickson, 2008) is the second most common type of disability in the United States (Stevens et al., 2016) with prevalence ranging from 6 to 11% (Okoro et al., 2018; Benn et al., 2015), depending on the survey year and sample. Previous studies have observed disparities in cognitive disability with greater odds among Black (Nuru-Jeter et al., 2011) and American Indian/Alaskan Native groups (Benn et al., 2015) and lower odds among Hispanic populations (Benn et al., 2015), with in-group variation by age (Benn et al., 2015; Nuru-Jeter et al., 2011), nativity (Benn et al., 2015), and socioeconomic factors (Benn et al., 2015). Adults with cognitive disabilities are less likely to receive preventive health screenings and more likely to have chronic conditions than people without disabilities (Reichard et al.,

2011). Given that preventing cognitive disability is critically important for improving overall population health, there have been multiple calls within public health to further our understanding of this issue across populations(Stevens et al., 2016; Krahn et al., 2015).

A number of factors may influence cognitive disability, including exposure to adverse childhood experiences (ACEs), specific forms of childhood trauma (abuse, neglect and household dysfunction) that were first studied together in 1998 by Felliti et al(Felitti et al., 1998). Different brain structures between those with and without a history of ACEs (Jeong et al., 2021; Walsh et al., 2014; Shonkoff and Garner, 2012) as well as previous studies looking at other measures of childhood trauma and cognitive function (Irigaray et al., 2013; Su et al., 2019), suggest ACEs may influence cognitive disability through multiple pathways including acquired and traumatic brain injuries (Guinn et al., 2019) and prolonged activation of the hypothalamic–pituitaryadrenal

axis (Bhushan et al., 2020) which can damage the hippocampus and affect memory (Lupien et al., 1998). Approximately 60% of the United States (US) population has been exposed to at least one ACE and 16% have been exposed to 4 or more ACEs (Merrick et al., 2018).

A report from the Georgia Department of Public Health using 2016 Behavioral Risk Factor Surveillance System (BRFSS) data found 41% of adults with 4 or more ACEs had difficulty making decisions compared to 21% of adults with no ACEs but it did not control for possible confounders, including race and ethnicity (Davis et al., 2018). ACES tend to be more prevalent among Black, Latino and American Indian/Alaskan Native populations (Merrick et al., 2018; Mersky et al., 2021; Giano et al., 2021; Giano et al., 2020), disparities that may result in differential influences on cognitive disability across racial and ethnic groups. Several factors may give rise to varying ACEs-cognitive disability associations among non-White populations, including greater exposure to structural barriers, often stemming from racial residential segregation, a fundamental cause of racial and ethnic health inequities (Williams and Collins, 2001). In the US, the legacy of slavery, Jim Crow laws, and redlining persist, with current segregated neighborhoods (Banaji et al., 2021). Segregation is associated with limited access to health promoting resources, including fewer educational and employment opportunities; lack of quality housing; less access to healthy food and physical activity outlets; and more crime (Williams and Collins, 2001) which can lead to greater stress (Williams, 2018) and poor health (Kramer and Hogue, 2009). Although previous studies have examined racial and ethnic variations in the association between ACEs and health outcomes (Stinson et al., 2021; Elkins et al., 2019), to our knowledge, no prior research has investigated ACEs associations with cognitive disability according to race and ethnicity.

Understanding the relationships between ACEs, cognitive disability and race and ethnicity is important for the design of future interventions to reduce ACEs and prevent cognitive disability across diverse populations. Using cross-sectional data from the 2019 BRFSS, this study investigated: 1) the association between self-reported ACEs and cognitive disability and 2) variations in this association by race or ethnicity.

2. Methods

2.1. Data and study sample

BRFSS is an annual telephone survey using probability-based sampling of non-institutionalized adults 18 and over in the US(CDC, 2019a). Each state conducts BRFSS with support from the Centers for Disease Control and Prevention and includes questions on a range of health behavior and risk topics. Since 2009, states have been able to add an optional module on ACEs. Secondary research using BRFSS publicly available deidentified data is not considered human subjects research, therefore our study was exempt from Institutional Review Board review.

The BRFSS ACE module includes 11 questions adapted from the ACE study questionnaire developed by Felitti et al, (Felitti et al., 1998) covering 9 different types of childhood exposures: emotional, physical, and sexual abuse; household-member mental illness, alcohol and drug use; witnessing domestic violence; parental separation/divorce; and incarcerated family members (Ford et al., 2014). Each category is represented by 1 question except for sexual abuse which has 3 related questions. Previous research to assess and validate BRFSS's ACE module found an acceptable level of internal consistency when using the set of 11 ACE items (Ford et al., 2014).

Following BRFSS instructions for preparing data files to analyze ACEs data, 4 BRFSS 2019 data files were used for this study (CDC, 2019b). In each of these files, we kept the 21 states that had publicly available survey responses for the ACE module. We then renamed the corresponding weight variable to a new and consistent weight variable in each file (CDC, 2019b) and appended the 4 files to create a dataset with 149 801 observations. After selecting records with complete data for all of the variables of interest, the analytic dataset was comprised of 93 692 observations (Fig. 1).

2.2. Measures

After creating our analytic dataset, we re-coded several of the ACE variables so that we could create an ordinal variable for the number of different ACEs. As previously done (Ford et al., 2014), we created dichotomous variables for ACE items that had more than 2 response options. For example, we created a new dichotomous variable that classified responses into "Never" or "One or more times" based on responses to the question "How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?".

Using the dichotomous ACE variables, we created a summary score to count how many ACEs each participant reported, counting each instance of "One or more times" as 1 ACE exposure. For the main independent variable, an ordinal variable was used with categories 0 ACE, 1 ACE, 2 ACEs, 3 ACEs and 4 or more ACEs. The 4 or more cut off is used to enable comparability of results across studies (Hawkins et al., 2020; Slack et al., 2017; Merrick et al., 2019) and to inform program and policy-making(ACEs Aware, 2021).

Cognitive disability is 1 of 6 disability types tracked by the census (Census, 2017) and several national population-based surveys in the US (HHS, 2011). As done in prior research (Okoro et al., 2018; Benn et al., 2015) respondents were classified as having cognitive disability if they reported "having serious difficulty concentrating, remembering, or making decisions because of a physical, mental or emotional condition" (Erickson, 2008). While this measure of cognitive disability is limited by its self-reported nature, it is important to investigate in national samples. It is also a required question by section 4302 of the Affordable Care Act (HHS, 2011).

We included the following variables that, based on the literature, may alter any observed association between exposure to ACEs and cognitive disability: age (Irigaray et al., 2013; Adams et al., 2020), race and ethnicity (Benn et al., 2015; Irigaray et al., 2013; Adams et al., 2020), income (Irigaray et al., 2013; Adams et al., 2020), perceived general health (Adams et al., 2020), gender (Benn et al., 2015; Adams et al., 2020), education level (Benn et al., 2015; Irigaray et al., 2013; Adams et al., 2020), and marital status (Benn et al., 2015). For age, income, educational level, perceived general health, gender, and race and ethnicity, we used the original categories from the 2019 BRFSS (CDC, 2020) as follows: age as a categorical variable (18–24; 25–34; 35–44; 45–54; 55–64; and 65 or older); annual household income from all sources (less than $15,000; $15,000 to less than $25,000; $25,000 to less than $35,000; $35,000 to less than $50,000; and $50,000 or more); level of education completed (did not graduate from high school (HS); graduated HS; attended college or technical school; and graduated from college or technical school); perceived general health (excellent, very good, good, fair, and poor); gender (as measured by the question "Are you male or female?"); and race and ethnicity (White, Non-Hispanic; Black, Non-Hispanic; Asian, Non-Hispanic; American Indian/Alaskan Native, Non-Hispanic; Hispanic and other race, non-Hispanic; hereafter referred to as "White," "Black," "Asian," "American Indian/Alaskan Native (AI/AN)," "Hispanic," and "other.") Marital status was classified as "married/member of an unmarried couple" and "divorced/widowed/separated/never married." Those respondents whose race and ethnicity was classified as "other" or who had missing data or responded as "don't know," "unsure" or refused answers to any of our selected variables were excluded from the analysis (Fig. 1).

2.3. Statistical Analysis:

We estimated the prevalence of cognitive disability and distributions of other variables according to ACEs, using chi square statistics. To assess the association between ACEs and cognitive disability, we used the overall sample and constructed a logistic regression model with cognitive disability as a dichotomous dependent variable while
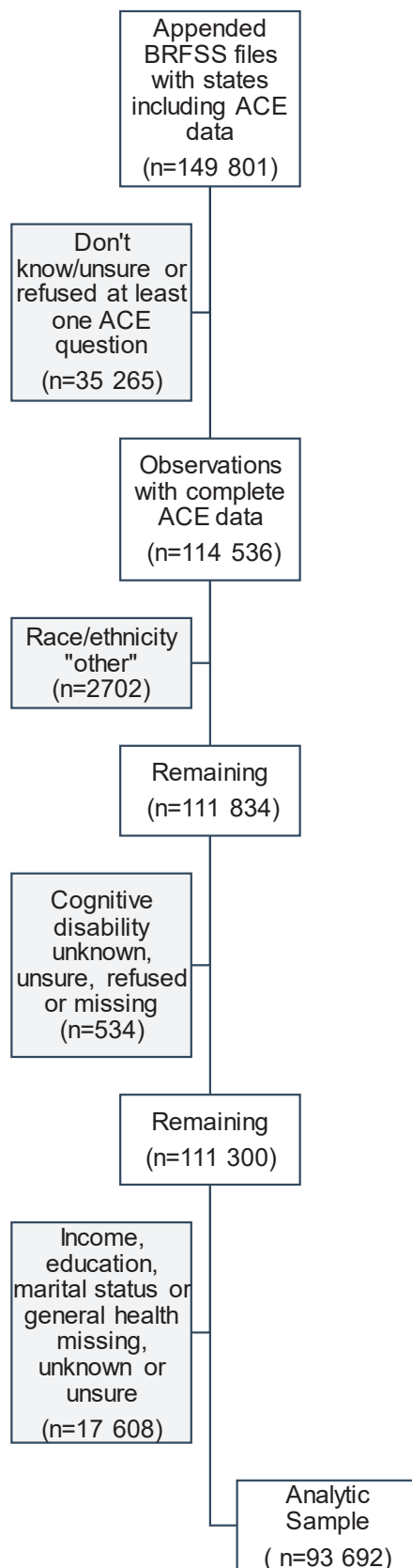
Fig. 1. Selection of analytic dataset from Behavioral Risk Factor Surveillance System: United States, 2019. ACEs, Adverse Childhood Experiences; BRFSS, Behavioral Risk Surveillance System; Responses in shaded boxes were excluded from this study.

adjusting for demographic (sex, race and ethnicity, marital status), socioeconomic factors (income and educational attainment), and perceived general health. To formally assess whether the association between ACEs and cognitive disability varied by race and ethnicity, a cross-product term between the levels of ACEs and race and ethnicity groups was added to the adjusted logistic regression model. Following recommendations for epidemiologic methods where the presence of an interaction is identified (Hennekens et al., 1987), we obtained odds ratios (ORs) and 95% confidence intervals from models stratified by race and ethnicity and adjusted for covariates. The test of interaction and ORs associated with p-values less than 0.05 were considered statistically significant. In sensitivity analyses, we used ACEs as a continuous variable and constructed the same regression models. We also used the margins command to estimate average adjusted predictions of cognitive disability (Williams, 2012). All analyses were conducted using Stata statistical software version 15.1 IC (StataCorp; College Station, TX). The analyses account for the complex design of the survey to ensure the study estimates were representative of the non-institutionalized US population, as recommended in the BRFSS technical documentation (CDC, 2019b). We completed our statistical analyses in 2021.

3. Results:

The total analytic sample was comprised of 93 692 individuals, of which 65% (n = 57 458) experienced at least 1 of 11 ACE items and 20% (n = 16 260) experienced 4 or more ACEs. In the sample as a whole, the average number of reported ACEs was 1.92 (standard error (SE): 0.01). The mean ACEs and SEs for each group by race and ethnicity were 1.06 (SE = 0.10) for Asian; 1.89 (SE = 0.02) for White; 2.07 (SE = 0.07) for Hispanic; 2.12 (SE = 0.05) for Black and 2.87 (SE = 0.14) for AI/AN and groups.

Prevalence of cognitive disability in the overall sample was 11% and this varied by race and ethnicity with the highest prevalence among respondents who identified as AI/AN (21%) and the lowest among respondents who identified as Asian (5%). The prevalence for those who identified as White, Black and Hispanic were 11%, 12% and 13% respectively.

Among 36 234 respondents who reported 0 ACEs, 5% reported a cognitive disability compared to 24% of the 16 260 who reported 4 or more ACEs (Table 1). Average adjusted predictions of cognitive disability were 4.5% among people with 0 ACEs compared to 15.7% among people with 4 or more ACEs. Stratified adjusted prediction results by race and ethnicity are available upon request.

There were statistically significant differences in the characteristics of the sample according to ACEs. Those reporting 4 or more ACEs were more likely to be younger than 65 years, more likely to be female, more likely to be non-White, to be in the lower income and education distributions and more likely to report worse perceived health status (Table 1).

In the overall sample, ACES were positively associated with cognitive disability. Reporting 1 ACE (OR: 1.45, 95% CI: 1.28, 1.64), 2 ACEs (OR: 2.21, 95% CI: 1.93, 2.53), 3 ACEs (OR: 2.97, 95% CI: 2.56, 3.46) and 4 or more ACES (OR: 5.73, 95% CI: 5.14, 6.38) was associated with greater odds of reporting serious difficulty concentrating, remembering or making decisions, compared with those reporting no ACEs (Table 2). After controlling for age, gender, race and ethnicity, household income, education, marital status, and perceived general health, ACEs remained associated with elevated odds of reported cognitive disability. The association appeared to follow a dose–response, with higher number of reported ACEs related to higher odds of cognitive disability, with the greatest magnitude of association observed for those that reported 4 or more ACEs (OR: 4.03, 95% CI:3.57, 4.55). In both unadjusted and adjusted models, the CIs did not cross the null value (Table 2).

We observed evidence of statistically significant variation in the ACEs-cognitive disability association by race and ethnicity (p =.03) (Table 2 and Fig. 2). Although the dose–response relationship persisted

Table 1

Characteristics of the sample from BRFSS 2019[a] in the United States[b] grouped by number of ACEs.

	Total Sample n	0 ACE n = 36 234 (%)	1 ACE n = 21 421 (%)	2 ACEs n = 12 063 (%)	3 ACEs n = 7 714 (%)	4 + ACEs n = 16 260 (%)
Cognitive disability (Yes)*	10 095	5.32	7.53	11.04	14.32	24.34
Age*						
18–24	4355	7.69	9.35	10.77	10.51	14.25
25–34	8847	12.55	16.12	14.71	16.16	23.25
35–44	10 723	14.62	15.32	15.99	17.62	18.84
45–54	13 940	15.06	15.99	17.15	18.92	18.03
55–64	20 514	19.29	18.49	19.96	19.76	15.65
65+	35 313	30.79	24.74	21.41	17.03	9.98
Sex (Female)*	42 847	49.79	47.46	48.73	50.82	57.97
Race and ethnicity*						
White	78 199	76.96	73.71	75.04	73.97	72.92
Black	8410	9.42	12.88	13.02	13.52	13.13
Asian	843	4.07	2.48	1.88	2.29	1.02
AI/AN	1278	0.96	0.96	1.04	1.24	2.27
Hispanic	4962	8.60	9.96	9.02	8.97	10.66
Household Income*						
<$15 K	8175	7.21	7.87	7.77	7.97	11.24
15–24.9 K	15 035	14.30	14.69	14.79	15.22	18.63
25–34.9 K	9 970	9.58	10.52	10.30	9.50	11.55
35–49.9 K	13 530	12.98	14.23	12.95	12.54	14.29
>%50 K	46 982	55.92	52.69	54.18	54.78	44.28
Education*						
Less than High School	5821	9.17	9.56	8.38	12.82	9.96
High School	25 639	28.35	29.20	27.73	30.41	28.85
Some College	26 450	27.73	30.41	35.28	35.64	31.11
College	35 782	34.75	30.83	28.61	21.14	30.09
Neither married nor member of a couple*	41 392	36.56	42.39	44.35	42.92	49.79
Perceived General Health*						
Excellent	13 670	19.90	17.22	15.31	13.82	11.91
Very Good	31 571	35.48	34.64	34.71	33.94	29.13
Good	30 014	30.62	32.38	32.47	33.37	33.39
Fair	13 399	10.70	11.75	13.17	13.57	18.70
Poor	5038	3.31	4.02	4.33	5.30	6.88

[a] Weighted percentages to account for complex survey design.

[ab] Data come from the 21 states that had the ACE module: Alabama, Delaware, Florida, Indiana, Iowa, Michigan, Mississippi, Missouri, New Mexico, North Dakota, Pennsylvania Rhode Island, South Carolina, Tennessee, Virginia, West Virginia, Wisconsin, Ohio, Kansas, Oklahoma, and New York.

* Indicates statistical significance (p <.001) based on Chi square test.

Abbreviations: ACE, Adverse Childhood Experience; BRFSS, Behavioral Risk Factor Surveillance System; AI/AN, American Indian/Alaskan Native.

among the White, Black, and Hispanic race and ethnicity groups, the strength and statistical significance of the associations differed. For example, the association between 1 ACE and cognitive disability was null (adjusted OR: 1.04, 95% CI: 0.71, 1.54) among the Black group in the unadjusted and adjusted models. Among the AI/AN group, the association was only statistically significant among those reporting 4 or more ACEs (adjusted OR 2.89, 95% CI: 1.25, 6.66). However, for respondents who identified as Hispanic, the association between ACEs and cognitive disability was statistically significant for every ACE level in both the crude and adjusted models and became larger after adjustment for covariates. Given frequencies less than 20 for cross-tabulations between ACEs and cognitive disability within the Asian subpopulation, we are unable to report estimates for this group (CDC, 2015).

Results from sensitivity analyses using ACEs as a continuous variable did not change the patterns or direction of association, with each additional reported ACE associated with greater odds of reporting cognitive disability (OR: 1.23, 95% CI: 1.21, 1.26, p <.001). The overall interaction between race and ethnicity and ACEs as a continuous variable was not significant (p =.10). This finding coupled with the significant interaction when using ACEs as a categorical variable suggest that ACEs may be sensitive to cut points when assessing differential associations by race and ethnicity.

4. Discussion

This study adds to the body of literature on childhood trauma and cognitive functioning by examining the association between ACEs and cognitive disability in a diverse sample of adults using population-based data from 21 US states. The elevated odds of cognitive disability associated with higher levels of reported ACEs were non-trivial and remained statistically significant after adjustment for demographic and socioeconomic factors as well as perceived health status. These results were consistent with a previous BRFSS study assessing the association between ACEs and overall disability that controlled for additional physical and mental health variables (Schüssler-Fiorenza Rose et al., 2014).

Prior theoretical work has postulated ACEs may disrupt early brain development by chronically activating the body's stress responses and brain glucocorticoid receptors (Shonkoff and Garner, 2012). Further, cross-sectional studies have observed differing brain structures between those with and without a history of ACES (Jeong et al., 2021; Walsh et al., 2014). This implies ACEs may influence cognition related processes including disability through complex factors associated with stress and stressors, possibly driven by socioeconomic (Walsh et al., 2014) and other structural factors such as racial residential segregation, a fundamental cause of racial and ethnic health inequities that is associated with fewer employment opportunities, greater violence, and limited access to healthy food (Williams and Collins, 2001).

This study found evidence of variability in the magnitude and statistical significance of the association between ACEs and cognitive disability across race and ethnicity. Although the association was positive for all racial and ethnic groups, ACEs were more strongly associated with elevated odds of cognitive disability for Hispanic adults in this study. While a prior study found an apparent Hispanic paradox and reported lower odds of cognitive disability among Hispanic compared to non-Hispanic White adults, (Benn et al., 2015) others have highlighted different ACE exposures for Latinx youth across first, second or third immigrant generation (Grest et al., 2021). Thus, the previously reported lower odds of cognitive disability may erode as Hispanic populations become integrated in the US. Structural barriers and socioeconomic deprivation for Hispanic populations in the US, such as fewer employment (Wilson et al., 2021) and educational opportunities (de Brey et al., 2018) may give rise to ACEs; this in turn may shape patterns of cognitive disability in these populations by exacerbating stress and reducing access to health promoting resources as well as those that may promote resilience (National Scientific Council, 2014).

The differing associations by race and ethnicity in the current study may be due to study design features, including how ACEs were examined. While the ordinal variable combining exposures from multiple ACE types make results comparable across studies using 4 or more ACEs as an indicator for high ACE exposure, racial and ethnic groups may experience certain ACEs more than others and at different periods of the life course, as well as experience differential effects from specific ACEs. Previous research has found people identifying as Hispanic and Black were more likely than those identifying as White to report divorce/separation and family death, (Mersky et al., 2021) experiences that may lead to differential cognitive outcomes for these groups (Gold et al., 2021). The psychometric properties of cognitive disability may also vary among different race and ethnicity groups (Chan et al., 2021). In the BRFSS survey, the Hispanic racial category includes a diverse group of people identifying as Mexican, Mexican American, Chicano/a, Puerto Rican, Cuban, and other Hispanic, Latina/x/os (María Del Río-González,

Table 2

Odds Ratios and 95% Confidence Intervals comparing the odds of cognitive disability among those reporting 1, 2, 3 and 4 + ACEs relative to 0, for the sample overall and stratified by race and ethnicity.

Crude	Total analytic sample (n = 93 692)		White (n = 78 199)		Black (n = 8410)		Asian (n = 843)		AI/AN (n = 1278)		Hispanic (n = 4962)	
	OR	95% CI	OR	95%CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
0 ACEs (Ref)	1.00	–	1.00	–	1.00	–	–	–	1.00	–	1.00	–
1 ACE	1.45	1.28, 1.64	1.44	1.27, 1.63	1.20	0.84, 1.73	–	–	1.97	0.76, 5.11	2.06	1.21, 3.51
2 ACEs	2.21	1.93, 2.53	2.18	1.90, 2.51	1.81	1.18,2.75	–	–	2.16	0.89, 5.23	3.26	1.82, 5.83
3 ACEs	2.97	2.56, 3.46	3.15	2.66, 3.73	2.04	1.33, 3.13	–	–	1.55	0.56, 4.28	3.98	2.36, 6.71
$\geq$ 4 ACES	5.73	5.14, 6.38	5.88	5.27, 6.56	3.88	2.75, 5.48	–	–	3.90	1.81, 8.39	7.74	5.06, 11.84
Adjusted	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
0 ACEs (Ref)	1.00	–	1.00	–	1.00	–	–	–	1.00	–	1.00	–
1 ACE	1.34	1.17, 1.53	1.31	1.15, 1.50	1.04	0.71, 1.54	–	–	1.60	0.63, 4.11	2.27	1.31, 3.93
2 ACEs	1.98	1.71, 2.29	1.88	1.62, 2.19	1.57	1.02, 2.43	–	–	1.38	0.53, 3.58	3.83	2.12, 6.94
3 ACEs	2.62	2.23, 3.08	2.53	2.11, 3.03	1.94	1.23, 3.06	–	–	1.18	0.41, 3.40	5.26	2.96, 9.32
$\geq$ 4 ACEs	4.03	3.57, 4.55	3.68	3.25, 4.16	3.47	2.38, 5.06	–	–	2.89	1.25, 6.66	8.79	5.46, 14.15

Overall sample analyses were adjusted for age, sex, race, household income, education, marital status, and general health. Stratified analyses were adjusted for age, sex, income, education, marital status and general health. Inadequate sample size for reporting ORs and CIs for Asian subpopulation (less than 10 observations for cognitive disability for 1, 2, and 3 ACEs) (CDC, 2015). Models are weighted to account for complex sample design of BRFSS. **Abbreviations:** ACE, Adverse Childhood Experience; AI/AN, American Indian/Alaskan; Ref, Referent group; OR, Odds Ratio; CI, Confidence Interval.
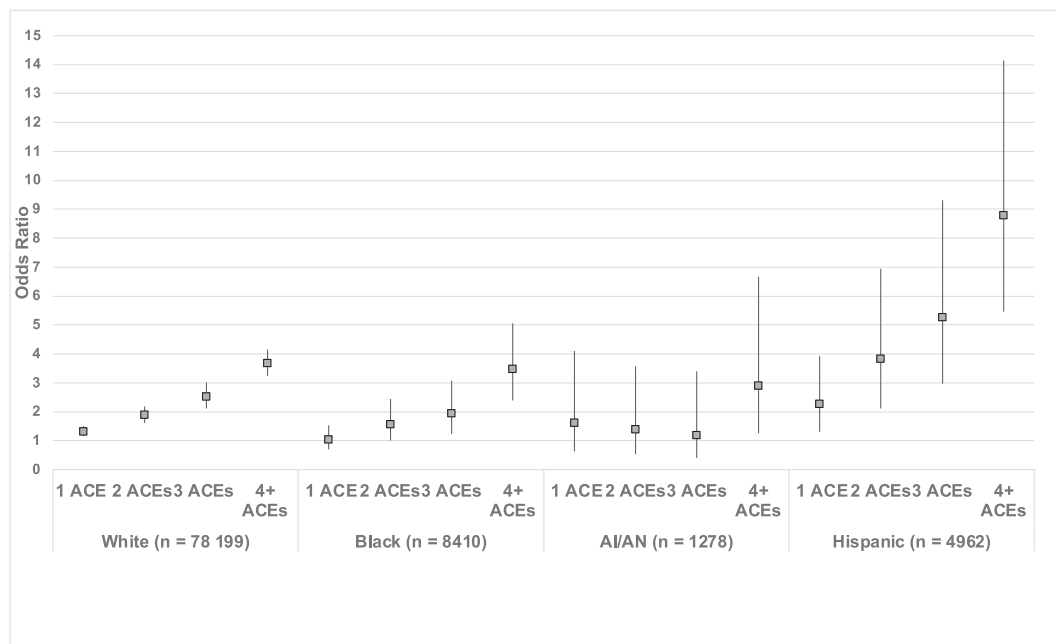

Fig. 2. Adjusted odds of cognitive disability for ACEs by race and ethnicity. BRFSS 2019, United States. Odds ratios with 95% confidence intervals were derived from logistic regression models, stratified by race and ethnicity and controlling for age, sex, income, education, marital status and general health. Insufficient sample size for Asian subpopulation (less than 10 observations for cognitive disability and 1, 2, and 3 ACEs). **Abbreviations:** ACEs, Adverse Childhood Experiences; AI/AN American Indian/Alaskan Native; BRFSS, Behavioral Risk Surveillance System; NH, Non-Hispanic.

2021) or Spanish origin (CDC, 2019c). Therefore, there may be different experiences with ACEs and cognitive disability within Hispanic population subgroups given previously documented differences in socioeconomic factors, cultural experiences, primary language and other characteristics across Hispanic groups (Benn et al., 2015; Pearson et al., 2010; Viruell-Fuentes et al., 2011) including factors related to immigration (Grest et al., 2021). Lastly, BRFSS data may be impacted by the language of the survey interview. To our knowledge, the ACEs module used to construct the exposure in this study has been validated only in English, thus, responses may differ according to the language of the interview for some ethnic groups (DuBard and Gizlice, 2008). The racial and ethnic variations in the ACEs-cognitive disability association we observed highlight the importance of conducting analyses stratified by race and ethnicity to more clearly reveal populations subgroups that may deserve particular attention in the design of future programs and policies to prevent cognitive disability.

While our study design was cross-sectional, precluding the ability to make causal inferences, the study's findings have implications for public health practice and prevention efforts as well as future research. Addressing the social determinants of health, including the reduction of poverty, is important for primary prevention of cognitive disability (Bhushan et al., 2020). This study also highlights a need for tertiary prevention to address exposure to multiple ACEs and cognitive disability. Some research suggests that programs promoting mindfulness (Whitaker et al., 2014) and emotional regulation (Kalia and Knauft, 2020) may help reduce the negative sequelae from ACEs. Nevertheless, tertiary prevention programs may be more effective if they are tailored to the circumstances, challenges and assets of race and ethnicity population subgroups. Understanding the mechanisms by which ACEs influence health outcomes, including brain health across subgroups, remains an important future area of research, policy and practice.

4.1. Limitations

There are several limitations to our study, including the constraints of our ACE variable described above. Additionally, our measure of cognitive disability is derived from a single question and is based on self-reported data, thus it does not reflect a medical diagnosis. Using the same measure on the Current Population Survey from 2008 to 2015, from a sample restricted to those who completed the disability questions on 2 occasions, a previous study found that only 28% of 721 178 respondents consistently reported cognitive disability, observing that disability status includes permanently and sporadically or temporarily disabled (Ward et al., 2017).

Additional limitations in the BRFSS data include missing responses for ACE questions which could cause underestimates of ACEs especially among those with lower income, females, less educated, divorced and people of color. While missing responses were more likely among the younger adults in our sample, ACEs could also be under-reported in older adults due to differential survival with greater premature mortality among those with ACEs (Brown et al., 2009). Older adults may also be less likely to respond to a survey as cognitive impairment progresses (Adams et al., 2020). As well, recall may influence participant responses, given that the data are from self-reports. Compared to those reporting no cognitive disability, those with cognitive disability may recall ACEs differently. Additionally, if participants are unwilling to report exposure to ACEs and or cognitive disability, and if these reports further vary by race and ethnicity, then it is difficult to predict how differential reporting may have also affected our results. Finally, while this study adjusted the analyses for household income and educational attainment, these variables measure part but not all of the socioeconomic factors among the adult respondents at the time of the survey and do not necessarily represent experiences of socioeconomic deprivation or structural racism at the time of ACE exposure(s).

4.2. Future research suggestions

This study did not include clinical and health behavior variables that may mediate or modify the association between ACEs and cognitive disability, such as depression, alcohol and substance use. Future investigations are needed to validate measures of ACEs and cognitive disability across race and ethnic groups and account for differences in language of interviews. Studies are also needed to include larger samples of Asian and AI/AN groups which may allow for examination of individual ACEs and cognitive disability by race and ethnicity. Additional subgroups that need to be included in future studies on this topic include sexual minorities, who are more likely to experience ACEs (Giano et al., 2020). Lastly, we recommend prospective studies with different population subgroups to collect data on the timing of ACEs and cognitive disability as children with cognitive difficulties may have higher odds of experiencing abuse (Afiaz et al., 2021).

5. Conclusion

This study found ACEs were associated with elevated odds of self-reported cognitive disability after controlling for demographics, socioeconomic factors, and perceived general health. The differential patterns by race and ethnicity highlight a need to further understand potential mechanisms underlying the relationship between ACEs and cognitive disability especially among those groups who may be more likely to experience structural racism. Programs and interventions addressing cognitive disability may benefit from considering ACEs across all populations, particularly among those with highest prevalence.

CRediT authorship contribution statement

Krista Ward: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Project administration. **Suzanne Ryan-Ibarra:** Conceptualization, Methodology, Writing – review & editing. **Monica Smith:** Conceptualization, Writing – review & editing, Supervision. **Emma V. Sanchez-Vaznaugh:** Conceptualization, Methodology, Writing – review & editing.

Declaration of Competing Interest

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