

Research Article

Assessing the Potential Impact of Adverse Childhood Experiences on Subjective Cognitive Decline

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Abstract

Objective: Adverse Childhood Experiences (ACEs) are childhood stressors that may have long-lasting effects and potentially increase risk of cognitive decline among adults. The purpose of this study was to assess the potential relationship between ACEs and adult cognitive decline.

Design: Cross-sectional

Setting: This study utilized data from the 2019 and 2020 Behavioral Risk Factor Surveillance System (BRFSS).

Participants: Subjects were respondents who answered questions on ACEs and Cognitive Decline.

Measures: Logistic regression models were used to assess the potential relationship between ACEs (individually, by category, and by total score) and self-reported cognitive decline, with adjustment for confounders.

Results: Most individual ACEs were significantly associated with increased odds of subjective cognitive decline, with strongest findings for individuals having lived with someone who was depressed, mentally ill, or suicidal (OR=1.98, 95%CI: 1.80, 2.18). Those reporting one category of ACEs had 88% greater odds of cognitive decline (OR=1.88, 95%: 1.72, 2.07), while those who experienced both categories had 299% increased odds of cognitive decline (OR=3.99, 95% CI: 3.34, 4.78). Finally, a total ACE score of 4+ was associated with a 4.03 odds of cognitive decline (95% CI: 3.60, 4.51).

Conclusions: ACEs were significantly and positively associated with subjective cognitive decline, with increasing number of ACEs linearly related to odds. There is a potential synergistic effect between household challenges and childhood abuse categories. ACEs have varying levels of impact and further research should explore these differences for trauma-informed care.

BACKGROUND

Cognitive decline is a growing public health concern as the number of older adults living in the United States continues to rise [1]. The current growth of the older population is at a rate unprecedented in the history of the U.S. and the prevalence of those 65 years or older is expected to double by 2050 [2]. Likely growing in tandem with the prevalence of the aging population is the associated risk of cognitive decline. Data from 2015 through 2017 showed an estimated 1 in 9 U.S. adults were living with some form of cognitive decline [1]. Unfortunately, the COVID-19 pandemic has likely heightened this increased risk among the elderly [3]. Furthermore, the number of individuals impacted may be much greater than currently measured, as cognitive decline may not be readily apparent to the individual or their family and friends.

Researchers have previously identified multiple risk factors linked with cognitive decline, including diabetes [4,5], smoking [5,6], and depression [6,7]. Another potential and highly prevalent risk factor for cognitive decline is chronic stress [8]. Indeed,

chronic stress is linked with a decline in episodic memory and visuospatial ability, two key aspects of cognitive decline [9,10]. This is likely due to physical changes to the prefrontal cortex that are caused by repeated stress [10].

One type of chronic stressor is adverse childhood experiences (ACEs). ACEs are stressors that occur during childhood, such as witnessing or experiencing physical abuse, parental divorce, or living in a household with substance abuse [11]. Studies show that such events have long-lasting adverse impacts on both mental and physical health [12,13]. With regards to mental health, having experienced any ACEs has been found to be associated with reduced cognitive performance in later life [14].

Though often studied collectively, specific ACEs may lead to different behavioral and physical health outcomes and associated with differing risks. A systematic review has found a wide range of health outcomes and differing associated risk [15]. A single instance of forced sexual intercourse, for example, has been found to be associated with a significant likelihood of depression in later life [16]. Researchers also recently found death of a parent during

childhood to be associated with worse adult cognition, despite a null association between total ACE score and cognition [17].

Despite this, most studies have analyzed ACEs as a total score. There is limited research assessing the impact of individual ACEs and ACE categories on health outcomes. A recent study suggested a potential association between ACEs and dementia in older adults, but researchers assessed ACEs only as a total score [18]. Another study examined ACEs both individually and as a total score and found some association with lower cognition in later life, but such findings were mixed [19].

As ACEs become more known and studied, there is a notable lack of in-depth research examining the association between ACEs and cognitive decline. With almost 1 out of every 6 adults having experienced four or more ACEs, it is critical to better understand the potential impact of ACEs on cognition [20]. By filling this knowledge gap, we can address a source of chronic stress that affects a large number of Americans. Thus, the purpose of this study was to assess the potential relationship between ACEs—especially the types and categories of ACEs—and cognitive decline in the older population.

METHODS

Study Design

This study included data from the 2019 and 2020 Behavioral Risk Factors Surveillance System (BRFSS) database. The BRFSS database has previously been described extensively, but briefly, the BRFSS dataset is a nationally collected, random digit dialing phone survey reaching across the US, conducted by the CDC and other federal agencies to assess health and behavioral factors among the general public [21]. In addition to socio-demographics, the BRFSS database includes information on health and wellness. For this study, subjects included those who were at least 18 years of age and had completed the modules for ACEs (Module 22) and Cognitive Decline (Module 20). A total of 68,921 subjects were included in this study.

Outcome Variables. The primary outcome variable of interest is subjective cognitive decline (SCD). Subjective cognitive decline within this study is defined as the subject's self-reported cognitive decline over the past year. For this variable, we looked at Question 1 of the BRFSS Module 20, which asks, "During the past 12 months, have you experienced confusion or memory loss that is happening more often or is getting worse?" Possible answers are "Yes", "No", or "Don't know/Not sure".

Because SCD is a self-reported measure, a second variable (Discussed variable) was incorporated for SCD. Question 6 of Module 20 from the BRFSS dataset asks, "Have you or anyone else discussed your confusion or memory loss with a health care professional?" Possible answers are "Yes", "No", or "Don't know/Not sure". Out of the 7,087 who reported SCD, 99.5% (N=7,054) also responded to this question and were included for analysis.

Exposure Variables. ACEs were assessed within this study as the independent variable. The BRFSS database contains 11 questions on.

ACEs in Module 22. Each question in this module asks if the respondent has experienced a particular adverse childhood experience [Table 1]. ACEs were assessed individually, by category, and overall as a total ACE score.

ACEs Individually

ACEs were assessed by individual type which included household mental illness, household substance abuse, household time served, parental divorce or separation, parental violence, physical abuse, mental abuse, and sexual abuse and were assigned (0 vs 1) depending on if the person had experienced that individual exposure [Table 1].

ACEs Categorically

Additionally, we differentiated ACEs by category, as shown in Table 1. The CDC-Kaiser ACE Study groups divided ACEs into three general categories: abuse, household challenges, and neglect [22]. Here, abuse includes emotional, physical, and sexual abuse. Household challenges range from a mother being treated violently to substance abuse in the household. Neglect, which was included only during the second wave of the study, includes emotional and physical neglect. Because the 2019 and 2020 BRFSS included no questions on past childhood neglect, the ACEs to be included in this study will be grouped into two overarching categories: household challenges and childhood abuse. Household challenges pertain to household events that someone may have been exposed to or saw as a child. Childhood abuse refers to abuse that occurred directly to the child.

ACE Score

A score was assigned (0, 1, 2, 3, or 4+) to each subject equal to the sum of experienced individual ACEs. For each question asked in Module 11, if the respondent answered "Yes" or at least "Once", this would add a single point to the ACE score.

Potential Confounders. Covariates identified through literature searches that have been shown to be associated with cognitive decline were included in the analysis. This included education level, race, ethnicity, sex, income, and age. Other risk factors for cognitive decline that may have a significant impact on the outcome variable are smoking and alcohol [23,24]. Additionally, the state location of the respondent was included. This was to control for contextual, state-specific confounding, and to address any potential trends we may see by state.

Statistical Analysis

Descriptive demographic analysis was conducted to assess trends and distributions of the study population. Logistic regression analyses were conducted to assess the potential relationship between the ACEs data and the SCD outcomes (SCD and Discussed variables). Both SCD outcome variables were coded as dichotomous variables. To assess the effect of individual ACEs, dummy variables were created for each of the 8 identified individual ACEs, such that each individual ACE could be coded as a dependent dichotomous variable. To assess ACEs by category, a categorical ACE variable was created with 4

Table 1: BRFSS Module 22 Questions by Individual ACE Type and ACE Category

Question	Answer(s)	Individual ACE Type	ACE Category
1. Did you live with anyone who was depressed, mentally ill, or suicidal?	<ul style="list-style-type: none"> • Yes • No 	Mental illness	Household challenge
2. Did you live with anyone who was a problem drinker or alcoholic?	<ul style="list-style-type: none"> • Yes • No 	Substance abuse	Household challenge
3. Did you live with anyone who used illegal street drugs or who abused prescription medications?	<ul style="list-style-type: none"> • Yes • No 	Substance abuse	Household challenge
4. Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	<ul style="list-style-type: none"> • Yes • No 	Served time	Household challenge
5. Were your parents separated or divorced?	<ul style="list-style-type: none"> • Yes • No 	Parental divorce	Household challenge
6. How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Parental violence	Household challenge
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?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Physical abuse	Childhood abuse
8. How often did a parent or adult in your home ever swear at you, insult you, or put you down?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Mental abuse	Childhood abuse
9. How often did anyone at least 5 years older than you or an adult ever touch you sexually?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Sexual abuse	Childhood abuse
10. How often did anyone at least 5 years older than you or an adult try to make you touch them sexually?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Sexual abuse	Childhood abuse
11. How often did anyone at least 5 years older than you or an adult force you to have sex?	<ul style="list-style-type: none"> • Never • Once • More than once • Don't know 	Sexual abuse	Childhood abuse

categories: no ACEs, only household challenges, only childhood abuse, and household challenges + childhood abuse. Both crude and adjusted models were analysed, with the adjusted model including all aforementioned covariates.

ACE score was assessed as an independent categorical variable. Possible categories were 0, 1, 2, 3, and 4+, based on existing literature. Similarly to the previous ACE models of this study, both crude and adjusted models were assessed. All analyses were conducted utilizing SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

Analysis of the demographic data [Table 2] found that there were slightly more female than male respondents. Female respondents were also more likely to have discussed SCD with a health care professional. Most respondents were at least 65 years of age. Additionally, about half of total respondents had a household income of at least \$50,000. Among those with SCD, however, only 30.6% reported an income of at least \$50,000, and 25.2% reported an income of \$15,000 to less than \$25,000. A similar trend is seen with education level. About 40% of respondents overall and respondents without SCD were college or technical school graduates and only 5.6% did not graduate from high-school. However, among respondents with SCD, we see that 11.3% did not graduate from high school while the rest are

equally distributed among the three remaining categories. Also notable is the difference in proportion of BMI category, with a larger proportion of obese respondents among those with SCD compared to those without. A greater proportion of respondents with SCD were also current smokers and a smaller proportion reported never smoking compared to those without SCD. On the contrary, only 39.9% of respondents with SCD drank alcohol in the past 90 days compared to 48.3% of those without SCD.

We found that a larger proportion of respondents with SCD experienced ACEs compared to those respondents without SCD [Table 3]. Additionally, a greater proportion of those who had discussed SCD with a provider had experienced individual ACEs than those who had not discussed their SCD with a provider [Table 3]. Following this, a greater proportion of respondents with SCD experienced household challenges and childhood abuse ACE categories, with 5.4% of those with SCD having experienced both. This is more than three times the 1.5% of those without SCD who had experienced both ACE categories. There is a similar trend when looking at those who also discussed their SCD with a provider. This is comparable to our findings when examining the distribution of total ACE score, wherein a larger proportion of respondents with SCD had an ACE score of 2, 3, or 4+. The same holds true for the Discuss outcome measure.

A logistic regression of SCD by individual ACEs [Table 4] shows

Table 2: Distribution of characteristics of 2019 & 2020 Behavioral Risk Factor survey respondents by Subjective Cognitive Decline (SCD) and whether they have discussed SCD with a health care professional

		N=66,719 (100.0)			N=6,951 (100.0)	
	n (%)	SCD ^a [6985 (10.5)]	No SCD [59734 (89.5)]	n (%)	Discussed ^b [3243 (46.7)]	Not Discussed [3708 (53.3)]
Sex ^{***,###}						
Male	30796 (46.2)	3272 (46.8)	27524 (46.1)	1341 (41.4)	1914 (51.6)	30796 (46.2)
Female	35923 (53.8)	3713 (53.2)	32210 (53.9)	1902 (58.6)	1794 (48.4)	35923 (53.8)
Age (years) ^{***,###}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
45 - 49	6036 (9.1)	487 (7.0)	5549 (9.3)	277 (8.5)	207 (5.6)	45 - 49
50 - 54	7286 (10.9)	727 (10.4)	6559 (11.0)	382 (11.8)	342 (9.2)	50 - 54
55 - 59	9060 (13.6)	949 (13.6)	8111 (13.6)	502 (15.5)	445 (12.0)	55 - 59
60 - 64	10432 (15.6)	996 (14.3)	9436 (15.8)	472 (14.6)	521 (14.1)	60 - 64
65 - 69	10554 (15.8)	1017 (14.6)	9537 (16.0)	471 (14.5)	543 (14.6)	65 - 69
70 - 74	9649 (14.5)	952 (13.6)	8697 (14.6)	437 (13.5)	510 (13.8)	70 - 74
75 - 79	6495 (9.7)	779 (11.2)	5716 (9.6)	324 (10.0)	452 (12.2)	75 - 79
80+	7207 (10.8)	1078 (15.4)	6129 (10.3)	378 (11.7)	688 (18.6)	80+
Income ^{***,###}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
< \$15,000	5946 (8.9)	1231 (17.6)	4715 (7.9)	656 (20.2)	566 (15.3)	5946 (8.9)
\$15,000 to <\$25,000	10831 (16.2)	1762 (25.2)	9069 (15.2)	813 (25.1)	943 (25.4)	10831 (16.2)
\$25,000 to <\$35,000	7076 (10.6)	883 (12.6)	6193 (10.4)	388 (12.0)	490 (13.2)	7076 (10.6)
\$35,000 to <\$50,000	9624 (14.4)	964 (13.8)	8660 (14.5)	426 (13.1)	534 (14.4)	9624 (14.4)
\$50,000+	33242 (49.8)	2145 (30.7)	31097 (52.1)	960 (29.6)	1175 (31.7)	33242 (49.8)
Education Level ^{###}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
Did not graduate High School	4140 (6.2)	785 (11.2)	3355 (5.6)	325 (10.0)	457 (12.3)	4140 (6.2)
Graduated High School	17876 (26.8)	2135 (30.6)	15741 (26.4)	887 (27.3)	1233 (33.3)	17876 (26.8)
Attended College or Technical School	18826 (28.2)	2059 (29.5)	16767 (28.1)	1049 (32.4)	1001 (27.0)	18826 (28.2)
Graduated from College or Technical School	25877 (38.8)	2006 (28.7)	23871 (40.0)	982 (30.3)	1017 (27.4)	25877 (38.8)
Race ^{**}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
White	55985 (83.9)	5864 (84.0)	50121 (83.9)	2742 (84.6)	3099 (83.6)	55985 (83.9)
Black or African American	5399 (8.1)	595 (8.5)	4804 (8.0)	274 (8.5)	316 (8.5)	5399 (8.1)
Other	5335 (8.0)	526 (7.5)	4809 (8.1)	227 (7.0)	293 (7.9)	5335 (8.0)
Ethnicity	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
Hispanic, Latino/a, or Spanish origin	2596 (3.9)	303 (4.3)	2293 (3.8)	129 (4.0)	170 (4.6)	2596 (3.9)
Not of Hispanic, Latino/a, or Spanish origin	64123 (96.1)	6682 (95.7)	57441 (96.2)	3114 (96.0)	3538 (95.4)	64123 (96.1)
BMI Category [*]	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
Underweight	1026 (1.5)	137 (2.0)	889 (1.5)	61 (1.9)	76 (2.1)	1026 (1.5)
Normal Weight	18200 (27.3)	1836 (26.3)	16364 (27.4)	827 (25.5)	998 (26.9)	18200 (27.3)
Overweight	24434 (36.6)	2343 (33.5)	22091 (37.0)	1049 (32.4)	1283 (34.6)	24434 (36.6)
Obese	23059 (34.6)	2669 (38.2)	20390 (34.1)	1306 (40.3)	1351 (36.4)	23059 (34.6)
Smoking Status ^{***}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
Current smoker - smokes every day	6985 (10.5)	1081 (15.5)	5904 (9.9)	530 (16.3)	548 (14.8)	6985 (10.5)
Current smoker - smokes some days	2358 (3.5)	367 (5.3)	1991 (3.3)	198 (6.1)	168 (4.5)	2358 (3.5)
Former smoker	21896 (32.8)	2686 (38.5)	19210 (32.2)	1219 (37.6)	1453 (39.2)	21896 (32.8)
Never smoked	35480 (53.2)	2851 (40.8)	32629 (54.6)	1296 (40.0)	1539 (41.5)	35480 (53.2)
Drank alcohol in past 30 days ^{**,#}	n (%)	SCD	No SCD	n (%)	Discussed	Not Discussed
Yes	31805 (47.7)	2800 (40.0)	29177 (48.6)	1206 (37.2)	1577 (42.5)	31805 (47.7)
No	34914 (52.3)	4207 (60.0)	30886 (51.4)	2037 (62.8)	2131 (57.5)	34914 (52.3)

Note: *p<0.05, **p<0.005, ***p<0.0005 for significance in association with SCD

#p<0.05, ##p<0.005, ###p<0.0005 for significance in association with SCD

^aSCD=Subjective Cognitive Decline

^bDiscussed=Discussed memory loss and confusion with health care provider

Table 3: Distribution of Adverse Childhood Experiences of 2019 & 2020 Behavioral Risk Factor survey respondents by Subjective Cognitive Decline and Discussion of Subjective Cognitive Decline.

		N = 66,719 (100.0)				N = 6,951 (100.0)			
		SCD ^a [n=6985 (10.5)]		No SCD [n=59734 (89.7)]		Discussed ^b [n=3243 (46.7)]		Not Discussed [n=3708 (53.3)]	
ACE Question	n(%)	Yes (ACE)	No (ACE)	Yes (ACE)	No (ACE)	Yes (ACE)	No (ACE)	Yes (ACE)	No (ACE)
1. Did you live with anyone who was depressed, mentally ill, or suicidal?		1714 (24.5)	5271 (75.5)	6729 (11.3)	53005 (88.7)	966 (29.8)	2277 (70.2)	739 (19.9)	2969 (80.1)
2. Did you live with anyone who was a problem drinker or alcoholic, or who used illegal street drugs or abused prescription medications?		2433 (34.8)	4552 (65.2)	13804 (23.1)	45930 (76.9)	1254 (38.7)	1989 (61.3)	1172 (31.6)	2536 (68.4)
3. Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?		573 (8.2)	6412 (91.8)	2301 (3.9)	57433 (96.1)	297 (9.2)	2946 (90.8)	273 (7.4)	3435 (92.6)
4. Were your parents separated or divorced?		1733 (24.8)	5252 (75.2)	11501 (19.3)	48233 (80.7)	867 (26.7)	2376 (73.3)	861 (23.2)	2847 (76.8)
		SCD ^a [n=6985 (10.5)]		No SCD [n=59734 (89.7)]		Discussed ^b [n=3243 (46.7)]		Not Discussed [n=3708 (53.3)]	
ACE Question		At Least Once	Never	At Least Once	Never	At Least Once	Never	At Least Once	Never
5. How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?		5399 (76.2) 340 (4.8)	1688 (24.2)	5297 (75.8)	8098 (13.6)	51636 (86.4)	835 (25.8)	2408 (74.2)	846 (22.8)
6. 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?		4576 (64.6) 550 (7.8)	2502 (35.8)	4483 (64.2)	12491 (20.9)	47243 (79.1)	1244 (38.4)	1999 (61.6)	1245 (33.6)
7. How often did a parent or adult in your home ever swear at you, insult you, or put you down?		4155 (58.6) 382 (5.4)	2914 (41.7)	4071 (58.3)	16404 (27.5)	43330 (72.5)	1468 (45.3)	1775 (54.7)	1435 (38.7)
8. How often did anyone at least 5 years older than you or an adult ever touch you sexually, try to make you touch them sexually, or force you to have sex?		5697 (80.4) 449 (6.3)	1631 (23.4)	5354 (76.6)	6887 (11.5)	52847 (88.5)	888 (27.4)	2355 (72.6)	737 (19.9)
ACE Category		SCD ^a [n=6985 (10.5)]		No SCD [n=59734 (89.7)]		Discussed ^b [n=3243 (46.7)]		Not Discussed [n=3708 (53.3)]	
None		1881 (26.9)		25716 (43.1)		757 (23.3)		1110 (29.9)	
Household Challenges		1044 (15.0)		10269 (17.2)		470 (14.5)		572 (15.4)	
Childhood Abuse		1105 (15.8)		9088 (15.2)		491 (15.1)		608 (16.4)	
Household Challenges + Childhood Abuse		2955 (42.3)		14661 (24.5)		1525 (47.0)		1418 (38.2)	
Total ACE Score		SCD ^a [n=6985 (10.5)]		No SCD [n=59734 (89.7)]		Discussed ^b [n=3243 (46.7)]		Not Discussed [n=3708 (53.3)]	
0.....		1881 (26.9)		25716 (43.1)		757 (23.3)		1110 (29.9)	
1.....		1463 (20.9)		14471 (24.2)		632 (19.5)		825 (22.3)	
2.....		1073 (15.4)		7907 (13.2)		522 (16.1)		545 (14.7)	
3.....		837 (12.0)		4765 (8.0)		415 (12.8)		421 (11.4)	
4+.....		1731 (24.8)		6875 (11.5)		917 (28.3)		807 (21.8)	

^aSCD=Subjective Cognitive Decline

^bDiscussed=Discussed memory loss and confusion with health care provider

Table 4: Logistic regression results for Subjective Cognitive Decline by Adverse Childhood Experiences Individually, Categorically, and Total Score (N= 66,719)

By Total ACE Score	Odds Ratio (CI)	
	Crude Model	Adjusted Model ^a
0.....	Reference	Reference
1.....	1.37 (1.22, 1.53)***	1.35 (1.21, 1.52)***
2.....	1.91 (1.69, 2.15)***	1.95 (1.73, 2.20)***
3.....	2.56 (2.24, 2.92)***	2.56 (2.24, 2.92)***
4+.....	3.96 (3.55, 4.41)***	3.79 (3.37, 4.25)***
Odds Ratio (CI)		
By ACE Category	Crude Model	Adjusted Model ^a
No ACEs	Reference	Reference
Household Challenges	1.47 (1.30, 1.66)***	1.40 (1.23, 1.59)***
Childhood Abuse	1.60 (1.41, 1.80)***	1.62 (1.43, 1.84)***
Household Challenges + Childhood Abuse	3.05 (2.78, 3.35)***	2.95 (2.68, 3.26)***
Odds Ratio (CI)		
By Individual ACE	Crude Model	Adjusted Model ^a
Lived with someone who was depressed, mentally ill, or suicidal	1.84 (1.67, 2.04)***	2.02 (1.82, 2.25)***
Lived with someone with some form of substance abuse	1.21 (1.10, 1.34)***	1.19 (1.08, 1.32)**
Lived with someone who served time or was sentenced to serve time in a prison, jail, or other correctional facility	1.25 (1.06, 1.47)*	1.13 (0.95, 1.33)
Parents were separated or divorced	0.95 (0.86, 1.05)	0.94 (0.85, 1.04)
Parents or adults in home slapped, hit, kicked, punched, or beat each other up <i>at least once</i>	1.25 (1.11, 1.41)***	1.19 (1.05, 1.35)*
Physical abuse	1.46 (1.32, 1.61)***	1.33 (1.19, 1.47)***
Mental abuse	1.15 (1.05, 1.27)**	1.27 (1.15, 1.40)***
Sexual abuse	1.58 (1.43, 1.76)***	1.57 (1.41, 1.76)***

Npte: *p<0.05; **p<0.005; ***p<0.0005. ^aCovariates in all adjusted models are state, sex, age group, race, Hispanic ethnicity, BMI category, education, income group, smoking status, and drinking history.

Table 5: Logistic regression results for Discussing Confusion or Memory Loss with Health Care Professional by Adverse Childhood Experiences Individually, Categorically, and Total Score (N=6,951)

By Total ACE Score	Odds Ratio (CI)	
	Crude Model	Adjusted Model ^a
0.....	Reference	Reference
1.....	1.17 (0.93, 1.47)	1.13 (0.91, 1.42)
2.....	1.42 (1.13, 1.78)**	1.34 (1.06, 1.69)*
3.....	1.23 (0.96, 1.56)	1.06 (0.82, 1.35)
4+.....	1.46 (1.19, 1.78)***	1.16 (0.94, 1.43)
Odds Ratio (CI)		
By ACE Category	Crude Model	Adjusted Model ^a
No ACEs	Reference	Reference
Household Challenges	1.20 (0.93, 1.54)	1.11 (0.87, 1.43)
Childhood Abuse	1.21 (0.96, 1.52)	1.18 (0.93, 1.49)
Household Challenges + Childhood Abuse	1.42 (1.19, 1.70)***	1.19 (0.99, 1.43)
Odds Ratio (CI)		
By Individual ACE	Crude Model	Adjusted Model ^a
Lived with someone who was depressed, mentally ill, or suicidal	1.48 (1.23, 1.78)***	1.33 (1.10, 1.60)**
Lived with someone with some form of substance abuse	1.02 (0.86, 1.21)	1.00 (0.84, 1.19)
Lived with someone who served time or was sentenced to serve time in a prison, jail, or other correctional facility	0.89 (0.68, 1.17)	0.88 (0.67, 1.16)
Parents were separated or divorced	0.98 (0.82, 1.17)	0.92 (0.77, 1.10)
Parents or adults in home slapped, hit, kicked, punched, or beat each other up <i>at least once</i>	0.91 (0.73, 1.13)	0.89 (0.72, 1.11)
Physical abuse	1.00 (0.83, 1.20)	1.02 (0.85, 1.23)
Mental abuse	0.98 (0.82, 1.16)	0.94 (0.78, 1.12)
Sexual abuse	1.33 (1.10, 1.60)**	1.16 (0.95, 1.41)

Note: *p<0.05; **p<0.005; ***p<0.0005. ^aCovariates in all adjusted models are state, sex, age group, race, Hispanic ethnicity, BMI category, education, income group, smoking status, and drinking history.

that for most individual ACEs, there is a significant increase in odds of SCD. Living with someone who was depressed, mentally ill, or suicidal increased the odds of SCD by nearly 100%. For parental separation or divorce, the result was null in the adjusted model.

When considering ACEs by category [Table 4], all results were highly significant. In the crude model, respondents who reported at least one household challenge had more than twice the odds of having SCD, and those who experienced childhood abuse had 2.83 times the odds of having SCD. The findings remained highly significant in the adjusted model. Those who reported ACEs from both categories had more than 3 times the odds of SCD in the adjusted model. This was more than a doubling in odds ratio compared to having had only household challenges. These findings suggest a possible synergistic effect between the two ACE categories.

We saw a similar result from our analysis of SCD by total ACE score [Table 4]. Compared to respondents with a total ACE score of 0, respondents had a higher odds of SCD as their total ACE score increased, suggesting a dose response trend. All findings in this logistic regression analysis, similar to the analysis of SCD by ACE category, were highly significant.

In Table 5, we saw that the effect of ACEs was not as highly significant when looking at those who had discussed their confusion or memory loss with a health care professional. For individual ACEs, living with someone who was depressed, mentally ill, or suicidal showed the greatest and most significant increase in odds at 35% for this outcome. By category, there was a greater odds of having discussed confusion or memory loss with a health care professional among those who reported childhood abuse or who reported both household challenges and childhood abuse. These findings were attenuated in the adjusted model, but childhood abuse remained marginally significant. Total ACE score in this analysis still showed a significant increase in odds of the outcome when compared to an ACE score of 0, with respondents who reported 4 or more ACEs being at a 31% greater odds of having discussed confusion or memory loss with a health care professional.

DISCUSSION

The findings of this study suggest that the presence of most individual ACEs may each increase the odds of self-reported confusion and/or memory loss in adulthood, even after accounting for multiple potential confounders. Notably, the individual ACEs that had the strongest association with SCD were sexual abuse and living with someone who was depressed, mentally ill, or suicidal. The former differs from past studies on the long-term cognitive effects of physical trauma, with one study suggesting that sexual trauma had no effect on cognitive performance [25]. These differences may in part be due to differences in outcome measures, as such studies used cognitive performance tests to measure cognition. There is also a lack of research examining the association between childhood sexual abuse and adult cognitive decline.

The ACE with the strongest individual effect on odds of SCD, living with someone who was depressed, mentally ill, or suicidal may have implications of other ACEs. These other ACEs include those that were not included in the BRFSS, particularly under the category of neglect. Physical and emotional neglect has been shown to potentially disrupt executive function in children [26]. Specifically, children who experienced neglect may be at greater risk of long-term cognitive deficits [27]. Studies also show that depression in parents is associated with higher rates of one's own depression, which is a known risk factor for cognitive decline [6,7].

When looking at the odds of discussing confusion or memory loss with a health care professional, living with someone who was depressed, mentally ill, or suicidal also shows the strongest and most significant effect out of the assessed individual ACEs. This may partially be due to a person's exposure to mental illness and treatment while growing up. Past research has suggested a higher odds of health care utilization for depression among individuals with a known family history of depression, due to their greater understanding of such conditions [28]. Perhaps those who lived with someone with mental illness are more aware of concerns regarding their own mental and cognitive health and are therefore more likely to discuss these issues with their providers.

Parental separation and divorce did not have a significant effect on odds of SCD or on odds of discussing confusion or memory loss with a health care professional, and this was seen in both crude and adjusted models. This is similar to a recent study that showed no significant increase in dementia occurrence associated with parental divorce [29]. It should be considered that as divorce rates increase, it becomes more commonplace, and more resources are available for children who may be impacted [30]. Programs and services that increase children's resilience may be key in examining the outcome of this ACE.

When assessing categories, our findings also indicate a potential synergistic effect between household challenges and childhood abuse categories. Experiencing direct abuse (physical, mental, and/or sexual) in childhood alone seems to have a greater impact than household challenges on cognition in adulthood. This is in line with past research suggesting that past physical trauma was associated with reduced cognitive function in adulthood [24]. Such events cause great amounts of stress, not only mentally, but also physically, which in turn leaves long-lasting effects on the brain [31]. Child abuse and maltreatment may result in structural changes in the brain, including smaller brain volume [31]. Those who have experienced both types of ACEs are then at even greater risk of systemic inflammation due to a large amount of stress in their childhood, thus resulting in greater likelihood of cognitive decline.

Most studies on ACEs have examined the potential impact of ACEs as a total score, and it is well-established that a higher ACE score is associated with a greater risk of multiple adverse outcomes [22]. Thus, it was no surprise that there was a dose

response trend when looking at aggregate ACE score, with a higher score indicating greater odds of SCD. These findings were similar to a recent study that found a positive association between ACE score and dementia in older adults [18]. More ACEs may lead to more chronic stress, thus resulting in higher risk of developing cognitive decline. Beyond this, ACEs are a source of trauma that may increase an individual's risk of engaging in risky behaviors that may further contribute to cognitive decline. These risky behaviors include smoking and drug use [32,33]. Additionally, ACEs are associated with morbidities that increase risk of cognitive decline [33].

Limitations. There are a few limitations within this study that merit discussion. The ACEs data provided by BRFSS is thorough and covers most ACEs that are predominantly studied by other researchers, except for neglect. This is the third overarching ACE category identified by the CDC [22]. The ACEs module in the 2019 and 2020 BRFSS does not include any questions addressing possible childhood neglect, which may be of interest when studying the impact of ACEs.

Additionally, the BRFSS ACEs data relies on participant recall to survey questions, leaving a possibility for both recall bias and the healthy volunteer effect. Those with more severe cases of cognitive decline were likely not captured. Some subjects may also not be comfortable reporting certain ACEs that could be more sensitive or traumatizing. Cognitive decline itself was self-reported rather than objectively diagnosed, and it is likely that some cases of cognitive decline were not reported.

Another limitation is that ACEs data was available only for the years 2019 and 2020, limiting our ability to assess trends over large periods of time. The current dataset also does not include information on head injury or trauma, which would be a notable condition to consider in assessing subjective cognitive decline as an outcome.

Though the BRFSS dataset is cross-sectional, temporality is not as much of a concern for this particular study. ACEs by definition took place during childhood, but a prospective study would allow us to track cognitive ability of participants over time.

CONCLUSION

Overall, the findings of this study suggest a strong association of ACEs with SCD in adulthood. Considering ACEs individually, by category, and as an aggregate score, we see a mostly significant effect on odds of cognitive decline. Notably, these findings also imply that although there is a positive relationship between ACEs and cognitive decline, outcomes vary by each individual ACE as well as by ACE category.

As there is a lack of research examining the impact of individual ACEs and ACE categories on various outcomes, future research should further explore ACEs at the individual and domain level. Although ACEs are well-established as risk factors for adverse adult mental and behavioral health outcomes, existing literature tends to examine ACEs only as an aggregate score. It would thus be beneficial to consider that all ACEs are not created equal.

With a growing elderly population in the United States and the potential long-term effects of COVID-19 [34], there is a growing at-risk population for cognitive decline. Thus, there is an increasing need to study causes of the systemic inflammation associated with this outcome. It is necessary to consider ACEs in this discussion. As of 2020, the California State Department of Health Care Services has implemented the ACES Aware Initiative, an effort to screen patients across the state for ACEs [35]. Such screenings are an important step in providing trauma-informed care. Future studies should further examine ACEs at the individual and domain level.

AUTHORS' CONTRIBUTIONS

Study conception and design: Christine Do; data abstraction and analysis: Christine Do; interpretation of results: Christine Do with feedback from Rhonda Spencer-Hwang, Synnove Knutsen, and David Shavlik; draft manuscript preparation: Christine Do with supervision from Rhonda Spencer-Hwang and additional feedback from Synnove Knutsen and David Shavlik. All authors reviewed the results and approved the final version of the manuscript.

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