Association Between Number of Adverse Events in Childhood and Adult Risk Behaviors and Poor Health Outcomes

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OBJECTIVES: This study examined the association between the number of adverse childhood experiences (ACEs) and risk behaviors, as well as self-reported poor general health, poor mental health, and associated limited activity. METHODS: Multivariate logistic regression was performed on 49,478 responses to a set of 11 questions, which was offered through the Behavioral Risk Factor Surveillance System (BRFSS) in the States of Minnesota (n=13,449), Montana (n=9,042), Vermont (n=6,545), Washington (n=13,612), and Wisconsin (n=4,349) during 2011, and in the State of Connecticut during calendar year 2012 (n=2,481). The model controlled for sex, age, living arrangement, and education. RESULTS: The adjusted odds ratio for smoking in adulthood increased significantly with increasing number of ACEs, in which 1-2 ACEs and 3-8 ACEs, was associated with a smoking risk of 1.8 (95% CI: 1.6, 2.0) and 2.8 (95% CI: 2.5, 3.2), respectively, compared to adults with no ACEs. Similar increasing risks were observed for poor general health, poor mental health, and limited activity due to poor health, with the addition of smoking as an independent covariate. CONCLUSIONS: These data suggest that ACEs is a risk factor for smoking and poor health in adulthood, and the likelihood of risk behaviors and poor health outcomes in adulthood increases with increasing number of ACEs.

Introduction

Adverse childhood experiences (ACEs) are traumatic events widely believed to increase susceptibility for poor outcomes in adulthood [1-7]. These adverse experiences during childhood include abuse (verbal, physical, and sexual), as well as dysfunction in the household (depression and mental illness, incarceration, substance abuse, parental divorce/separation, and domestic violence). The detection of ACEs in children and adults is a mechanism for identifying at risk families and providing trauma-informed care to alleviate its effects [8].

Starting in 2009, and continuing since, states in the U.S. have had the opportunity to offer a set of questions related to ACEs in their state health surveys (**Table 1**). This survey, called the Behavioral Risk Factor Surveillance System (BRFSS), is funded in all states of the U.S. through the Centers for Disease Control and Prevention with an established sampling methodology [9,10]. During calendar year 2009, Arizona, Louisiana, New Mexico, Texas, and Washington offered the module of questions to its citizens, and a report by Bynum and coworkers highlighted the percent prevalence of ACEs in these states [11]. In 2010, the module was offered in Washington, Hawaii, Nevada, Vermont, and Wisconsin. In 2011, the module was offered in Minnesota, Montana, Vermont, Washington, and Wisconsin, and in 2012, the module was offered by Connecticut.

Previous to the 2011 BRFSS calendar year, the survey was limited to land line users. Although the exclusion of cell phones from the survey was not an issue in the 1980's when the survey methodology was first developed, the 2000's began to show a shift toward cell phone use, and particularly toward households that only use cell phones. This shift in cell phone use and associated demographics led to a change in the BRFSS sampling methodology starting in calendar year 2011 that now includes both land line and cell phone users. The effect of this shift in BRFSS methodology has not been studied with adverse childhood experiences.

The purpose of this study was to explore the prevalence and number of ACEs reported by adults during childhood, using the new methodology developed by BRFSS for calendar years 2011 and 2012, and to evaluate the association between ACEs and adult risk behaviors and poor health outcomes.

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The results of this study suggest that the number of ACEs is significantly associated with increasing risk of smoking in adulthood as well as poor health outcomes.

Methods

Variable Construction and Data Analysis

Data for this study were obtained from the Behavioral Risk Factor Surveillance System (BRFSS). Data from Connecticut were obtained from the CT-BRFSS coordinator [12]. Data from all other states were downloaded from the BRFSS website [13]. Each year, CDC works with states to ensure data quality, and assigns for each survey response a weight that permits generalization to state populations, using a methodology previously described by CDC [10]. These weights are included in the datasets made available for public use [13].

During calendar year 2011, a module of eleven questions was modified from the Kaiser-CDC study [1], which related to adverse childhood experiences (ACEs; **Table 1**), and offered by the BRFSS. The module was offered from January 1, 2011 through December 31, 2011 within the states of Minnesota, Montana, Vermont, Washington, and Wisconsin. The module was offered in Connecticut from September 1, 2012 through December 31, 2012. Combined state data to the module resulted in a total of 58,668 responses.

The ACEs module was processed according to the method described by Bynum and coworkers [11]. Briefly, a set of three types of abuse (verbal, physical and sexual) and five types of family dysfunction (mental illness, prison, substance abuse, parental separation/divorce, and domestic violence) were developed from the 11 questions. A "Yes" response to questions 1 or 4 corresponded directly to a positive response to household mental illness or prison, respectively. A "Yes" response to question 5 corresponded with a positive response to parental divorce/separation; a "Parents not married" response corresponded with a negative response to this indicator. A "Yes" response to either question 2 or question 3 corresponded to a positive response for substance abuse. A response of "Once" or "More

Table 1
Adverse Childhood Experiences Module 22
Behavioral Risk Factor Surveillance System (BRFSS)

I'd like to ask you some questions about events that happened during your childhood. This information will allow us to better understand problems that may occur early in life, and may help others in the future. This is a sensitive topic and some people may feel uncomfortable with these questions. At the end of this section, I will give you a phone number for an organization that can provide information and referral for these issues. Please keep in mind that you can ask me to skip any question you do not want to answer.

All questions refer to the time period before you were 18 years of age. Now, looking back before you were 18 years of age -

Question	Response
1. Did you live with anyone who was depressed, mentally ill, or suicidal?	Yes, No, Don't know/not sure, Refused
2. Did you live with anyone who was a problem drinker or alcoholic?	Yes, No, Don't know/not sure, Refused
3. Did you live with anyone who used illegal street drugs or who abused prescription medications?	Yes, No, Don't know/not sure, Refused
4. Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Yes, No, Don't know/not sure, Refused
5. Were your parents separated or divoced?	Yes, No, Parents not married, Don't know/not sure, Refused
6. How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up?	Never, Once, More than once, Don't know/not sure, Refused
7. Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking. Would you say -	Never, Once, More than once, Don't know/not sure, Refused
8. How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Never, Once, More than once, Don't know/not sure, Refused
9. How often did anyone at least 5 years older than you or an adult touch you sexually?	Never, Once, More than once, Don't know/not sure, Refused
10. How often did anyone at least 5 years older than you or an adult try to make you touch them sexually?	Never, Once, More than once, Don't know/not sure, Refused
11. How often did anyone at least 5 years older than you or an adult force you to have sex?	Never, Once, More than once, Don't know/not sure, Refused

As I mentioned when we started this section, I would give you a phone number for an organization that can provide information and referral for these issues. You can dial [*insert state or local hotline*] to reach a referral service to locate an agency in your area. [*If no local or state hotline is available, give respondent the National Hotline for child abuse 1-800-422-4-A-CHILD (1-800-422-4453).*]

than once" to question 6 or 7 corresponded to a positive response for domestic abuse or physical abuse in the household, respectively. A response of "More than once" to question 8 corresponded to a positive response for verbal abuse. A response of "Once" or "More than once" to question 9, 10, or 11 corresponded to a positive response for sexual abuse. Responses of "Refused" were coded as missing, and responses of "Don't know/not sure" to any question were coded as negative responses.

Additional variables obtained from the BRFSS dataset included: sex (BRFSS variable SEX; male, female); age group (BRFSS variable _AGE_G; collapsed into 18-24, 25-34, 35-44, and 55 and over years old); housing arrangement (RENTHOME1; own or rent housing, in which other housing arrangements were combined with renting); education (_EDUCAG; less than high school degree, high degree, and more than high school); and race/ethnicity (_RACE_G; non-Hispanic White/ Caucasian, non-Hispanic Black/African American, and Hispanic/Latino, in which other and multi-race responses were combined with non-Hispanic Black/ African American to create a single non-Hispanic Black/African American/Other/Multi-race category). Housing arrangement was used as a proxy for income, assuming that individuals who can afford to buy homes would live in a home they own. Indicators for perceived health were developed: poor general health (_RFHLTH, less than 14 days of poor health, at least 15 days of poor health); poor mental health (_RFMENT, less than 14 days of poor mental health, at least 14 days of poor mental health); poor physical health (_PHYSHLTH, less than 14 days of poor physical health, at least 14 days of poor physical health); and limited activity, such as self-care, work, or recreation, due to poor mental or physical health (_RFPOOR, less than 14 days of activity limitation, at least 14 days of activity limitation). In addition, four indicators of risk behaviors were developed: heavy drinking (_RFDRHV4, more than two drinks per day for men, or more than one drink per day for women); binge drinking (_RFBING5, in the past month had five or more drinks on at least one occasion); less frequent seat belt use (_RFSEAT3, nearly always, sometimes, seldom or never use a seatbelt when driving or riding in a car); and smoking (_RFSMOK3, currently smoke and have smoked at least 100 total cigarettes). All unknown or refused responses were coded as missing, and all other possibilities for these variables were coded as missing.

A total of 52,797 adult residents were offered the ACE module in Minnesota (n=14,365), Montana (n=9,618), Vermont (n=6,832), Washington (n=14,370), and Wisconsin (n=4,707) in calendar year 2011, and in Connecticut (n=2,905) from September 1 through December 31 in calendar year 2012 (**Table 2**). Of this number, 9,190 respondents declined to answer any one of the questions in the module and were coded as missing. The total number of respondents who answered the full set of eleven questions varied by state: 2,481 (85% cooperation rate) in Connecticut, 13,449 (94%) in Minnesota, 9,042 (94%) in Montana, 6,545 (96%) in Vermont, 13,612 (95%) in Washington, and 4,349 (92%) in Wisconsin. A total of 49,478 responses were subsequently analyzed as non-missing responses (**Table 2**).

Multivariate logistic regression of adult risk behaviors and poor health outcomes was conducted using the covariates: Number of ACEs (0-ref, 1-2, 3 -8); housing arrangement (own home—ref, rent home or other arrangement); sex (female—ref, male); educational level (more than high school degree—ref, high school degree or less); and age (18-34 years, 35-54 years, 55 and over years—ref). The ACEs, education, and age variables were collapsed for the regression analysis due to low frequencies among respondents (**Table 2**), and race/ ethnicity was also excluded from the logistic regression analysis because of low frequencies. Regression analysis of poor health outcomes included smoking behavior as an additional covariate. The difference between the log likelihood values of logistic regression using all covariates, with and without the ACEs variable, created a chi-square value that was significant ($p < 0.0001$) for all outcome variables, indicating that the ACEs covariate contributed significantly to each regression model [14].

All analyses were conducted with SAS (Statistical Analysis System, Cary, NC), using SURVEYFREQ and SURVEYLOGISTIC procedures, and using _LLCPWT as the weighting variable. The weighting variable in Connecticut was adjusted for four of twelve months that the ACE module was offered to achieve the total estimated statewide adult population of 2,759,586. The stratification variable was also provided in the BRFSS dataset (_STSTR). Percent prevalence and weighted frequencies generally exhibited coefficient

Table 2
Frequency Distribution of BRFSS Sample Responses
2011 and 2012, ACEs Module, Multiple States[1]

Characteristic	Sample Frequency												
	Total	No ACEs	1-2 ACEs	3-4 ACEs	5-8 ACEs	Verbal	Physical	Sexual	Mental Illness	Prison	Substance Abuse	Parent Sep/Div	Violence
Overall[1]	49,478	21,673	17,162	6,905	3,738	13,843	8,061	6,055	8,280	2,334	13,736	10,256	7,632
State													
Connecticut (2012)	2,481	1,067	901	352	161	686	412	252	385	116	650	544	384
Minnesota (2011)	13,449	6,194	4,607	1,789	859	3,575	2,023	1,373	2,189	638	3,561	2,381	1,843
Montana (2011)	9,042	3,901	3,066	1,278	797	2,646	1,512	1,114	1,517	478	2,759	2,023	1,459
Vermont (2011)	6,545	3,028	2,250	849	418	1,690	946	753	1,089	227	1,746	1,266	913
Washington (2011)	13,612	5,454	4,849	2,068	1,241	4,127	2,475	2,099	2,524	655	3,957	3,210	2,333
Wisconsin (2011)	4,349	2,029	1,489	569	262	1,119	693	464	576	220	1,063	832	700
Age group[1]													
18-24 years old	2,097	738	768	356	235	683	357	150	568	291	649	792	308
25-34 years old	4,398	1,567	1,555	719	557	1,413	806	484	1,102	491	1,406	1,575	840
35-54 years old	15,576	5,660	5,683	2,623	1,610	5,314	3,047	2,358	3,130	879	5,158	4,142	2,923
55+ years old	27,407	13,708	9,156	3,207	1,336	6,433	3,851	3,063	3,480	673	6,523	3,747	3,561
Living Arrangement[1]													
Own	38,540	17,962	13,371	4,916	2,291	9,998	5,553	4,248	5,780	1,269	9,900	6,806	5,304
Rent/Other	10,692	3,577	3,717	1,963	1,435	3,782	2,478	1,787	2,465	1,057	3,778	3,404	2,298
Education[1]													
No High School Degree	2,803	1,060	934	432	377	824	682	428	441	337	936	883	704
High School Degree	13,338	5,880	4,608	1,789	1,061	3,513	2,169	1,491	1,783	799	3,951	3,090	2,254
More Than High School Degree	33,269	14,691	11,601	4,679	2,298	9,493	5,204	4,132	6,048	1,196	8,835	6,266	4,669
Race/Ethnicity[1]													
non-Hispanic White/Caucasian	43,783	19,683	15,208	5,893	2,999	11,967	6,734	5,120	7,219	1,739	11,873	8,428	6,202
non-Hispanic Black/Afr Am/ Other/Multi-Race	1,135	350	460	203	122	327	189	175	162	155	318	480	263
Hispanic/Latino	1,466	530	506	266	164	442	361	208	243	134	490	426	376
Sex[1]													
Men	20,656	9,297	7,408	2,723	1,228	5,763	3,398	1,389	2,672	1,055	5,253	4,243	3,023
Women	28,822	12,376	9,754	4,182	2,510	8,080	4,663	4,666	5,608	1,279	8,483	6,013	4,609

[1] - Total sample responses for Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined.

of variation values that were less than 10%. Coefficients of variation for minority race/ethnicity and 18-24 years of age, due to low frequencies, were greater than 10%, but did not exceed 15%.

The BRFSS has been classified as exempt by a Human Investigation Committee within the Connecticut State Department of Public Health (January 2013).

Results

Percent Prevalence of Adverse Childhood Experiences (ACEs): Types of ACEs

The percent prevalence in the adult population of verbal abuse, physical abuse, sexual abuse during childhood, as well as five measures of household dysfunction during childhood, are shown in **Table 3** by state of residence, age, living arrangement, education, race/ethnicity, and sex, with accompanying standard errors. Among all states combined, the highest percent prevalence of childhood abuse in the adult population was for verbal abuse, affecting 29.8% of the population (95% Confidence Interval: 29.0%, 30.7%). A significantly smaller percent prevalence occurred for physical verbal abuse ($p < 0.05$), affecting 18.0% of the adult population (95% CI: 17.3%, 18.7%), followed by sexual abuse, affecting 11.0% of the population (95% CI: 10.5%, 11.5%. Among indicators of household dysfunction, the highest prevalence was for substance abuse, affecting 28.6% of the adult population (95% CI: 27.9%, 29.5%), followed by parental divorce/separation (25.2% percent prevalence), mental illness and domestic violence (17.4%, and 17.2%, respectively), and incarceration (7.0%).

Relative to the overall percent prevalence of each type of ACE, the state of Washington had a significantly higher prevalence of all types except incarceration, and the state of Montana had a significantly higher prevalence of substance abuse ($p < 0.05$) (**Table 3**). The state of Minnesota had a significantly lower prevalence of all types of childhood abuse, as well as a significantly lower prevalence of parental divorce/separation and domestic violence ($p < 0.05$).

Among the types of ACEs reported by adults, all were sensitive to age and living arrangements, and all but one were sensitive to educational level (**Table 3**). All types of ACEs had a significantly lower percent prevalence among adults at least 55 years old, compared to adults 35-54 years old ($p < 0.05$). A higher prevalence also occurred among adults 25-34 years old for all types ACEs except sexual abuse, and adults 18-24 years old for all types of ACEs except sexual abuse and domestic violence. The percent prevalence of all types of ACEs among adults who own their own home was significantly lower than that among adults who either rented housing or had other living arrangements.

The percent prevalence of all types of ACEs except verbal abuse varied by education, in which adults with at least a high school degree had a lower prevalence of ACEs than those without a high school degree ($p < 0.05$; **Table 3**). Adults with a high school degree had a significantly higher prevalence of household incarceration and substance abuse during childhood, and a significantly lower prevalence of physical abuse and sexual abuse, as well as household mental illness, parental divorce/ separation, and domestic violence ($p < 0.05$). Among racial/ethnic groups, non-Hispanic White/Caucasian adults had a significantly lower prevalence of physical abuse, as well as household incarceration, parental divorce/separation, and domestic violence, relative to Hispanic/Latino adults ($p < 0.05$), and significantly lower prevalence of household incarceration, parental divorce/separation, and domestic violence relative to non-Hispanic Black/ African American/Other/Multi-Race adults. Percent prevalence of ACEs varied by sex for sexual abuse, as well as household mental illness and substance abuse. For all these types of ACEs, adult women reported a higher prevalence than men ($p < 0.05$).

The percent prevalence of some types of ACEs shown in **Table 3** for the states of Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin combined, using the BRFSS methodology implemented in 2011 were similar to that reported using the BRFSS methodology in place prior to 2011, when the states of Arkansas, Louisiana, New Mexico, Tennessee, and Washington were evaluated [11]. Sexual abuse, as well as household incarceration, substance abuse, parental divorce/ separation, and domestic violence were not significantly different ($p < 0.05$). The percent prevalence values of verbal and physical abuse, however, were significantly higher in this study, relative to the previously published study ($p < 0.05$) [11]. The percent prevalence of household mental illness in this study was significantly lower than that of the previous study. Similar trends among demographic groups were observed in this study when compared to the previous study [11]. These

Table 3
Percent Prevalence of Adverse Childhood Experiences (ACEs)
2011 and 2012, ACEs Moldule, Multiple States[1]

Characteristic	Abuse						Household Dysfunction									
	Verbal Abuse		Physical Abuse		Sexual Abuse		Mental Illness		Incarceration		Substance Abuse		Parental Divorce/ Separation		Domestic Violence	
	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error
Overall[1]	29.8	0.40	18.0	0.36	11.0	0.26	17.4	0.35	7.0	0.26	28.6	0.40	25.2	0.41	17.2	0.35
State																
Connecticut (2012)	28.8	1.28	17.7	1.12	8.8	0.69	15.9	1.11	5.7	0.67	26.6	1.19	25.5	1.23	17.1	1.09
Minnesota (2011)	27.7↓	0.59	15.5↓	0.48	9.10↓	0.35	16.1	0.48	6.4	0.36	27.1	0.57	20.3↓	0.54	14.1↓	0.45
Montana (2011)	30.9	0.75	17.3	0.61	12.1	0.54	19.0	0.65	7.5	0.50	31.5↑	0.75	27.6	0.75	16.8↓	0.62
Vermont (2011)	28.2	0.77	15.2	0.60	10.8	0.50	18.2	0.68	5.5	0.49	29.1	0.78	24.8	0.77	15.2	0.62
Washington (2011)	32.6↑	0.68	20.9↑	0.60	14.8↑	0.51	20.4↑	0.59	7.7	0.44	31.9↑	0.68	29.7↑	0.68	19.7↑	0.59
Wisconsin (2011)	29.2	1.10	17.4	0.93	9.3	0.63	15.7	0.92	7.7	0.72	26.8	1.04	23.9	1.09	17.3	0.92
Age group[1]																
18-24 years old	31.4↑	1.66	17.7↑	1.41	7.40↓	0.91	23.6↑	1.48	13.7↑	1.18	28.5↑	1.55	35.7↑	1.70	15.9	1.31
25-34 years old	35.4↑	1.25	20.8↑	1.10	10.2	0.72	25.1↑	1.19	12.6↑	0.87	32.1↑	1.19	38.7↑	1.30	21.8↑	1.13
35-54 years old	34.0↑	0.69	20.7↑	0.61	13.6↑	0.47	18.3↑	0.56	6.40↑	0.38	32.8↑	0.68	27.8↑	0.66	19.5↑	0.59
55+ years old	22.5↓	0.46	14.0↓	0.39	9.70↓	0.30	11.1↓	0.35	2.90↓	0.25	22.8↓	0.47	13.2↓	0.38	13.2↓	0.39
Living Arrangement[1]																
Own	26.9↓	0.45	15.4↓	0.38	9.50↓	0.26	14.9↓	0.37	4.70↓	0.25	26.0↓	0.43	19.8↓	0.41	14.9↓	0.37
Rent/Other	37.1↑	0.92	24.6↑	0.83	14.8↑	0.63	23.7↑	0.82	12.8↑	0.64	35.4↑	0.89	38.8↑	0.94	23.0↑	0.82
Education[1]																
No High School Degree	30.7	1.64	24.2↑	1.52	15.0↑	1.23	18.4↑	1.41	15.1↑	1.32	33.7↑	1.68	37.7↑	1.82	25.5↑	1.56
High School Degree	29.0	0.80	18.2↓	0.68	10.3↓	0.47	14.6↓	0.63	8.60↑	0.53	30.0↑	0.77	26.5↓	0.78	17.8↓	0.66
More than High School Degree	30.1	0.50	16.9↓	0.43	10.6↓	0.29	18.6	0.44	4.90↓	0.26	27.2↓	0.47	22.6↓	0.46	15.6↓	0.41
Race/Ethnicity[1]																
non-Hispanic White/Caucasian	29.4	0.43	17.1↓	0.36	10.6	0.26	17.6	0.37	5.80↓	0.24	28.7	0.42	23.4↓	0.41	15.9↓	0.36
non-Hispanic Black/Afr Am/Other/Multi-Race	35.2	2.73	18.7	2.24	13.9	1.68	13.5	1.86	18.4↑	2.27	29.6	2.48	48.0↑	2.72	23.4↑	2.26
Hispanic/Latino	29.3	2.34	24.5↑	2.24	10.8	1.33	16.8	2.21	11.1↑	1.58	29.1	2.06	32.4↑	2.41	24.9↑	2.07
Sex[1]																
Men	29.9	0.64	18.1	0.56	6.10↓	0.29	14.2↓	0.53	7.50	0.40	26.9↓	0.6	24.9	0.62	16.5	0.54
Women	29.8	0.54	17.8	0.46	15.6↑	0.41	20.4↑	0.47	6.50	0.33	30.2↑	0.53	25.6	0.54	17.8	0.46

[1] - Total sample responses for Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined.

Data shown are percent prevalence, weighted and defined as described in the **Methods** Section.
The symbols ↓ and ↑ indicate that the percent prevalence is statistically lower and higher, respectively, relative to each other ($p < 0.05$). States with symbols indicate a percent prevalence that is significantly different from the overall prevalence.

Table 4
Percent Prevalence of the Number of Adverse Childhood Experiences (ACEs)
2011 and 2012, ACEs Module, Multiple States[1]

Characteristic	Number of ACEs							
	No ACEs		1-2 ACEs		3-4 ACEs		5-8 ACEs	
	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error	Percent (%)	Standard Error
Overall[1]	40.2	0.43	35.8	0.43	14.9	0.32	9.1	0.29
State								
Connecticut (2012)	39.0	0.37	37.9	1.37	15.5	1.02	7.7	0.84
Minnesota (2011)	44.3↑	0.63	34.9	0.62	13.7	0.44	7.10↓	0.35
Montana (2011)	39.9	0.78	34.5	0.76	14.6	0.57	11.0↑	0.56
Vermont (2011)	41.7	0.80	35.1	0.80	15.1	0.64	8.1	0.52
Washington (2011)	35.7↓	0.66	36.1	0.69	16.0	0.53	12.2↑	0.53
Wisconsin (2011)	42.7	0.15	35.0	0.13	14.2	0.80	8.1	0.76
Age group[1]								
18-24 years old	36.7↓	0.85	35.2	1.75	17.1↑	1.35	11.0↑	1.13
25-34 years old	32.4↓	1.17	36.1	1.27	17.5↑	0.99	14.0↑	0.96
35-54 years old	35.1↓	0.67	37.5↑	0.70	16.3↑	0.51	11.1↑	0.51
55+ years old	50.0↑	0.57	34.0↓	0.55	11.5↓	0.36	4.44↓	0.23
Living Arrangement[1]								
Own	44.5↑	0.50	35.6	0.48	13.3↓	0.34	6.60↓	0.27
Rent/Other	29.4↓	0.83	36.0	0.92	18.9↑	0.72	15.7↑	0.74
Education[1]								
No High School Degree	32.0	1.67	36.6	1.80	16.5	1.30	14.9↑	1.34
High School Degree	40.5	0.86	35.5	0.82	14.7	0.61	9.31↓	0.52
More than High School Degree	41.4	0.52	35.8	0.51	14.7	0.38	8.12↓	0.34
Race/Ethnicity[1]								
non-Hispanic White/Caucasian	41.6↑	0.45	35.5↓	0.44	14.4↓	0.33	8.51↓	0.29
non-Hispanic Black/Afr Am/ Other/Multi-Race	23.5↓	2.38	43.8↑	2.77	19.2↑	2.06	13.5↑	2.08
Hispanic/Latino	31.3↓	2.18	39.5	2.56	19.8↑	2.04	9.3	1.52
Sex[1]								
Men	41.2	0.66	36.7	0.66	14.4	0.48	7.60↓	0.43
Women	39.3	0.57	34.8	0.56	15.3	0.42	10.6↑	0.38

[1] - Total sample responses for Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined.
Data shown are percent prevalence, weighted and defined as described in the **Methods** Section.
The symbols ↓ and ↑ indicate that the percent prevalence is statistically lower and higher, respectively, relative to each other ($p < 0.05$). States with symbols indicate a percent prevalence that is significantly different from the overall prevalence.

data suggest that the new methodology in use for the BRFSS since 2011 captures a demographic that has a higher prevalence of ACEs, which includes: 1) a younger age demographic; 2) those living in either rental or other housing that they do not own; and 3) those who do not have a school degree.

Percent Prevalence of Adverse Childhood Experiences (ACEs): Number of ACEs

The eleven ACEs questions offered by the BRFSS module were processed into eight total ACEs types, as described in the **Methods** section. Of the total number of eight possible ACEs, 40.2% (95% CI: 39.3%, 41.0%) of the populations of Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined, had no ACEs during childhood (**Table 4**). The remaining majority of 59.8% had at least one ACE. Within the combined population, 35.8% (95% CI: 35.0% , 36.7%) reported one or two ACEs, 14.9% (95% CI: 14.2%, 15.5%) reported three or four ACEs, and 9.1% (95% CI:

Table 5
Multivariate Logistic Regression of Adult Risk Behaviors
Association with Number of Adverse Childhood Experiences (ACEs)
2011 and 2012, ACEs Module, Multiple States[1]

	Regression Coefficeint			
	Adult Risk Behaviors			
Covariate	Smoking	Less Seatbelt Use	Heavy Drinking	Binge Drinking
Number of ACEs (no ACEs, ref)				
1-2 ACEs	0.034	0.000	-0.019	0.034
3-8 ACEs	0.503 **	0.232 **	0.286 **	0.205 **
Housing Arrangement (Own Home, ref)				
Rent Home/Other Arrangement	0.382 **	0.030	0.021	0.016
Sex (Female, ref)				
Male	0.124 **	0.386 **	0.051	0.375 **
Educational Level (More than High School, ref)				
High School Degree or Less	0.347 **	0.225 **	-0.022	-0.123 **
Age Group (55 and over, ref)				
18-34 years old	0.116 *	0.292 **	0.177 *	0.670 **
35-54 years old	0.154 **	-0.050	0.069	0.140 **
Sample Size	48,953	49,135	48,875	48,902
Overall regression fit (Wald Chi Sq, df=7)	857.7	318.0	86.8	904.0

[1] - Total sample responses for Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined.

Multivariate logistic regression was performed as described in the **Methods** section.
Regression coefficients that are statistically significant are shown (* $p < 0.05$; ** $p < 0.001$).

8.58%, 9.73%) reported at least five ACEs.

Compared to the overall prevalence of ACEs among the states combined, Minnesota had a significantly higher percent prevalence of no ACEs (44.3%; 95% CI: 43.0% , 45.5%), and correspondingly lower prevalence of 5-8 ACEs (7.14%; 95%CI: 6.44%, 7.82%; **Table 4**). In contrast, Washington had a significantly lower percent prevalence of no ACEs and correspondingly higher percent prevalence of 5-8 ACEs (35.7%, and 12.2%, respectively). The percent prevalence of 5-8 ACEs was significantly higher among individuals less than 55 years of age, compared to those at least 55 years of age; individuals who live in rental or other housing, compared to those who own homes; and individuals with less than a high school education, compared to those who had at least a high school degree ($p < 0.05$). A significantly higher number of ACEs was also more prevalent among individuals of non-Hispanic Black/African American/Other/Multi-races compared to individuals of non-Hispanic White/Caucasian race, as well as women compared to men ($p < 0.05$).

These data collectively indicate that a significant portion of the population within the states in this study had experienced at least one ACE, and that those who experienced more at least three ACEs were more frequently: 1) Women; 2) Minority race/ ethnicities; 3) Without a high school degree; 4) Living in either rental of other living arrangements other than a home they own; and 5) A younger age demographic.

Association Between Number of ACEs and Adult Risk Behaviors

The associations between number of ACEs (0, 1-2, and 3-8) and the adult risk behaviors smoking, less seatbelt use, and either heavy or binge alcohol drinking, were evaluated by multivariate logistic regression as described in the **Methods** section, when controlled for housing arrangements, sex, education, and age (**Table 5**). Data for all states were combined.

Regression coefficients for 1-2 ACEs for all adult risk behaviors were not significant ($p > 0.05$),

Table 6
Multivariate Logistic Regression Analysis of Adult Health Outcomes
Association with Number of Adverse Childhood Experiences (ACEs) and Tobacco Use
2011 and 2012, ACEs Module, Multiple States[1]

	Regression Coefficient			
	Adult Health Outcomes			
Covariate	Poor General Health	Poor Mental Health	Poor Physical Health	Limited Activity
Number of ACEs (no ACEs, ref)				
1-2 ACEs	-0.055	-0.078	-0.013	0.031
3-8 ACEs	0.376 **	0.451 **	0.208 **	0.533 **
Smoking (No, ref)				
Yes	0.255 **	0.290 **	0.297 **	0.332 **
Housing Arrangement (Own Home, ref)				
Rent Home/Other Arrangement	0.421 **	0.267 **	0.224 **	0.372 **
Sex (Female, ref)				
Male	0.027	-0.081 *	0.034	-0.066
Educational Level (More than High School, ref)				
High School Degree or Less	0.346 **	0.202 **	0.235 **	0.264 **
Age Group (55 and over, ref)				
18-34 years old	-0.776 **	-0.246 **	-0.922 **	-0.822 **
35-54 years old	0.001	-0.035	0.128 *	0.236 **
Sample Size	48,803	15,289	17,361	34,055
Overall regression fit (Wald Chi Sq, df=3)	881.7	290.5	385.5	572.4

[1] - Total sample responses for Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin, combined. Multivariate logistic regression was performed as described in the **Methods** section.

Regression coefficients that are statistically significant are shown (* $p < 0.05$; ** $p < 0.001$).

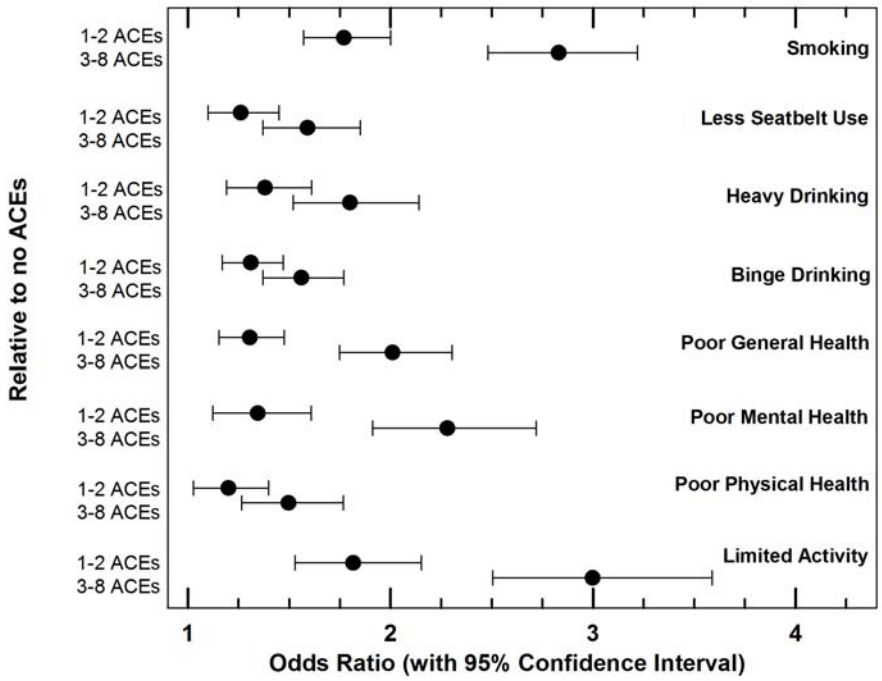
but the coefficients for 3-8 ACEs were statistically significant ($p < 0.001$; **Table 5**). All covariates in the model were significant for smoking behavior ($p < 0.05$), but varied with the other risk behaviors. For instance, relative to owning a home, living in rental or other housing arrangements was not significant for less seatbelt use, or either heavy or binge drinking ($p > 0.05$). Male gender and lower education were significant for all risk behaviors except heavy drinking, and younger ages were significant for all risk behaviors.

The ACEs regression coefficients for risk behaviors produced odds ratios relative to no ACEs that were significantly increased with 1-2 ACEs (**Figure 1**). Compared to no ACEs, 1-2 ACEs was associated with a 1.8-fold greater risk of adult smoking (95%CI: 1.57, 2.0), a 1.3-fold greater risk of less seatbelt use (95% CI: 1.1, 1.4), a 1.4-fold increased risk of heavy drinking (95% CI: 1.2, 1.6), and a 1.3-fold greater risk of binge drinking (95% CI: 1.2, 1.5). Compared to the risk of adult risk behaviors with 1-2 ACEs, the risk of smoking behavior in adulthood associated with 3-8 ACEs increased significantly ($p < 0.05$), where, relative to no ACEs, the risk of smoking behavior was 2.8-fold greater (95% CI: 2.5, 3.2). Other risk behaviors did not increase significantly with 3-8 ACEs, relative to 1-2 ($p > 0.05$).

Generally, adult risk behaviors were more likely among residents between 18-54 years of age, compared to adults 55 and over, and more likely among men than women (**Table 5**). Smoking and less seatbelt use were more likely among residents who lived in rental or other housing. Hispanic/Latino ethnicity was protective against smoking, heavy drinking and binge drinking, and non-Hispanic Black/African American/Other/Multi-race was protective against binge drinking. Whereas no more than a high school education was a risk factor for smoking and less seat belt use, this demographic was protective against binge drinking.

These data suggest that, whereas 1-2 ACEs is associated with a mild yet statistically significant increase in adult risk behaviors, 3-8 ACEs is

Figure 1
Adjusted Odds Ratios
Adult Risk Behaviors and Poor Health Outcomes



Multivariate logistic regression was performed on weighted responses to the Adverse Childhood Experiences (ACEs) offered through the Behavioral Risk Factor Surveillance System (BRFSS) in Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin. Odds ratios for adult risk behaviors and poor health outcomes are shown with 95% confidence intervals for 1-2 and 3-8 ACEs, relative to no ACEs, as described in the **Methods** section.

associated with a strong likelihood of adult risk behaviors. A dose dependency between number of ACEs and risk of smoking behavior in adulthood was also observed.

Association Between Number of ACEs and Adult Health Outcomes

Multivariate logistic regression analysis was conducted for poor general, mental or physical health outcomes, and limited activity due to poor health as described in the **Methods** section, using smoking behavior as an additional covariate (**Table 6**). For all the health outcomes studied, the category of 1-2 ACES was not statistically significant ($p > 0.05$) and the covariate sex was either not significant or was only marginally significant. The age group of 35-54 was significant only for poor general health. All other categories and covariates were significant.

The number of ACEs was strongly associated with increasing risk of poor general health (**Figure 1**). Compared to no ACEs, individuals with 1-2 ACEs were 1.3 times (95% CI: 1.2, 1.5) more likely to have poor general health, and those with 3-8 ACEs were 2.0 (95% CI: 1.7, 2.3) times more likely to have poor general health. The increase in risk from 1-2 ACEs to 3-8 ACEs was statistically significant ($p < 0.05$). A similar trend was seen with poor mental health, and limited activity due to poor physical or mental health, in which 5-8 ACEs was associated with a significantly higher risk than 1-2 ACEs. Relative to no ACEs, 3-8 ACEs was associated with a 2.3-fold higher risk of poor mental health (95% CI: 1.9, 2.7), and a 3.0-fold increased risk of limited activity due to poor health (95% CI: 2.5, 3.6). The risk of poor physical health with 3-8 ACEs was not significantly greater than that with 1-2 ACEs. These increased risks were independent of the expected association between smoking and poor health outcomes.

These data indicate that 1-2 ACEs is associated with a mild yet significant increased risk of poor general, mental, and physical health outcomes in

adulthood, and that 3-8 ACEs is associated with a significantly stronger risk of poor mental and general health outcomes. The data also suggest a dependency on the number of ACEs and degree to which poor health limits work, recreational, or self-care activities.

Discussion

The results of this study indicate that adverse childhood events (ACEs) are associated with risk behaviors and poor health outcomes in adulthood. The strongest correlation between ACEs and adverse events in adulthood are smoking behavior and poor general health, poor mental health, and limited activity that results from poor mental or physical health. Smoking behavior, which is also a risk factor for poor health outcomes, was a controlled covariate in the analysis of poor health outcomes. The data also indicate that, whereas 1-2 ACEs is associated with a mild yet significant increased likelihood of adult risk behaviors and poor health outcomes, a larger number of ACEs is associated with a stronger risk of both smoking behavior and poor health outcomes.

The results obtained in this study have implications for state and local programs that serve adults and children. The demographic of families at risk for poor outcomes includes those whose adults and children have a high number of ACEs. Indicators of poor family outcomes and ACEs are similar, and include families of low income, families without post-high school education, and families of minority race/ethnicity. Adult and child program clients of low income, therefore, should be screened for ACEs by service providers, and positive screens should be referred for trauma-informed care [15,16].

A program designed specifically for at-risk families to break the intergenerational cycle of poor outcomes is the newly established Maternal, Infant, and Early Childhood home visiting program funded by the U.S. Health and Resources Services Administration, through the U.S. Patient Protection and Affordable Care Act of 2010 (Public Law 111-148). It is operated by all states in the country and is designed to serve pregnant and postpartum women, infants, and young children at risk for poor family outcomes. The program managed within the Connecticut Department of Public Health, includes screening for ACEs as a measure of eligibility and is an example of how ACEs can be used to screen and refer clients for trauma-informed care.

Recent work by Smith and coworkers [17] suggests that ACEs among pregnant women is associated with increased likelihood of preterm birth and low birth weight. This finding highlights the need for screening and trauma-focused care among at-risk women, not only during pregnancy. Preconception and inter-conception care are an increased focus nationwide as states work to reduce low birth weight and associated infant mortality [18-20], and screening and referral services for ACEs could also contribute significantly to this effort.

The results discussed in this report indicate that adult men and women are roughly equally at risk for adverse health behaviors and outcomes associated with ACEs events. There is also no significant difference in prevalence between men and women for type of ACEs, except for sexual abuse and household substance abuse. Screening and referral services, therefore, are important for both men and women.

Smoking in adulthood is associated with a 1.5- to 2 -fold increased risk of poor general, mental, and physical health, as well as limited activity due to poor health (**Table 6**; D. Sorosiak, DPH, *personal communication*). Adverse childhood experiences is also associated with smoking in adulthood, and as the number of ACEs increases, the risk of smoking behavior increases. Tobacco use cessation programs, such as that managed statewide by the Connecticut Department of Public Health (B. Walsh, DPH, Project Director), could be ideal venues for screening and referring adults with ACEs.

The results reported in this study did not judge the degree of severity of individual ACEs and how the severity contributes to adult risk behaviors and poor health outcomes. Physical abuse, for instance, was considered equally with witnessing domestic violence in the household, and sexual abuse and divorce or separation in the household were equally weighted as traumatic events. Within Connecticut, adult residents who reported verbal abuse as children also tended to report physical abuse, and those who reported physical abuse as children also tended to report witnessing domestic violence in the household (data not shown). Similarly, women who reported sexual abuse, and residents with household incarceration during childhood tended to report an increased number of ACEs. These data suggest that some types of traumatic events during childhood are more likely to be accompanied with other ACEs, a finding consistent with that of Dong and coworkers [21].

The frequency of responses from adults 18-24 years old and minority race/ethnicity groups was low and could not be examined fully in this study. Analysis of available prevalence data, however, suggest that individuals of minority race/ethnicity may be at higher

risk of adverse health behaviors and outcomes in adulthood. For instance, residents of Black/African American race had a high prevalence of 5-8 ACEs, which is strongly associated with an increased risk of smoking behavior in adulthood and poor health outcomes. Also, physical abuse and witnessing domestic violence in the household appear to be more prevalent within the Hispanic/Latino community. The possible need for enhanced ACEs screening and referral services within minority race/ethnic communities needs to be explored more fully.

It is not known why the prevalence of ACEs in the population is lower among adults at least 55 years, compared to younger adults. It is possible that the prevalence of ACEs has increased over the past few generations. It is also possible, and suggested by recent research [1,4], that mortality is higher among adults with ACEs, creating length bias, in which residents who remain alive at older ages are those who experienced less trauma in childhood. Alternatively, it is also possible that recent definitions of abuse have changed over time, or that older adults simply recall less ACEs. This study could not distinguish between these possibilities.

The data used for this study were a combination of BRFSS responses from six states: Connecticut, Minnesota, Montana, Vermont, Washington, and Wisconsin. Individual summary reports of the ACEs module have been produced by these states [22-27], and the prevalence findings in this report are consistent with those individual reports. In addition, the conclusions by some of these states about ACEs and adult behaviors and health outcomes are consistent with the findings in this report [23, 25, 27].

The results in this study indicate that ACEs events are more prevalent than previously reported [11]. Before calendar year 2011, the BRFSS survey collected survey responses only from residents who had landline phones, although the demographic of cell phone users was changing. This created a drift toward less population generalizability, which has been partly addressed by a new sampling and weighting methodology that solicits responses from individuals who only use cell phones, compared to earlier versions of the survey that relied solely on land line phones.

Other sources of bias to which this study are subject include: 1) nonresponse bias, 2) recall bias, and 3) selection bias. Modules in the BRFSS survey are offered at the end of the survey, which can require up to 22 minutes to complete, and the ACEs module is a set of 11 questions. Some respondents in this study terminated the survey before the entire ACEs module was completed. In addition, all respondents must remember in adulthood events that occurred during childhood. Finally, although the survey sampling methodology selects respondents at random, participation in the survey is voluntary.

In summary, this report demonstrates that adverse events in childhood have long-lasting effects into adulthood that are associated with risk behaviors, especially smoking behavior, and poor health outcomes. The results highlight the need for program providers serving at-risk families to screen and refer clients for trauma during childhood.

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