The Prevalence of Adverse Childhood Experiences and their Association with Adult Health: 2018 Indiana Behavioral Risk Factor Surveillance System Survey

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Abstract

Adverse childhood experiences (ACEs) are traumatic events, including abuse, household dysfunction, and neglect, that are experienced before the age of 18. Research has shown that ACEs increase the risk for various adverse health outcomes in adulthood. This cross-sectional study assessed the prevalence of ACEs and their association with health risks, perceived poor health indicators, and chronic health conditions using data from the 2018 Indiana Behavioral Risk Factor Surveillance System (BRFSS) survey. Data for 5,885 Indiana adults (ages 18 years and older) who responded to the ACE module in the 2018 Indiana BRFSS survey were analyzed. Multivariate logistic regression models were conducted to assess the relationships between cumulative ACE exposures and health risks, perceived poor health indicators, and chronic health conditions when adjusting for age, sex, race, and education. An additional set of models estimating the odds of perceived poor health indicators and chronic health conditions for respondents who reported three or more ACEs compared to those who reported no ACEs also adjusted for smoking and obesity. Prevalence estimates indicate that a majority of respondents (61.2%) reported at least one ACE and that exposure to ACEs differed by sex, age, race, income, education, and disability status. Models adjusting for sociodemographic factors demonstrated that increasing ACE exposure significantly increased the odds for current smoking, heavy drinking, binge drinking, obesity, fair or poor general health, poor physical and mental health, depressive disorder, chronic obstructive pulmonary disease, coronary heart disease, and arthritis. Further adjustment for smoking and obesity resulted in slightly attenuated, yet still significant, model estimates. Findings from this study demonstrate that ACEs are prevalent and are significantly associated with various health risks and adverse health outcomes among Indiana adults.

Adverse Childhood Experiences

Adverse childhood experiences (ACEs) are traumatic or stressful events, including various types of abuse, household adversity, and neglect, occurring before age 18.[1] As mounting epidemiological evidence demonstrates that ACEs are associated with leading causes of morbidity and mortality among US adults,[2] exposure to ACEs is a significant public health concern. Thus, this study aims to determine the prevalence of ACEs in Indiana and their association with health risk behaviors, perceived health status, and chronic health conditions among Indiana adults.

The ACE Study

The ACE Study, conducted by Kaiser Permanente in collaboration with the Centers for Disease Control and Prevention (CDC) from 1995 to 1997, was the first study to examine the relationship between a broad range of traumatic childhood events and a variety of adult health outcomes.[3,4] This study included over 17,000 participants who received physical exams and completed surveys regarding their childhood experiences and current health.[3,4] The ACEs assessed by the survey included psychological, physical, and sexual abuse, psychological and physical neglect, and exposure to substance abuse, mental illness, violent treatment of the maternal parent, and criminal behavior in the household.[4]

The study found that ACEs are common, with almost two-thirds of study participants reporting at least one ACE and over 20 percent reporting three or more ACEs.[3,4] Findings also demonstrated strong, "dose-response" relationships between the cumulative number of childhood exposures and various health risks (e.g. smoking, severe obesity, physical inactivity, depressed mood, and alcoholism) as well as various chronic conditions (e.g. heart disease, cancer, emphysema, hepatitis, and perceived poor health); as the number of reported ACEs increased, the odds for various adverse health outcomes increased.[4] The researchers suggested that the observed relationship between cumulative exposure to ACEs and adverse health outcomes could be attributed to the adoption of health risk behaviors as coping mechanisms to reduce the stress and psychological impacts of childhood traumas. This conceptual framework is depicted in Figure 1.[4]

The ACE Study has also been used to demonstrate that epidemiological and neurobiological evidence of the effects of childhood trauma are analogous; the observed dose-response relationship between the number of reported ACEs and various adverse health outcomes in the ACE Study theoretically corresponds with the relationship between cumulative exposure to stress on the developing brain and subsequent impairment to various brain structures and functions.[5] This convergence of findings between the epidemiological and neurobiological fields validates the conceptual framework that was first developed by researchers of the ACE Study (Figure 1).



Figure 1. Conceptual Framework for the ACE Study

Table 1. Adverse Childhood Experiences Module and Scoring
Child abuse:
Emotional abuse [More than once] 1. How often did a parent or adult in your home ever swear at you, insult you, or put you down? **Physical abuse** [Once or more than once] 2. How often did a parent or adult in your home ever hit, beat, or physically hurt you in any way? **Sexual abuse** [Once or more than once to any question] 3. How often did anyone at least 5 years older than you, or an adult, ever touch you sexually? 4. How often did anyone at least 5 years older than you, or an adult, try to make you touch them sexually? 5. How often did anyone at least 5 years older than you, or an adult, force you to have sex?
Household dysfunction:
Mental illness in the household [Yes] 6. Did you live with anyone who was depressed, mentally ill, or suicidal? **Domestic violence in the household** [Once or more than once] 7. How often did your parents or adults in your home ever slap, hit, kick, punch, or beat each other up? **Substance abuse in the household** [Yes to either question] 8. Did you live with anyone who was a problem drinker or alcoholic? 9. Did you live with anyone who used illegal street drugs or who abused prescription medications? **Parental separation/divorce** [Yes] 10. Were your parents separated or divorced? **Incarcerated household member** [Yes] 11. Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?

The Behavioral Risk Factor Surveillance System and the ACE Module

The Behavioral Risk Factor Surveillance System (BRFSS) was established by the CDC in 1984 and is now the largest, continuously conducted health surveillance system in the world.[6] The BRFSS is a state-based telephone survey that collects information from non-institutionalized U.S. adults regarding their health conditions and risk behaviors each year.[7] Responses are weighted by the CDC to ensure estimates are reflective of the known population so that results can be generalized to the state as a whole.[6] Indiana was one of the first 15 states to begin implementing the BRFSS since it began in 1984.[6]

In 2008, the CDC developed an optional BRFSS ACE module with questions adapted from the original ACE Study in order to collect information regarding the prevalence of ACEs and their relation to major public health concerns within each state.[8] Since then, 48 states and the District of Columbia have included the ACE module for at least one year on their survey.[7] Indiana first included the ACE module in 2018.[7]

The ACE module consists of 11 questions referring to the respondents' first 18 years of life.[7] The 11 questions assess eight categories of ACEs, which comprise three types of child abuse and five types of household dysfunction.[7] Table 1 depicts how the ACE questions are divided amongst the eight categories.

Methods

Data for this study were obtained from the 2018 Indiana BRFSS survey.

ACE Module Scoring

An ACE score was calculated for each respondent based on exposure to the eight ACE categories. Table 1 displays the responses that correspond with exposures to each of the ACE categories.

For categories with "yes" or "no" response choices, a response of "yes" to any question in that category indicated exposure to that category. For categories

with “never”, “once”, or “more than once” response choices, a response of “once” or “more than once” to any question in that category indicated exposure to that category, excluding emotional abuse.

The definition of exposure to emotional abuse differs by state; some researchers have defined exposure to emotional abuse as a response of “once” or “more than once” to the emotional abuse question presented in Table 1, while others have defined it as only a response of “more than once”.[9] This study utilized the latter definition; a respondent was exposed to emotional abuse only if they responded with “more than once”.

Exposure to any ACE category counted as one point toward the final ACE score, which ranged from zero to eight. ACE scores were only calculated for respondents who answered all 11 ACE module questions; respondents who did not know or refused any ACE question did not receive an ACE score and were not included in subsequent analyses.

ACE Score Groups

ACE scores were categorized into three main ACE score groups: “0 ACEs” for those who reported no ACEs, “1-2 ACEs” for those who reported one or two ACEs, and “3+ ACEs” for those who reported three to eight ACEs. This grouping is in accordance with the “Adverse Childhood Experiences Among Adults” life course indicator for the Life Course Metrics Project[10] and has been utilized in other states’ reports on ACEs.[9,11]

Sociodemographic Variables

Various sociodemographic characteristics were obtained from the survey. Continuous variables, including age and annual household income, were categorized. Other categorical variables that were obtained include sex, race, education, and disability status. In accordance with CDC guidelines, an individual was classified as having a disability if they reported: being deaf or having serious difficulty hearing; being blind or having serious difficulty seeing even when wearing glasses; having difficulty dressing or bathing; having serious difficulty walking or climbing stairs; or having serious difficulty concentrating, remembering, making decisions, or doing errands alone because of a physical, mental, or emotional condition.[12]

Health Risk Outcomes

Health risk factors that were obtained from the survey include smoking status, various drinking behaviors, engagement in physical activity, and obesity status. Current smoking was defined as individuals who reported smoking some or every day. Heavy drinking was defined as males who have more than 14 drinks per week or females who have more than seven drinks per week. Binge drinking was assigned to males who had five or more drinks or females who had four or more drinks on one or more occasions in the past 30 days. Drinking and driving was assigned to individuals who reported having driven at least once after having too much to drink. Physical inactivity was assigned to individuals who reported not engaging in any physical activity or exercise in the past 30 days. Obesity was defined as having a body mass index greater than or equal to 30.

Perceived Poor Health Outcomes

There were three perceived poor health indicators obtained from the survey: fair or poor health, poor physical health, and poor mental health. Fair or poor health was assigned to individuals who reported that their general health was fair or poor. Poor physical health was assigned to individuals who reported having 14 or more days of poor physical health in the past 30 days. Poor mental health was assigned to individuals who reported having 14 or more days of poor mental health in the past 30 days.

Chronic Condition Outcomes

The chronic condition outcomes were assigned to individuals if they reported having ever been diagnosed with that condition by a doctor. Depressive disorder was assigned to individuals who reported having ever been diagnosed with depression, major depression, dysthymia, or minor depression. Chronic Obstructive Pulmonary Disease (COPD) was assigned to individuals who reported that they had ever been diagnosed with COPD, emphysema, or chronic bronchitis. Diabetes was assigned to individuals who reported having been

diagnosed with diabetes at any time other than pregnancy. The remaining conditions assigned to individuals who reported diagnosis include current asthma, coronary heart disease (CHD), any cancer other than skin, kidney disease, and any form of arthritis.

Statistical Analysis

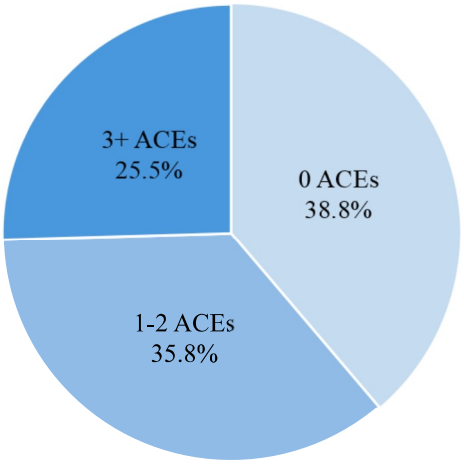
All analyses were performed using SAS version 9.4 and weighted using the weighting and stratification variables from the 2018 Indiana BRFSS dataset. Only weighted percentages are presented. All missing data (N=1,511) were excluded from analyses.

The prevalence of ACE score groups and individual ACE categories were calculated. Prevalence estimates were also calculated for ACE score groups and individual ACE categories according to sociodemographic characteristics. Significant differences between sociodemographic groups were determined based on whether the 95 percent Wald confidence intervals (CIs) overlapped; non-overlapping 95 percent CIs were determined to be significantly different.

The prevalence of health risks, perceived health status, and chronic health conditions by ACE score groups was also calculated. Bivariate relationships between these adverse health outcomes and ACE score groups were considered statistically significant if chi-squared tests of independence produced p-values less than 0.05.

Multivariate logistic regression models were conducted to assess the relationships between ACE score groups and adverse health outcomes when adjusting for age, sex, race, and education. ACE score groups were the main predictors of the models, and the 0 ACEs score group was used as the referent. An additional set of models estimating the odds of perceived poor health indicators and chronic health conditions for respondents who reported three or more ACEs compared to those who reported no ACEs also adjusted for smoking and obesity. Adjusted odds ratios were determined to be significant if the corresponding 95 percent CIs did not include 1.00.

Figure 1. Prevalence of ACE Scores among Indiana Adults



Results

Prevalence of ACE Scores

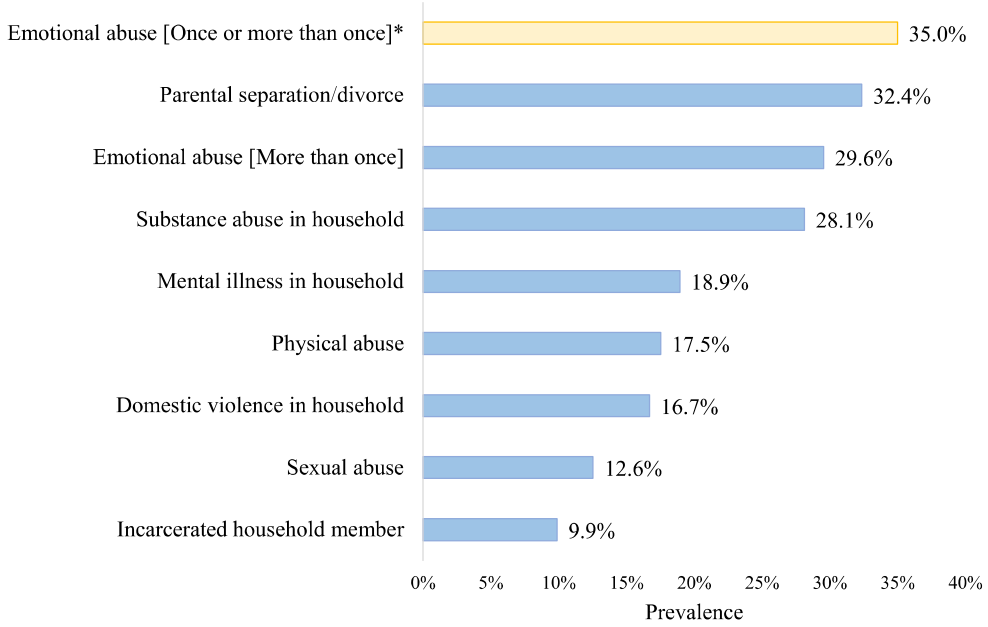
The prevalence of ACE scores among Indiana adults is displayed in Figure 1. A majority (61.2%) of survey respondents reported having experienced at least one ACE, and approximately one-fourth (25.5%) reported having experienced three or more ACEs.

Prevalence of Individual ACE Categories

The prevalence estimates of individual ACE categories are displayed in Figure 2. The prevalence estimates of both aforementioned definitions of exposure to emotional abuse are presented in Figure 2 to demonstrate the variability in results depending on the selected definition.

If exposure to emotional abuse had been defined as responses of "once" or "more than once" to the corresponding question in Table 1, then emotional abuse would have been the most prevalent (35.0%) ACE category; however, this study defined exposure to emotional abuse as a response of "more than once", making it the second most prevalent (29.6%) ACE category behind parental separation or divorce (32.4%). Substance abuse in the household was also commonly experienced, with over one-fourth of respondents (28.1%) reporting exposure to that ACE category.

Figure 2. Prevalence of Individual ACE Categories among Indiana Adults



* Estimate is presented to demonstrate variability in results due to differences in categorizing emotional abuse; this study defines exposure to emotional abuse as a response of "more than once" (Table 1).

Prevalence of ACE Scores by Sociodemographic Characteristics

The prevalence of ACE scores by sociodemographic characteristics is presented in Table 2. ACE scores did not differ significantly by sex. The percentage of adults experiencing three or more ACEs was significantly higher among young adults compared to older adults, especially those aged 65 years and older; non-Hispanic multiracial individuals compared to other non-Hispanic individuals; low-income individuals compared to higher-income individuals, especially those who make $75,000 or more per year; individuals who did not graduate from high school, graduated from high school, or attended college or technical school compared to those who graduated from college/technical school; and individuals with disabilities compared to non-disabled individuals.

Table 2. Prevalence of ACE Scores by Sociodemographic Characteristics[†], 2018 IN BRFSS							
	Sample Size	0 ACEs		1-2 ACEs		3+ ACEs	
		%	95% CI	%	95% CI	%	95% CI
Sex							
Male	2,441	**40.6**	38.1 – 43.1	**35.8**	33.3 – 38.3	**23.6**	21.2 – 26.0
Female	3,433	**37.0**	34.9 – 39.1	**35.8**	33.6 – 38.0	**27.2**	25.1 – 29.3
Age							
18 – 24	257	**23.9**	18.1 – 29.7	**39.6**	32.8 – 46.3	**36.5**	29.8 – 43.2
25 – 34	431	**27.8**	23.2 – 32.5	**35.9**	30.8 – 41.0	**36.3**	31.1 – 41.5
35 – 44	559	**34.0**	29.5 – 38.4	**35.7**	31.1 – 40.2	**30.4**	26.0 – 34.8
45 – 54	896	**38.3**	34.6 – 42.0	**36.7**	33.0 – 40.4	**25.0**	21.8 – 28.3
55 – 64	1,303	**42.0**	38.9 – 45.1	**36.8**	33.8 – 39.9	**21.2**	18.6 – 23.8
65+	2,439	**55.9**	53.5 – 58.3	**32.1**	29.8 – 34.4	**12.0**	10.3 – 13.6
Race							
White[¤]	4,977	**40.7**	38.9 – 42.4	**34.9**	33.1 – 36.6	**24.5**	22.8 – 26.2
Black[¤]	420	**28.1**	22.8 – 33.5	**46.6**	40.5 – 52.7	**25.3**	20.0 – 30.6
Other race[¤]	130	**43.9**	29.4 – 58.4	**32.7**	18.8 – 46.7	**23.4**	11.4 – 35.3
Multiracial[¤]	97	**19.8**	10.9 – 28.8	**26.1**	15.1 – 37.0	**54.1**	41.5 – 66.8
Hispanic	186	**29.9**	21.9 – 37.8	**36.9**	28.3 – 45.6	**33.2**	24.7 – 41.7
Income							
Less than $10,000	192	**22.6**	14.8 – 30.3	**35.3**	26.8 – 43.8	**42.1**	33.2 – 51.1
$10,000-$14,999	210	**29.4**	21.4 – 37.4	**34.6**	26.0 – 43.2	**36.1**	26.5 – 45.7
$15,000-$19,999	349	**33.9**	27.5 – 40.3	**37.7**	30.6 – 44.8	**28.4**	21.8 – 35.0
$20,000-$24,999	470	**34.4**	28.9 – 39.9	**36.7**	30.7 – 42.7	**29.0**	23.3 – 34.7
$25,000-$34,999	582	**38.8**	33.5 – 44.0	**31.7**	26.4 – 36.9	**29.6**	24.3 – 34.9
$35,000-$49,999	752	**35.8**	31.5 – 40.1	**36.4**	31.7 – 41.1	**27.8**	23.2 – 32.4
$50,000-$74,999	831	**40.9**	36.5 – 45.3	**35.6**	31.3 – 39.8	**23.5**	19.5 – 27.5
$75,000+	1,404	**41.9**	38.6 – 45.2	**38.8**	35.5 – 42.1	**19.3**	16.4 – 22.2
Education							
Did not graduate HS	461	**28.1**	23.0 – 33.3	**36.6**	30.8 – 42.4	**35.3**	29.3 – 41.3
Graduated HS	1,982	**39.3**	36.6 – 42.0	**36.3**	33.6 – 39.2	**24.3**	21.7 – 26.8
Attended College[€]	1,517	**35.4**	32.4 – 38.5	**35.3**	32.1 – 38.5	**29.3**	26.2 – 32.4
Graduated College[€]	1,913	**48.3**	45.4 – 51.1	**35.0**	32.2 – 37.7	**16.8**	14.6 – 18.9
Disability							
Yes	1,992	**31.4**	28.8 – 34.0	**33.2**	30.4 – 36.0	**35.4**	32.5 – 38.4
No	3,840	**41.7**	39.6 – 43.7	**37.0**	34.9 – 39.0	**21.4**	19.5 – 23.3
Overall:	5,885	**38.8**	37.2 – 40.4	**35.8**	34.1 – 37.4	**25.5**	23.9 – 27.0

Abbreviation. HS: High School.
[†] Table displays row percentages; denominator for each percentage is the total number of respondents in each demographic category. Numerator for each percentage is the total number of respondents in each demographic category who experienced 0, 1-2, or 3+ ACEs. All percentages were weighted using the BRFSS weighting variable _LLCPWT.
[¤] Non-Hispanic.
[€] Or technical school.

Prevalence of Individual ACE Categories by Sociodemographic Characteristics

The prevalence estimates of individual ACE categories by sociodemographic characteristics are presented in Appendix A. While males and females did not differ significantly in ACE score groups (Table 2), a greater percentage of females reported experiencing mental illness in the household and sexual abuse compared to males.

Age, income, and education presented similar trends as those observed in Table 2, with the prevalence estimates for each individual ACE category decreasing with increasing age, income, and educational attainment. Non-Hispanic multiracial individuals had consistently higher prevalence estimates of each ACE category compared to all other race categories. A significantly greater percentage of individuals with disabilities reported experiencing each individual ACE category compared to those without disabilities, excluding parental separation or divorce.

Table 3. Prevalence of Adverse Health Outcomes by ACE Scores[†], 2018 IN BRFSS

	0 ACEs		1-2 ACEs		3+ ACEs	
	N	%	N	%	N	%
Health Risks						
Current smoker***	287	12.8	365	20.6	387	35.7
Drinking and driving	25	2.1	25	2.2	21	4.6
Heavy drinking**	104	4.4	113	7.0	84	8.7
Binge drinking***	200	11.4	264	16.6	193	23.3
Obesity*	776	32.3	706	37.1	456	37.1
Physical inactivity (past 30 days)	768	26.7	636	27.5	376	28.8
Perceived Poor Health						
14+ days of poor mental health***	139	5.4	240	12.5	297	25.9
Fair or poor general health***	418	14.2	483	19.5	399	28.6
14+ days of poor physical health***	298	9.9	309	11.4	291	20.8
Chronic Health Conditions						
Depressive disorder***	266	9.1	408	17.3	479	39.9
COPD***	221	6.6	249	8.6	221	13.4
Arthritis	1,001	28.5	820	29.5	535	32.9
Current asthma***	206	7.2	193	8.8	196	16.1
Stroke	133	3.8	113	4.0	88	4.8
CHD	182	5.2	153	5.0	88	5.0
Kidney disease	132	3.5	97	3.4	66	4.0
Diabetes	465	13.3	375	12.9	205	12.4
Cancer (other than skin)	291	8.1	223	7.2	126	6.8
Overall:	2,701	38.8	2,008	35.8	1,176	25.5

Abbreviations. COPD: Chronic Obstructive Pulmonary Disease; CHD: Coronary Heart Disease.

[†] Table displays column percentages; denominator for each percentage is the total number of respondents who experienced 0, 1-2, or 3+ ACEs. Numerator for each percentage is the total number of respondents who experienced 0, 1-2, or 3+ ACEs and who reported each health risk, perceived poor health indicator, or chronic health condition. All percentages were weighted using the BRFSS weighting variable _LLCPWT.

* p < .05; ** p < .01; *** p < .001 from chi-squared test of independence.

Prevalence of Adverse Health Outcomes by ACE Scores

The prevalence estimates of adverse health outcomes including health risks, perceived poor health indicators, and chronic health conditions, are presented by ACE score groups in Table 3. With regard to the health risks, current smoking, heavy drinking, binge drinking, and obesity demonstrated statistically significant bivariate relationships with ACE score groups. All three perceived poor health indicators also exhibited statistically significant bivariate relationships with ACE score groups. For chronic health conditions, depressive disorder, COPD, and current asthma were statistically significantly related to ACE score groups. Those who reported being diagnosed with a depressive disorder exhibited the largest difference in reporting 0 ACEs (9.1%) compared to reporting three or more ACEs (39.9%). There were no significant bivariate relationships observed between ACE score groups and drinking and driving, physical inactivity, arthritis, stroke, CHD, kidney disease, diabetes, or cancer (other than skin).

Association of ACE Scores with Adverse Health Outcomes

The results from the multivariate logistic regression models are presented in Table 4. With regard to health risk models, physical inactivity in the past 30 days was the only health risk to not exhibit a significant association with either the 1-2 or 3+ ACE score groups compared to the 0 ACEs reference group after adjusting for sociodemographic variables. Individuals who reported three or more ACEs had significantly higher odds of drinking and driving compared to individuals who reported no ACEs when sociodemographic variables were held constant. All other health risks exhibited significant graded associations among ACE score groups compared to the 0 ACEs reference group when sociodemographic variables were held constant.

Table 4. Adjusted Odds Ratios for Adverse Health Outcomes by ACE Scores, 2018 IN BRFSS

	1-2 ACEs		3+ ACEs	
	aOR*	95% CI	aOR*	95% CI
Health Risks				
Current smoker	**1.58**	1.26 – 1.97	**3.00**	2.36 – 3.81
Drinking and driving	1.18	0.55 – 2.55	**2.63**	1.16 – 5.95
Heavy drinking	**1.60**	1.12 – 2.27	**1.95**	1.31 – 2.90
Binge drinking	**1.42**	1.11 – 1.82	**1.95**	1.48 – 2.56
Obesity	**1.24**	1.04 – 1.47	**1.28**	1.05 – 1.57
Physical inactivity (past 30 days)	1.09	0.91 – 1.30	1.22	0.99 – 1.51
Perceived Poor Health				
14+ days of poor mental health	**2.22**	1.66 – 2.96	**4.79**	3.60 – 6.37
Fair or poor general health	**1.57**	1.27 – 1.93	**3.02**	2.39 – 3.81
14+ days of poor physical health	**1.28**	1.02 – 1.61	**2.99**	2.34 – 3.83
Chronic Health Conditions				
Depressive disorder	**2.02**	1.61 – 2.54	**6.31**	5.00 – 7.97
COPD	**1.59**	1.23 – 2.05	**3.40**	2.58 – 4.48
Arthritis	**1.48**	1.25 – 1.75	**2.60**	2.10 – 3.20
Current asthma	1.15	0.86 – 1.52	**2.36**	1.78 – 3.14
Stroke	1.18	0.85 – 1.63	**2.09**	1.48 – 2.95
CHD	**1.36**	1.01 – 1.81	**2.00**	1.40 – 2.86
Kidney disease	1.27	0.90 – 1.79	**1.88**	1.26 – 2.83
Diabetes	1.22	0.99 – 1.48	**1.64**	1.28 – 2.10
Cancer (other than skin)	1.14	0.88 – 1.46	**1.48**	1.07 – 2.04

Abbreviations. aOR: Adjusted Odds Ratio; COPD: Chronic Obstructive Pulmonary Disease; CHD: Coronary Heart Disease.
Bold Adjusted Odds Ratios indicate statistical significance.
* Odds Ratios adjusted for sex, age, race, and education with 0 ACEs as the referent.

For the perceived poor health models, all three indicators exhibited strong significant associations with both the 1-2 and 3+ ACE score groups compared to the 0 ACEs reference group after adjusting for sociodemographic variables. The strongest relationship was observed between the poor mental health indicator and the 3+ ACEs score group; individuals who reported three or more ACEs had 4.79 times higher odds of experiencing 14 days or more of poor mental health in the past 30 days compared to individuals who reported no ACEs.

With regard to the chronic health condition models, individuals who reported three or more ACEs had significantly higher odds of having current asthma, stroke, kidney disease, diabetes, and cancer (other than skin) compared to individuals who reported no ACEs after adjusting for sociodemographic variables. All other chronic health conditions, including depressive disorder, COPD, arthritis, and CHD, exhibited significant graded associations among ACE score groups compared to the 0 ACEs reference group when sociodemographic variables were held constant. The relationship between depressive disorder and the 3+ ACEs score group was especially strong; individuals who reported three or more ACEs had 6.31 times higher odds of having a depressive disorder compared to individuals who reported no ACEs.

An additional set of models assessing the relationships between the 3+ ACEs score group and adverse health outcomes adjusted for smoking and obesity in addition to sociodemographic variables

(Appendix B). The adjusted odds ratios for these models decreased slightly from the estimates that did not adjust for smoking or obesity but remained significant for all health outcomes.

Discussion

ACEs are prevalent among Indiana adults; over one-half of respondents reported having experienced at least one ACE, while approximately one-fourth reportedly experienced three or more ACEs. These findings are consistent with results from other states[1,7,9,11,13,14] and the original ACE Study.[3,4] Parental separation or divorce, emotional abuse, and substance abuse in the household were the three most commonly reported ACEs, which is also consistent with findings from other states.[7,9,11,13,14,15]

ACE score differed significantly by age, race, income, education, and disability status. The substantially smaller percentage of older adults experiencing three or more ACEs compared to young adults could represent actual differences in exposure to ACEs but could also be attributed to differential ability to recall or willingness to disclose ACEs. This trend could also be influenced by increased rates of early mortality among individuals with high exposure to ACEs.[11] Differences in ACE score observed among race, income, and education are comparable with those reported across other states.[13] Although a significant difference was not observed between males and females for ACE scores, a significantly higher percentage of females reported experiencing sexual abuse and mental illness in the household, in congruence with other states.[9,13,15]

A strikingly higher proportion of individuals with disabilities reported experiencing three or more ACEs compared to those without disabilities. Individuals with disabilities also reported experiencing each individual ACE category more than those without disabilities, excluding parental separation or divorce. Similar results have been demonstrated in other studies;[15] however, since the BRFSS disability questions do not differentiate disabilities that may have been present in childhood from disabilities that may have developed later in life, some states have assessed disability as a health outcome.[9,11] Despite this inconsistency in assessments, it is evident that there is a relationship between disability status and ACEs.

Results from the health risk models show that ACEs are associated with various health risks in adulthood, as has been previously demonstrated across other states[9,11,14,15] and in the original ACE Study.[4] Individuals who have experienced multiple ACEs may adopt certain health risk behaviors as coping mechanisms to relieve the psychological impacts of childhood trauma.[4] For example, since nicotine has been shown to regulate the neuro-pathways involved in stress response, anxiety, and depression,[16] people may engage in smoking or other tobacco-related behaviors to consciously or unconsciously adapt to any mental distress imparted by ACEs.[8]

The perceived poor health models demonstrate that ACEs are strongly associated with perceived poor health among adults, suggesting that multiple traumatic experiences in childhood can negatively affect health status and quality of life in adulthood.[11] Similar findings have been shown by other states.[9,11,15]

The results from the chronic health condition models demonstrate that ACEs are also associated with various chronic health conditions in adulthood. Although many of the bivariate relationships between chronic health conditions and ACE score groups were insignificant, adjusting for sociodemographic characteristics revealed significant associations. Further adjustment for smoking and obesity resulted in slightly reduced, yet still significant odds ratios, indicating that the effect of experiencing multiple ACEs on various health outcomes surpasses that of the well-documented health risks smoking and obesity. Comparable graded associations between ACE scores and various chronic health conditions have been shown in previous studies.[4,11,14,15] Researchers from the original ACE Study suggested that ACEs may be associated with adverse health outcomes via the adoption of health risk behaviors as coping mechanisms for psychological impairment, as demonstrated in Figure 1.[4]

The findings from this study are subject to several limitations. First, due to the cross-sectional design of this study, it cannot be determined whether any observed relationships are causal. In addition, the use of self-report data is subject to various biases; for example, survey respondents may not be able to accurately remember personal information or experiences. Respondents may also be less inclined to report undesirable or socially-stigmatized characteristics, behaviors, conditions, or experiences; conversely, respondents may be inclined to over-report socially desirable factors. Lastly, all missing data were removed from any analyses, which could result in biased estimates.

Despite these limitations, the results from this study demonstrate that exposure to ACEs is a significant public health concern in Indiana. Preventing ACEs could potentially reduce a large number of health conditions.[1,14] In order to augment child maltreatment prevention efforts in Indiana, it will be necessary to raise awareness of the prevalence of ACEs and their association with adverse adult health outcomes among key stakeholders across Indiana, such as child welfare agencies, human service providers, healthcare agencies, and policymakers. Several states have demonstrated how ACE findings can be used to inform prevention efforts.[2]

For example, Oklahoma utilized ACE data to unify agencies across multiple sectors, such as the Department of Mental Health and Substance Abuse and Family Support and Prevention Services, to guide prevention efforts. Oklahoma also applied for, received, and allocated federal funding for the prevention of ACEs; for example, the Oklahoma Department of Mental Health and Substance Abuse Services was awarded a grant to support the initiative Strengthening Hope and Resiliency Everyday (SHARE), which raises awareness about ACEs and provides strategies for communities to prevent and mitigate the effects of ACEs.[2]

While specific prevention efforts have varied across states, general strategies that have been implemented include dissemination of key findings to stakeholders, appropriation of funding to programs that prevent ACEs and mitigate their effects, and use of key findings to inform ACE prevention policies.[2]

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Appendix

Appendix A. Prevalence of Individual ACE Categories by Sociodemographic Characteristics, 2018 IN BRFSS

	Sample Size[¶]	Mental Illness in Household		Substance Abuse in Household		Incarcerated Household Member		Parental Separation/ Divorce	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
Sex									
Male	2,591	**16.7**	14.6 – 18.9	**26.8**	24.5 – 29.1	**10.9**	9.0 – 12.7	**31.1**	28.6 – 33.5
Female	3,644	**21.0**	19.1 – 22.9	**29.4**	27.3 – 31.4	**9.0**	7.5 – 10.5	**33.7**	31.5 – 35.9
Age									
18 – 24	274	**33.0**	26.6 – 39.4	**37.5**	31.0 – 43.9	**21.4**	15.7 – 27.0	**44.8**	38.2 – 51.4
25 – 34	458	**31.5**	26.7 – 36.3	**34.0**	29.1 – 39.0	**17.0**	13.0 – 20.9	**45.6**	40.4 – 50.7
35 – 44	591	**22.1**	18.3 – 25.9	**29.6**	25.5 – 33.8	**11.4**	8.5 – 14.4	**42.1**	37.5 – 46.7
45 – 54	944	**16.2**	13.5 – 18.9	**28.3**	25.0 – 31.7	**7.0**	5.1 – 9.0	**34.0**	30.5 – 37.6
55 – 64	1,379	**12.2**	10.3 – 14.2	**26.0**	23.3 – 28.7	**5.4**	3.9 – 6.8	**23.2**	20.6 – 25.9
65+	2,600	**7.6**	6.3 – 8.9	**19.5**	17.5 – 21.4	**3.4**	2.4 – 4.3	**15.7**	13.9 – 17.4
Race									
White[¤]	5,263	**18.8**	17.3 – 20.4	**27.8**	26.1 – 29.5	**8.7**	7.5 – 9.9	**30.3**	28.6 – 32.1
Black[¤]	454	**15.7**	10.9 – 20.5	**27.5**	22.2 – 32.7	**15.3**	10.9 – 19.7	**46.7**	40.8 – 52.6
Other race[¤]	142	**18.7**	7.9 – 29.4	**23.0**	11.8 – 34.1	—	—	**27.3**	15.1 – 39.5
Multiracial[¤]	109	**34.5**	22.5 – 46.5	**51.2**	39.1 – 63.3	**22.4**	11.9 – 33.0	**50.7**	38.7 – 62.8
Hispanic	195	**20.4**	13.0 – 27.9	**28.1**	20.4 – 35.8	**17.5**	10.6 – 24.4	**40.2**	31.6 – 48.8
Income									
Less than $10,000	213	**25.0**	17.2 – 32.8	**40.6**	32.2 – 49.0	**20.7**	13.1 – 28.2	**50.7**	42.1 – 59.4
$10,000-$14,999	226	**23.1**	14.6 – 31.5	**31.6**	22.9 – 40.3	**15.7**	8.4 – 22.9	**41.8**	32.4 – 51.2
$15,000-$19,999	382	**17.3**	12.0 – 22.6	**32.3**	25.9 – 38.7	**11.6**	7.1 – 16.0	**40.1**	33.1 – 47.1
$20,000-$24,999	497	**17.2**	12.7 – 21.8	**31.4**	25.6 – 37.2	**15.0**	10.1 – 19.8	**38.5**	32.5 – 44.5
$25,000-$34,999	607	**18.7**	14.0 – 23.5	**30.0**	24.8 – 35.1	**10.7**	7.2 – 14.3	**31.8**	26.7 – 37.0
$35,000-$49,999	785	**25.4**	20.8 – 30.1	**32.0**	27.5 – 36.6	**10.1**	6.7 – 13.5	**32.5**	27.8 – 37.1
$50,000-$74,999	861	**18.8**	15.1 – 22.5	**27.1**	23.1 – 31.1	**8.5**	5.7 – 11.3	**28.6**	24.4 – 32.8
$75,000+	1,458	**15.3**	12.7 – 17.9	**23.3**	20.5 – 26.2	**5.0**	3.1 – 6.8	**28.0**	24.9 – 31.2
Education									
Did not graduate HS	495	**23.8**	18.4 – 29.2	**39.8**	34.0 – 45.6	**22.4**	17.0 – 27.7	**46.8**	40.9- 52.7
Graduated HS	2,135	**16.3**	14.1 – 18.6	**26.8**	24.3 – 29.2	**10.0**	8.2 – 11.8	**34.1**	31.4 – 36.9
Attended College[€]	1,609	**21.8**	19.0 – 24.7	**30.4**	27.4 – 33.4	**9.3**	7.2 – 11.3	**33.2**	30.2 – 36.3
Graduated College[€]	1,994	**16.2**	14.0 – 18.3	**20.9**	18.6 – 23.2	**3.7**	2.5 – 4.9	**20.8**	18.4 – 23.1
Disability									
Yes	2,158	**23.8**	21.2 – 26.5	**37.5**	34.7 – 40.4	**14.6**	12.2 – 17.0	**34.0**	31.2 – 36.9
No	4,023	**16.7**	15.1 – 18.4	**24.2**	22.4 – 26.1	**7.8**	6.5 – 9.2	**31.8**	29.8 – 33.8
Overall:	7,396	**18.9**	17.5 – 20.4	**28.1**	26.6 – 29.7	**9.9**	8.7 – 11.1	**32.4**	30.7 – 34.0

Abbreviation. HS: High School.

[†] Table displays row percentages; denominator for each percentage is the total number of respondents in each demographic category. Numerator for each percentage is the total number of respondents in each demographic category who experienced each individual ACE category. All percentages were weighted using the BRFSS weighting variable _LLCPWT.

[¶] Sample size varies slightly by ACE category due to "don't know/not sure", refusal, and missing responses.

[¤] Non-Hispanic.

[€] Or technical school.

Appendix A. Prevalence of Individual ACE Categories by Sociodemographic Characteristics, 2018 IN BRFSS (continued)									
	Sample Size[¶]	**Domestic Violence in Household**		**Emotional Abuse**		**Physical Abuse**		**Sexual Abuse**	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
Sex:									
Male	2,591	**15.6**	13.6 – 17.5	**29.5**	27.1 – 32.0	**18.1**	16.0 – 20.2	**6.3**	5.0 – 7.6
Female	3,644	**17.8**	16.0 – 19.5	**29.7**	27.6 – 31.7	**17.1**	15.3 – 18.8	**18.4**	16.7 – 20.1
Age:									
18 – 24	274	**22.1**	16.5 – 27.7	**39.8**	33.2 – 46.4	**25.3**	19.3 – 31.3	**10.2**	6.0 – 14.5
25 – 34	458	**18.4**	14.3 – 22.4	**38.9**	33.8 – 44.0	**21.4**	17.1 – 25.7	**13.0**	9.5 – 16.5
35 – 44	591	**18.6**	15.1 – 22.2	**30.6**	26.3 – 34.8	**20.0**	16.3 – 23.7	**14.3**	11.1 – 17.5
45 – 54	944	**16.4**	13.6 – 19.1	**30.2**	26.8 – 33.6	**16.4**	13.7 – 19.0	**15.8**	13.1 – 18.5
55 – 64	1,379	**16.6**	14.3 – 19.0	**28.9**	26.1 – 31.7	**15.5**	13.3 – 17.7	**14.6**	12.4 – 16.7
65+	2,600	**11.4**	9.8 – 13.1	**16.6**	14.9 – 18.4	**11.3**	9.8 – 12.8	**8.3**	7.0 – 9.5
Race:									
White[¤]	5,263	**15.8**	14.4 – 17.2	**29.6**	27.9 – 31.3	**17.2**	15.7 – 18.6	**12.3**	11.1 – 13.5
Black[¤]	454	**18.3**	13.7 – 22.8	**24.5**	19.4 – 29.6	**14.0**	9.8 – 18.1	**14.1**	10.2 – 18.1
Other race[¤]	142	**11.3**	4.7 – 17.9	**21.9**	11.3 – 32.6	—	—	—	—
Multiracial[¤]	109	**29.4**	17.3 – 41.5	**57.1**	45.4 – 68.9	**36.0**	24.0 – 48.0	**24.1**	13.0 – 35.2
Hispanic	195	**25.6**	18.0 – 33.1	**31.1**	23.1 – 39.1	**24.4**	17.1 – 31.8	**11.9**	6.5 – 17.3
Income:									
Less than $10,000	213	**31.7**	23.4 – 40.0	**42.2**	33.6 – 50.8	**30.4**	22.3 – 38.5	**22.0**	15.0 – 29.0
$10,000-$14,999	226	**19.4**	11.9 – 26.8	**40.0**	31.1 – 48.8	**27.0**	18.8 – 35.1	**22.1**	13.8 – 30.4
$15,000-$19,999	382	**19.3**	14.0 – 24.5	**29.1**	22.7 – 35.5	**17.8**	12.1 – 23.6	**13.1**	8.7 – 17.5
$20,000-$24,999	497	**19.2**	14.5 – 24.0	**29.2**	23.5 – 34.8	**16.4**	12.3 – 20.5	**18.6**	13.7 – 23.5
$25,000-$34,999	607	**20.4**	15.8 – 24.9	**28.5**	23.5 – 33.5	**22.0**	17.2 – 26.7	**11.7**	8.2 – 15.2
$35,000-$49,999	785	**17.7**	13.8 – 21.6	**32.2**	27.5 – 36.8	**19.3**	15.4 – 23.3	**14.2**	10.9 – 17.5
$50,000-$74,999	861	**14.9**	11.7 – 18.0	**30.3**	26.2 – 34.5	**15.9**	12.6 – 19.1	**12.6**	9.9 – 15.4
$75,000+	1,458	**13.1**	10.9 – 15.4	**27.1**	24.0 – 30.2	**13.3**	10.8 – 15.8	**8.5**	6.5 – 10.5
Education:									
Did not graduate HS	495	**25.9**	20.8 – 31.1	**34.1**	28.3 – 40.0	**22.4**	17.2 – 27.5	**17.9**	13.3 – 22.5
Graduated HS	2,135	**14.3**	12.4 – 16.3	**27.1**	24.5 – 29.6	**17.0**	14.8 – 19.2	**10.7**	9.0 – 12.4
Attended College[€]	1,609	**19.8**	17.1 – 22.4	**33.2**	30.1 – 36.3	**19.9**	17.3 – 22.6	**15.2**	13.0 – 17.4
Graduated College[€]	1,994	**11.1**	9.4 – 12.9	**25.7**	23.2 – 28.1	**12.6**	10.7 – 14.4	**8.9**	7.4 – 10.4
Disability:									
Yes	2,158	**24.3**	21.7 – 26.8	**37.8**	34.9 – 40.7	**25.3**	22.6 – 27.9	**20.6**	18.1 – 23.0
No	4,023	**13.5**	12.0 – 14.9	**26.0**	24.2 – 28.0	**14.2**	12.7 – 15.7	**9.3**	8.1 – 10.5
Overall:	7,396	**16.7**	15.4 – 18.0	**29.6**	28.0 – 31.3	**17.5**	16.2 – 18.9	**12.6**	11.4 – 13.7

Abbreviation. HS: High School.

[†] Table displays row percentages; denominator for each percentage is the total number of respondents in each demographic category. Numerator for each percentage is the total number of respondents in each demographic category who experienced each individual ACE category. All percentages were weighted using the BRFSS weighting variable _LLCPWT.

[¶] Sample size varies slightly by ACE category due to "don't know/not sure", refusal, and missing responses.

[¤] Non-Hispanic.

[€] Or technical school.

Appendix B. Adjusted Odds Ratios for Health Outcomes for 3+ ACE Scores, 2018 IN BRFSS				
	Model 1		**Model 2**	
	aOR*	95% CI	aOR**	95% CI
Perceived Poor Health				
14+ days of poor mental health	**4.79**	3.60 – 6.37	**4.10**	3.03 – 5.57
Fair or poor general health	**3.02**	2.39 – 3.81	**2.82**	2.19 – 3.63
14+ days of poor physical health	**2.99**	2.34 – 3.83	**2.76**	2.14 – 3.57
Chronic Health Conditions				
Depressive disorder	**6.31**	5.00 – 7.97	**5.38**	4.21 – 6.87
COPD	**3.40**	2.58 – 4.48	**2.72**	2.02 – 3.66
Arthritis	**2.60**	2.10 – 3.20	**2.40**	1.93 – 3.00
Current asthma	**2.36**	1.78 – 3.14	**2.01**	1.49 – 2.71
Stroke	**2.09**	1.48 – 2.95	**1.94**	1.35 – 2.79
CHD	**2.00**	1.40 – 2.86	**1.93**	1.32 – 2.83
Kidney disease	**1.88**	1.26 – 2.83	**1.63**	1.06 – 2.51
Diabetes	**1.64**	1.28 – 2.10	**1.56**	1.19 – 2.06
Cancer (other than skin)	**1.48**	1.07 – 2.04	**1.54**	1.10 – 2.16

Abbreviations. aOR: Adjusted Odds Ratio; COPD: Chronic Obstructive Pulmonary Disease; CHD: Coronary Heart Disease.
Bold Adjusted Odds Ratios indicate statistical significance.
* Odds ratios adjusted for sex, age, race, and education for 3+ ACEs compared to 0 ACEs (referent).
** Odds ratios adjusted for sex, age, race, education, obesity, and smoking status for 3+ ACEs compared to 0 ACEs (referent).