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The Effect of Adverse Childhood Experiences on Adult Health: 2012 North Carolina Behavioral Risk Factor Surveillance System Survey

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Abstract

Objective: Adverse childhood experiences (ACEs) include emotional, physical and sexual abuse as well as household dysfunction experienced before age 18. Research has demonstrated that ACEs put individuals at increased risk for a wide variety of chronic mental, physical and emotional health problems in adulthood. Our objective was to estimate the prevalence of ACEs and examine their association with perceived health, health risks and chronic conditions among North Carolina adults.

Methods: In 2012, 10,383 adults responded to the ACE module included in the N.C. Behavioral Risk Factor Surveillance System (BRFSS) survey. These population-based data were used to calculate the prevalence of ACEs among North Carolina adults and to compare the risk for perceived poor health, health risks and chronic conditions in adulthood among individuals who experienced no ACEs, one to two ACEs and three to eight ACEs.

Results: More than half of respondents (57.6%) reported having experienced at least one ACE. Exposure to ACEs varied by age, sex, race, income and education. Multivariate analysis indicated a statistically significant increase in risk for current smoking, binge drinking, obesity, HIV risk behaviors, poor physical and mental health, activity limitation, chronic obstructive pulmonary disease, cardiovascular disease, arthritis, depression and disability with increasing ACE exposure, even after controlling for sex, age, race and education. An increased risk was also found for perceived poor health and chronic condition outcomes after additional adjustment for current smoking and obesity.

Conclusion: ACEs are prevalent among the general population of North Carolina and are significantly related to development of health risk behaviors and poor health outcomes in adulthood. Examining the epidemiology of ACEs and associated outcomes in North Carolina emphasizes the importance of a life course perspective and strengthens the argument for focusing on the prevention of ACEs as an effective long-term strategy for improving population health outcomes.

Adverse Childhood Experiences

Adverse childhood experiences (ACEs) are traumatic or stressful life events experienced before age 18. ACEs include sexual, physical and emotional abuse as well as various forms of household dysfunction (i.e., mental illness in the household and parental divorce or separation). Recently, increasing attention has been given to ACEs as these early experiences have been found to have broad and long-lasting effects on mental and physical well-being. Evidence from epidemiological studies has consistently demonstrated a relationship between ACEs and numerous health risk behaviors and health outcomes in adulthood.[1] The purpose of this study is to determine the prevalence of ACEs in North Carolina and explore the impact of ACEs on reported health status, health risks and chronic condition prevalence among North Carolina adults.

The Original ACE Study

The original study of ACEs and their effect on health and well-being across the life course began in 1995 as collaboration between the Centers for Disease Control and Prevention (CDC) and Kaiser Permanente. The study was designed to examine the contribution of traumatic childhood experiences to the development of risk behaviors and disease in adulthood. At the time the study was conceptualized, the relationship between single types of abuse, primarily sexual abuse and poor outcomes across the life course had been well documented, but the impacts of a broad range of childhood abuse, trauma and household dysfunction had not yet been examined. Based on this knowledge, the study sought to examine multiple types of abuse and trauma and their cumulative effects on health outcomes in adulthood. The conceptual framework for the study is presented in Figure 1.[2]

In total, more than 17,000 Kaiser Health Plan members completed a standardized medical evaluation at the Kaiser Permanente San Diego Health Appraisal Clinic between 1995 and 1997 and a follow-up questionnaire regarding adverse childhood experiences. The categories of ACEs assessed by the questionnaire included emotional, physical and sexual abuse, emotional and physical neglect, substance abuse, mental illness, domestic violence in the household, parental divorce or separation, and an incarcerated household member.[3]

In the study, almost two-thirds of participants reported having experienced at least one ACE and 15 percent reported four or more ACEs.[3] Researchers found that given exposure to any single category of ACE, the probability of exposure to another category was high.[2] Results also revealed that as the number of ACEs reported increased, the risk of the following health risk behaviors and health outcomes in adulthood also increased: poor self-rated health, depression, smoking, alcohol abuse, drug abuse, obesity, ischemic heart disease, chronic obstructive pulmonary disease and liver disease.[1]

Stress and the Body's Response

Results from the original ACE study and several studies that followed clearly demonstrated that early life experiences had important implications for health and well-being later in life. However, a greater understanding of the mechanisms by which this effect took place was necessary. Thus, researchers began to examine the role of the body's response to various types of stress. It was determined that in young children, there are three distinct types of physiological responses to stress: positive, tolerable and toxic.[4]

A positive stress response is normal and an important part of healthy development. The response includes slight increases in heart rate and mild changes in stress hormone levels that are brief in duration. When occurring in the

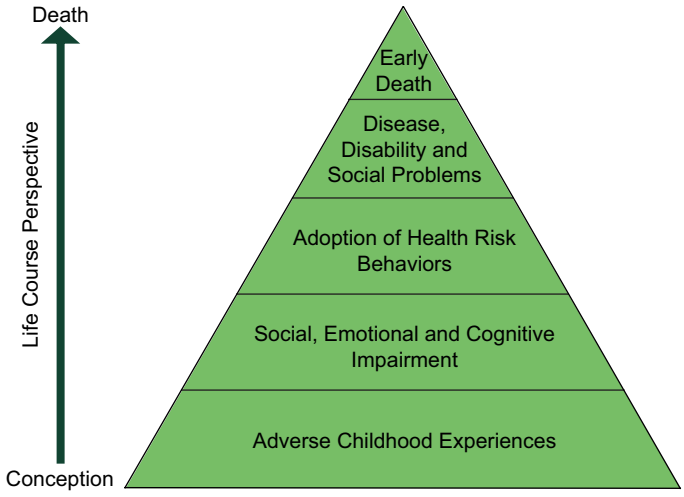


Figure 1. Conceptual Framework for the ACE Study

context of a stable and responsive relationship with an adult, positive stress provides opportunities to learn how to cope with difficult situations. Examples of circumstances that might result in a positive stress response include the anxiety of meeting new people and getting an immunization.[5]

A tolerable stress response involves a greater physiological response than positive stress. However, when buffered by the presence of a supportive adult, an excessive response by the body's stress system, which can have long-term consequences, is less likely. Circumstances that might result in a tolerable stress response include more severe, longer-lasting difficulties such as the death of a family member, a natural disaster or a serious injury or illness.[4,5]

The final type of stress response in young children is a toxic stress response. This response occurs when a child experiences strong, frequent and/or chronic adversity in the absence of adequate adult support. A toxic stress response results in intense and prolonged activation of the body's stress response systems including heightened levels of stress hormones such as cortisol.[4,5] The categories of adverse childhood experiences examined in the original ACE study represent examples of multiple stressors that can bring about a toxic stress response in children.[5]

Toxic Stress, ACEs and the Developing Brain

Early childhood experiences are built into a child's developing body with significant adversity having the potential to disrupt healthy development. Prolonged activation of the body's stress response systems, which occurs during the toxic stress response caused by ACEs, can lead to permanent changes in brain structure and function.[6,7,8] The early childhood brain is highly malleable which causes it to be particularly sensitive to chemical influences such as elevated stress hormone levels. When elevated stress hormone levels are frequent or sustained, normal brain development is disrupted.[5,8] Such disruptions in brain development during childhood can have damaging effects on learning, behavior and health across the life course.[4] For example, frequent or sustained physiological stress responses have been shown to increase vulnerability to a number of stress-related disorders such as depression, drug abuse, cardiovascular disease and diabetes.[8]

Converging evidence from both epidemiological and neurobiological studies indicates that it is the *cumulative* exposure of the developing brain to the stress response that can cause brain impairment and dysfunction.[9] Thus, the more ACEs experienced, the greater the exposure of the developing brain to the body's toxic stress response and the greater the likelihood of developmental difficulties and health problems later in life.[4]

Resiliency

It is important to keep in mind that exposure to ACEs and the toxic stress response does not guarantee poor outcomes. Rather, such experiences increase the *risk* for poor outcomes. Some children who experience ACEs fare better than others and demonstrate positive adjustment and healthy development. Certain factors can help a child to build resiliency and mitigate the negative effects ACEs and the toxic stress response pose to health and development. The most important of these protective factors is a safe, stable and supportive relationship with a caring adult. A relationship with a responsive adult helps a child learn how to cope with adversity and return his or her stress response system to baseline rather than leaving it continually activated.[4] Other protective factors that can help to build resiliency in children faced with adversity include intellectual and cognitive ability, academic engagement, social competence, the ability to regulate emotions, self-esteem, a sense of personal control, problem-solving skills, family cohesion and stability, high quality peer relationships, involvement in extracurricular activities and hobbies and a positive school environment.[10]

The Behavioral Risk Factor Surveillance System and the ACE Module

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing telephone survey established by the CDC that collects state-level data regarding health risk behaviors, chronic health conditions and use of preventive services among non-institutionalized adults age 18 and older. The survey consists of required core questions, standardized optional modules and state-specific questions.[11] The North Carolina Division of Public Health has participated in the BRFSS since 1987.[12]

In 2008, the CDC developed an ACE module as one of the standardized optional modules for the BRFSS. The purpose of the module was to help determine if the findings from the original ACE study could be replicated in a representative sample of the United States adult population. The questions and terminology included in the module were based on those used in the original ACE study.[13] The ACE module asks adults to recall experiences that occurred before age 18 and is made up of 11 questions that assess eight categories of adverse childhood experiences. These eight categories include three questions

associated with childhood abuse and five questions associated with household dysfunction:

1. Physical abuse (childhood abuse)
2. Sexual abuse (childhood abuse)
3. Emotional abuse (childhood abuse)
4. A household member who was depressed, mentally ill or suicidal (household dysfunction)
5. Alcohol or drug abuse in the household (household dysfunction)
6. An incarcerated household member (household dysfunction)
7. Violence between adults in the household (household dysfunction)
8. Parental divorce or separation (household dysfunction)

Since 2009, 17 states and Washington, D.C. have administered the optional ACE module as part of the state BRFSS survey, and many have published reports regarding findings from the data collected.[14] Analyses based on data from Washington state, Montana and Wisconsin have revealed similar results to those of the original ACE study: ACEs are common, ACEs do not occur in isolation and ACEs have a strong relationship with health and well-being in adulthood.[15,16,17] In 2012, North Carolina added the ACE module to the state BRFSS survey.

Methods

Data for this study were derived from the 2012 North Carolina BRFSS survey. In 2012, the North Carolina BRFSS included both landline and cell phone interviews.

In total, 11,898 adults participated in the 2012 North Carolina BRFSS survey, of which 10,383 (87.3%) responded to the ACE module. The number of respondents who did not answer the entire ACE module (1,515; 12.7%) is comparable to the number of respondents who either did not know or refused to answer the question regarding their annual income (2,085; 17.5%). Respondents may have chosen not to answer questions on the ACE module due to the sensitive nature of the topic. All responses to the BRFSS survey were weighted by the CDC to ensure that estimates were consistent with proportions of age, sex, race, ethnicity, geographic region, education level, marital status, home ownership and telephone ownership within the state.

ACE Module Scoring

Table 1 presents the questions included in the ACE module and the specific category of ACE each question assessed.

Table 1.
Adverse Childhood Experiences Module

Household dysfunction

Mentally ill household member

1. Did you live with anyone who was depressed, mentally ill or suicidal? [Yes/No]

Substance abuse in household

2. Did you live with anyone who was a problem drinker or alcoholic? [Yes/No]
3. Did you live with anyone who used illegal street drugs or who abused prescription medications? [Yes/No]

Incarcerated household member

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]

Parental separation/divorce

5. Were your parents separated or divorced? [Yes/No]

Violence between adults in household

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]

Childhood abuse

Physical abuse

7. 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. [Never/Once/More than once]

Emotional abuse

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]

Sexual abuse

9. How often did anyone at least 5 years older than you or an adult touch you sexually? [Never/Once/More than once]
10. How often did anyone at least 5 years older than you or an adult, force you to have sex? [Never/Once/More than once]
11. 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]

For categories with "yes" or "no" response choices, a response of "yes" corresponded to having experienced that category of ACE. For categories with "never," once" or "more than once" response choices, a response of "once" or "more than once" corresponded to having experienced that category of ACE. For substance abuse in the household, a response of "yes" to one or more of the two questions included in this category corresponded to having experienced substance abuse in the household. For sexual abuse, a response of "once" or "more than once" to one or more of the three questions included in this category corresponded to having experienced sexual abuse in the household. Responses of "don't know" or "refused" were coded as missing for all questions.

An ACE score was calculated based on the eight categories of ACEs assessed. Exposure to any single category counted as one point toward the ACE score, and the final score was a sum of the total number of points accumulated. The ACE score does not capture the frequency or severity of any individual ACE, but rather is a measure of *cumulative* exposure to ACEs. The emphasis is on the total number of ACE categories experienced.

ACE Study Groups

Three ACE study groups were created on the basis of the ACE score. Those who reported zero ACEs were assigned to the (1) No ACE group, those who reported one to two ACEs were assigned to the (2) Low ACE group, and those who reported three to eight ACEs were assigned to the (3) High ACE group. This designation complies with the "Adverse Childhood Experiences among Adults" indicator established by the Association of Maternal and Child Health Programs for inclusion in the Life Course Metrics Project.[18]

Health Risks Outcomes

Indicators of health risks were derived from CDC-calculated variables.[19] Current smoking was assigned to those who reported smoking on some days or every day. Binge drinking was assigned to those who reported they had five or more drinks for males or four or more drinks for females on one or more occasions in the past month. Heavy drinking was assigned to those who reported having more than two drinks per day for males and more than one drink per day for females. Obesity was assigned to those with a Body Mass Index (BMI) ≥30. No exercise was assigned to those who reported that they did not engage in any physical activity or exercises in the past 30 days. HIV risk was assigned to those who reported they had used intravenous drugs, been treated for a sexually transmitted or venereal disease, given or received money or drugs in exchange for sex and/or had anal sex without a condom in the past year.

Perceived Poor Health Outcomes

Indicators of perceived poor health were developed based on previous research and were captured from four questions from the survey.[15,16,17] The first indicator, fair or poor health, was assigned to those who reported their general health as fair or poor. Poor physical health was assigned to those who reported 14 or more days of poor physical health in the past 30 days. Likewise, poor mental health was assigned to those who reported 14 or more days of poor mental health in the past 30 days, and activity limitation was assigned to those who reported 14 or more days of activity limitation in the past 30 days due to poor physical or mental health. Those with missing values for activity limitation due to the report of no days of poor physical health in the past 30 days and no days of poor mental health in the past 30 days were assigned to no activity limitation.

Chronic Condition Outcomes

Chronic conditions indicators were obtained from the CDC optional module on chronic disease. Cardiovascular disease (CVD) was assigned to those who reported a doctor diagnosed heart attack, stroke and/or angina or coronary heart disease. Diabetes was assigned to those who reported doctor diagnosed diabetes at any time other than during pregnancy. Disability was assigned to those who reported they were limited in activities because of physical, mental or emotional problems and/or had any health problem requiring the use of special equipment such as a cane, wheelchair, special bed or special phone. Other doctor diagnosed conditions reported by participants included current asthma, chronic obstructive pulmonary disease (COPD), arthritis, a depressive disorder, cancer (any type other than skin) and kidney disease.

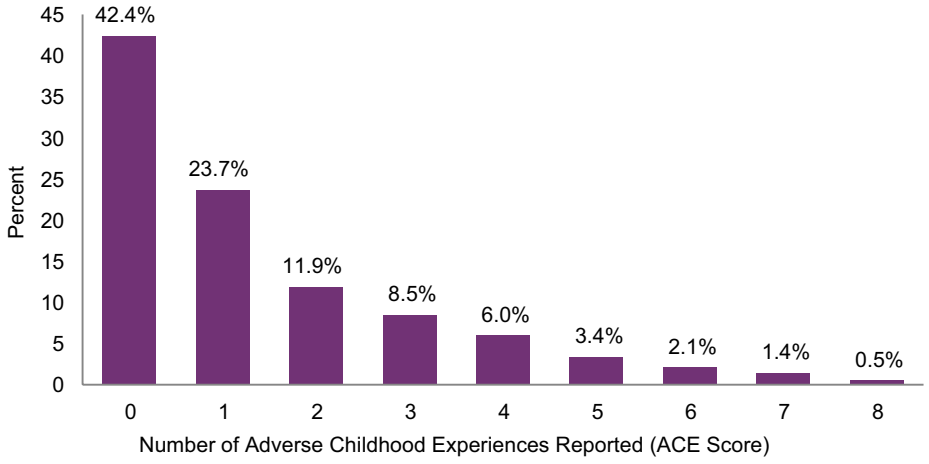
Analysis

The prevalence of the ACE study groups by demographic characteristics and perceived poor health, health risk and chronic condition outcomes was calculated. Difference-in-rates tests were calculated to compare the difference between the ACE study groups for all outcomes. Resulting p-values of less than 0.05 were considered statistically significant.

Using the ACE study groups as the primary independent variable with the No ACE group as the reference group,

multivariate logistic regression models were conducted for the perceived poor health, health risk and chronic condition outcomes. Separate models were constructed for each outcome with the Hosmer and Lemeshow goodness-of-fit test used to determine the "best" set of independent variables to include in each model. Control variables used in developing the models included age, sex, race and education. A set of models controlling for obesity and smoking were conducted for perceived poor health and chronic condition outcomes. Adjusted odds ratios and 95 percent confidence intervals were calculated.

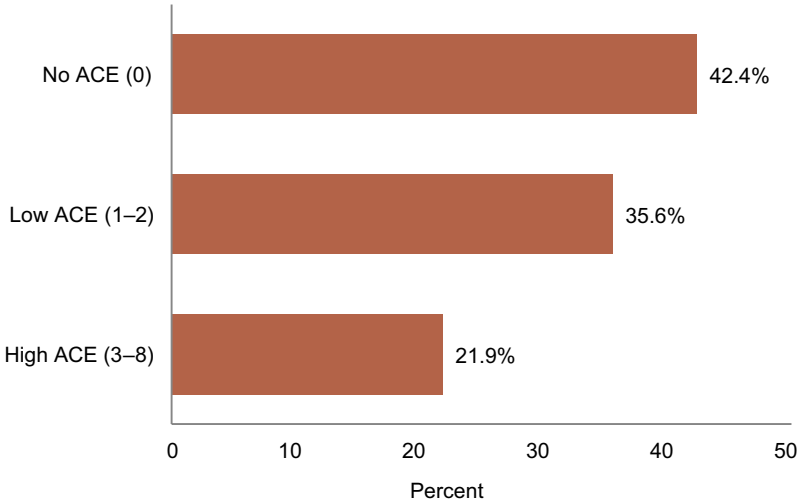
Figure 2.
Prevalence of Adverse Childhood Experiences among North Carolina Adults



All analyses were conducted in SAS® version 9.3 using the SURVEYFREQ and SURVEYLOGISTIC procedures which allow for the analysis of data from surveys with complex sample designs. All analyses were weighted using the weighting and stratification variables available in the N.C. BRFSS dataset. Only weighted percentages are presented.

More than half (57.6%) of respondents reported having experienced at least one ACE, and approximately one-third (33.8%) reported having experienced multiple ACEs. When categorized into the ACE study groups, 35.6 percent of participants reported one to two ACEs (Low ACE group), and 21.9 percent reported experiencing three or more ACEs (High ACE Group; Figure 3).

Figure 3.
Prevalence of ACE Study Groups



Results

Prevalence of ACEs

ACEs were found to be prevalent among the general population of North Carolina. Figure 2 shows the prevalence of the ACE score among North Carolinians.

Prevalence of Individual ACE Categories

Figure 4 displays the prevalence of each individual ACE category. Parental separation or divorce (27.4%) and substance abuse, including alcohol and prescription and illicit drugs, in the household (26.8%) were the most common ACEs reported by North Carolinians. Emotional abuse was also a commonly reported ACE and was reported by almost one-fourth (23.7%) of participants.

Figure 5 shows the prevalence of individual categories of ACEs for the Low and High ACE study groups. Substance abuse in the household and emotional abuse were common among the High ACE group: 76.5 percent reported substance abuse in the household and 72.3 percent reported having been emotionally abused as a child. Parental separation or divorce (38.9%) was the most common ACE among the Low ACE group. The proportion of respondents reporting sexual abuse (9.1%) and physical abuse (9.9%) was relatively similar for the Low ACE group. However, for the High ACE group, the proportion

Figure 4.
Prevalence of Adverse Childhood Experiences (ACEs) by Category

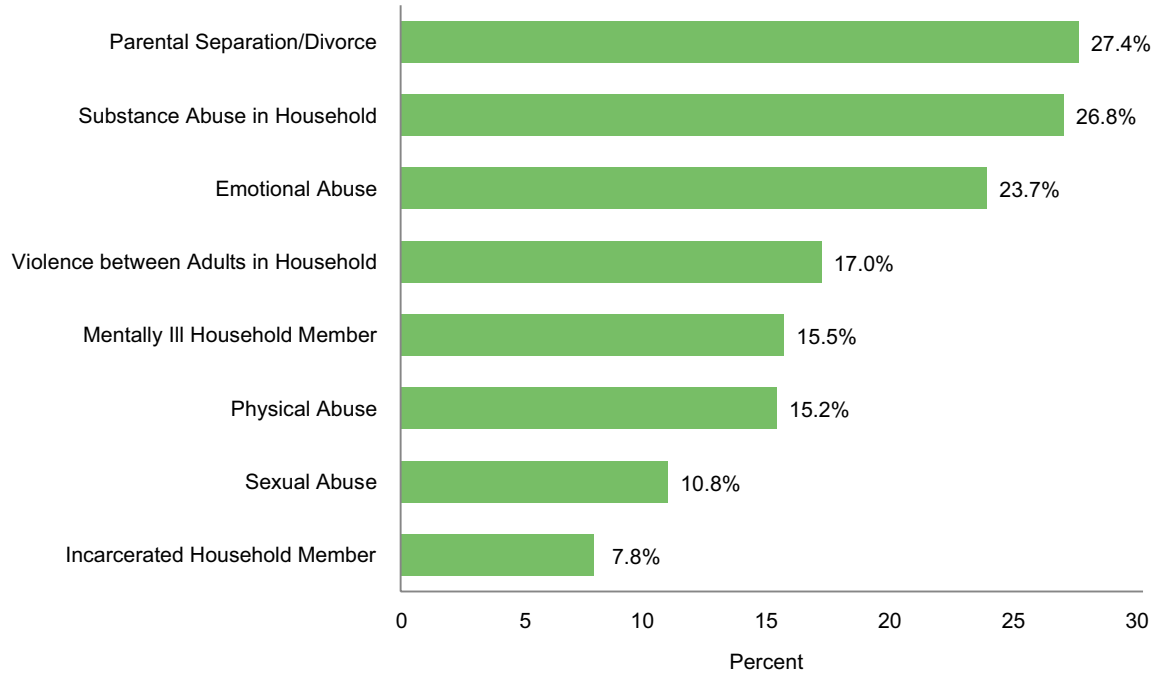
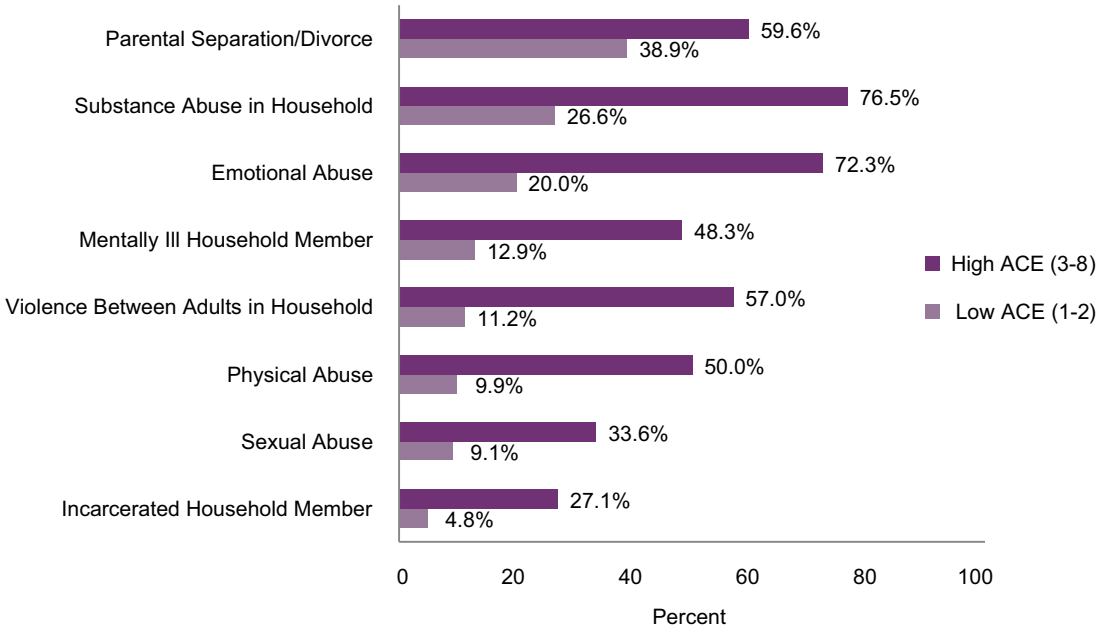


Figure 5.
Prevalence of Adverse Childhood Experiences (ACEs) by Study Group



varied considerably between the two categories with 50 percent reporting physical abuse and 33.6 percent reporting sexual abuse. For the Low ACE group, the proportion reporting a mentally ill household member (12.9%) and violence between adults in the household (11.2%) was comparable, whereas for the High ACE group, a higher proportion of those in the High ACE group reporting violence between adults in the household (57.0%) than a mentally ill household member (48.3%).

Clustering of ACEs

Other studies and state analyses have demonstrated that ACEs do not occur in isolation.[2,15,16,17] Rather, these studies have shown that if an individual has experienced one ACE, it is highly likely that he or she has also experienced additional ACE categories. To examine the clustering tendency of ACEs in North Carolina, the prevalence of the ACE score among participants reporting at least one ACE is presented in Figure 6. Approximately six in 10 respondents reporting one ACE also reported additional ACEs (59%). Those reporting the highest number of ACEs (5–8) represented 13 percent of those reporting at least one ACE.

Demographics of ACE Study Groups

The demographic characteristics of respondents by ACE study groups are presented in Table 2. The prevalence of the ACE study groups differed significantly by sex, race, age, education and income. The distribution of males and females was equivalent for the No ACE and Low ACE groups. However, there were more females (58.5%) than males (41.5%) in the High ACE Group. Age varied across the ACE study groups. For young adults in the 18–44 age group and adults in the 45–54 age group, the proportion of respondents increased across ACE study groups from the No ACE group to the Low and High ACE groups. For older adults both in the 55–64 age group and in the 65+ age group, the proportion of respondents decreased across ACE study groups from the No ACE group to the Low and High ACE groups. A much greater proportion of younger adults age 18–44 (56.5%) were in the High ACE group than older adults ages 65+ (8.4%). With regard to race, the proportion of whites decreased across the ACE study groups whereas the proportion of blacks was higher in the Low and High ACE groups than in the No ACE group.

Differences were also observed for indicators of socioeconomic status by the ACE study groups. Among those with less than a high school education, a greater proportion were represented in the High ACE group (20.6%) than the Low ACE (16.0%) or No ACE (13.1%) groups. With regard to employment status, the rate of unemployment increased from 5.8 percent in the No ACE group to 8.8 percent in the Low ACE group and 13.7 in the High ACE group. The rate of those unable to work also increased across the ACE study groups in a similar fashion. By income, the proportion of respondents in the two lowest income groups (less than $15,000 and $15,000 to $24,999) increased from the No ACE group to the Low and High ACE groups while the proportion in the highest income group ($50,00+) decreased across these groups.

Figure 6.
Prevalence of Adverse Childhood Experiences (ACEs) Score among Respondents Reporting at Least One ACE

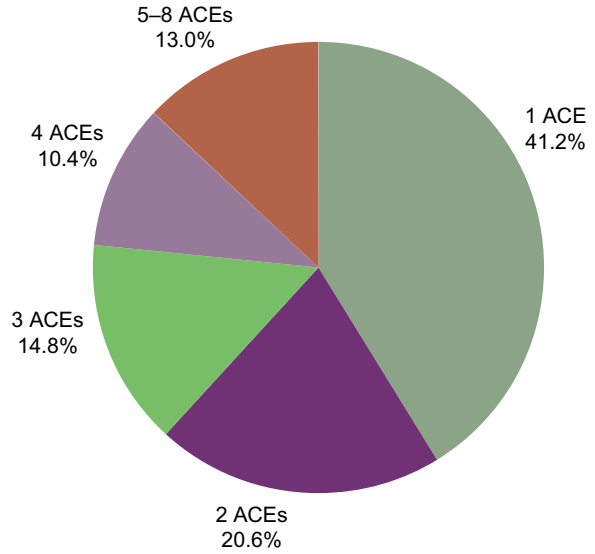


Table 2. Prevalence of Demographic Characteristics by ACE Study Groups, 2012 N.C. BRFSS Survey

Characteristics	No ACE		Low ACE (1-2)		High ACE (3+)	
	N*	%	N	%	N	%
Sex						
Males	1,903	48.4	1,387	50.0	714	41.5
Females	2,943	51.6	2,091	50.0	1,345	58.5
Age						
18-44	1,100	38.2	1,148	49.3	857	56.6
45-54	707	17.0	648	19.6	452	20.2
55-64	969	17.8	734	15.8	423	14.8
65+	2,017	26.9	920	15.3	320	8.4
Race						
White	3,572	73.7	2,388	66.6	1,445	68.8
Black	790	18.2	700	23.9	378	21.5
Other	441	8.1	368	9.5	221	9.7
Education						
Less than high school	534	13.1	428	16.0	287	20.6
High school	1,426	27.9	958	26.8	587	27.2
Post high school	1,245	30.8	956	32.7	643	33.7
College	1,619	28.2	1,128	24.5	542	18.5
Marital status						
Married	2,625	58.6	1,727	49.9	938	44.8
Divorce/separated	652	10.3	631	13.7	491	18.8
Widowed	893	9.9	422	6.3	163	3.9
Never married/partner	664	21.2	692	30.1	462	32.5
Income						
Less than $15,000	462	10.2	391	12.1	369	19.0
$15,000 to $24,999	789	18.7	607	20.6	391	23.9
$25,000 to $34,999	530	12.9	374	12.0	211	11.2
$35,000 to $49,999	614	16.2	451	15.2	227	12.6
$50,000+	1,530	42.1	1,144	40.0	604	33.3
Employment						
Employed	2,025	50.8	1,713	57.1	1,040	54.5
Unemployed	232	5.8	268	8.8	238	13.7
Unable to work	319	5.8	297	7.0	307	11.7
Retired	1,842	25.5	886	15.7	285	8.4
All other	417	12.0	305	11.4	184	11.8
Housing status						
Home owner	3,788	79.3	2,471	71.3	1,243	60.0
Renter	800	15.6	799	21.5	679	31.8
Other	219	5.1	184	7.2	125	8.1
Total by Group	**4,846**	**42.4**	**3,478**	**35.6**	**2,059**	**22.0**

N* = unweighted

Prevalence of Adverse Health Outcomes by ACE Study Groups

The prevalence of the ACE study groups by indicators of perceived poor health, health risks and chronic conditions is presented in Table 3. With regard to perceived poor health, rates of fair or poor health status and 14+ days of poor physical health in the past 30 days were significantly higher for the High ACE group compared to the No ACE group. Rates of 14+ days of poor mental health in the past 30 days and 14+ days of activity limitation in the past 30 days due to poor physical or mental health were significantly higher for both the High ACE and Low ACE groups compared to the No ACE group.

For health risks, the rates of current smoking, binge drinking, heavy drinking, obesity and HIV risk were significantly higher for both the Low ACE and High ACE groups compared to the No ACE group. With regard to chronic conditions, rates of current asthma, COPD, depressive disorder and disability were significantly higher for both the High and Low ACE groups compared to the No ACE group. There were no significant differences in rates between the ACE study groups for CVD, diabetes, arthritis, cancer or kidney disease.

Risk of Adverse Health Outcomes for High and Low ACE Groups

Results from multivariate logistic regression are shown in Table 4. In multivariate models for health risks, no exercise in the past 30 days was the only health risk not to demonstrate a strong association with ACE scores after adjustment for demographic factors. An increased risk was found for heavy drinking for the High ACE group compared to the No ACE group. All other health risks including current smoking, binge drinking, obesity and HIV risk situations demonstrated a strong association with ACE scores for both the Low and High ACE groups compared to the No ACE group. In multivariate models

Table 3. Prevalence of Adverse Health Outcomes by ACE Study Groups: N.C. BRFSS 2012 Survey

Health indicators	No ACE %	Low ACE (1–2) [1] %	High ACE (3+)[2] %
Health risks			
Current smoker	13.4%	20.4%***	33.0%***
Heavy drinking	3.6%	4.9%*	7.5%***
Binge drinking	9.4%	13.5%***	17.9%***
Obesity	26.2%	30.7%**	35.0%***
No exercise (past 30 days)	22.2%	22.5%	26.9%*
HIV risk	1.8%	4.4%***	9.1%***
Perceived poor health			
Fair or poor general health	16.7%	16.9%	27.8%***
14+ days of poor physical health	9.6%	11.3%	17.5%***
14+ days of poor mental health	7.1%	10.8%***	23.5%***
14+ days of activity limitation	4.9%	7.1%***	13.4%***
Chronic conditions			
Current asthma	6.0%	7.8%*	10.0%***
COPD[a]	5.0%	6.7%**	10.7%***
CVD[a]	9.2%	8.5%	8.8%
Diabetes	11.4%	9.9%	11.1%
Arthritis	26.4%	25.2%	28.6%
Depressive disorder	10.4%	15.7%***	33.3%***
Disability	18.6%	20.1%***	30.2%***
Cancer (other than skin)	7.1%	6.3%	6.3%
Kidney disease	2.4%	2.4%	3.3%

*p < 0.05; **p < 0.01; ***p < 0.001.
[1] P values associated with T-test for difference in rates between 0 ACE and 1-2 ACEs.
[2] P values associated with T-test for difference in rates between 0 ACE and 3-8 ACEs.
[a] Abbreviations: COPD — chronic obstructive pulmonary disease; CVD — cardiovascular disease.

for indicators of perceived poor health, an increased risk was found for 14+ days of poor physical health, 14+ days of poor mental health, and 14+ days of activity limitation for both the Low and High ACE groups compared to the no ACE group. Fair or poor general health demonstrated an association with ACE scores for the High ACE group only compared to the No ACE group. In chronic conditions multivariate models, an increased risk for current asthma, diabetes, cancer (other than skin) and kidney disease was found for the High ACE group compared to the No ACE group. All other chronic conditions indicators including COPD, CVD, arthritis, depressive disorder and disability demonstrated a strong association with ACE scores for both the Low and High ACE groups compared to the No ACE group.

Conclusions

ACEs are prevalent among the general population of North Carolina and are associated in a strong, graded fashion with perceived poor health, health risks and chronic conditions in adulthood. Such findings parallel those of the original ACE study and analyses from several other states. Finding that ACEs are common among the general population indicates that ACEs impact a significant proportion of North Carolina residents and are an important public health issue. Demonstrating that the risk ACEs pose to health persists well into adulthood highlights the importance of a life course perspective in prevention and intervention efforts and strengthens the argument for focusing on the prevention of ACEs as an effective long-term strategy for improving population health.

Results from this study found ACEs to be prevalent among North Carolina adults; more than half of respondents (57.6%) reported at least one ACE, and one in five respondents (22.0%) reported experiencing three or more ACEs. Parental separation or divorce (27.4%), substance abuse in the household (26.8%) and emotional abuse (23.7%) as a child were the most common ACEs reported. Substance abuse in the household and emotional abuse were also ACE categories that were prevalent among the High ACE group indicating that these specific ACEs tended to co-occur or cluster with other ACE categories. Such findings provide a rationale for assessing exposure to multiple ACEs in research and in the identification and treatment of maltreated children, as ACEs appear not to occur independently.[20] Comparable rates of ACE scores and patterns of clustering of ACEs have been demonstrated in other states.[15,16,17]

ACE exposure varied by each of the demographic characteristics examined. Notably, a greater percentage of young adults reported three or more ACEs than older adults. It may be the case that fewer older adults experienced ACEs than young adults, however this finding could also be due to poorer recall among older adults or because older generations interpret childhood

experiences differently than younger generations. It may also be the case that those who experience a greater number of ACEs die at younger ages than those who experience fewer ACEs.[2] In addition, differences in ACE exposure were observed by socioeconomic status including higher ACE score among adults that were unemployed, had lower education levels and/or lower annual incomes.

Based on the results regarding health risks, it appears that ACEs are associated with various health risk behaviors among adults. Those who have experienced ACEs may adopt certain risk behaviors as ways to cope with the trauma they have experienced. For example, research into the effects of cigarette smoking on the brain has shown that nicotine induces pleasure and provides relief from stress and anxiety.[21] Among various theories that have been proposed to explain excessive smoking among those exposed to ACEs, researchers have proposed that the use of nicotine serves as a coping mechanism for countering the negative biological and emotional effects associated with ACEs. [22] Similarly, attempts to manage the stress of ACEs may result in the adoption of other health risk behaviors such as overeating, risky sexual behavior and alcohol and other substance abuse.

Table 4. Adjusted Odds Ratios for Low and High ACE Study Groups for Selected Health Indicators: N.C. BRFSS 2012 Survey

Health Indicators	Low ACE (1-2) *aOR1 (95% C.I.)*	High ACE (3-8) *aOR2 (95% C.I.)*
Health risks		
Current Smoker	**1.44** (1.22, 1.69)	**2.50** (2.11, 2.97)
Heavy drinking	1.31 (0.97, 1.76)	**1.98** (1.46, 2.68)
Binge drinking	**1.25** (1.01, 1.57)	**1.78** (1.42, 2.22)
Obesity	**1.21** (1.06, 1.39)	**1.50** (1.28, 1.74)
No exercise (past 30 days)	0.93 (0.81, 1.07)	0.85 (0.73, 1.00)
HIV risk	**1.98** (1.30, 3.01)	**4.14** (2.80, 6.12)
Perceived poor health		
Fair or poor general health	1.01 (0.94, 1.29)	**2.34** (1.96, 2.79)
14+ days of poor physical health	**1.33** (1.10, 1.60)	**2.26** (1.85, 2.75)
14+ days of poor mental health	**1.46** 1.18, 1.80)	**3.26** (2.65, 4.02)
14+ days of activity limitation	**1.59** (1.28, 1.98)	**3.26** (2.59, 4.09)
Chronic conditions		
Current asthma	1.27 (0.97, 1.66)	**1.48** (1.12, 1.96)
COPDa	**1.69** (1.36, 2.11)	**2.94** (2.32, 3.73)
CVDa	**1.25** (1.04, 1.50)	**1.70** (1.36, 2.12)
Diabetes	1.02 (0.86, 1.22)	**1.45** (1.17, 1.80)
Arthritis	**1.31** (1.15, 1.51)	**1.94** (1.65, 2.28)
Depressive disorder	**1.65** (1.39, 1.97)	**4.15** (3.47, 4.97)
Disability	**1.36** (1.17, 1.56)	**2.68** (2.28, 3.15)
Cancer (other than skin)	1.19 (0.98, 1.46)	**1.49** (1.17, 1.87)
Kidney Disease	1.16 (0.82, 1.62)	**1.80** (1.26, 2.56)

Bold indicates statistical significance.
[1] Odds ratios adjusted for age, sex, race and education for Low ACE compared to No ACE (referent).
[2] Odds ratios adjusted for age, sex, race and education for High ACE compared to No ACE (referent).
[a] Abbreviations: COPD — chronic obstructive pulmonary disease; CVD — cardiovascular disease.

Results for the indicators of perceived poor health show that ACEs are strongly related to the perception of poor health in adulthood. The perceived health indicators included in the BRFSS have been shown to be closely related to more objective measures of health and morbidity such as the presence of multiple chronic conditions, chronic conditions with a heavy burden of symptoms, clinically diagnosed mental disorders and other measures of health dysfunction.[23,24,25] As such, these indicators are a good measure of health-related quality of life overall and provide a more global understanding of the health status of those who have experienced ACEs as they are suggestive of the actual burden of physical and mental distress experienced by respondents. Therefore, it appears that the experience of ACEs, particularly the experience of three or more ACEs, is detrimental to overall quality of life and health status, even years after the ACEs occurred.

The chronic conditions results indicate that ACEs increase the risk for the development of various chronic diseases and conditions in adulthood. While unadjusted rates did not show significant differences in the prevalence of several chronic conditions between the ACE study groups, odds ratios adjusted for demographic factors revealed that ACEs were associated with an increased risk for several of the chronic conditions examined for those in both the Low and High ACE groups.

The investigators of the original ACE study proposed that the link between exposure to ACEs and the development of chronic disease in adulthood was the health risk behaviors that were often adopted as coping mechanisms for the stress caused by childhood abuse, trauma and household dysfunction (Figure 1). When certain risk behaviors such as smoking or alcohol abuse are used as a way to cope with the long term, harmful effects brought about by ACE exposure, their use becomes habitual. Because these behaviors are risk factors for many chronic diseases, regular use of such coping mechanisms may then lead to the later development of chronic disease in adulthood.[2]

Because current smoking and obesity varied by the ACE study groups and are themselves risk factors for perceived poor health and the chronic conditions considered, a second set of models were adjusted for these risk factors in addition to the demographic factors considered (Table 5, Appendix A). The odds ratios adjusted for smoking and obesity were slightly attenuated for the High ACE group compared to the No ACE group but remained significant for all indicators of perceived poor health and chronic conditions. This indicates that the experience of multiple ACEs has an important effect on the development of perceived poor health and chronic conditions in adulthood, even above and beyond the effect of established risk factors such as obesity and smoking.

A final consideration is highlighted by findings from several studies suggesting an intergenerational transmission of ACEs.[26] Evidence of this phenomenon comes from studies demonstrating that those who have experienced ACEs have an increased risk for unemployment, early and unintended pregnancy, intimate partner violence victimization and perpetration, prescription and illicit drug abuse and alcohol abuse in adulthood.[27–33] Because many of these outcomes are ACE categories in and of themselves, such findings indicate a cyclical pattern: adults who experienced ACEs as children may have a higher risk of exposing their own children to ACEs.[34] In this cycle, the mental, social and behavioral problems related to the ACEs that parents experienced as children become the ACEs experienced by the next generation.[26]

Recommendations

ACEs are an important public health concern in North Carolina. Increasing awareness of the prevalence of ACEs and their effect on health and well-being among the general population of North Carolina and among key stakeholders in the state such as human service providers, policy makers, early childhood educators, health care providers and other community-based organizations will serve to mobilize and enhance prevention efforts. An emphasis on incorporating ACEs as a risk factor for poor health outcomes into strategies designed to address health risks and chronic conditions on a population level will be important.

Because ACEs are common and affect health outcomes well into adulthood, primary, secondary and tertiary prevention efforts are important. A focus on each level of prevention will include efforts to prevent the occurrence of ACEs and strengthen the foundations of health in early childhood, reduce the adoption of health risks among those who have experienced ACEs, and improve long-term outcomes among those who have already developed adverse physical and mental health conditions as a result of ACEs.[2] In addition, intervention efforts to address ACEs and their associated outcomes among parents will help to mitigate the intergenerational transmission of ACEs.

Identified evidence-based strategies to prevent ACEs and promote healthy parenting include the Nurse Family Partnership, the Incredible Years Parenting Program and the Triple P Positive Parenting Program.[35,36,37] The CDC is also currently funding a program in five states, including North Carolina, titled *Essentials for Childhood.* The program is intended to prevent child maltreatment by focusing on the creation of safe, stable and nurturing relationships and environments for children.[38]

Washington state represents a concrete example of ways ACE research can be translated into public policy and prevention efforts. In 2011, Washington became the first state to enact public policy targeted specifically at the prevention of ACEs (House Bill 1965). Based on findings from ACE related research, the legislation focuses on reducing the prevalence of ACEs in the state and mitigating the adverse effect of ACEs on health and well-being through primary prevention strategies and the enhancement of community capacity to address population health issues and improve public health. As a result of the legislation, dedicated funds for evidence-based home visiting programs have been established and Thrive by Five, a private-public partnership, was created to improve the quality of childcare and learning opportunities in the early developmental years across the state.[39]

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Appendix A

Table 5. Adjusted Odds Ratios for High ACE Study Group for Perceived Poor Health and Chronic Conditions: N.C. BRFSS 2012 Survey

Health Indicators	Adjusted OR Model 1† (95% CI)	Adjusted OR Model 2‡ (95% CI)
Perceived poor health		
Fair or poor health status	**2.34** (1.96, 2.79)	**2.16** (1.80, 2.61)
14+ days of poor physical health	**2.26** (1.85, 2.75)	**1.98** (1.61, 2.43)
14+ days of poor mental health	**3.26** (2.65, 4.02)	**2.79** (2.25, 3.48)
14+ days of activity limitation	**3.26** (2.59, 4.09)	**2.83** (2.24, 5.89)
Chronic conditions		
Current asthma	**1.48** (1.12, 1.96)	**1.41** (1.07, 1.87)
COPD[a]	**2.94** (2.32, 3.73)	**2.40** (1.86, 3.08)
CVD[a]	**1.70** (1.36, 2.12)	**1.57** (1.25, 1.98)
Diabetes	**1.45** (1.17, 1.80)	**1.30** (1.03, 1.63)
Arthritis	**1.94** (1.65, 2.28)	**1.77** (1.50, 2.10)
Depressive disorder	**4.15** (3.47, 4.97)	**3.61** (2.99, 4.34)
Disability	**2.68** (2.28, 3.15)	**2.43** (2.05, 2.88)
Cancer	**1.49** (1.17, 1.87)	**1.40** (1.10, 1.80)
Kidney disease	**1.80** (1.26, 2.56)	**1.70** (1.17, 2.46)

Bold indicates statistical significance.
† Odds ratios adjusted for age, sex, race and education for High ACE compared to No ACE (referent).
‡ Odds ratios adjusted for age, sex, race, education, current smoking and obesity for High ACE compared to No ACE (referent).
[a] Abbreviations: COPD – chronic obstructive pulmonary disease; CVD – cardiovascular disease.

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