Association of Adverse Childhood Experiences with Life Course Health and Development

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Several studies demonstrate an association between adverse childhood experiences (ACEs) and poor outcomes over the life course. Data from the 2012 North Carolina Behavioral Risk Factor Surveillance System show that ACEs are common among North Carolina residents, ACEs co-occur, and cumulative ACE exposure is associated with poor health outcomes.

Adverse Childhood Experiences

In 1998, a seminal article regarding the association of adverse childhood experiences (ACEs) with poor health and development in adulthood was published [1]. Since then, there has been a proliferation of research related to the concept of ACEs. ACEs are traumatic or stressful events experienced before the age of 18 and typically include negative events experienced within the family unit or household, such as physical, sexual, and emotional abuse, physical and emotional neglect, and household dysfunction (ie, adult incarceration, mental illness, substance abuse, or violence in the household and parental separation or divorce). Recent conceptualizations of ACEs have also included measures of additional negative experiences both within and outside of the family unit such as spanking [2, 3], poverty [4, 5], peer victimization and rejection [4-6], discrimination [5, 6], and exposure to community violence [4-6].

Adverse Childhood Experiences and Health Outcomes

The overarching goal of the seminal study on ACEs was to examine the association of cumulative exposure to multiple types of childhood abuse and trauma with health outcomes in adulthood [1]. As part of the study, more than 17,000 individuals completed a standardized medical questionnaire to assess health outcomes and a questionnaire recalling exposure to ACEs prior to age 18 [1, 7]. The categories of ACEs assessed included physical, sexual, and emotional abuse, adult incarceration, mental illness, substance abuse or violence in the household, and parental separation or divorce [1, 7]. Notably, nearly two-thirds of participants reported having experienced at least one ACE, with the most commonly reported ACEs being physical abuse (28%), substance abuse in the household (27%), and parental separation or divorce (23%) [7]. The results revealed that ACEs tended to co-occur. Participants with exposure to 1 category of ACE were found to have a 65%–95% probability of exposure to an additional category, depending on the specific categories examined [1]. The results also demonstrated a dose-response relationship between cumulative ACE exposure and poor adult health outcomes. As the number of ACEs an individual reported having experienced increased, the odds of poor outcomes in adulthood also increased. These outcomes included smoking, illicit drug use, alcohol abuse, sexually transmitted infections, unintended pregnancy, depression, anxiety, suicide ideation and attempts, intimate partner violence victimization, heart disease, cancer, and respiratory disease [1, 7].

Additional studies have demonstrated similar associations of cumulative ACE exposure with poor outcomes in childhood, including internalizing and externalizing behaviors, social and developmental delays, and chronic conditions [8, 9, 10], as well as poor outcomes in adolescence, including delinquency, bullying, suicide attempts, poor physical and emotional health, and alcohol use [11-13]. Collectively, this literature base demonstrates both immediate and long-term associations of ACE exposure with poor health outcomes.

Results from the seminal ACE study and the numerous studies that have been conducted since then have generated substantial interest in understanding the mechanisms underlying the association between ACEs and poor life course health and development. The authors of the 1998 study on ACEs proposed a conceptual framework focused on behavioral mechanisms underlying this association [1]. In this framework, ACE exposure is posited to contribute to social, emotional, and cognitive impairments that then lead to the adoption of health-risk behaviors such as smoking and substance use [1]. These health-risk behaviors then contribute to the development of subsequent poor health outcomes [1]. In addition to behavioral mechanisms, an

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emerging body of research has begun to explore potential biological mechanisms underlying the association of ACEs with poor health outcomes, including the effect of childhood exposure to adversity on brain development, structure, and function. For example, research suggests that exposure to ACEs may affect brain development through frequent or sustained activation of the body's stress response system, which includes heightened levels of stress hormones, such as cortisol and adrenaline [14, 15]. Exposure to heightened levels of stress hormones during early childhood, a time of rapid brain growth and development, can result in stress-induced changes in the structure and function of various regions of the brain, such as the amygdala and hippocampus [14-16]. There is also evidence to suggest that exposure to early adversity can manifest in alterations in immune function, inflammatory markers associated with various chronic health conditions, and the expression of certain genes [14-16]. Overall, research regarding the mechanisms underlying the association of ACEs with poor health outcomes indicates that both the cumulative burden of exposure to multiple ACEs and the timing of ACE exposure during sensitive periods of physical, emotional, and social development in childhood has implications for health, learning, and behavior across the life course.

Behavioral Risk Factor Surveillance System

The Behavioral Risk Factor Surveillance System (BRFSS) is a random-digit-dial telephone survey designed to collect population-representative data regarding the health and health practices of non-institutionalized resident adults aged 18 years and older in the United States. The survey is administered and supported by the Centers for Disease Control and Prevention (CDC) and managed by state health departments. The BRFSS is conducted annually in all 50 states, the District of Columbia, and 3 US territories.

A notable limitation of the 1998 study on ACEs was that the study population consisted of insured, primarily white, well-educated individuals, limiting generalizability of the results to the larger US population. Thus, in 2008, the CDC developed a standardized optional ACE module for the BRFSS with the intent of collecting data on ACEs in representative samples of the US population. The BRFSS ACE module asks adult respondents to recall ACE exposure prior to age 18. The module consists of 11 questions that assess 5 categories of household dysfunction and 3 categories of childhood abuse (see Table 1). Based on responses to the ACE module, an ACE score can be calculated. The ACE score measures cumulative exposure to ACEs. To calculate the ACE score, exposure to any single ACE category counts as one point toward the score. The final score is the sum of the total number of points accumulated and ranges from 0 to 8.

Adverse Childhood Experiences in North Carolina

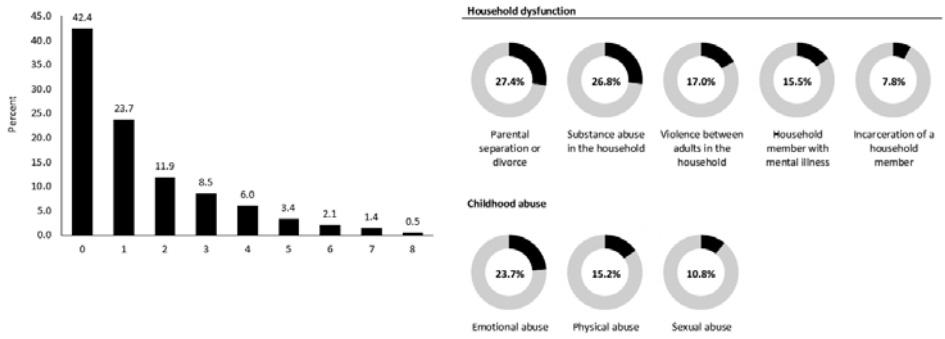
Data regarding ACEs among North Carolina residents from the 2012 North Carolina BRFSS survey are presented below. In total, 11,898 North Carolina adults participated in the 2012 BRFSS survey, of which 10,383 (87.3%) responded to the ACE module. Note that all percents presented are

TABLE 1.
Behavioral Risk Factor Surveillance System Adverse Childhood Experiences Module

Household dysfunction	
Parental separation or divorce	Were your parents separated or divorced? [Yes/No]
Substance abuse in the household	Did you live with anyone who was a problem drinker or alcoholic? [Yes/No]
	Did you live with anyone who used illegal street drugs or who abused prescription medications? [Yes/No]
Violence between adults in the household	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]
Mental illness in the household	Did you live with anyone who was depressed, mentally ill, or suicidal? [Yes/No]
Incarcerated household member	Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility? [Yes/No]
Childhood abuse	
Emotional abuse	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]
Physical abuse	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]
Sexual abuse	How often did anyone at least 5 years older than you or an adult touch you sexually? [Never/Once/More than once]
	How often did anyone at least 5 years older than you or an adult, force you to have sex? [Never/Once/More than once]
	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]

Note: For ACE categories with more than one question, a response of "yes" to one or more questions within the category corresponds to having experienced that category of ACE. For questions with "never," "once," or "more than once" response options, a response of "once" or "more than once" is equivalent to a response of "yes," except for emotional abuse, where only a response of "more than once" is equivalent to a response of "yes."
Source. North Carolina Behavioral Risk Factor Surveillance System, 2012.

FIGURE 1.
Prevalence of the Adverse Childhood Experiences Score and Categories: North Carolina Behavioral Risk Factor Surveillance System, 2012



Source. North Carolina Behavioral Risk Factor Surveillance System, 2012.

weighted to account for the complex sampling design of the North Carolina BRFSS survey.

Adverse Childhood Experiences Score

The prevalence of the ACE score among North Carolina residents is shown in Figure 1. More than half of North Carolinians (57.6%) reported having experienced at least one ACE, and more than one-third (33.8%) reported having experienced multiple (ie, 2 or more) ACEs.

Prevalence of Adverse Childhood Experiences

Figure 1 also shows the prevalence of each of the 5 categories of household dysfunction and 3 categories of childhood abuse. Parental separation or divorce (27.4%), substance abuse in the household (26.8%), and emotional abuse (23.7%) were the mostly commonly reported ACE categories among North Carolina residents.

Co-occurrence of Adverse Childhood Experiences

The seminal ACE study demonstrated that rather than occurring in isolation, ACEs tend to co-occur such that if an individual has experienced one ACE category, it is likely that he or she has also experienced additional ACE categories [1]. The co-occurrence of the individual ACE categories with the other categories of ACEs among North Carolina residents is presented in Table 2. For example, among those who reported having experienced substance abuse in the household as a child, 44.0% also reported experiencing parental separation or divorce, 40.0% violence between adults in the household, 35.6% a household member with a mental illness, 6.5% incarceration of a household member, 48.8% emotional abuse, 31.8% physical abuse, and 21.8% sexual abuse.

Adverse Childhood Experiences and Adult Health Outcomes

The prevalence of the ACE score differed by several indicators of health risks, perceived poor health, and chronic health conditions among North Carolina residents, with higher prevalences generally noted among those with higher ACE scores. Several of these poor health outcomes—including current smoking, obesity, HIV risk behaviors, fair or poor health, poor physical and mental health, activity limitations, current asthma, chronic obstructive pulmonary disease,

TABLE 2.
Co-occurrence of Adverse Childhood Experiences: North Carolina Behavioral Risk Factor Surveillance System, 2012

	Parental separation or divorce (N = 2,521)	Substance abuse (N = 2,777)	Violence between adults (N = 1,718)	Mental illness (N = 1,533)	Incarceration (N = 698)	Emotional abuse (N = 2,376)	Physical abuse (N = 1,486)	Sexual abuse (N = 1,198)
	%	%	%	%	%	%	%	%
Parental separation or divorce		44.0	47.8	46.3	54.3	41.8	41.3	43.9
Substance abuse	43.0		62.7	61.0	74.9	55.3	55.8	53.8
Violence between adults	30.0	40.0		38.5	43.1	42.6	54.6	40.1
Mental illness	26.1	35.6	35.4		39.9	38.8	37.6	38.8
Incarceration	15.5	6.5	19.9	20.3		16.6	17.3	20.7
Emotional abuse	36.2	48.8	59.3	58.8	49.8		70.5	55.7
Physical abuse	23.0	31.8	48.6	36.8	33.5	45.4		40.5
Sexual abuse	17.3	21.8	25.5	27.0	28.5	25.6	28.9	

Source. North Carolina Behavioral Risk Factor Surveillance System, 2012.

cardiovascular disease, arthritis, kidney disease, depression, and disability—demonstrated a dose-response relationship with the ACE score in adjusted models such that as the number of ACEs an individual reported having experienced increased, the odds of the outcome also increased (see Table 3).

Conclusion

In summary, the seminal study on ACEs and the data from the North Carolina BRFSS indicate that ACEs are common in the general population; ACEs do not occur in isolation, but rather tend to co-occur; and cumulative ACE exposure is associated with a range of poor health outcomes across the life course. In North Carolina, noting that more than half of the state's adults reported having experienced at least one ACE indicates that ACEs are an important social and public health issue in the state. The finding that ACEs tend to co-occur provides a rationale for considering multiple types of childhood adversity in research, practice, and policy intended to improve the well-being of children. Demonstrating an association between ACEs and poor health outcomes brings the issue of childhood trauma and adversity more centrally into the field of public health and strengthens the argument for the potential of primary prevention of ACEs to be an effective long-term strategy for improving population-level health.

It is important to bear in mind that a "high" ACE score does not guarantee poor health outcomes. Health and well-being are influenced by exposure to factors that either undermine (ie, risk factors) or promote (ie, protective factors) optimal development across the life course [15, 17, 18]. A growing body of research has begun to explore the concept of resilience, broadly considered to be positive adaptation in the context of exposure to severe trauma and adversity, and the mechanisms by which that occurs [19, 20]. Several studies have examined the role of various factors at the individual, interpersonal, and community level in buffering individuals from the potential negative effects of ACEs and mitigating the risk for poor health outcomes [21-23]. Results from this research suggest that certain types of interpersonal connections such as relationships with caring, responsive adults [21-23] may function as protective fac-

TABLE 3.
Association of Adverse Childhood Experiences with Adult Health Outcomes: North Carolina Behavioral Risk Factor Surveillance System, 2012

	1 ACE Odds ratio[a] (95% CI)	2 ACEs Odds ratio[a] (95% CI)	3 ACEs Odds ratio[a] (95% CI)	≥4 ACEs Odds ratio[a] (95% CI)
Health risks				
Current smoking	1.51 (1.25, 1.81)	1.63 (1.31, 2.03)	2.58 (2.03, 3.27)	3.15 (2.60, 3.82)
Heavy drinking[b]	1.20 (0.87, 1.67)	1.51 (0.99, 2.30)	2.26 (1.53, 3.35)	1.78 (1.25, 2.54)
Binge drinking[c]	1.23 (0.96, 1.57)	1.36 (1.01, 1.85)	1.91 (1.42, 2.58)	1.65 (1.27, 2.16)
Obesity[d]	1.28 (1.10, 1.49)	1.26 (1.04, 1.52)	1.50 (1.21, 1.86)	1.66 (1.39, 1.99)
HIV risk behaviors[e]	1.55 (0.98, 2.43)	2.95 (1.78, 4.90)	3.10 (1.75, 5.50)	4.94 (3.27, 7.45)
Perceived poor health				
Fair or poor general health	1.13 (0.95, 1.34)	1.35 (1.09, 1.69)	2.17 (1.72, 2.74)	3.33 (2.73, 4.06)
≥14 days of poor physical in past 30 days	1.33 (1.08, 1.64)	1.66 (1.27, 2.17)	1.78 (1.34, 2.37)	3.41 (2.73, 4.28)
≥14 days of poor mental in past 30 days	1.25 (0.98, 1.59)	2.22 (1.71, 2.89)	2.83 (2.15, 3.72)	4.40 (3.50, 5.54)
≥14 days of activity limitations in past 30 days	1.54 (1.20, 1.99)	2.18 (1.64, 2.91)	2.81 (2.06, 3.83)	4.79 (3.70, 6.20)
Chronic health conditions[f]				
Current asthma	1.18 (0.88, 1.58)	1.59 (1.11, 2.27)	1.45 (0.99, 2.11)	1.71 (1.26, 2.33)
Chronic obstructive pulmonary disease	1.82 (1.42, 2.35)	1.68 (1.23, 2.29)	2.31 (1.59, 3.35)	4.23 (3.26, 5.51)
Cardiovascular disease	1.29 (1.04, 1.61)	1.59 (1.22, 2.07)	1.88 (1.35, 2.59)	2.23 (1.71, 2.92)
Diabetes	1.01 (0.83, 1.24)	1.31 (1.03, 1.69)	1.87 (1.39, 2.52)	1.48 (1.14, 1.92)
Arthritis	1.33 (1.13, 1.56)	1.57 (1.30, 1.90)	1.81 (1.44, 2.28)	2.53 (2,09, 3.05)
Cancer (other than skin)	1.19 (0.94, 1.50)	1.42 (1.06, 1.90)	1.09 (0.75, 1.58)	2.01 (1.52, 2.66)
Kidney disease	1.18 (0.79, 1.75)	1.19 (0.76, 1.87)	1.63 (1.00, 2.65)	2.10 (1.41, 3.13)
Depression	1.54 (1.27, 1.88)	2.10 (1.69, 2.62)	3.11 (2.43, 3.98)	5.63 (4.62, 6.88)
Disability[g]	1.37 (1.17, 1.62)	1.64 (1.34, 2.01)	2.17 (1.73, 2.73)	3.87 (3.19, 4.68)

Note. ACE = adverse childhood experience.
[a]Reference group is 0 ACEs. Odds ratios are adjusted for age, sex, and race.
[b]Heavy drinking: >2 drinks per day for males and >1 drink per day for females.
[c]Binge drinking: ≥5 drinks for males and ≥4 drinks for females in one sitting.
[d]Obesity: body mass index ≥30 kg/m^2.
[e]HIV risk behaviors: intravenous drug use, treated for a sexually transmitted infection, given or received money or drug for sex, or had anal sex without a condom in past year.
[f]Chronic health conditions were diagnosed by a doctor, nurse, or other health care professional.
[g]Disability: limited in any activities due to physical, mental, or emotional problems or any health problem requiring the use of special equipment.
Source. North Carolina Behavioral Risk Factor Surveillance System, 2012.

tors in promoting positive outcomes. Research in this area is still developing as professionals address questions related to how to best define and measure protective factors (ie, is a protective factor the mere absence of a risk factor, or is it something additional?) and what it means for an individual to be resilient.

In response to the growing scientific literature on ACEs, some have suggested implementing public health screening for ACEs or the ACE score in pediatric or primary care practices in order to inform clinical practice and the tailoring of services to patients' ACE exposure [24]. However, others have cautioned that before population-based screening is implemented, additional research is needed regarding what interventions are effective for screened and referred individuals, and additional resources will likely be needed to ensure that these services are accessible [25]. It is also important to note that while the ACE score measures cumulative exposure to childhood adversities, it does not capture the frequency, severity, or developmental timing of ACE exposure, which may have important implications in terms of health outcomes. Moreover, the ACE score treats individual ACE categories as interchangeable. The interventions that are effective in promoting positive outcomes for those with a "high" ACE score may vary widely depending on which specific ACEs the individual has experienced.

Overall, data regarding the association of ACEs with poor health outcomes represents a powerful tool for advocating for increased research and programmatic and policy initiatives focused on the prevention of childhood adversity and the promotion of positive life course health and development. NCMJ

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