Adverse Childhood Experiences and Successful Adult Health and Economic Outcomes: A Cross-Sectional Study

Alexa Allchin[1], Joseph Feinglass[2]

1. alexaallchin2018@u.northwestern.edu, 2. j-feinglass@northwestern.edu

Abstract

Background: Adverse childhood experiences (ACEs) are stressful or traumatic events experienced in childhood and are related to the development of a broad range of health problems throughout a person's lifespan. Reporting four or more ACEs is strongly associated with adult health and social problems, however, there is a lack of research studying individuals' ability to overcome ACEs and achieve successful outcomes. The purpose of this study was to examine the proportion of individuals who reported four or more ACEs who attained 'successful' health and economic outcomes as adults.

Methods: Data were obtained from the Centers' for Disease Control and Prevention's 2011-2012 Behavioral Risk Factor Surveillance System (BRFSS) from nine states with respondents to the ACEs question module (N=86,968), and were presented as weighted estimates to be representative of the approximate 32 million adult state residents. 'Successful' adult health was defined as excellent, very good, or good self-reported health and economic 'success' was defined as being in the upper 50% of household income in an age group. The likelihood of health and economic 'success' across four categories of reported ACEs are reported.

Results: Comparing respondents who reported zero ACEs to those reporting four or more, 93.5% versus 84.1% of age 18-34 attained successful health outcomes, respectively, and 56.3% versus 44.9% attained successful economic outcomes. Of respondents age 35-54, 86.3% and 49.7% with an ACE count of zero attained successful health and successful economic outcomes, respectively, compared to 74.5% and 38.2% of respondents with an ACE count of four or more.

Among respondents age 55 and over, 77.0% and 58.5% with an ACE count of zero attained successful health and successful economic outcomes, respectively, compared to 64.9% and 59.2% of respondents with an ACE count of four or more, all comparisons $p < 0.001$.

Conclusion: Study findings indicate those with four or more ACEs attain significantly fewer 'successful' health and economic outcomes compared to those with zero ACEs, however, a majority of those with high ACE counts were successful under the definitions used in the study. More research is needed on patterns of resilience among those who have successfully coped with ACEs.

Introduction

Adverse Childhood Experiences

Adverse childhood experiences (ACEs) are stressful or traumatic events experienced in childhood (age 0-17), such as physical, sexual, or emotional abuse, neglect, witnessing intimate partner violence, and substance misuse within the household. ACEs are of particular concern because of their relation to the development of a broad range of health problems through a person's lifespan.[1]

Public Health Significance

ACEs are common, with more than half (54.2 percent) of adolescents ages 12-17 in the U.S. having experienced at least one ACE, and nearly one in ten having experienced four or more.[2] ACEs are at the root of many of society's health problems, including chronic health conditions and smoking, as well as contribute to high costs of health care and many social costs, such as morbidity, mortality, and quality of life. Additionally, a dose-response relationship exists, meaning as the number of adverse experiences increases, so does the risk of health problems from childhood through adulthood. Experiencing traumatic experiences before the age of 18 often causes stress that is detrimental to the developing brain and body, disrupting their optimal functioning.[3] From a neuroscience perspective, it is argued that early-life adversity amplifies crosstalk between peripheral inflammation and neural circuitries, promoting threat-related, reward-related, and executive control-related processes. It is believed this crosstalk results in chronic low-grad inflammation, which contributes to adiposity, insulin resistance, and other pre-disease states. Additionally, these inflammatory mediators act on the threat and reward portions of the brain in a manner that predisposes individuals to self-medicating behaviors, such as

smoking, drug use, and consumption of high-fat diets. These behaviors, in combination with inflammation, accelerate the development of emotional and physical health problems.[4]

About half of all adults – 117 million people – had one or more chronic health conditions as of 2012, with heart disease and cancer together accounting for nearly 48% of all deaths.[5] 25% of the risk of getting heart disease or cancer is attributable to ACEs, with individuals who had faced four or more categories of ACEs being twice as likely to be diagnosed with cancer as individuals who hadn't experienced childhood adversity.[5,6] In addition to attributing to heart disease and cancer risk, each additional ACE score increases the risk of being hospitalized with an autoimmune disease.[7] In 2014, 8.6% of children 18 years or under and 7.4% of adults had asthma.[8] According to the National Survey of Children's Health from 2011-12, 29.2% of children with exposure to at least one ACE reported asthma, which is twice the number of children with zero ACEs who reported having asthma during that period.[9]

Mental illness and drug use are significant causes of morbidity and disability, as well as negatively impact society in terms of health, productivity, and health care expenditures. In 2015, an estimated 16.1 million adults aged 18 or older in the U.S. had at least one major depressive episode in the year, or about 6.7% of all U.S. adults.[10] Someone with an ACE score of four is 460% more likely than someone with an ACE score of zero to have depression.[11] In addition to mental illness, substance abuse is also associated with ACEs. In 2013, an estimated 9.4% of Americans aged 12 or older – 24.6 million people – had used illegal drugs in the past month.[12] An ACE score of three increases the risk of IV drug use by 93%.[13] ACEs increases risks for first and subsequent incidents of violence as either a victim or perpetrator, with a man with an ACE score of four being 400% more likely to be a perpetrator of domestic violence than a man with an ACE score of zero.[11] Women who have experienced five or more ACEs are three times more

likely than women who have experienced zero ACEs to be victims of domestic violence as adults.[10]

Research Objectives

Reporting four or more ACEs in comparison to zero ACEs is very strongly associated with adult health and social problems. However, relatively few research studies exist about individuals' ability to overcome ACEs and achieve successful health and economic outcomes as adults. Our study aims to address this gap in knowledge by examining the proportion of individuals with four or more ACEs who attained 'successful' health and economic outcomes as adults. While not directly providing evidence about the mechanisms of resilience, study findings can be used to hypothesize the prevalence of successful resilience.

Methods

Behavioral Risk Factor Surveillance System (BRFSS)

Data obtained from the Behavioral Risk Factor Surveillance System (BRFSS) were used for the purpose of this cross-sectional study. The BRFSS was developed in 1984 by the Centers for Disease Control to collect data about U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. Originally established in 15 states, BRFSS now collects data in all 50 states as well as the District of Columbia and three U.S. territories. The BRFSS completes more than 400,000 adult interviews each year, which makes it the largest continuously conducted health survey system in the world.[14] IRB approval was not necessary as data from the BRFSS is public and deidentified, and therefore exempt.

Population-weighted sampling was attained by calling cell phones within selected geographic areas determined by wireless phone service provider data. Starting in 2011, BRFSS respondents who received 100 percent of their calls on cell phones were eligible for participation in the cell phone survey.

The BRFSS uses post stratification weighting methodology to compute state representative population estimates, and in 2011 this was replaced with iterative proportional fitting (or "raking"). Raking allows for the incorporation of cell phone survey data, permits the introduction of additional demographic characteristics, and more accurately matches sample distributions to known demographic characteristics of state level populations. Raking has been shown to improve nonresponse bias and reduce the error of estimates.[15] All data presented below are based on weighted state level estimates for the nine states (Iowa, Minnesota, Montana, North Carolina, Oklahoma, Tennessee, Vermont, Washington, and Wisconsin) with respondents to the ACEs module in 2011-2012. Wisconsin, which had respondents in both 2011 and 2012, is only included for 2012 respondents. The weighted median response rate, as defined by the American Association for Public Opinion Research (AAPOR), was 49.72% for the 2011 BRFSS survey and 45.2% for the 2012 BRFSS survey.

ACE Questions

The BRFSS Adverse Childhood Experience Module is a standardized 11-item questionnaire used to collect information on whether respondents experienced child abuse and neglect and household challenges before the age of eighteen. The module includes questions that assess various forms of abuse: one question to assess verbal and physical abuse and three questions to evaluate sexual abuse. Additionally, the module includes a question to assess family dysfunction

(exposure to domestic violence, living with a family member with either mental depression, drug or alcohol use disorder, or an incarcerated family member).[16]

Our analysis included both dichotomized individual ACEs items and overall ACE counts (based on the sum of affirmed ACE categories ranging from zero to eight). ACE counts were grouped as 0 ACEs, 1 ACE, 2-3 ACEs, and 4 or more ACEs for each respondent. ACE categories were grouped as such in data tables because existing research suggests a graded dose-response relationship between these groupings of ACE exposure and health outcomes.[17] We first present the distribution of ACE counts across all states combined by respondents age, race and ethnicity, education, employment status, income, and marital status. Further analysis focused primarily on the health and economic status of respondents who reported four or more ACEs.

Respondent Characteristics

Respondent age groups were initially classified as 18-24, 25-34, 35-44, 45-54, 55-64, and 65 and over. The definitions of 'success' would vary widely across the six age groups, which differ significantly in income and SROH. Hence the age groups were collapsed into 3 categories (18-34, 35-54, 55 or over) to have a more synonymous definition of 'success'. Race and ethnicity were self-reported and categorized as Non-Hispanic Whites, Non-Hispanic Blacks, Hispanics, and unknown or other. Respondent's educational level was categorized into four levels: some high school or less, high school graduate, some college, and college graduate. Household income was collapsed into 5 levels: $15,000 or less; $15,000-$30,000; $30,000-$45,000; $45,000-$60,000; and $60,000 and above. Because about 14% of respondents were missing income data, missing income level was imputed using linear regression estimates of known income data as a function of race/ethnicity, educational attainment, employment status, and other measures. Marital status was dichotomized as married or living as married. Employment was

dichotomized as working part or full time. General health status was categorized as excellent, very good, good, fair, and poor. Bad physical or mental health was dichotomized as any days of bad physical or mental health in the last 30 days versus those with no bad days.

'Successful' Adult Health and Economic Outcomes Among Respondents with a 4+ ACE Score

Measures of 'success' were defined specific to each of the 3 age groups (18-34, 35-54, and 55+), to determine the proportion of the population in each group that reports having good health and economic status relative to other respondents with zero ACE counts of the same age.

Successful health and economic outcomes were categorized to reflect respondents being among the top 75% of health and top 50% of income for their age cohort. For all age groups, good health was indicated by a general health status answer of excellent, very good, or good versus fair or poor. A successful income level was defined differently per age group as respondents in the 18-34 age group are more likely to be in entry-level jobs with lower income, and those 55+ are more likely to be retiring and living off a fixed income. For the age groups 18-34 and 55+ economic success was indicated by an answer of household income of $30,000-$45,000, $45,000-$60,000, and $60,000 and above. For the age group 35-54 economic success was indicated by an answer of household income of $45,000-$60,000 or $60,000 and above.

Statistical Analysis

The Stata Version 14 (College Station, TX) complex survey design module was used to analyze population-weighted data which represents the estimated 2011-2012 nine states adult population. Thus the 86,968 respondents were representative of about 32 million adult respondents from the 9 states, and all data are presented as weighted estimates. The significance of univariate associations between respondents ACEs counts and respondents' sociodemographic

characteristics (age, sex, race/ethnicity, household income, education level, marital status, and employment status) was determined using chi-square tests.

Results

Respondent Differences by ACEs Counts

Self-reported respondent characteristics by ACE counts are presented in Table 1. The largest divergences across ACE count level were for respondents who were employed, college educated, and married. Of respondents employed full or part time, 46.4% had an ACE count of zero, compared to 15.2% had an ACE count of four or more ($p<0.001$). Of respondents who reported an educational level of college graduate, 51.6% had an ACE count of zero, in comparison to 10.7% having an ACE count of four or more ($p<0.001$). Of respondents who reported being married, 50.3% had an ACE count of zero, compared to 12.9% had an ACE count of four or more ($p<0.001$).

Income Distribution and Economic Success

A histogram of respondent self-reported income distribution is presented in Figure 1. For respondents age 18-34 and 55 and above, the 50^{th} percentile for income was approximately $30,000, while for respondents age 35-54 the 50^{th} percentile for income was approximately $45,000. This was used to empirically establish the success levels for each age

Health Status Distribution by Age Group

ACE count category and self-reported health status by age group are presented in Table 2. In general, as ACE score increased the percent of excellent, very good, and good health decreased,

while the percent of fair and poor health increased. Across all age groups, the percentage of respondents with an ACE score of zero reporting any days of bad physical or mental health was significantly less than the percentage of respondents with an ACE score of four or more reporting any days of bad physical or mental health.

Percent of 'successful' adult health and economic outcomes by ACE score and age group are presented in Table 3. Among respondents age 18-34, 93.5% and 56.3% with an ACE count of zero (N=4,329,120) attained successful health and successful economic outcomes, respectively, compared to 84.1% and 44.9% of respondents with an ACE count of four or more (N=1,851,319). Of respondents age 35-54, 86.3% and 49.7% with an ACE count of zero (N=4,920,869) attained successful health and successful economic outcomes, respectively, compared to 74.5% and 38.2% of respondents with an ACE count of four or more (N=2,110,098). Among respondents age 55 and over, 77.0% and 58.5% with an ACE count of zero (N=6,331,973) attained successful health and successful economic outcomes, respectively, compared to 64.9% and 59.2% of respondents with an ACE count of four or more (N=1.010,843). For all comparisons $p < 0.001$. Respondents age 18-34 attained the highest percent of 'successful' outcomes across all categories of ACE score compared to the other age groups. For respondents age18-34 and 35-54, economic 'success' was attained at a significantly higher percent among respondents with an ACE score of zero compared to respondents with an ACE score of four or more, however, the difference was insignificant among respondents age 55+.

Discussion

To our knowledge, this is the first study of its kind examining the relationship between ACE count and 'success'. Our study examined the proportion of individuals with four or more ACEs who attained 'successful' health and economic outcomes as adults using a large, nationally representative data set. Among respondents age 18-34, 93.5% and 56.3% with an ACE count of zero attained successful health and successful economic outcomes, respectively, compared to 84.1% and 44.9% of respondents with an ACE count of four or more. Of respondents age 35-54, 86.3% and 49.7% with an ACE count of zero attained successful health and successful economic outcomes, respectively, compared to 74.5% and 38.2% of respondents with an ACE count of four or more. Among respondents age 55 and over, 77.0% and 58.5% with an ACE count of zero attained successful health and successful economic outcomes, respectively, compared to 64.9% and 59.2% of respondents with an ACE count of four or more. Such findings indicate that respondents with four or more ACEs attain 'successful' outcomes significantly less compared to respondents with zero ACEs. However, a large proportion are still able to attain 'successful' outcomes, speaking to the potentially high prevalence of successful resilience.

Resilience

The findings from this study can be used to hypothesize the prevalence of successful resilience and aid in other ACEs related research. Theories of "Resilience" have been proposed to explain how individuals may overcome or cope with ACEs.[18] Resilience is the ability to overcome adverse situations, such as child abuse and neglect, and is the result of interactions between an individual's adverse experiences and his/her protective attributes. Such attributes include nurturing parents, stable relationships, positive attitude, and the ability to regulate emotions. It is

thought that this interaction determines the developmental path that either leads towards health and well-being or towards illness and dysfunction.[19] One mechanism thought to play a role in resilience is a child's family structure, which affects outcomes for the child once he/she reaches adulthood.[20] Understanding such mechanisms is thought to be essential for furthering theory and research in the field.[21]

Limitations

First, our study is vulnerable to recall bias due to the retrospective reporting of childhood experiences, as respondents may have difficultly recalling certain events. For example, in longitudinal follow-up of adults whose childhood abuse was documented, their retrospective reports of such abuse were likely to underestimate the actual occurrence.[22,23] Difficulty recalling childhood events likely results in misclassification (for example, classifying persons truly exposed to 1 ACE as unexposed) that would lead to a conservative reporting of ACEs and an overestimation of 'successful' health and economic outcomes. Second, our study is susceptible to survival bias as respondents, particularly those with four or more ACEs, may have died from conditions attributed to ACEs, such as chronic diseases or substance abuse, and therefore were not able to participate in the survey into the older age categories. Third, the data used in the analysis is not particularly recent. More recent data does not exist because in the years after 2011-2012 the data from the state modules was not released nationally. Therefore, the study uses the most recent, nationally representative data available, and to our knowledge is the largest source of data on ACEs yet collected.

Conclusion

In conclusion, our study examined the relationship between an ACE score of four or more and 'successful' adult health and economic outcomes, and indicates those with four or more ACEs attain significantly less 'successful' outcomes compared to those with zero ACEs. While a gradient in successful outcomes was apparent, most individuals with high ACE scores nevertheless experienced relatively successful health and economic outcomes by the limited measures used here.

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Tables and Figures

Table 1
Characteristics of Respondents by Self-Reported Adverse Childhood Experience (ACEs) Counts
Percent of Weighted Nine State Adult Population, N =32,552,191
Behavioral Risk Factor Surveillance System, 2011-2012

	O ACEs Weighted N=15,582,733	1 ACE Weighted N=6,210,958	2-3 ACEs Weighted N=5,787,779	4+ ACEs Weighted N=4,970,719
Age				
Age 18-24	44.2	18.2	18.8	18.8
Age 25-34	45.0	17.5	18.3	19.3
Age 35-44	41.5	20.1	19.1	19.2
Age 45-54	43.7	19.6	19.4	17.4
Age 55-64	48.8	19.5	18.7	12.9
Age 65+	62.4	19.3	12.9	5.4
Race and Ethnicity				
NH White	48.3	19.5	17.4	14.9
NH Black	43.8	20.3	19.2	16.8
Hispanic	45.3	16.8	22.8	15.1
Other/RaceUnknown	50.9	15.4	15.8	17.9
Education				
Some High School or Less	44.4	17.0	18.3	20.3
High School Graduate	48.9	18.9	17.1	15.1
Some College	45.2	19.2	18.5	17.0
College Graduate	51.6	20.3	17.4	10.7
Employed Full or Part Time	46.4	19.8	18.6	15.2
Median Household Income				
Less than $15,000	45.7	15.3	17.6	21.4
$15,000-$30,000	48.8	17.2	17.5	16.6
$30,000-$45,000	47.7	19.6	17.8	15.0
$45,000-$60,000	48.4	20.3	17.9	13.4
$60,000 and Above	47.9	22.0	18.2	11.9
Married	50.3	19.7	17.1	12.9

All comparisons $p<0.001$

Figure 1

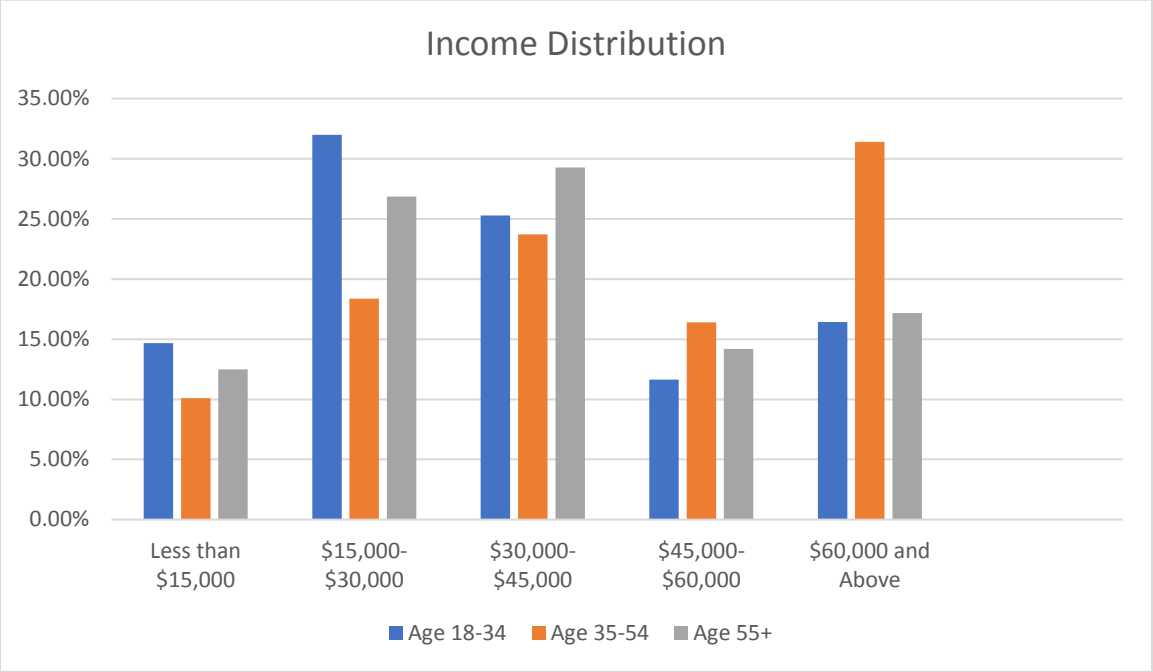

Figure 1. Household Income Distribution Nine States by Age
Nine States, Behavioral Risk Factor Surveillance System 2011-2012, N=32,552,191

Table 2

Adverse Childhood Experience (ACEs) Count and Self-Reported Health Status by Age Group
Percent of Weighted Nine State Adult Population
Behavioral Risk Factor Surveillance System, 2011-2012

Age 18-34, N=9,697,850

	0 ACEs N=4,329,120	1 ACE N=1,724,277	2-3 ACE N=1,793,132	4+ ACEs N=1,851,319
General Health Status				
Excellent	28.3	24.0	19.8	15.0
Very Good	36.5	40.1	38.9	36.2
Good	28.9	29.2	30.3	33.1
Fair	5.2	6.0	9.3	13.8
Poor	1.1	0.7	1.7	2.0
Any Days of Bad Physical Health	28.4	29.8	34.8	44.3
Any Days of Bad Mental Health	33.0	37.7	46.0	56.9

Age 35-54, N=11,543,207

	0 ACEs N=4,920,869	1 ACE N=2,290,172	2-3 ACEs N=2,222,067	4+ ACEs N=2,110,098
General Health Status				
Excellent	21.3	19.4	17.8	13.4
Very Good	35.4	36.3	34.8	29.1
Good	29.8	31.4	30.4	32.1
Fair	10.0	9.3	11.8	16.9
Poor	3.6	3.6	5.2	8.5
Any Days of Bad Physical Health	28.4	31.4	38.0	48.1
Any Days of Bad Mental Health	27.7	31.8	40.4	51.8

Age 55+, N=11,311,135

	0 ACEs N=6,331,973	1 ACE N=2,195,491	2-3 ACEs N=1,772,454	4+ ACEs N=1,010,843
General Health Status				
Excellent	14.0	13.0	11.5	9.8
Very Good	30.0	30.3	28.5	25.1
Good	33.3	34.7	32.9	30.2
Fair	15.4	15.0	16.9	21.7
Poor	7.3	7.1	10.2	13.2
Any Days of Bad Physical Health	31.7	35.5	39.4	50.6
Any Days of Bad Mental Health	18.4	23.7	30.6	42.6

All comparisons $p<0.001$

Table 3
Adverse Childhood Experience (ACEs) Count and 'Successful' Adult Health and Economic Outcomes by Age Group
Percent of Weighted Nine State Adult Population
Behavioral Risk Factor Surveillance System, 2011-2012

Age 18-34, N=9,697,850

	0 ACEs N=4,329,120	1 ACE N=1,724,277	2-3 ACEs N=1,793,132	4+ ACEs N=1,851,319
Health Success (Excellent, Very Good, Good Overall Health Status)	93.5	93.2	88.7	84.1
Economic Success (Household Income >30k)	56.3	58.2	50.2	44.9

Age 35-54, N=11,543,207

	0 ACEs N=4,920.869	1 ACE N=2,290,172	2-3 ACEs N=2,222,067	4+ ACEs N=2,110,098
Health Success (Excellent, Very Good, Good Overall Health Status)	86.3	87.0	83.0	74.5
Economic Success (Household Income >45k)	49.7	51.8	48.5	38.2

Age 55+, N=11,311,135

	0 ACEs N=6,331,973	1 ACE N=2,195,491	2-3 ACEs N=1,772,454	4+ ACEs N=1,010,843
Health Success (Excellent, Very Good, Good Overall Health Status)	77.0	77.6	72.7	64.9
Economic Success (Household Income >30k)	58.5	65.3	63.3	59.2

All comparisons $p<0.001$