ASU Morrison Institute for Public Policy
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Cost of Adverse Childhood Experiences in Arizona

Adversity is a common part of life. Even as children, many people experience sad and unfortunate events like divorce or loss of contact with a parent. Some children, though, experience more adversity than others. For more than 20 years, researchers and public health officials have studied the impact of adversity on the growth and development of children. Two decades of research has shown that early childhood adversity can increase the risk of experiencing negative health outcomes later in life.

Adverse Childhood Experiences (ACEs) are traumatic events such as abuse, neglect, and household dysfunction that occur during childhood (before age 18) and have a negative and lasting impact on future health and functioning. ACEs include:[1]

- emotional, physical, or sexual abuse
- physical or emotional neglect
- domestic violence
- parental substance abuse
- household mental illness
- divorce
- imprisoned family

A seminal study conducted in 1998 found a direct link between the number of ACEs someone experienced and their risk for chronic diseases later in life.[2] More than 17,000 people in California participated in the study by completing a survey about their childhood experiences and health as an adult. This large-scale study was a partnership between the Centers for Disease Control and Kaiser Permanente, a health care company.[3] Arguably the most surprising and influential finding was that the more ACEs a person experienced, the more likely they were to have a chronic health condition. This finding has been referred to as a dose-response relationship.[4] The sobering finding about this dose-response relationship is that individuals who reported experiencing four or more ACEs were twice as likely to have chronic health conditions like heart disease, cancer, chronic bronchitis/COPD, and diabetes.[5]

The association between high levels of childhood adversity and chronic health conditions is significant. The chronic health conditions listed above are not only the leading causes of death in adults, but also some of the most costly health conditions to treat.

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Since the 1998 study, many states started collecting information on the prevalence of ACEs through the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is a partnership between federal and state governments to collect data on health practices, quality of life, health conditions, and barriers to health care. The survey provides rich public health data and helps inform public health policies, practices, and programs in states.[6]

Some states like Alaska, California, and Tennessee have used the ACEs data from the BRFSS to determine not only the prevalence of ACEs, but also how much ACEs contribute to chronic and costly health conditions in their states. This type of analysis provides information on the cost burden of childhood adversity and the potential savings of preventing childhood trauma and related chronic health conditions later in life.

Costs of ACEs in Alaska, Tennessee, and California

A study in Alaska used BRFSS and Medicaid data to determine that ACEs generated $800 million in annual disease-related and child maltreatment-related costs. For its study, Alaska chose to look at Medicaid costs for specific diseases like obesity, diabetes, and arthritis, but also the contribution of ACE-related increases in risky health behaviors such as smoking and binge drinking.[7]

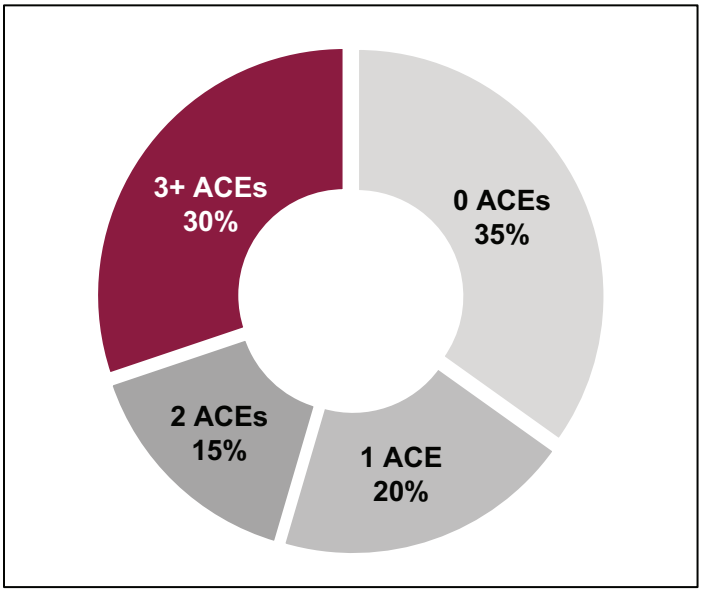
Researchers in California conducted a similar study looking at the correlation between ACEs and the costs associated with the following chronic illnesses/health risk factors: asthma, arthritis, COPD, depression, cardiovascular disease, lifetime smoking, heavy drinking, and obesity. California found that more than half of the state's population had experienced at least one ACE, and revealed an overall associated $10.5 billion in personal healthcare spending during 2013.[8] This finding showed that in 2013 the average personal healthcare cost rose by $589 per individual exposed to at least one ACE.

In Tennessee, researchers estimated $5.2 billion in annual healthcare expenditures stemming from ACE-related health conditions, such as smoking, depression, cardiovascular disease, diabetes, COPD, asthma, and hypertension.[9] In Tennessee, more than half of the adult population had experienced at least one ACE, and 17% had experienced four or more ACEs. Smoking was found to be the health condition with the largest associated cost ($2.1 billion annual costs in 2017), followed by depression (with a cost of $923 million annual cost).[10]

Prevalence of ACEs in Arizona

One survey that looked at the prevalence of ACEs in child populations found that Arizona children on average have higher ACE scores than the national average with 21.9% of Arizona children having experienced two or more ACEs. The national average is 18.6%.[11] The trend of higher ACE scores among Arizona's children and the connection of ACEs to negative health outcomes were prompted this analysis of ACEs among Arizona adults and the corresponding health outcomes. Preventing or addressing ACEs could help improve the quality of life for Arizona's population while lowering Medicaid expenditures, resulting in savings that could be reallocated.

Figure 1: Prevalence of ACEs for adults in Arizona



Source: 2018 BRFSS.

For this study, prevalence of ACEs in Arizona was determined using 2018 BRFSS data, which is based on surveys of adults in the state.

Figure 1 shows the percentages of the Arizona population who have experienced different numbers of ACEs. It is important to note that there is some disagreement as to the complete list of ACEs. The original ACE study in 1998 included the experience of child neglect as an ACE. However, child neglect was not included in the 2018, 2016, or 2014 Arizona BRFSS and is therefore not captured in this study. As neglect is far more common than child abuse, the number of ACEs in the study may be an under-representation of ACEs in the Arizona adult population.

ACEs Contribute to Negative Health Outcomes

In this study, Morrison Institute reviewed how ACEs are associated with diseases that are the leading causes of death for adults in Arizona. With this focus in mind, heart disease, cancer, stroke, diabetes, and chronic lower respiratory diseases like COPD or chronic bronchitis were included in this study.[12]

Chart 1: Leading Causes of Death in Arizona, 2018

Disease	Death Rate per 100,000	Number of Deaths
Heart Disease	136.4	12,455
Cancer	131.9	12,113
Chronic Lower Respiratory Disease	41.2	3,832
Stroke	31.0	2,836
Diabetes	22.4	2,046

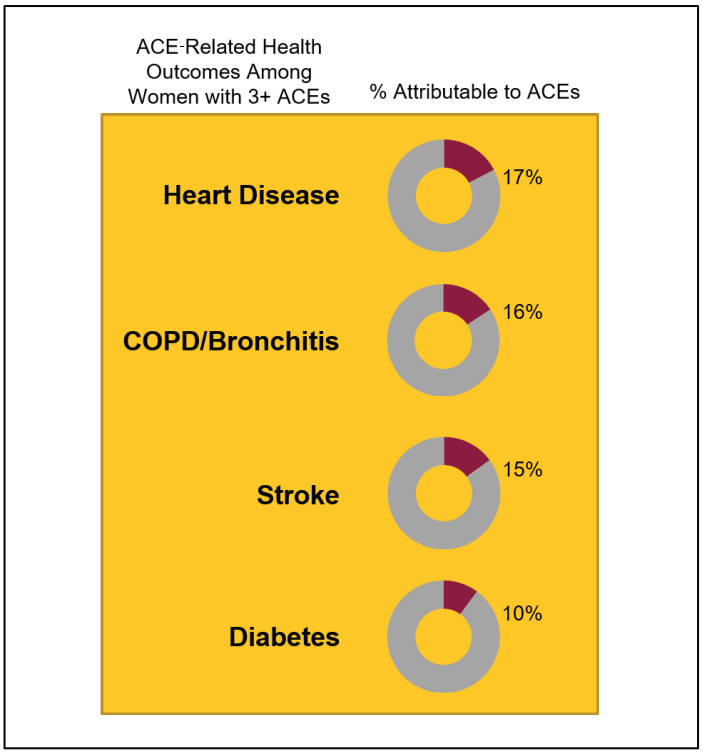
Source: Center for Disease Control and Prevention.

In determining any link between ACEs and disease, the first step is to determine the

proportion of disease cases that was potentially attributable to ACE exposure.[13] This concept is called “attributable risk” and is often used in public health spheres when making health policy decisions.

In order to determine the attributable risk of diseases associated with ACEs in Arizona, this study used three waves of data (2018, 2016, 2014) from the BRFSS and estimated attributable risk uusing multinomial probit regression models to estimate the relative chance of ACES and disease reporting combinations. This is a type of statistical model that, given the data, predicts the most likely categorical outcome (different types of diseases) that a predictor variable (sex, ethnicity, ACE exposure) is associated with.

Figure 2: Percent of Health Outcomes Associated with Experiencing 3+ ACEs Among Women



See the Appendix for more details on the methodology. Initially, Morrison Institute was interested in identifying attributable risk for different demographics, including sex (men/women) and ethnicity. However, in many cases, there were too few people belonging to a given demographic category and either results could not be estimated or results were not significant, meaning that any findings might be due to chance.

Women were the only demographic group for which the statistical model could produce meaningful results. The analysis revealed negative health outcomes for women who were exposed to ACEs as children. Specifically, the analysis showed that a woman who was exposed to three or more ACEs as a child was more likely to develop heart disease, cancer, stroke, COPD/chronic bronchitis, or diabetes as an adult. Exposure to even one ACE increased the likelihood that a woman would report having COPD/chronic bronchitis or having experienced a stroke. Figure 2 shows the proportion of the disease cases that are associated with women being exposed to three or more ACEs during childhood.

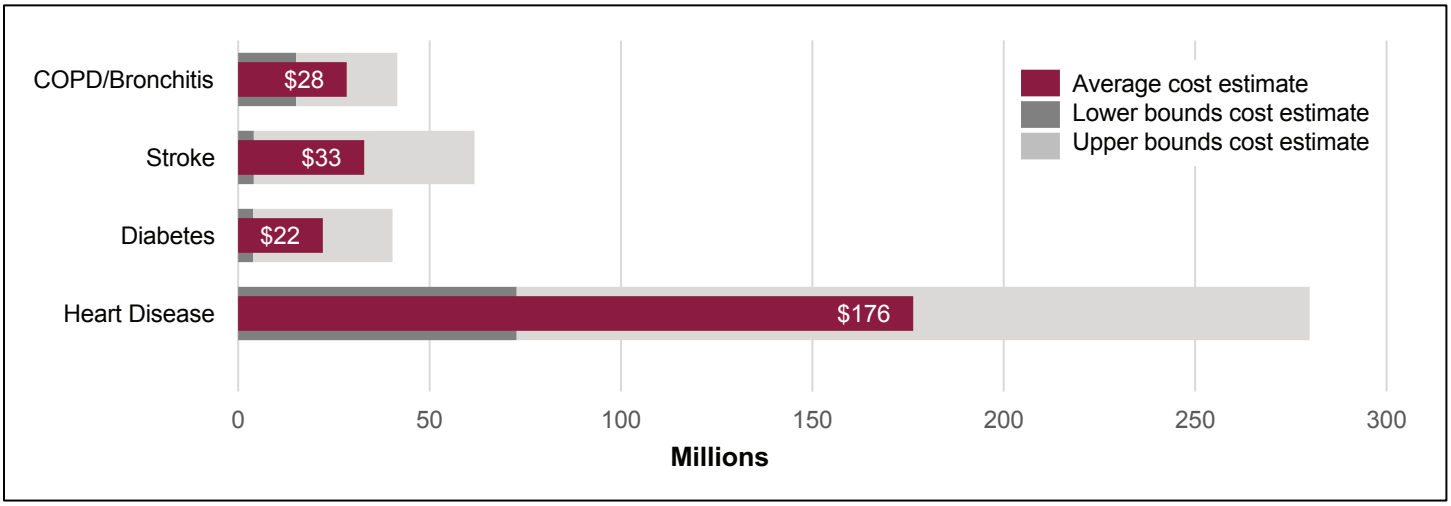
$260 Million

Annual Cost in 2019 dollars

Cost of ACEs in Arizona

Finally, Morrison Institute sought to quantify the impacts of ACEs in Arizona. Medicaid data

Figure 3: Costs Associated with 3+ ACEs among Women in Arizona



Source: ADHS BRFSS 2018, AHCCCS 2019.

for Arizona, through the Arizona Healthcare Cost Containment System (AHCCCS), were used to approximate annual costs associated with the diseases of interest. It is worth noting that Medicaid data were used because these data are well-documented and easy to match to the populations of interest, but the costs reported in this study are conservative and likely represent only a fraction of the total costs. This under-reporting stems from the fact that private insurance medical costs are not captured, nor are other costs such as lost productivity associated with missed workdays due to medical issues.

Based on 2019 Arizona Medicaid data and the calculated attributable risk, exposure to three or more ACEs for women was associated with $260 million in healthcare spending. Figure 3 shows the estimated healthcare costs for one year using 2019 Arizona Medicaid data. The total annual Arizona Medicaid spending for women who received treatment for COPD/chronic bronchitis, heart disease, stroke, or diabetes was $1.6 billion in 2019 irrespective of ACE exposure. This means that the ACE-related spending on these diseases for women with 3-plus ACEs ($260 million) represents approximately 16% of the total Arizona Medicaid spending on women with these diseases annually ($1.6 billion).

Bottom Line

There is a lot of evidence to support the link between childhood trauma and associated chronic illnesses later in life that comes with a steep price tag borne by both the affected individual and the government. This study was conducted to inform policy makers about the costs associated with ACEs and the potential savings and improvement to population health that would be possible with early intervention and prevention programs addressing ACEs in Arizona.

Appendix

Methods for determining AHCCCS costs

Population Inclusion:
- AHCCCS Population
- Age 18+ (as of Jan. 1st 2019)
- Continuously enrolled in calendar year with allowed gap of 30 days disenrollment

Claim Inclusion:
- Claims in calendar year 2019
- Medical claims only (exclude dental and pharmacy)
- Claims with primary diagnosis in categories listed in definition

Definitions
- Disease Categories
  - Any claim with primary diagnosis (dx_type = 1) in the listed Clinical Classification Software categories are considered a service for care in the given disease category
  - Heart disease: This is a comprehensive heart disease category including Congestive Heart Disease and Myocardial Infarction. The net is quite large for this disease. CCS: 96-104, 106, 107-108
  - Cancer: All forms of neoplasms included. CCS: 11-45
  - Stroke: CCS:109-113
  - Diabetes: CCS: 50-51
  - COPD and/or Bronchitis - CCS: 127

Costs:
- The entire claim is attributed to the disease according to the definition above. Thus, costs are not itemized by service but rather attributed as a lump total. Only amounts paid by Medicaid are reported. Total costs for each person in each disease category is summed. Then the average cost per person is calculated.

Race/ethnicity:
- Collapse (Hispanic>race, race: Hispanic, White, Black, Asian/PI, NA, other)

Gender:
- Binary, no definition

Methods for obtaining attributable risk

Variable	Variable Name in BRFSS	BRFSS Year
Did you live with anyone who was depressed, mentally ill, or suicidal?	Az12_1	2014
Did you live with anyone who was a problem drinker or alcoholic?	Az12_2	2014
Did you live with anyone who used illegal street drugs or who abused prescription medications?	Az12_3	2014
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Az12_4	2014
Were your parents separated or divorced?	Az12_5	2014
How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	Az12_6	2014
Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking.	Az12_7	2014
How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Az12_8	2014
How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	Az12_9	2014
How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	Az12_10	2014
How often did anyone at least 5 years older than you or an adult, force you to have sex?	Az12_11	2014
Race	_IMPRACE	2014
Sex	SEX	2014
Ever told you have chronic obstructive pulmonary disease, emphysema or chronic bronchitis?	CHCCOPD1	2014
Ever told you had skin cancer?	CHCSCNCR	2014
Ever told you had any other types of cancer?	CHCOCNCR	2014
Ever told you have diabetes?	DIABETE3	2014
Ever Diagnosed with Heart Attack?	CVDINFR4	2014
Ever Diagnosed with Angina or Coronary Heart Disease?	CVDCRHD4	2014
Ever Diagnosed with a Stroke?	CVDSTRK3	2014
Version 2 weight: Land-line and cellphone data	_LCPWTV2	2014
Did you live with anyone who was depressed, mentally ill, or suicidal?	Az8_1	2016
Did you live with anyone who was a problem drinker or alcoholic?	Az8_2	2016

Variable	Variable Name in BRFSS	BRFSS Year
Did you live with anyone who used illegal street drugs or who abused prescription medications?	Az8_3	2016
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Az8_4	2016
Were your parents separated or divorced?	Az8_5	2016
How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	Az8_6	2016
Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking.	Az8_7	2016
How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Az8_8	2016
How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	Az8_9	2016
How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	Az8_10	2016
How often did anyone at least 5 years older than you or an adult, force you to have sex?	Az8_11	2016
Race	_IMPRACE	2016
Sex	_IMPSEX	2016
Ever told you have chronic obstructive pulmonary disease, emphysema or chronic bronchitis?	CHCCOPD1	2016
Ever told you had skin cancer?	CHCSCNCR	2016
Ever told you had any other types of cancer?	CHCOCNCR	2016
Ever told you have diabetes?	DIABETE3	2016
Ever had coronary heart disease or myocardial infarction?	_MICHD	2016
Ever Diagnosed with a Stroke?	CVDSTRK3	2016
Version 2 weight: Land-line and cell-phone data	_LCPWTV2	2016
Did you live with anyone who was depressed, mentally ill, or suicidal?	Az13_1	2018
Did you live with anyone who was a problem drinker or alcoholic?	Az13_2	2018
Did you live with anyone who used illegal street drugs or who abused prescription medications?	Az13_3	2018
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Az13_4	2018
Were your parents separated or divorced?	Az13_5	2018

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How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Az13_8	2018
How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	Az13_9	2018
How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	Az13_10	2018
How often did anyone at least 5 years older than you or an adult, force you to have sex?	Az13_11	2018
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Sex	_IMPSEX	2018
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Ever told you had any other types of cancer?	CHCOCNCR	2018
Ever told you have diabetes?	DIABETE3	2018
Ever had coronary heart disease or myocardial infarction?	_MICHD	2018
Version 2 weight: Land-line and cellphone data	_LCPWTV2	2018

Using the BRFS Arizona 2018, 2016, and 2014 data, we estimated the risk parameters and associated margins of error using Stata's statistical software for estimating proportions of nominal categorical variables from a multinomial regression model and combining the estimates to produce risk estimates. For any disease Y is defined as at least one assertive answer to a set of Q= $q_1,\ldots q_k\}$ BRFS questions and an ACEs status (X) is defined as scoring at least x or more on the ACEs total score T. Survey respondents were classified into one of 4 mutually exclusive statuses ($Y \cap X = \{a,b,c,d\}$).

$$Y = \max(Q)$$

X = I (T ˜ x)	Disease = Yes	Disease = No	Total
ACEs = Yes	a	b	a+b
ACEs = No	c	d	c+d
Total	a+c	b+d	a+b+c+d

A review article by Uter & Pfahlberg (1999) detailed three estimates of associated risk that we employ in our study.[15] The first estimate is called population attributable risk, which is simply the total risk of disease for a specific population minus the risk of disease for the non-ACE-exposed individuals in that specific population.

$$\text{PAR} = \Pr(\text{Disease} = \text{Yes}) - \Pr(\text{Disease} = \text{Yes} | \text{ACEs} = \text{No})$$

or in terms of our table above

$$\text{PAR} = a+c - \frac{c}{c+d}$$

The second is attributable risk (*AR*)[16] is estimated with

$$\text{AR} = \frac{\Pr(\text{ACEs}) \times (\text{RR} - 1)}{\Pr(\text{ACEs}) \times (\text{RR} - 1) + 1}$$

or in terms of our table above

$$\text{AR} = \frac{(a+b) \times (\text{RR} - 1)}{(a+b) \times (\text{RR} - 1) + 1}$$

where *RR* is the risk ratio estimated with ratio of the disease chance given ACEs to the disease chance given no ACEs

$$\text{RR} = \frac{\binom{a}{a+b}}{\binom{c}{a+b}} = \frac{a\,(c+d)}{c\,(a+b)}$$

The third is the attributable risk of the exposed (*ARE*)[17] which is defined as

$$\text{ARE} = \frac{\text{RR} - 1}{(\text{RR} - 1) + 1}$$

where *RR* is defined as above.

Each of these functions are generalized as $\hat{f}(a,b,c,d)$ in the estimation discussion following.

Step 2

The general approach classified each observation in the data as one of each status *a,b,c, or d*). The data were then combined across 3 waves of the Arizona BRFSS (2014, 2016 and 2018) to create additional observations for each cell. Multinomial probit regression models for each sub-population were then estimated with controls for years 2014 and 2016. Population coded so that intercepts represented weighted averages across years.

Step 3

Based on the regression model, marginal predictions of the associated risk estimates, noted as the 1×4 matrix = [Pr (*a*)…Pr (*d*)], were combined with the predicted probability estimates' sampling variance 4×4 covariate matrix V{ψ} using the delta method[18] to estimate f (*a,b,c,d*) and its sampling variance V{$\hat{f}$ (*a,b,c,d*)}, the square root of which is the standard error SE_{$\hat{f}$ (*a,b,c,d*)}. These procedures were automated using Stata "margins" command with the "expression" option detailing {$\hat{f}$ (*a,b,c,d*)}. Note that for many tables, these estimates were based on a sub-population of the survey responses (e.g., White males), however the sampling variance was still computed using the entire available sample as is typical (e.g., Wolter 2007).[19]

Lower and upper bounds of a 100×(1-α)% confidence interval were computed by taking $\hat{f}$ (*a,b,c,d*)} ±z_(1-α/2)×SE_{$\hat{f}$ (*a,b,c,d*)} where "z_(1-α/2)" "z{1-a/2} is a quantile of the standard normal distribution associated with two-tailed significance level α; where α=0.05 is associated with 1.96 or α=0.1 is associated with 1.64. Note that in some cases, the {$\hat{f}$ (*a,b,c,d*)} estimate was negative (which is possible when those with ACEs are less likely to have the disease, i.e., RR < 1). In these cases, estimating chances for *a,b,c,* and *d* was halted for more extreme ACEs thresholds. For example, if the model failed to produce a valid {$\hat{f}$ (*a,b,c,d*)} for x=2 or more ACEs, models with x=3 or x=4 or more ACEs were not attempted.

Step 4

Using the {$\hat{f}$ (*a,b,c,d*)}, and likewise the lower and upper bound, for any subgroup and disease, we then multiply {$\hat{f}$ (*a,b,c,d*)} against the average cost (and allowed cost) and multiply by the number of cases to produce the cost estimate. We do this only for results in which the PAR is statistically significant using a two-tailed test at the 0.1 significance level (e.g., $\hat{f}$ (a,b,c,d))/SE_{$\hat{f}$ (*a,b,c,d*)} ≥1.64) and greater than 0.

Assumptions of the Analysis

- ACEs and chronic disease are strongly associated.
- ACEs have an independent relationship with chronic disease even when other known factors are present that are associated with chronic disease.
- If ACEs were reduced, there would be a decrease in the risk of chronic diseases.

Limitations of the Analysis

- Cost estimates are conservative and do not reflect costs of individuals who have private insurance. Costs do not reflect co-pays, deductibles, or co-insurance coverage and only reflec amounts paid by Medicaid. Costs also do not reflect societal costs including lost productivit , lost wages, costs for other medical conditions or health behaviors associated with experiencing ACEs such as depression or heavy drinking. Costs also do not reflect services obtained from other sectors such as criminal justice or social services.
- Attributable risk estimates are based on Arizona's adult population and may not be generalizable to other states or populations.
- Attributable risk calculations can vary based on the prevalence of chronic disease and ACEs in the population sample; the analysis pooled data from multiple waves of the BRFSS to account for this.

Notes

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