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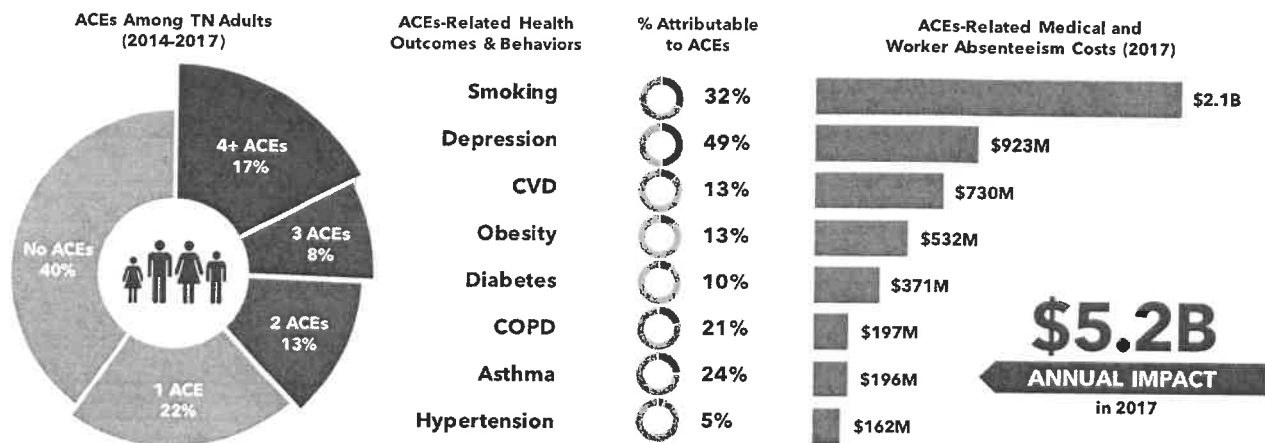
# THE ECONOMIC COST OF ACEs IN TENNESSEE

## Medical Costs and Worker Absenteeism from Health Issues Attributed to Adverse Childhood Experiences

### KEY TAKEAWAYS

- Adverse childhood experiences (ACEs) can increase a person’s risk of health, social, and economic problems throughout life.
- In 2017, ACEs among Tennessee adults led to an estimated \$5.2 billion in direct medical costs and lost productivity from employees missing work.
- ACEs are associated with risky health behaviors and poorer health outcomes even after accounting for other factors.
- Over half of adult Tennesseans reported at least one ACE between 2014 and 2017, and about 17% had experienced 4 or more.

**Figure 1. The \$5 Billion Annual Economic Impact of Adverse Childhood Experiences in Tennessee**



Note: Obesity-related costs include only direct medical costs. See **Methods Appendix** for a complete discussion. Source: The Sycamore Institute’s analysis of 2014-2017 CDC BRFSS data provided by the TN Department of Health’s Division of Policy, Planning and Assessment, Office of Health Statistics (1), the CDC Chronic Disease Calculator (2), Trogdon et al. 2012 (3), Tennessee Department of Health (4), CDC SAMMEC (5), and Ford et al. 2014 (6)

**Adverse childhood experiences (ACEs) can disrupt healthy brain development in ways that affect health later in life.** Abuse, neglect and household dysfunction can cause chronic and severe stress during childhood that is especially toxic to the developing brain. (7) (8) Studies show that as the number of ACEs increases, so does the risk of long-term health, social, and economic problems – including chronic disease, decreased work performance, and risky health behaviors. (9) (10)

**The effects of ACEs are widespread and costly for individuals, families, and communities.** Nationally, child abuse and neglect alone cost an estimated \$124 billion in 2008 and \$80 billion in 2012. These costs are shared across many sectors including health care, taxpayer-funded social services, law enforcement, and special education. (9) (11)

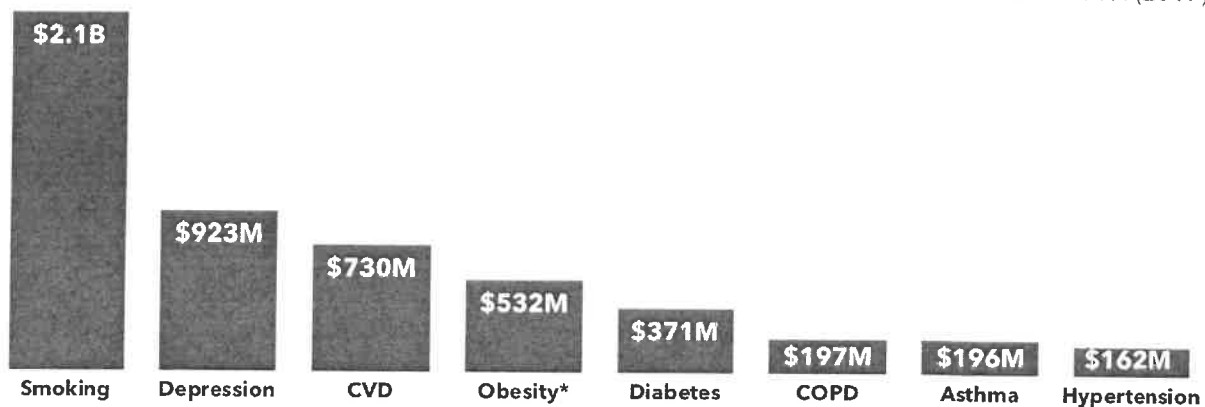
**To better understand how ACEs affect Tennesseans and Tennessee’s economy, this study estimates the economic impact of ACEs-related health outcomes and behaviors in our state.** The findings offer insight into the potential economic upside of efforts to prevent and mitigate ACEs.

## THE ECONOMIC COST OF ACEs IN TENNESSEE

**In 2017, ACEs among Tennessee adults led to an estimated \$5.2 billion in direct medical costs and lost productivity from employees missing work (Figure 1).** (1) (2) (3) (4) (5) (6) These costs are associated with eight ACEs-related health outcomes and behaviors. Among these, cigarette smoking (\$2.1 billion) and depression (\$923 million) were the most costly (Figure 2). The calculation of these estimates includes an adjustment to account for the other known factors and behaviors/conditions that are associated with increased prevalence of these health outcomes.

### Figure 2. Cost of Medical Care and Worker Absenteeism from Health Issues Attributed to Adverse Childhood Experiences

ACEs-Related Medical and Worker Absenteeism Costs of Select Health Outcomes and Behaviors in TN (2017)



Note: Obesity estimate includes only direct medical costs. All other estimates include direct medical costs and cost of worker absenteeism. The analysis accounted for other known factors and behaviors/conditions that are associated with increased prevalence of these health outcomes. See **Methods Appendix** for a complete discussion.

Source: The Sycamore Institute’s analysis of 2014-2017 CDC BRFSS data provided by the TN Department of Health’s Division of Policy, Planning and Assessment, Office of Health Statistics (1), the CDC Chronic Disease Calculator (2), Trogdon et al. 2012 (3), Tennessee Department of Health (4), CDC SAMMEC (5), and Ford et al. 2014 (6)

## Implication for Tennessee's Economy

**These estimates begin to shed light on how ACEs shape Tennesseans' health and influence our state's economy.** By affecting our health outcomes and behaviors, ACEs increase health care costs in taxpayer-funded programs like TennCare, raise employers' costs for health care and productivity loss, and shrink earnings for employees who miss work. Efforts to prevent ACEs and mitigate their effects could potentially reduce those expenses. The details and costs of any such efforts fall outside this report's scope.

## OUR METHOD

**This study estimates the ACEs-related direct medical and worker absenteeism costs associated with eight health outcomes and behaviors.** After determining the prevalence of ACEs reported by Tennessee adults between 2014 and 2017, we estimated the percentage of each health outcome or behavior that is connected to ACEs. This percentage is known as the population attributable risk (PAR).

We adjusted the PAR for other known associated factors like education, income, exercise habits, age, and overlapping chronic diseases. This serves to isolate the effects of ACEs from the effects of other factors. The adjusted PARs were then applied to annual estimates of Tennessee-specific direct medical costs and absenteeism for each health outcome and behavior.

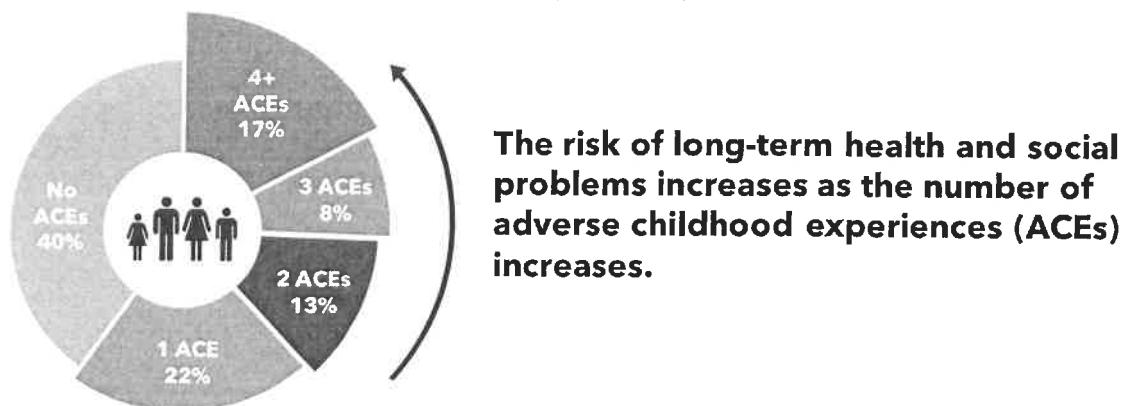
See the **Methods Appendix** for a more detailed discussion of our methods.

## The Prevalence of ACEs in Tennessee

**Over half of adult Tennesseans reported at least one ACE between 2014 and 2017, and about 17% had experienced four or more (Figure 3).** (1) Of the 60% of people who reported at least one ACE, the most common were divorce or separation (52%) and emotional abuse (49%) (Figure 4).

## Figure 3. Over Half of Tennesseans Reported At Least One Adverse Childhood Experience Between 2014 and 2017

Adverse Childhood Experiences Among Tennessee Adults (2014-2017)

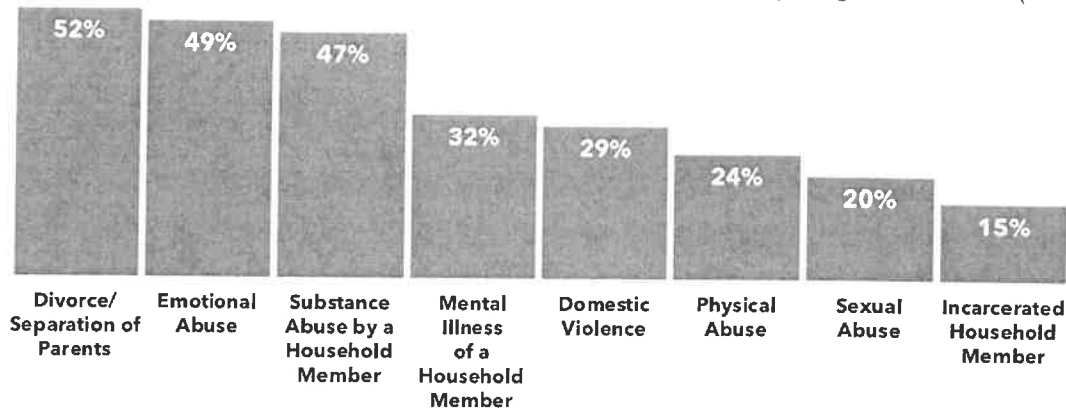


Note: Numbers do not add up to 100% due to rounding.

Source: The Sycamore Institute's analysis of 2014-2017 CDC BRFSS data provided by the TN Department of Health's Division of Policy, Planning and Assessment, Office of Health Statistics (1)

## Figure 4. The Most Common Adverse Childhood Experiences Among Tennesseans Are Divorce/Separation and Emotional Abuse

Prevalence of Common Adverse Childhood Experiences Among TN Adults Reporting 1 or More ACE (2014-2017)



Source: The Sycamore Institute's analysis of 2014-2017 CDC BRFSS data provided by the TN Department of Health's Division of Policy, Planning and Assessment, Office of Health Statistics (1)

### The Link Between ACEs and Health Outcomes and Behaviors

**ACEs are associated with risky health behaviors and poorer health outcomes among Tennesseans, even after accounting for other factors.** As the number of ACEs increases, so do rates of risky health behaviors like smoking (**Figure 5**) and poor health outcomes like depression (**Figure 6**), diabetes, obesity, depression, poor/fair self-rated health status, cardiovascular disease (CVD) and chronic obstructive pulmonary disease. (1) If all ACEs were eliminated, for example, we would expect 49% fewer adult Tennesseans with depression and 32% fewer adult cigarette smokers (**Figure 7**). (1)

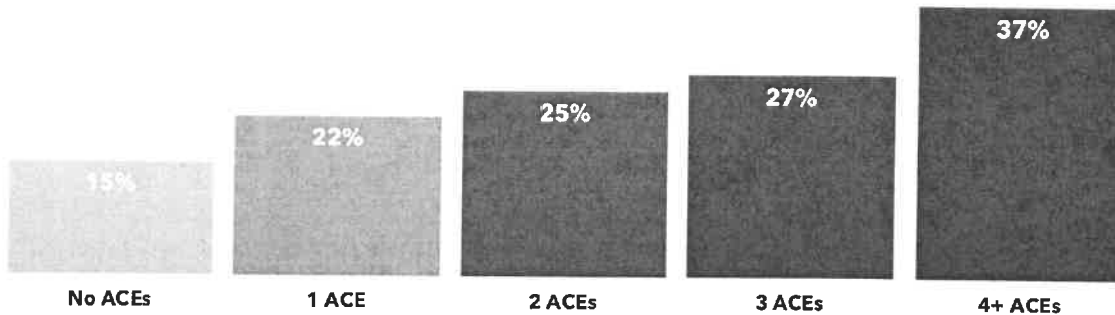
## ACEs ARE FACT, NOT FATE.

**Exposure to ACEs does not guarantee that negative outcomes will follow.** Some people with adverse childhood experiences do not have negative health and social outcomes. Likewise, not everyone with negative health outcomes was exposed to ACEs.

**ACEs should be viewed from a population health perspective.** Science has demonstrated the relationship between ACEs and adverse outcomes – along with the benefits of preventing and mitigating ACEs. Individual differences in environment, genetics, and other experiences also affect outcomes. Further research can help inform policies, resources, and programs that can effectively prevent and mitigate the effects of ACEs. (12)

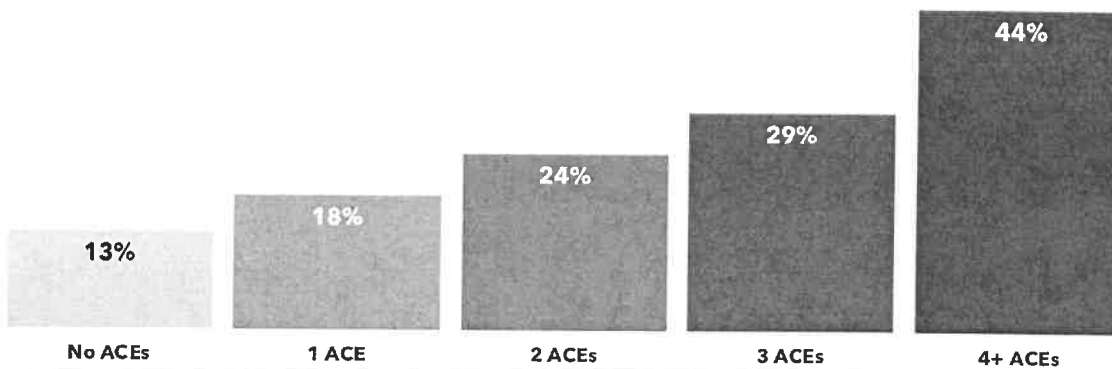
### Figure 5. Adults with More Adverse Childhood Experiences Are More Likely to Smoke Tobacco

Smoking Rates Among Tennessee Adults by Number of ACEs (2014-2017)



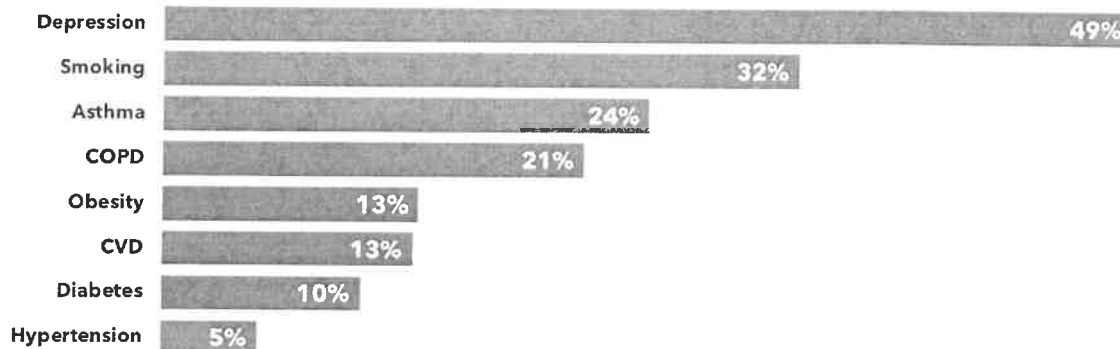
### Figure 6. Adults with More Adverse Childhood Experiences Are More Likely to Experience Depression

Prevalence of Depression Among Tennessee Adults by Number of ACEs (2014-2017)



### Figure 7. Share of Health Outcomes and Behaviors Attributed to Tennesseans' Adverse Childhood Experiences

The Estimated Proportion of Each Adult Health Outcomes/Behavior in TN That Is Attributable ACEs (2014-2017)



Note: Values represent the population attributable risk (PAR) of having at least 1 ACE, adjusted for other known factors and behaviors/conditions that are associated with increased prevalence of these health outcomes. See **Methods Appendix** for complete discussion.

Source for Figures 5-7: The Sycamore Institute's analysis of 2014-2017 CDC BRFSS data provided by the TN Department of Health's Division of Policy, Planning and Assessment, Office of Health Statistics (1)

## PARTING WORDS

Chronic, severe stress during childhood can disrupt healthy brain development. These adverse childhood experiences (ACEs) increase a person's risk of health, behavioral, and social problems throughout life.

The negative health effects of ACEs carry significant economic costs for Tennessee. Efforts to prevent ACEs and mitigate their negative effects could potentially improve Tennesseans' health and well-being while reducing economic costs of medical care and worker absenteeism.

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## METHODS APPENDIX

**This study estimates the single-year costs of increased health care expenditures and worker absenteeism due to adverse childhood experiences in Tennessee.** This section outlines our methodology and assumptions for calculating these costs and the limitations of our approach.

### Our Methodology

Our method draws from other studies that analyze the contribution of ACEs to health outcomes and behaviors in other populations. (12) (13)

**Determining the prevalence of ACEs in Tennessee:** To produce more reliable estimates of ACEs, we pooled 4 years of Behavioral Risk Factor Surveillance System (BRFSS) data (2014-2017) to determine the prevalence of ACEs reported by Tennessee adults between 2014 and 2017. The BRFSS uses a complex sampling design that requires the use of sample weights. The CDC recommends reweighting data when multiple years of data are combined. (14) To create a final weight, we checked the sample size of each data set, compared the sample size in each data set, and calculated a final weight by multiplying by the proportion of the whole. See **Appendix Table 1** for frequencies and proportions used to reweight the data.

**APPENDIX TABLE 1. POOLED BRFSS DATA REWEIGHTING**

Year	Number of Responses	Proportion Applied to Yearly Weight
2014	5,142	22%
2015	5,979	26%
2016	6,167	27%
2017	5,843	25%
Total	23,131	

The BRFSS includes 11 questions across 8 categories of ACEs. **Appendix Table 2** describes the questions and responses that were considered to be an ACE for the purpose of our analysis.

**Determining the proportion of each health outcome or behavior that is connected to ACEs:** Population attributable risk (PAR) (also called population attributable fraction and population attributable risk proportion) is a method used in epidemiology to determine the proportion of an outcome that is associated with a causal factor. (15) This can be helpful to policymakers and public health professionals when evaluating interventions and programs. (16) In this study, we estimated the proportion of health behaviors and chronic disease that can be attributed to being exposed to at least 1 adverse childhood experience.

We calculated an adjusted PAR to control for other factors that also influence health outcomes and behaviors – including income, age, education, exercise habits, binge drinking, and related chronic diseases. (17) This more accurately isolates the impact of ACEs and mitigates double-counting across related outcomes and behaviors (e.g. smoking and asthma). **Appendix Table 3** details which factors were accounted for each health outcome or behavior. The PAR for each outcome/behavior was adjusted only for factors that are associated with the outcome. The adjusted PAR was calculated using the attribrisk package in R. (18)



**APPENDIX TABLE 2. ACE CATEGORIES, QUESTIONS, AND RESPONSES**

ACE Category	ACE Question	Response That Determined an ACE
Physical abuse	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.	"Once" or "More than once"
Sexual abuse	How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	"Once" or "More than once" to any question
	How often did anyone at least 5 years older than you or an adult, force you to have sex?	
	How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	
Emotional abuse	How often did a parent or adult in your home ever swear at you, insult you, or put you down?	"Once" or "More than once"
Mental illness in a household member	Did you live with anyone who was depressed, mentally ill, or suicidal?	"Yes"
Substance abuse by a household member	Did you live with anyone who was a problem drinker or alcoholic?	"Yes" to either question
	Did you live with someone who used illegal street drugs or who abused prescription medications?	
Divorce	Were your parents separated or divorced?	"Yes"
Domestic Violence	How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	"Once" or "More than once"
Incarceration of a household member	Did you live with someone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	"Yes"

**APPENDIX TABLE 3. POPULATION-ATTRIBUTABLE RISK (PAR) ADJUSTMENT FACTORS**

Health Outcome/Behavior	Adjustment Factors
Asthma	Body mass index (BMI), smoking
COPD - chronic obstructive pulmonary disease	Income, age, education, asthma, smoking
CVD - cardiovascular disease	Income, age, education, exercise, BMI, smoking, and race/ethnicity
Depression	Binge drinking, kidney disease, heart disease, arthritis
Diabetes	Education, income, age, race, and body mass index (BMI)
Hypertension	Age, exercise, education, BMI, smoking, race/ethnicity, and diabetes
Obesity	Income, age, education, and exercise habits
Smoking	Education, income, and age

**Estimating the ACEs-related costs:** To determine the economic costs of ACEs in Tennessee, we applied the adjusted PAR to estimated annual costs of chronic diseases and health behaviors in Tennessee (**Appendix Table 4**). The annual costs of diseases were obtained from the CDC'S Chronic Disease Calculator and peer-reviewed literature. (4) (2) (3) (5) (6) For more information about how the CDC calculates state-level estimates of chronic disease, see [Trogdon et al. \(19\)](#) All costs were adjusted to 2017 real dollars using the Bureau of Economic Analysis' gross domestic product price indices. (20)

Two types of annual costs were included in our analysis:

1. **Direct Medical Costs** are associated with inpatient and outpatient hospital care, doctor's office visits, prescription drugs, home health, and emergency room visits. (21) In our analysis, the costs only include those paid for by the "payer," which is generally the health insurance company. The estimates do not include out-of-pocket costs paid directly by patients (discussed further in the limitations section below).
2. **Absenteeism Costs** estimate the productivity losses associated with missed workdays — which include both lost wages to employees and wages paid by employers with no work garnered.

**APPENDIX TABLE 4. ESTIMATED ANNUAL COSTS OF HEALTH OUTCOMES AND BEHAVIORS ASSOCIATED WITH ACEs (2017)**

Health Outcome/Behavior	Total Annual Cost in Tennessee (in millions)*	Population Attributable Risk (PAR)	Estimated ACEs-Related Annual Cost (in millions)
Asthma	\$801	24%	\$196
COPD	\$867	21%	\$197
CVD	\$5,830	13%	\$730
Depression	\$1,900	49%	\$923
Diabetes	\$3,752	10%	\$371
Hypertension	\$3,369	5%	\$162
Obesity	\$4,154	13%	\$532
Smoking	\$6,474	32%	\$2,063
<b>Total</b>			<b>\$5,172</b>

Note: Annual costs presented in this table have been adjusted to 2017 dollars from the original costs in the literature. Annual costs are from the following sources: Depression, asthma, hypertension, cardiovascular disease (CVD), and diabetes are from CDC's Chronic Disease Calculator and Tennessee Department of Health (4) (2). Obesity costs are from Trogon et al. 2012 and only include direct medical costs (3). Smoking costs are from CDC SAMMEC (5). Chronic obstructive pulmonary disease (COPD) costs are from Ford et al. 2014 (6)

### Assumptions of the Analysis (15)

- ACEs and chronic disease and health behaviors are strongly associated.
- ACEs have an independent relationship with chronic disease and health behaviors even in the presence of other known factors that are associated with these chronic diseases and health behaviors.
- If ACEs were eliminated, there would be a decrease in the risk of chronic disease and poor health behaviors.

### Limitations of the Analysis

- Cost estimates are conservative and do not include societal costs, indirect medical costs, costs for other medical conditions, or costs in other sectors (i.e. criminal justice, social services, etc.).
- Annual costs of chronic diseases and health behaviors were not adjusted for changes in prevalence of disease or behaviors or costs of medical treatment that may have occurred since the cost estimates were calculated. Although many of the cost estimates are dated, to our knowledge, these are the best available sources.
- PAR calculations may vary based on the prevalence of chronic disease and ACEs in the population sample. For example, results may be different if using BRFSS data from another state, a different time period, or another dataset. We pooled data from multiple years to account for this.
- PAR estimates were based on Tennessee's adult population and may not be generalizable to other states or other populations.

- Although the BRFSS is weighted to provide a general sample of Tennesseans, it only includes individuals who responded to the survey and may not be representative of all Tennesseans. BRFSS sampling methods only include those who answered a landline or cell phone call. It is possible that Tennesseans who responded to the survey are different from Tennesseans who chose not to respond. (22)
- Like many other surveys, BRFSS collects self-reported data and is vulnerable to response bias. Individuals may offer bias assessments of their behavior for various reasons (e.g. interpretations and/or misunderstanding of survey questions or desire to provide “acceptable” answers). (23)
- The ACEs survey questions are an add-on module that Tennessee adopted and may or may not be fully representative of adverse childhood experiences in the state. The prevalence of ACEs in Tennessee may be underestimated.