The Science of ACEs and Toxic Stress

This fact sheet explains Adverse Childhood Experiences (ACEs) and the impact of ACEs and toxic stress on health.

The term Adverse Childhood Experiences (ACEs) comes from the landmark 1998 study by the Centers for Disease Control and Prevention (CDC) and Kaiser Permanente. It describes 10 categories of adversities in three domains experienced by age 18 years: abuse, neglect, and/or household dysfunction (Figure 1).

Data show that 62% of California residents have experienced at least one ACE and 16% have experienced four or more ACEs, using 2011-2017 Behavioral Risk Factor Surveillance System (BRFSS) data from a random-digit-dialed telephone survey.

Figure 1: 10 Categories of Adverse Childhood Experiences (ACEs)

Abuse: physical, emotional, and sexual abuse

Neglect: physical and emotional neglect

Household dysfunction: parental incarceration, mental illness, substance use, parental separation or divorce, and intimate partner violence
Key findings of the ACE Study and subsequent body of research include:

- **ACEs are highly prevalent.** Two thirds of respondents in the Kaiser Permanente/CDC study reported at least one ACE and one in eight reported four or more ACEs.\(^1\,3,\,4\) Subsequent studies have shown a rate of four or more ACEs that is closer to one in six.\(^5\,6\)

- **ACEs are strongly associated, in a dose-response fashion, with some of the most common and serious health conditions** facing our society today, including at least nine of the 10 leading causes of death in the U.S. (Figure 2). Find the ACE-Associated Health Conditions as part of the [ACE Screening Workflows, Risk Assessment and Treatment Algorithms, and ACE-Associated Health Conditions](https://ACEsAware.org/assessment-and-treatment) at ACEsAware.org/assessment-and-treatment.

- **ACEs affect all communities.** The original ACE Study was conducted among a population that was mostly Caucasian, middle class, employed, college educated, and privately insured.\(^1\,3,\,4\) Subsequent studies have found higher prevalence rates of ACEs in people who are low-income, of color, justice-involved, and/or part of the lesbian, gay, bisexual, transgender, and queer (LGBTQ+) community.\(^5\,10\)
### Figure 2: Leading Causes of Death in the U.S.

<table>
<thead>
<tr>
<th>Leading Causes of Death in the U.S., 2017</th>
<th>Odds Ratios for ≥ 4 ACEs (relative to no ACEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Heart disease</td>
<td>2.1</td>
</tr>
<tr>
<td>2 Cancer</td>
<td>2.3</td>
</tr>
<tr>
<td>3 Accidents (unintentional injuries)</td>
<td>2.6</td>
</tr>
<tr>
<td>4 Chronic lower respiratory disease</td>
<td>3.1</td>
</tr>
<tr>
<td>5 Stroke</td>
<td>2.0</td>
</tr>
<tr>
<td>6 Alzheimer’s or dementia</td>
<td>11.2</td>
</tr>
<tr>
<td>7 Diabetes</td>
<td>1.4</td>
</tr>
<tr>
<td>8 Influenza and pneumonia</td>
<td>Risk unknown</td>
</tr>
<tr>
<td>9 Kidney disease</td>
<td>1.7</td>
</tr>
<tr>
<td>10 Suicide (attempts)</td>
<td>37.5</td>
</tr>
</tbody>
</table>

Source of **causes of death**: CDC, 2017.¹¹
Sources of **odds ratios**: Hughes et al., 2017 for 1, 2, 4, 7, 10.¹²
Petrucelli et al., 2019 for 3 (injuries with fracture), 5.³,⁵,¹³
Center for Youth Wellness, 2014 for 6 (Alzheimer’s or dementia).¹⁴
Center for Youth Wellness, 2014 and Merrick et al., 2019 for 9.⁵,¹⁴
Toxic Stress

Several decades of scientific research have identified the biological mechanisms by which early adversity leads to increased risk of negative health and social outcomes through the life course. Repeated or prolonged activation of a child’s stress response, without the buffering protections of trusted, nurturing caregivers and safe, stable environments, leads to long-term changes in the structure and functioning of the developing brain, metabolic, immune, and neuroendocrine responses, and even the way DNA is read and transcribed. This is known as the toxic stress response (Figure 3).15-18

These biological changes play an important role in the clinical progression from ACE exposure to negative short- and long-term health and social outcomes. Further, both the disrupted biology and the associated negative outcomes demonstrate a pattern of high rates of intergenerational transmission. Development of the toxic stress response is influenced by a combination of cumulative adversity, buffering or protective factors, and predisposing vulnerability.

In addition to ACEs, social determinants of health (SDOH), such as poverty, discrimination, and housing and food insecurity, are associated with health risks and may also be risk factors for toxic stress. While validated odds ratios are available in large, population-based studies utilizing the 10 standardized ACE criteria, the strengths of associations between SDOH and health outcomes have not been similarly standardized.
Figure 3: Toxic Stress Response

Adapted from Bucci et al., 2016

CLINICAL IMPLICATIONS

Epigenetic
- Endocrine
- Metabolic
- Reproductive
- Neurological
- Psychiatric
- Behavioral
- Immune
- Inflammatory
- Cardiovascular

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The Impact of ACEs and Toxic Stress on Health

ACEs are associated with increased risk of a wide range of negative health conditions in both pediatric and adult populations. The life expectancy of individuals with six or more ACEs is 19 years shorter than that of individuals with none.²⁰ Find a list of ACE-Associated Health Conditions for pediatrics and adults as part of the ACE Screening Workflows, Risk Assessment and Treatment Algorithms, and ACE-Associated Health Conditions at ACEsAware.org/assessment-and-treatment.

Pediatric Health
The effects of toxic stress are detectable as early as infancy. In babies, high doses of adversity are associated with failure to thrive, growth delay, sleep disruption, and developmental delay. School-aged children may have increased risk of viral infections, pneumonia, asthma, and other atopic diseases, as well as difficulties with learning and behavior.

Among adolescents with high ACEs, somatic complaints — including headache and abdominal pain, increased engagement in high-risk behaviors, teen pregnancy, teen paternity, sexually transmitted infections (STIs), mental health disorders, and substance use — are common.

Adult Health
As noted above, ACEs are associated with some of the most common and serious health conditions facing our communities. Learn more about ACE-Associated Health Conditions for adults at: ACEsAware.org/assessment-and-treatment.
Mental and Behavioral Health

The higher the ACE score, the greater the likelihood an individual may experience mental health disorders such as depression, post-traumatic stress disorder, anxiety, and sleep disorders, and engage in risky behaviors such as early and high-risk sexual behaviors and substance use. High doses of childhood adversity are associated with increased risk of engaging in high-risk behaviors that can lead to negative health outcomes.

However, even in the absence of health-damaging behavior, strong associations between cumulative childhood adversity and increased risk of serious health conditions persist. Evidence suggests that the toxic stress response likely plays a role in mediating both behavior-related and non-behavior-related pathways.

Cost of ACEs in California

Considering just five ACE-Associated Health Conditions (asthma, arthritis, COPD, depression, and cardiovascular disease) and three health risk factors (lifetime smoking, heavy drinking, and obesity), the annual total cost of these health-related impacts of ACEs in California is $112.5 billion. This includes direct healthcare expenditures ($10.5 billion), and the cost in disability and years of productive life lost to ACEs ($102 billion).

In sum, ACEs are common, highly consequential for health and well-being, and very costly—and thus constitute a major and under-addressed public health crisis of our era.

For information on the clinical response to ACEs, see the "Clinical Response to Adverse Childhood Experiences and Toxic Stress" fact sheet at ACEsAware.org/toolkitclinical-response.
References


Visit ACEsAware.org and join us as we launch a movement — led by the Office of the California Surgeon General and the California Department of Health Care Services — to ensure everyone is ACEs Aware.