Adverse Childhood Experiences: Connecting a Developmental Lens to the Health of Society

Robert Anda, MD, MS

www.cdc.gov/ace

www.acestudy.org
The Walk to Paradise Garden
W. Eugene Smith
Stress (adrenaline, cortisol)

Unpredictable Severe

Predictable Moderate

Number of Episodes Chronicity*

Vulnerability

Resilience

(Poly)genetics Epigenetics Intrauterine exposures*
Persistent Stress Changes Brain Architecture

Normal

Typical neuron—many connections

Toxic stress

Damaged neuron—fewer connections

Prefrontal Cortex and Hippocampus

Sources: Radley et al. (2004)  
Bock et al. (2005)
Seeing the Pain
America's physicians confront family violence
Early connections in the brain

The brain is undoubtedly one of nature’s most remarkable creations: cells that can react to impulses, analyze and control behavior. As early as in the seventh week, nerve cells in the brain have begun to touch one another by means of projections, and some have even become connected in primitive nerve paths. The picture also shows nerve cells at this time, greatly enlarged. The rate of production is tremendous: 100,000 new nerve cells are created every minute, and by the time the baby is born, there will be some 100 billion. Left, the posterior lobes of the cerebrum shimmer through the skin of the forehead.
SYNAPTIC DENSITY: Synapses are created with astonishing speed in the first three years of life. For the rest of the first decade, children’s brains have twice as many synapses as adults’ brains.

Drawings supplied by H.T. Chugani.
RAPID EARLY DEVELOPMENT: These PET scans suggest that the brain of a one year old more closely resembles an adult’s brain than a newborn’s.

Source: H.T. Chugani
Healthy Brain
This PET scan of the brain of a normal child shows regions of high (red) and low (blue and black) activity. At birth, only primitive structures such as the brain stem (center) are fully functional; in regions like the temporal lobes (top), early childhood experiences wire the circuits.

Back

Temporal lobes

Front

An Abused Brain
This PET scan of the brain of a Romanian orphan, who was institutionalized shortly after birth, shows the effect of extreme deprivation in infancy. The temporal lobes (top), which regulate emotions and receive input from the senses, are nearly quiescent. Such children suffer emotional and cognitive problems.

Back

Temporal lobes

Front
“The Creation of Adam”
Michelangelo  1508–1512
The Adverse Childhood Experiences (ACE) Study

Examines the health and social effects of ACEs throughout the lifespan among 17,421 members of the Kaiser Health Plan in San Diego County

A Primary Care Setting…
Educated…
Middle Class..
Predominantly White…
ACE Study Design

Survey Wave I (N=9,508)

Survey Wave II (N=8,667)

Follow-up

Mortality
National Death Index
Morbidity
Hospital Discharge
Outpatient Visits

Emergency room visits

Pharmacy Utilization

Comprehensive medical Evaluations abstracted
<table>
<thead>
<tr>
<th>Household dysfunction:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance abuse</td>
<td>27%</td>
</tr>
<tr>
<td>Parental sep/divorce</td>
<td>23%</td>
</tr>
<tr>
<td>Mental illness</td>
<td>17%</td>
</tr>
<tr>
<td>Battered mother</td>
<td>13%</td>
</tr>
<tr>
<td>Criminal behavior</td>
<td>6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abuse:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological</td>
<td>11%</td>
</tr>
<tr>
<td>Physical</td>
<td>28%</td>
</tr>
<tr>
<td>Sexual</td>
<td>21%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neglect:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional</td>
<td>15%</td>
</tr>
<tr>
<td>Physical</td>
<td>10%</td>
</tr>
</tbody>
</table>
Adverse Childhood Experiences Rarely Occur in Isolation…

They come in groups.
Domestic Violence in the Home and the Risk of Other ACEs...
Prevalence of Childhood Abuse by Frequency of Witnessing Domestic Violence

Frequency of witnessing domestic violence:
- Never
- Once, Twice
- Sometimes
- Often
- Very often

Childhood Abuse:
- Emotional
- Physical
- Sexual

Percent (%)

0 20 40 60 80 100

Frequency of witnessing domestic violence
ACEs tend to come in groups…

<table>
<thead>
<tr>
<th>Additional ACEs (%)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>≥5</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you had:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A battered mother</td>
<td>95</td>
<td>82</td>
<td>64</td>
<td>48</td>
<td>52</td>
</tr>
</tbody>
</table>
## Adverse Childhood Experiences Score Biologic Stress “Dose”

<table>
<thead>
<tr>
<th>ACE Score</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>33%</td>
</tr>
<tr>
<td>1</td>
<td>26%</td>
</tr>
<tr>
<td>2</td>
<td>16%</td>
</tr>
<tr>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td>4 or more</td>
<td>16%</td>
</tr>
</tbody>
</table>
ACEs, Smoking, and Lung Disease

ACE Score

- 0
- 1
- 2
- 3
- 4 or more

Percent With Health Problem (%)

Early smoking initiation
Current smoking
COPD
The ACE Score…
Alcohol Use and Abuse

The graph illustrates the relationship between ACE Score and the percent of individuals with alcohol-related problems. It shows that higher ACE scores are associated with a greater percentage of individuals with alcohol-related problems. The categories of ACE scores include 0, 1, 2, 3, and 4 or more. The graph is divided into two sections: Alcoholic and Married an Alcoholic. The bars represent the percentage of individuals in each category, with the highest percentage found in the Married an Alcoholic category with an ACE score of 4 or more.
ACE Score and HIV Risks

ACE Score

Percent With Health Problem (%)

Ever Injected Drugs
Had 50 or More Intercourse Partners
Ever Had an STD

ACE Score

0 1 2 3 4 or more
ACEs are a Pathway to Diseases in Adults...
The ACE Score and the Prevalence of Liver Disease (Hepatitis/Jaundice)
The ACE Score and the Prevalence Ischemic Heart Disease

ACE Score

Percent (%)

ACE Score

0
1
2
3
4
5
6
0 1 2 3         >=4

Percent (%)

0
1
2
3
4
5
6

0 1 2 3         >=4

ACE Score
A Focus on Mental Health...
The ACE Score and a Lifetime History of Depression

- **ACE Score**: A measure of ACEs experienced by an individual.
- **Percent depressed (%)**: Percentage of individuals experiencing depression.

The graph shows the percentage of women and men depressed at different ACE scores. The x-axis represents the ACE Score, ranging from 0 to >=4, and the y-axis represents the Percent depressed (%), ranging from 0 to 70%.
The ACE Score and the Prevalence of Attempted Suicide
Cumulative ACEs Increase Clinical Complexity in Terms of the Number of Lifetime DSM-IV Diagnoses

*Putnam, Harris, Putnam unpublished data, 2011
Art of: Hieronymous Bosch
“The Kiss”

Constantin Brancusi
1909
ACE Score and the Risk of Being a Victim of Domestic Violence

ACE Score

Women

Men

Risk of Victimization (%)

ACE Score

0 1 2 3 4 ≥5

0 1 2 3 4 ≥5
ACE Score and the Risk of Being Sexually Assaulted as an Adult

![Bar chart showing the risk of sexual assault by ACE Score for women and men.](chart_image)
ACEs and Reproductive Behavior

.... Are they self replicating??
Adverse Childhood Experiences and Teen Pregnancy

Percent who had a teen pregnancy

ACE Score

0 1 2 3 4 5 6 7 8
Percent of Women Who Ever Had an Unintended Pregnancy by ACE Score
The Costs of the Status Quo..

Reflect the Costs of Ignoring and Impairing Early Childhood Development
Significant Adversity Impairs Development in the First Three Years

Source: Barth et al. (2008)
ACEs and High School Sophomores and Seniors

![Diagram showing the distribution of students with different numbers of Adverse Childhood Experiences (ACEs) in a 30-student classroom.]

- 6 students with no ACE
- 5 students with 1 ACE
- 6 students with 2 ACEs
- 3 students with 3 ACEs
- 7 students with 4 or 5 ACEs
- 3 students with 6 or more ACEs

Population Average
Students with 3 or more ACEs:

- Are 2 ½ times more likely to fail a grade
- Score lower on standardized tests
- Have language difficulties
- Are suspended or expelled more
- Are designated to special education more frequently
- Have poorer health
Costs of the Status Quo

Criminal Justice

..the prison pipeline
ACEs Among **Youth on Probation**
Pierce County, Washington
ACE Exposure and Youth Outcomes

History of Alcohol & Drug Use and ACE Score

<table>
<thead>
<tr>
<th>ACE Score</th>
<th>Alcohol</th>
<th>Drug</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50%</td>
<td>54%</td>
</tr>
<tr>
<td>1</td>
<td>63%</td>
<td>68%</td>
</tr>
<tr>
<td>2</td>
<td>71%</td>
<td>77%</td>
</tr>
<tr>
<td>3</td>
<td>74%</td>
<td>80%</td>
</tr>
<tr>
<td>4</td>
<td>72%</td>
<td>74%</td>
</tr>
<tr>
<td>≥ 5</td>
<td>81%</td>
<td>84%</td>
</tr>
</tbody>
</table>
ACE Score and Poor Academic Performance
Youth on Probation, Pierce County, WA

Poor academic performance during most recent school term

<table>
<thead>
<tr>
<th>ACE Score</th>
<th>Prevalence (%)</th>
<th>Prevalence (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16.9% (n=11)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>25.0% (n=68)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>29.1% (n=132)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28.1% (n=117)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>32.3% (n=105)</td>
<td></td>
</tr>
<tr>
<td>5+</td>
<td>35.7% (n=135)</td>
<td></td>
</tr>
</tbody>
</table>
ACE Score and Repeated Suspension/Expulsion
Youth on Probation, Pierce County, WA

History of ≥ 7 expulsions or suspensions since the first grade

![Bar chart showing the prevalence of ACE scores and history of expulsions or suspensions.](chart.png)
ACE Score and Felony Re-offense

Felony Re-offense Post Probation and ACE Score

Within One Year

Within Two Years

0 12% 16% 10% 18% 16% 11% 19% 23% 19% 25% 23% ≥ 5 31%
Costs of the Status Quo

Corporations and the Workforce
Drains on Profitability..

**Depression** and its work related outcomes, absenteeism, reduced productivity, and medical expenses: $44 billion per year

**Back pain** in the workforce: $28 billion per year

**Chemical dependency:** $246 billion per year

These massive losses occur despite the existence of workplace safety programs and the most expensive system of medical care in the world.
ACE Score and Indicators of Impaired Worker Performance

ACE Score

Prevalence of Impaired Performance (%)

Absenteeism (≥2 days/month)

Serious Financial Problems

Serious Job Problems

ACE Score

0 1 2 3 4 or more
4 Areas of Health and Well-Being as Mediators

- Relationship Problems
  - marital
  - family
  - sexual

- Emotional Distress
  - depressed mood
  - panic reactions
  - difficulty with anger

- Somatic Symptoms
  - back pain
  - headaches
  - joint problems

- Substance Abuse
  - alcoholism
  - smoking
  - illicit drug use

Adverse Childhood Experiences → 4 Areas of Health and Well-Being as Mediators → Poor Worker Performance
A Look at Comorbidity...
ACEs Effect An Array of Brain Functions

Affect Regulation
Panic reactions, depression, anxiety, hallucinations

Somatic Issues
Sleep disturbances, severe obesity, pain

Substance Use
Smoking, alcoholism, illicit drug use, IV drug use

Sexuality
Early intercourse, promiscuity, sexual dissatisfaction

Memory
Amnesia (childhood)

Arousal
High stress, problems with anger, perpetrating domestic violence
Neurobiology and Epidemiology Converge

Complex Trauma—Trauma Spectrum Disorders and the mean number of a variety of problems

![Bar graph showing mean number of co-occurring outcomes by ACE score]
ACEs appear to affect multiple brain systems and functions. This leads to multiple problems in different health and social domains.

*Developmental Trauma Disorder*
ACEs Changed the Landscape

• Provided a compelling tabulation of childhood adversity that directly related to easily understood costly outcomes

• Largely responsible for increased awareness of policy makers of the role of childhood trauma in costly medical, psychiatric and social problems

• Legitimized and stimulated interest in childhood adversities for researchers in a range of fields
States With ACE Studies in 2009

6 States

Source: Behavioral Risk Factor Surveillance System, CDC.
States With ACE Studies in 2009-2010

13 States

Source: Behavioral Risk Factor Surveillance System, CDC.
States With ACE Studies in 2009-2011

Source: Behavioral Risk Factor Surveillance System, CDC.
States With ACE Studies
2009-2012

Source: Behavioral Risk Factor Surveillance System, CDC.
Adverse Childhood Experiences
As a National Health Issue

ACEs have a strong influence on:
- adolescent health
- reproductive health
  - smoking
  - obesity
  - alcohol abuse
- illicit drug abuse
- sexual behavior
  - mental health
- risk of violence and revictimization
- stability of relationships
- performance in the workforce
Adverse Childhood Experiences
As a National Health Issue

ACEs increase the risk of:

- Early death
- Heart disease
- Chronic Lung disease
- Lung cancer
- Liver disease
- Autoimmune disease
- Suicide
- Injuries
- HIV and STDs
- other risks for leading causes of death
Beham, (Hans) Sebald (1500-1550): Hercules slaying the Hydra, 1545 from The Labours of Hercules (1542-1548).
A Public Health Framework For Change

Treatment

Education

Prevention

All must consider

Intergenerational transmission
Bridging The Chasm

Intergenerational Care

Consolidation and Coordination

Child health as it stands today

Child and adult health as it could be
Bridging The Chasm

Breakthroughs in molecular genetics and neurobiology:
- Mental illness
- Substance abuse
- Violence

Improved recognition and treatment of:
- Mental illness
- Substance abuse
- Domestic violence
- Child abuse
Bridging The Chasm

Mass education about child development & parenting:
- Media
- Schools

Promoting Healthy Neurodevelopment through better early childhood development (Promoting Resilience)
Bridging The Chasm

Harnessing Brain Plasticity To Overcome the Effects of Adversity (Secondary Resilience or Recovery)

Documenting the societal burden of child health as it stands today

New directions in prevention, treatment, and policy

Child health as it stands today

Child health as it could be
ACEs Changed the Landscape

• Pervasiveness of ACEs
  – Huge number of major public health problems that were ACE-related (e.g., Depression, Substance Abuse, STDs, Cancer, Heart Disease, Chronic Lung Disease, Diabetes)
  – Significant number of middle-class Americans had ACEs

• Perniciousness of ACEs
  – Major contributors to the leading causes of death and disability
  – Life-shortening (~20 years for people with 6+ ACEs)

• Persistence of ACEs
  – Life-time effects
  – Likelihood of intergenerational transmission
Beyond ACEs

• Link ACEs to existing and future programs seeking to prevent mental illness, medical diseases, substance abuse, health risk behaviors, and social dysfunction

• Prevent ACEs
  – Zero ACEs is protective
  – Prevent further ACEs in maltreatment victims

• Identify and treat ACEs early in life

• Identify mechanisms (behavioral and biological) through which ACEs negatively impact life trajectories
States With ACE Studies in 2009

Source: Behavioral Risk Factor Surveillance System, CDC.
States With ACE Studies in 2009-2010

Source: Behavioral Risk Factor Surveillance System, CDC.
States With ACE Studies in 2009-2011

Source: Behavioral Risk Factor Surveillance System, CDC.
Preventing Child Maltreatment: a guide to taking action and generating evidence
ACE Score and Poor Academic Performance
Youth on Probation, Pierce County, WA

Poor academic performance during most recent school term:

- 16.9% (n=11)
- 25.0% (n=132)
- 29.1% (n=117)
- 28.1% (n=105)
- 32.3% (n=68)
- 35.7% (n=135)

ACE Score

Prevalence (%)

aOR (95% CI)
Costs of the Status Quo

Health Care
Corporations and the Workforce
Criminal Justice
Significant risk of early use/abuse of:
- Alcohol, tobacco, illicit & prescription drugs
- Slowed language & reading
- Lateralization
- Diminished IQ
- Poor decision making skills
- Attention problems
- ADD
- ADHD
- Aggressive behavior
- Social isolation among peers
- Poor understanding of social cues = conflict

Significant risk of early use/abuse of:
Alcohol, tobacco, illicit & prescription drugs
- Special education
- School failure
- Dropping out
- Suspension
- Expulsion
- Delinquency
- Dropping out

EARLY TRAUMA & STRESS
Predictable patterns of brain development, traits & behaviors

THE FAST TRACK TO POVERTY
- Low-wage jobs
- Unemployment
- Public Assistance
- Prison
- Chronic health problems
- Debilitating mental health
Public Health Surveillance

Information for Program Applications

Data Collection → Data Analysis → Data Interpretation → Information Dissemination → Program Planning → Program Implementation → Program Evaluation → Data Collection

Source: Remington and Goodman 1998
Human Brain Development

Neural Connections for Different Functions Develop Sequentially

- Sensory Pathways (Vision, Hearing)
- Language
- Higher Cognitive Function

First Year

Birth (Months) | (Years)
---|---
-8 -7 -6 -5 -4 -3 -2 -1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Costs of the Status Quo

Health Care
Persistent Stress Changes Brain Architecture

Normal

Typical neuron—many connections

Toxic stress

Damaged neuron—fewer connections

Prefrontal Cortex and Hippocampus

Sources: Radley et al. (2004)
Bock et al. (2005)
The brain’s activity can be measured in electrical impulses—here, “hot” colors like red or orange indicate more activity, and each column shows a different kind of brain activity. Young children institutionalized in poor conditions show much less than the expected activity.

Preventive Intervention is More Efficient and Produces Higher Returns than Later Remediation

Rates of return to human capital investment

Programs targeting the earliest years

Preschool programs

K-12 interventions

Job training

0-3  4-5  6-18  19+

Age

Heckman, J. (2007)
Adverse Childhood Experiences

• Abuse and Neglect (e.g., psychological, physical, sexual)
• Household Dysfunction (e.g., domestic violence, substance abuse, mental illness)

Impact on Child Development

• Neurobiologic Effects (brain abnormalities, stress hormone dysregulation, physical development)
• Psychosocial Effects (e.g., poor attachment, poor socialization, poor self-efficacy, revictimization)
• Health Risk Behaviors (e.g., smoking, obesity, substance abuse, promiscuity)

Long-Term Consequences

Disease and Disability

• Major Depression, Suicide, PTSD
• Drug and Alcohol Abuse
• Heart Disease
• Cancer
• Chronic Lung Disease
• Sexually Transmitted Diseases
• Intergenerational transmission of ACEs

Social Problems

• Homelessness
• Prostitution
• Criminal Behavior
• Unemployment
• Parenting problems
• High utilization of health and social services
“In the brain, as in the economy, getting it right the first time is ultimately more effective and less costly than trying to fix it later. “

James Heckman
Nobel Laureate Economist

States With ACE Studies in 2008

Source: Behavioral Risk Factor Surveillance System, CDC.
..the prison pipeline extends into adulthood
ACE Score and Rates of Antidepressant Prescriptions

![Graph showing the relationship between ACE Score and prescription rates](image-url)
The ACE Score…
Alcohol Use and Abuse

Percent with alcohol related problem

ACE Score
0 1 2 3 4 or more

Ever heavy drinker
Problem with alcohol use
Alcoholic
Married an Alcoholic
ACE Score and Rates of Prescribed Antidepressant Medications by Age, 1997-2004

Relative rates are adjusted for age, sex, race/ethnicity, and education. Adults with an ACE Score of 0 are the referent.
Prescription Drugs in the United States (2003)

- nearly $180 billion spent
- 11% of total national health expenditures
- more than four times the amount spent in 1990
These Mediators Account for Most of the Effect of ACEs on Worker Performance

<table>
<thead>
<tr>
<th>Indicators of Worker Performance</th>
<th>% Mediation by 4 Areas of Health and Well-Being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absenteeism</td>
<td>50-67%</td>
</tr>
<tr>
<td>Serious Financial Problems</td>
<td>50-83%</td>
</tr>
<tr>
<td>Serious Job Problems</td>
<td>79-100%</td>
</tr>
</tbody>
</table>
Watercolor
By Tennessee Dixon
@ 1978
Estimates of the Population Attributable Risk* (PAR) of ACEs for Selected Outcomes in Women

<table>
<thead>
<tr>
<th>Mental Health</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current depression</td>
<td>54%</td>
</tr>
<tr>
<td>Depressed affect</td>
<td>41%</td>
</tr>
<tr>
<td>Suicide attempt</td>
<td>58%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drug Abuse</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoholism</td>
<td>65%</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>50%</td>
</tr>
<tr>
<td>IV drug abuse</td>
<td>78%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Promiscuity</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crime Victim</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual assault</td>
<td>62%</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>52%</td>
</tr>
</tbody>
</table>

*Based upon the prevalence of one or more ACEs (62%) and the adjusted odds ratio >1 ACE.
Relationship Between Number of Adverse Childhood Experiences and Fetal Death—First or Second Pregnancy

percent who had a fetal death after 1st or 2nd pregnancy

ACE Score

0 1-2 3-4 5+

0 10 12 14 16 18
Alcohol Abuse in the Home and the Risk of Other ACEs...
Alcohol Abuse in the Home and the Risk of Childhood Abuse

Number of alcohol abusers:
- 0
- 1
- 2 or more

Percent Abused (%)

Type of Abuse
- Emotional
- Physical
- Sexual

Chart showing the percentage of children abused by type of abuse and the number of alcohol abusers.
ACE Score and Teen Sexual Behaviors

ACE Score

- 0
- 1
- 2
- 3
- 4 or more

Percent With Health Problem (%)

Intercourse by Age 14
Teen Pregnancy
Teen Paternity
Barriers to Educational Achievement Emerge at a Very Young Age