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## Less than ideal cardiovascular health among adults is associated with experiencing adverse childhood events: BRFSS 2019★

Donald K. Hayes<sup>a,\*</sup>, Jennifer L. Wiltz<sup>b,c</sup>, Jing Fang<sup>a</sup>, Fleetwood Loustalot<sup>a,c</sup>

<sup>a</sup>Division for Heart Disease and Stroke Prevention, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control & Prevention, United States of America

<sup>b</sup>Office of Medicine and Science, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control & Prevention, United States of America

<sup>c</sup>U.S. Public Health Service Commissioned Corps, United States of America

### Abstract

Ideal cardiovascular health (CVH) is associated with a lower risk of heart disease and stroke while adverse childhood events (ACEs) are related to health behaviors (e.g., smoking, unhealthy diet) and conditions (e.g., hypertension, diabetes) associated with CVH. Data from the 2019 Behavioral Risk Factor Surveillance System was used to explore ACEs and CVH among 86,584 adults 18 years from 20 states. CVH was defined as poor (0–2), intermediate (3–5), and ideal (6–7) from summation of survey indicators (normal weight, healthy diet, adequate physical activity, not smoking, no hypertension, no high cholesterol, and no diabetes). ACEs was summed by number (0, 1, 2, 3, and 4). A generalized logit model estimated associations between poor and intermediate CVH (ideal as referent) and ACEs accounting for age, race/ethnicity, sex, education, and health care coverage. Overall, 16.7% (95% Confidence Interval [CI]: 16.3–17.1) had poor, 72.4% (95% CI: 71.9–72.9) had intermediate, and 10.9% (95% CI: 10.5–11.3) had ideal

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\*Corresponding author at: Centers for Disease Control & Prevention, Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy, MS S107-1, Atlanta, GA 30341, United States of America. Bkn00@cdc.gov (D.K. Hayes).

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#### CRedit authorship contribution statement

**Donald K. Hayes:** Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Jennifer L. Wiltz:** Conceptualization, Methodology, Writing - review & editing. **Jing Fang:** Conceptualization, Methodology, Writing - review & editing. **Fleetwood Loustalot:** Conceptualization, Methodology, Writing - review & editing, Supervision.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Appendix A. Supplementary data

Supplementary tables to this article can be found online at <https://doi.org/10.1016/j.ypmed.2023.107457>.

CVH. Zero ACEs were reported for 37.0% (95% CI:36.4–37.6), 22.5% (95%CI:22.0–23.0) reported 1, 12.7% (95%CI:12.3–13.1) reported 2, 8.5% (95% CI:8.2–8.9) reported 3, and 19.3% (95%CI:18.8–19.8) reported 4 ACEs. Those with 1 (Adjusted Odds Ratio [AOR] = 1.27;95%CI = 1.11–1.46), 2 (AOR = 1.63;95%CI:1.36–1.96), 3 (AOR = 2.01;95%CI:1.66–2.44), and 4 (AOR = 2.47;95%CI:2.11–2.89) ACEs were more likely to report poor (vs. ideal) CVH compared to those with 0 ACEs. Those who reported 2 (AOR = 1.28;95%CI = 1.08–1.51), 3 (AOR = 1.48;95%CI:1.25–1.75), and 4 (AOR = 1.59;95%CI:1.38–1.83) ACEs were more likely to report intermediate (vs. ideal) CVH compared to those with 0 ACEs. Preventing and mitigating the harms of ACEs and addressing barriers to ideal CVH, particularly social and structural determinants, may improve health.

## Keywords

Adverse childhood events; Ideal cardiovascular health; BRFSS; Population survey; Epidemiology

## 1. Introduction

Cardiovascular disease is the leading cause of death in the United States, accounting for nearly 900,000 deaths in 2019 (Tsao et al., 2022). In 2010, the American Heart Association (AHA) introduced “Life’s Simple 7” to promote cardiovascular health (CVH) based on seven healthy behaviors and factors (Lloyd-Jones et al., 2010; Sacco, 2011). Ideal CVH reflected having at least 6 of the following: being of normal body weight, consuming a healthy diet, regular physical activity, not smoking; and having normal blood pressure, blood cholesterol, and blood glucose. A meta-analysis of prospective cohort studies identified that achieving ideal CVH was associated with a lower risk of both all-cause mortality and cardiovascular mortality (Fang et al., 2016). Since its introduction, multiple studies have looked at this concept including a systematic review and meta-analysis that highlighted an overall low level of ideal CVH (3.3%; range: 0.5%–15%) across all 21 studies reflecting the need for national efforts at population and individual levels (Jankovic et al., 2021).

Adverse childhood events (ACEs) are preventable, potentially traumatic experiences that occur in childhood (0–17 years of age) such as neglect and experiencing or witnessing violence. Also included are a child’s environment that can undermine their sense of safety and stability such as growing up in a household with substance use, mental health problems, or instability due to parental separation or incarceration. The original study from the Kaiser Permanente Health Maintenance Organization in the mid-1990’s identified consistent associations between reports of multiple ACEs and early causes of death (Felitti et al., 1998). Studies have also associated ACEs with risk factors for the leading causes of deaths including smoking, drug use, excess alcohol intake, obesity, hypertension, and diabetes (Bellis et al., 2019; Hughes et al., 2017; Merrick et al., 2019; Remigio-Baker et al., 2017; Vasquez et al., 2019). The objective of this study was to determine associations between ACEs and less than ideal CVH.

## 2. Methods

Data from the 2019 Behavioral Risk Factor Surveillance System (BRFSS) were analyzed. This telephone survey, using both landline and cell phone numbers, interviews adults aged 18 years or older in the civilian, non-institutionalized United States population. The survey includes a core component, optional modules, and state-added questions. The optional module on ACEs was implemented by 20 states in 2019 (Alabama, Delaware, Florida, Indiana, Iowa, Kansas, Michigan, Mississippi, Missouri, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin). Using the American Association of Public Opinion Research response rate (e.g., number of respondents who completed the survey as a proportion of all eligible and likely-eligible people), (The American Association for Public Opinion Research (The American Association for Public Opinion Research, 2016)) the median rate among states that included the ACEs module was 51% and ranged from 37% to 61%. Relative to other surveys, data from BRFSS have acceptable reliability and validity for several chronic disease risk factors and conditions (Pierannunzi et al., 2013). Additional information is available online at <https://www.cdc.gov/brfss/index.html>. The number of respondents completing the ACEs module varied by state, ranging from 4040 to 16,101 with a median of 7032. There were 95,941 respondents with information on CVH status with 9357 (9.8%) of these excluded due to missing or unknown information on the ACEs module resulting in 86,584 adults. An additional 295 adults were excluded due to missing information on education group or health care coverage in the generalized logit analysis, resulting in a final sample 86,289 adults. This secondary analyses of de-identified publicly available data ([https://www.cdc.gov/brfss/annual\\_data/annual\\_data.htm](https://www.cdc.gov/brfss/annual_data/annual_data.htm)) in which participants provided informed consent does not constitute human subjects research is considered exempt from Institutional Review Board.

### 2.1. Outcome

Each individual CVH metric was scored as 0 or 1. Individual metrics were summed and categorized as poor (0–2), intermediate (3–5), and ideal (6–7). For the primary analysis, poor and intermediate CVH was compared to ideal. The seven CVH metrics are categorized by various BRFSS questions using definitions based on the AHA standards (Lloyd-Jones et al., 2010) (Supplementary Table S1). A normal weight was based on self-reported height and weight with calculation of Body Mass Index (BMI) of 18.5 to <25.0 kg/m<sup>2</sup>. The AHA's healthy diet score is based on multiple components – intakes of fruits and vegetables, whole grains, sodium, sugar-sweetened beverages, and fish. These were not all available in BRFSS so five or more fruits and vegetables servings per day were used. Fried potatoes were removed which decreased the healthy diet measure from 15.2% to 12.0%. Adequate physical activity was defined as moderate-intensity aerobic physical activity of at least 150 min per week, at least 75 min of vigorous-intensity activity, or an equivalent combination. Not smoking was defined by not having smoked at least 100 cigarettes in their lifetime or having smoked at least 100 cigarettes and not currently smoking. The indicators for no hypertension, no high cholesterol, and no diabetes were based on self-reported answers to ever being told by a health care provider that they had these conditions.

## 2.2. Primary predictor

Overall, the 11 questions in the ACEs module are framed around experiences prior to respondent having turned 18 years of age (Supplementary Table S2). These questions are adapted from the original Kaiser Permanente Study and used in several studies using BRFSS data (Anda and Brown, 2010; Felitti et al., 1998; Ford et al., 2014; Oreskovich and Ballew, 2013; Remigio-Baker et al., 2014). The number of ACEs was defined as a categorical variable with levels of 0, 1, 2, 3, and 4 based on the sum of the 11 questions. ACEs were collapsed for those reporting 4 due to small numbers and commonly reported including a recent CDC Vital signs publication (Merrick et al., 2019). The response for each question was 'Yes' or 'No', except for 'Witness domestic violence', and the questions of physical, verbal and sexual abuse. Of these, three questions refer to sexual abuse (someone >5 years older or an adult ever: touch you sexually; try to make you touch them sexually; or force you to have sex). For these, three available responses were 'Once', 'More than once' or 'Never'. Except for verbal abuse, a response of at least 'Once' defined the presence of the corresponding ACE. For verbal abuse, a response of 'More than once' was necessary for verbal abuse to be considered present. This criteria for verbal abuse is consistent with how it is typically reported (Hughes et al., 2017; Merrick et al., 2019).

Socio-demographic covariates selected are commonly associated with chronic disease and their risk factors. Age was categorized into four groups (18–44, 45–64, 65–79, and 80 years). Self-identified race and Hispanic ethnicity were categorized as White, non-Hispanic (White); Black, non-Hispanic (Black); Asian, non-Hispanic (Asian); Hispanic (any race); and All Others, non-Hispanic. The "All Others, non-Hispanic" group comprised adults who identified themselves as American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, those who indicated more than one race, and those who did not report a race. Education group, based on highest grade or year of school completed, was categorized as not completing high school (<12 years), completing high school or its equivalent (12 years), 1 to 3 years of college or technical school, or college graduate (4 or more years of college). Health care coverage was defined as having coverage based on the question: "Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?"

Prevalence estimates and 95% confidence intervals (CIs) were calculated for CVH status by ACEs and the socio-demographic characteristics. A generalized logit model was developed to assess the association between poor and intermediate CVH with ideal CVH as the referent group. Crude and adjusted odds ratios (AOR) with ACEs as the primary predictor were calculated with the final adjusted model accounting for age, sex, race/ethnicity, education group, and health care coverage. SAS (version 9.4) and SAS callable SUDAAN (version 11.0) were used to account for the complex sampling design to provide weighted population estimates and calculate accurate variance estimates. A *p*-value <0.05 was considered statistically significant.

## 3. Results

By age, 35.6% of the population were 18–44 years, 37.7% were 45–64, and 21.2% were 65–79. Just over half were female (51.1%; Table 1). By race/ethnicity, 72.6% of the population

was comprised of White adults, 12.5% were Black adults, 8.8% were Hispanic adults, and 2.4% were Asian adults. By education level, 9.7% of the population had less than a high school education, and about 30% each had a high school degree or equivalent, some college, or were a college graduate. Not having health care coverage occurred in 8.0% of the adult population.

There was wide variation in the components of ACEs with 5.4% of respondents reporting being forced to have sex compared to 28.7% reporting verbal abuse and 28.1% reporting parents were divorced (Fig. 1). Overall, 37.0% reported 0, 22.5% reported 1, 12.7% reported 2, 8.5% reported 3, and 19.3% reported 4 ACEs (Table 1).

The components of CVH status ranged from 12.0% of adults reporting a healthy diet to 86.2% reporting no diabetes (Fig. 2). Overall, 16.7% reported poor CVH, 72.4% reported intermediate CVH, and 10.9% reported ideal CVH (Table 2). Estimates of CVH status (poor:15.5%–18.5%; intermediate:71.7%–72.7%; and ideal:8.8%–12.2%) varied by number of ACEs (Table 2).

In the poor vs. ideal CVH portion of the generalized logit model, after adjusting for age, sex, race/ethnicity, education group, and health care coverage, those with 1 (AOR = 1.27;95% Confidence Interval [CI]:1.11–1.46), 2 (AOR = 1.63;95% CI:1.36–1.96), 3 (AOR = 2.01;95% CI: 1.66–2.44), and 4 (AOR =2.47;95% CI:2.11–2.89) ACEs were more likely to have poor CVH compared to those who reported 0 ACEs (Table 3, Fig. 3). Additionally, in the adjusted model, those aged 45–64 years of age were (AOR = 7.24; 95% CI:6.26–8.38), those aged 65–79 years were (AOR = 13.02; 95% CI:11.22–15.12), and those 80 years of age were (AOR = 8.54; 95% CI:6.87–10.62) were all more likely to have poor CVH compared to those aged 18–44 years. Males were 1.84 (95% CI:1.66–2.05) times more likely than females to have poor CVH. Black adults were 1.91 (95% CI:1.55–2.36) times more likely to have poor CVH compared to White adults. Compared to those who were college graduates, those with less than a high school education (AOR = 9.36; 95% CI:6.90–12.69), a high school degree or equivalent (AOR = 4.06; 95% CI:(3.53–4.67), and some college (AOR = 2.76; 95%CI:2.43–3.13) were all more likely to have poor CVH.

In the intermediate vs. ideal CVH portion of the generalized logit model, after adjusting for age, sex, race/ethnicity, education group, and health care coverage, those with 2 (AOR = 1.28;95% CI:1.08–1.51), 3 (AOR = 1.48;95% CI: 1.25–1.75), and 4 (AOR = 1.59;95% CI:1.38–1.83) ACEs were more likely to have intermediate CVH compared to those who reported 0 ACEs (Table 3, Fig. 3). Additionally, in the adjusted model, those aged 45–64 years (AOR = 1.67; 95% CI:1.50–1.87), 65–79 years (AOR = 2.26; 95% CI:2.02–2.54), and 80 years (AOR = 2.00; 95% CI:1.67–2.39) were all more likely to have intermediate CVH compared to those aged 18–44 years. Males were 1.70 (95% CI:1.55–1.88) times more likely than females to have intermediate CVH. Black adults were 1.35 (95% CI:1.10–1.64) times more likely to have intermediate CVH compared to White adults. Compared to those who were college graduates, those with less than a high school education (AOR = 2.73; 95% CI:2.03–3.67), a high school degree or equivalent (AOR = 1.80; 95% CI:(1.59–2.03), and some college (AOR = 1.55; 95%CI:1.39–1.72) were all more likely to have intermediate CVH.

## 4. Discussion

The introduction of a composite measure of CVH was released more than a decade ago by the AHA. National initiatives, such as the Department of Health and Human Services *Healthy People* program, have aligned and promoted its use through programmatic and policy initiatives. However, continued progress in achieving population-level ideal health is needed, as demonstrated in findings from this study, where an estimated 8 in 9 adults had less than ideal CVH. This study demonstrated associations between adverse childhood experiences and their potential health implications in adulthood. Continued efforts to promote positive experiences during childhood, resiliency, and supportive structures among those that experience adversity may help improve overall CVH across the lifespan.

The focus of our study was to evaluate the association between ACEs and CVH. A 2019 CDC Vital Signs Report estimated the proportion of adult health problems attributable to ACEs using 2015–2017 BRFSS data. That report highlighted that 39.0% of the population reported not experiencing ACEs and 15.6% reported at least 4 ACEs, which was similar to our estimates of 37.0% and 19.3%, respectively (Merrick et al., 2019). Additionally, that study showed reporting 4 ACEs accounted for a disproportionate share across every negative health and socioeconomic outcome measured. As ACEs score increased, the association with adverse outcomes became more pronounced across a range of behaviors and diseases including smoking, alcohol consumption, depression, heart disease, cancer, kidney disease, and stroke. This similar pattern with increasing number of ACEs associated with worse CVH was seen in our study. Our study also showed those reporting 4 ACEs had the highest burdens of less than ideal CVH with poor CVH (2.5 times) and intermediate CVH (1.6 times) compared to ideal CVH. Additionally, ACEs are associated with earlier onset of chronic disease in young adulthood which could potentially lead to poor CVH, supports the need for prevention of ACEs and anticipatory guidance on chronic disease prevention early in the lifecourse (Sonu et al., 2019).

Limited data are available on ACEs and CVH status; however, one prior study did describe early trauma experiences and CVH, highlighting some modifying factors. For example, early trauma, including general trauma, emotional abuse and sexual abuse, was associated with worse CVH among low but not higher income Black adults (Islam et al., 2021). Positive neighborhood characteristics, like social cohesion and activity with neighbors, have also been associated with better CVH among Black adults (Islam et al., 2020). Social cohesion and activity with neighbors may be representative of neighborhoods with higher incomes and more resiliency. Another study demonstrated the importance of early identification and prevention of ACEs, as one ACE was strongly and independently associated with diabetes, hypertension, and high cholesterol among adults under 40 years of age (Kreatsoulas et al., 2019). Additionally, other measures such as neighborhood resiliency and social support may potentially limit the negative impact of ACEs on individuals.

Although this study focused on adult CVH status, non-ideal CVH status has been documented in young children and adolescents (Yang et al., 2014). For example, less than half of children 12–19 years of age in the US had 5 or more ideal CVH components based on 2005–2010 data (Shay et al., 2013). Lack of improvement in ideal CVH among children



and adolescents suggest the importance of interventions to prevent the deleterious effects later in life (Arteaga and Gillman, 2020). The National Heart Lung and Blood Institute has also called for efforts to evaluate, in a multi-dimensional manner, the impact of social determinants of health and their contribution to disparities in cardiovascular disease. These efforts may include circumstances that make children vulnerable to poor health early in life, including interventional studies that demonstrate a reduction in adverse outcomes across the life-course (Suglia et al., 2020). The CDC has programs and initiatives that include preventing exposure to ACEs in early childhood or adolescence as well as aiding adults to address the long-term health impact of childhood experiences (<https://www.cdc.gov/violenceprevention/aces/preventingace-datatoaction.html>). The CDC also promotes specific strategies to prevent ACEs through opportunities with states to leverage the best available evidence to prevent and respond to ACEs. Some of these strategies include strengthening economic supports for families, promoting social norms that protect against violence and adversity, ensuring a strong start for children, enhancing skills to help parents and youths handle stress and manage emotions, and interventions to lessen immediate and long term harms among those who experience ACEs (<https://www.cdc.gov/violenceprevention/aces/index.html>). There are a couple of CDC programs that are more specific to cardiovascular health that could potentially complement the general approach to prevent ACEs and improve health across the life course. For example, the Million Hearts® initiative and the Well-Integrated Screening and Evaluation for WOMen Across the Nation (WISEWOMAN) program both promote CVH through multiple avenues. Million Hearts®, co-led by CDC and the Centers for Medicare & Medicaid Services, aims to prevent 1 million heart attacks and strokes over 5 years through implementation of evidence-based strategies to improve cardiovascular health (<https://millionhearts.hhs.gov/index.html>). The priority areas include building healthy communities, optimizing care, and focusing on health equity. These priorities are addressed through convening health care and public health champions; facilitating impactful collaboration and resource sharing; promoting implementation of evidence-based strategies to prevent cardiovascular disease, and addressing health inequities through specific policies, processes, and practices. WISEWOMAN provides low-income, uninsured and under-insured women ages 40–64 years with heart disease and stroke risk factor screenings and services that promote healthy behaviors (<https://www.cdc.gov/wisewoman/about.htm>). These programs could be complemented by strategies promoting the prevention of ACEs, potentially improving ideal CVH in younger and older age groups through promotion of healthy behaviors and reduction of adversity.

In this study, we primarily explored the associations between ACEs and CVH, but there were also significant associations among the socio-demographic characteristics analyzed such as age, sex, race/ethnicity, and education group. There were differences in magnitude between the two outcomes with generally higher associations by magnitude among those reporting poor CVH compared to those reporting intermediate CVH for these socio-demographic characteristics. They likely play an important role that should be considered in developing initiatives or programs to improve CVH. Of these age and education group had the largest magnitude differences among their response levels. Those experiencing 4 or more ACEs are more likely to have lower educational attainment, be unemployed, and have no insurance (Merrick et al., 2019). Our study demonstrated that Black race was associated

with a higher likelihood for both poor and intermediate CVH. Additionally, Black adults report experiencing 4 or more ACEs more than White adults (Merrick et al., 2019). These findings highlight the complexity of the intersection among cultural factors such as race/ethnicity, other social and structural determinants of health, and factors such as ACEs. There is a need to better understand these differences as well as accounting for both individual and larger societal interactions such as barriers influencing health outcomes are needed to describe, understand, and support improved health for individuals and populations.

Limitations of this study include the use of self-reported data. Responses may be subject to social desirability bias, such as under-reporting smoking while over-reporting adequate physical activity, normal weight, and a healthy diet. Responses on childhood experiences asked of adults is also subject to the potential of recall bias and also may be subject to societal changes over time. The cross-sectional data prevents analysis the cumulative effect of health behaviors over time and limits the ability to establish a causal relationship between ACEs and CVH later in life. The AHA published an update to the “Life’s Simple 7” in 2022, which modified some of the individual metrics and expanded the number of components in the composite metric to eight (i.e., addition of adequate sleep), coining the new metric as “Life’s Essential 8” (Lloyd-Jones et al., 2022). Unfortunately, the level of detail needed to refine the existing measures, and the assessment of sleep, is not available in the 2019 BRFSS. In addition, the small sample sizes within subgroups may limit the detection of significant associations among various race/ethnic groups (e.g., Hispanic sub-ethnicities, Hispanic in combination with various race groups, Asian subgroups, Native American/Alaskan Native, Native Hawaiian or Other Pacific Islander subgroups, and those that report more than one race). Additionally, there were limited variables available in the data to evaluate key drivers of social determinants of health to better understand the structural and societal factors that impact ACEs and ideal CVH. The inclusion of reliable and validated metrics in future surveys could inform interventions that address health inequities.

## 5. Conclusions

Awareness of the impact of ACEs is growing, and numerous public health and clinical efforts to address them are underway, including many at the state level which aim to prevent ACEs from occurring, promote positive childhood experiences, and promote trauma-informed systems of care that can mitigate the consequences of ACEs when they have already occurred (Halder et al., 2021). More research is needed on ACEs screening including assessments of referral and response protocols to trauma-informed systems of care. This further understanding could potentially align with efforts to promote healthy behaviors, promote early screening, and promote prevention and management of health outcomes that could potentially improve CVH. For example, early guidance and health promotion throughout the life course would likely benefit the adoption of ideal health behaviors including among those who report having experienced ACEs.

In this study, an estimated 1 in 6 adults report poor CVH, the majority (78.5%) of adults report intermediate CVH, and just 1 in 9 report ideal CVH, and. At least one ACE was reported in nearly two-thirds of adults and about 1 in 5 reported 4 ACEs. This study demonstrates the disproportionate burden for those reporting 4 ACEs having both poor and



intermediate CVH. Preventing and mitigating the harms of ACEs and addressing barriers to ideal CVH, particularly social and structural determinants, may improve health across the life course.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Data availability

The data used is available publically at [www.cdc.gov/brfss](http://www.cdc.gov/brfss) any code used can be requested from corresponding author

## Abbreviations:

<b>ACEs</b>	Adverse Childhood Events
<b>CVH</b>	Cardiovascular Health
<b>BRFSS</b>	Behavioral Risk Factor Surveillance System

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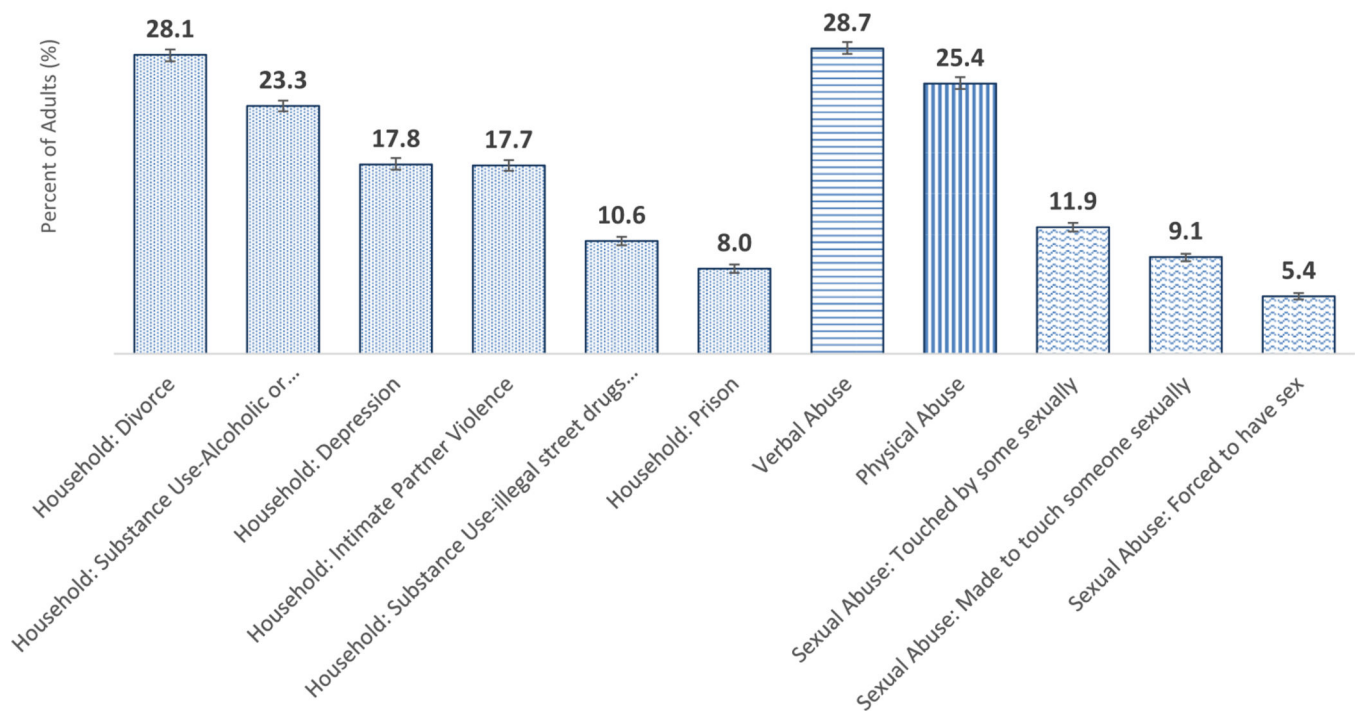
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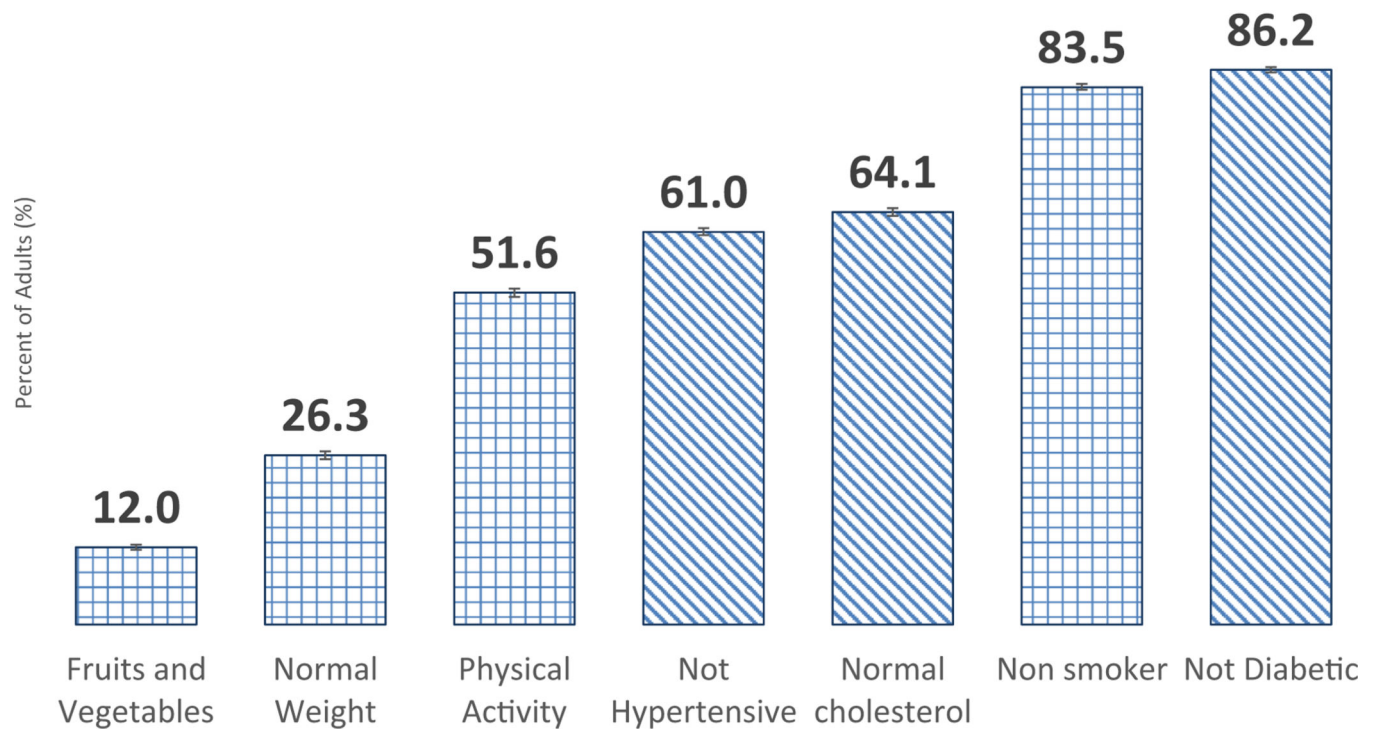
## Distribution of Adverse Childhood Experiences Components



**Fig. 1.**

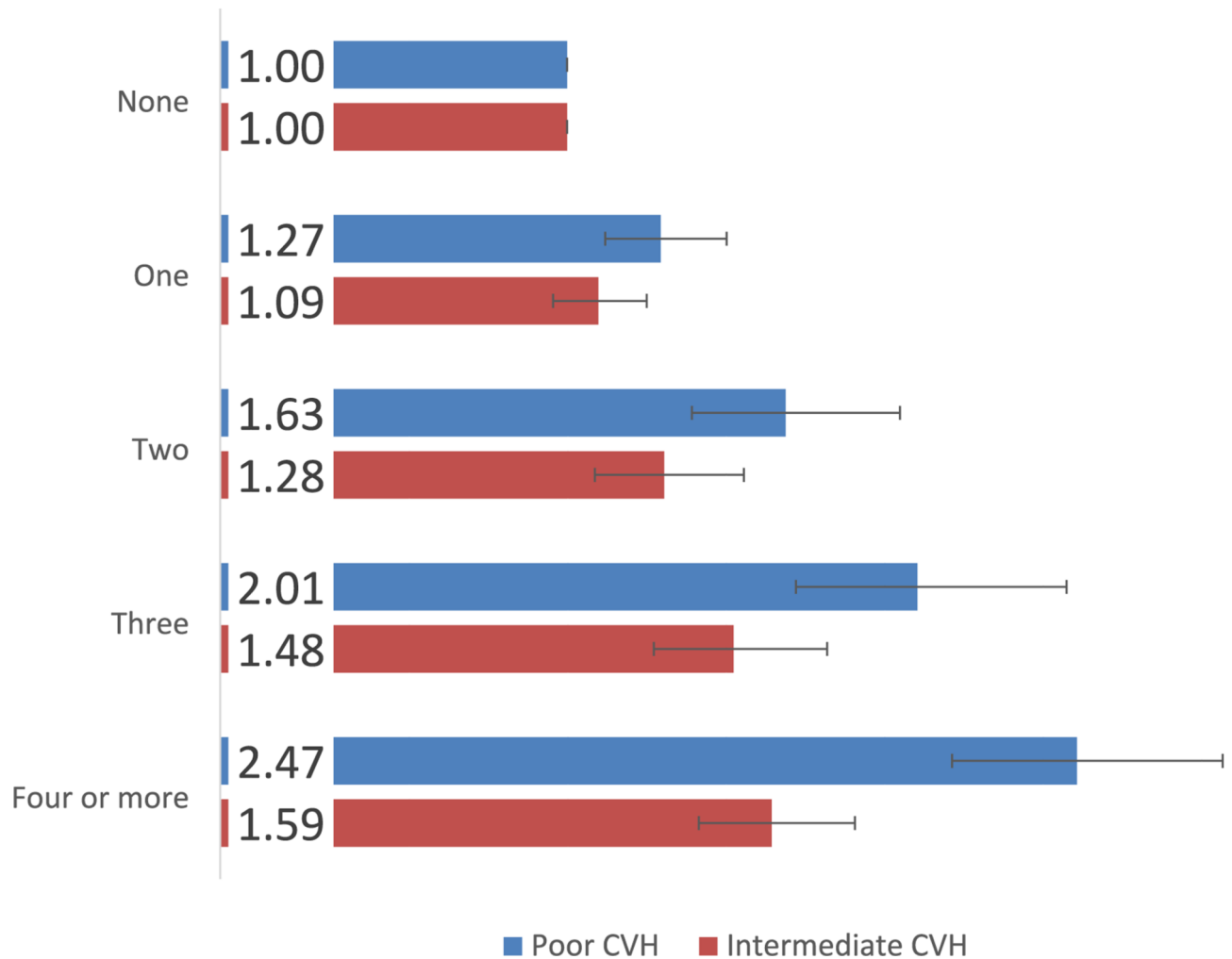
Overall Distribution of Adverse Childhood Experiences Components of Household Challenges (denoted by fill of dots), Verbal Abuse (horizontal fill lines), Physical Abuse (vertical fill lines) and Sexual Abuse (waves fill pattern) among adults, 2019 BRFSS. Note: 95% Confidence Intervals shown.

## Distribution of Cardiovascular Health Status Components



**Fig. 2.** Overall Distribution of Cardiovascular Health Components of Reported Behaviors (square) and Chronic Conditions (diagonal lines) among adults, 2019 BRFSS. Note: 95% Confidence Intervals shown.

### Adjusted Odd Ratios of Poor and Intermediate Cardiovascular Health by Number of Adverse Childhood Events



**Fig. 3.**

Adjusted Odd Ratios of Poor and Intermediate Cardiovascular Health (referent: Ideal) by Number of Adverse Childhood Events among Adults. Notes: Odds ratio shown are Adjusted for Age, Race/Ethnicity, Sex, Educational Level, and Health Care Coverage. 95% Confidence Intervals are shown.



**Table 1**

Prevalence of Adverse Childhood Experiences and Selected Characteristics among adults: BRFSS 2019.

	Unweighted sample (n)	Estimate (%)	95% CI <sup>a</sup>
Adverse childhood events			
None	35,607	37.0	(36.4–37.6)
One	19,146	22.5	(22.0–23.0)
Two	10,588	12.7	(12.3–13.1)
Three	6906	8.5	(8.2–8.9)
Four or more	14,337	19.3	(18.8–19.8)
Age group (years)			
18–44	17,957	35.6	(35.0–36.3)
45–64	32,571	37.7	(37.1–38.3)
65–79	28,240	21.2	(20.8–21.7)
80 and more	7816	5.5	(5.2–5.7)
Race/ethnicity			
White, non-Hispanic	70,068	72.6	(72.0–73.3)
Black, non-Hispanic	8169	12.5	(12.0–13.0)
Asian, non-Hispanic	667	2.4	(2.1–2.7)
Hispanic adults	3901	8.8	(8.3–9.3)
All others, non-Hispanic	3779	3.7	(3.4–3.9)
Sex			
Male	38,976	48.9	(48.2–49.5)
Female	47,608	51.1	(50.5–51.8)
Education level			
<High school	5266	9.7	(9.3–10.2)
High school degree or equivalent	23,819	29.1	(28.5–29.7)
Some college	24,574	31.0	(30.5–31.6)
College graduate	32,824	30.2	(29.6–30.7)
Unknown/missing	101		
Health care coverage			
None	5235	8.0	(7.7–8.4)
Yes	81,154	92.0	(91.6–92.3)
Unknown/missing	195		
Total	86,584	100.0	

Note: For Race/ethnicity, all groups did not select a Hispanic ethnicity except for those listed as Hispanic.

<sup>a</sup>95% CI refers to 95% confidence intervals.

**Table 2**

Prevalence of Adverse Childhood Experiences and Selected Characteristics by Cardiovascular Health Score among adults: BRFSS 2019.

		Cardiovascular health score					
		Poor ( <i>n</i> = 17,861)		Intermediate ( <i>n</i> = 60,795)		Ideal ( <i>n</i> = 7928)	
		Estimate (%)	95% CI <sup>a</sup>	Estimate (%)	95% CI	Estimate (%)	95% CI
Adverse childhood events	None	15.5	(14.8–16.2)	72.3	(71.4–73.2)	12.2	(11.5–13.0)
	One	17.2	(16.3–18.2)	71.7	(70.5–72.9)	11.1	(10.2–12.1)
	Two	18.1	(17.0–19.3)	72.1	(70.5–73.6)	9.9	(8.7–11.2)
	Three	18.5	(17.1–20.1)	72.6	(70.8–74.4)	8.8	(7.8–10.1)
	Four or more	18.5	(17.5–19.6)	72.7	(71.4–73.9)	8.8	(8.0–9.7)
	18–44	5.9	(5.4–6.4)	78.5	(77.4–79.5)	15.6	(14.7–16.6)
	45–64	21.7	(20.9–22.5)	69.6	(68.7–70.5)	8.8	(8.2–9.4)
Age	65–79	26.4	(25.5–27.3)	67.0	(66.1–68.0)	6.6	(6.1–7.1)
	80 and more	21.5	(19.8–23.4)	70.5	(68.5–72.4)	8.0	(6.9–9.2)
	White, non-Hispanic	17.0	(16.6–17.4)	72.3	(71.7–72.8)	10.8	(10.3–11.2)
	Black, non-Hispanic	21.9	(20.4–23.5)	69.9	(68.0–71.8)	8.2	(6.9–9.7)
Race/ethnicity	Asian, non-Hispanic	8.8	(6.0–13.6)	72.2	(66.0–77.6)	19.1	(14.7–24.4)
	Hispanic	12.8	(10.8–15.0)	75.8	(72.9–78.5)	11.4	(9.4–13.8)
	All others, non-Hispanic	17.9	(16.0–20.1)	71.4	(68.7–73.9)	10.7	(9.0–12.7)
	Male	17.6	(16.9–18.2)	74.0	(73.2–74.8)	8.4	(7.9–9.0)
Sex	Female	16.6	(16.0–17.2)	70.6	(69.8–71.3)	12.9	(12.2–13.5)
	<high school	29.8	(27.7–32.0)	65.5	(63.1–67.8)	4.7	(3.6–6.2)
Education group	High school	21.0	(20.2–21.9)	71.0	(69.9–72.0)	8.0	(7.3–8.8)
	Some college	16.5	(15.8–17.3)	73.5	(72.5–74.4)	10.0	(9.2–10.8)
	College graduate	9.7	(9.2–10.2)	74.4	(73.5–75.3)	15.9	(15.2–16.8)
Health insurance coverage	None	14.5	(13.0–16.0)	75.2	(73.0–77.3)	10.3	(8.6–12.3)
	Yes	17.3	(16.9–17.8)	72.0	(71.4–72.6)	10.7	(10.3–11.2)
Total		16.7	(16.3–17.1)	72.4	(71.9–72.9)	10.9	(10.5–11.3)

<sup>a</sup> 95% CI refers to 95% confidence intervals.

**Table 3**

Associations of Poor and Intermediate Cardiovascular Health Score by Adverse Childhood Experiences and Selected Characteristics among adults: BRFSS 2019.

	Poor vs. ideal			Intermediate vs. ideal		
	Crude		Adjusted <sup>b</sup>	Crude		Adjusted
	Odd ratios	95% CI <sup>a</sup>		Odd ratios	95% CI	
Adverse childhood events						
None	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00
One	1.22	(1.07–1.40)	1.27	1.09	(0.97–1.23)	1.09
Two	1.44	(1.21–1.71)	1.63	1.23	(1.05–1.44)	1.28
Three	1.65	(1.38–1.98)	2.01	1.38	(1.18–1.63)	1.48
Four or more	1.66	(1.44–1.92)	2.47	1.39	(1.23–1.59)	1.59
Age						
18–44	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00
45–64	6.55	(5.71–7.52)	7.24	1.58	(1.42–1.76)	1.67
65–79	10.62	(9.25–12.21)	13.02	2.03	(1.82–2.26)	2.26
80 and more	7.14	(5.82–8.76)	8.54	1.76	(1.49–2.09)	2.00
Race/ethnicity						
White, non-Hispanic	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00
Black, non-Hispanic	1.70	(1.39–2.07)	1.91	1.28	(1.05–1.54)	1.35
Asian, non-Hispanic	0.29	(0.17–0.50)	0.69	0.56	(0.40–0.78)	0.77
Hispanic	0.71	(0.54–0.93)	0.82	0.99	(0.79–1.24)	1.03
All others, non-Hispanic	1.06	(0.85–1.33)	0.98	0.99	(0.81–1.22)	0.92
Sex						
Male	1.62	(1.46–1.79)	1.84	1.60	(1.46–1.76)	1.70
Female	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00
Education group						
<high school	10.44	(7.73–14.12)	9.36	2.98	(2.22–3.99)	2.73
High school	4.33	(3.78–4.96)	4.06	1.90	(1.68–2.15)	1.80
Some college	2.73	(2.42–3.09)	2.76	1.58	(1.42–1.75)	1.55
College graduate	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00
Health insurance coverage						
None	0.87	(0.70–1.09)	0.84	1.09	(0.89–1.33)	0.98
Yes	1.00	(1.00–1.00)	1.00	1.00	(1.00–1.00)	1.00

<sup>a</sup>95% CI refers to 95% confidence interval.

<sup>b</sup>Adjusted reflects adjustment for all other characteristics shown.