Positive Childhood Experiences and Cardiovascular Health in U.S. Children

By

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Dissertation

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ABSTRACT

Background: Cardiovascular health (CVH) in childhood is a predictor of long-term health outcomes. Positive Childhood Experiences (PCEs) are recognized for their potential protective role in health, especially in otherwise difficult environments. The Healthy Outcomes from Positive Experiences (HOPE) framework offers a structured, strengths-based approach to conceptualize and measure PCEs; however, it has seen limited use in CVH research.

Purpose: 1) Examine the underlying structure of PCEs and identify associations between PCEs and CVH indicators in U.S. children ages 6-17 years, 2) identify whether the association between PCEs and CVH indicators differs by the number of Adverse Childhood Experiences (ACEs) and/or child's demographics, and 3) examine the changes in PCEs and CVH indicators over a 5-year period (2018-2022).

Design: Using data from the 2021-2022 National Survey of Children's Health (NSCH), we conducted Principal Component Analysis (PCA) to explore the underlying structure of 15 PCEs and their alignment with the HOPE framework. We then examined associations between PCEs and a subset of CVH indicators. The categorical CVH indicators included: physical activity (PA) (meets PA guidelines, insufficient PA, no PA), sleep (meets age-appropriate guidelines, suboptimal, very suboptimal), and body mass index (BMI) (obese, overweight, normal/underweight) using logistic and multinomial regressions. Models were adjusted for child's sex, child age group, race/ethnicity, household income level, caregiver's highest education, family structure type, and child's current insurance status. Interaction terms were used to examine the interaction between ACEs and PCEs, and demographic variables (child age group, sex, race/ethnicity) and PCEs, on the association with CVH indicators. Finally, regression

models were used to test for linear trends in the four CVH indicators, PCEs, and ACEs between 2018-2022.

Setting: National Survey of Children's Health data, 2018-2022

Results: Analysis of data revealed five principal components (PC): (PC1) positive social and emotional engagement, (PC2) neighborhood characteristics, (PC3) caregiver health and family resilience, (PC4) community involvement and extracurricular participation, and (PC5) access to community/ healthcare resources. Each count increase in PC1-5 was associated with decrease in the relative risk (RR) of no PA. PC1-3, and PC5 were inversely associated with very suboptimal sleep. PC1, PC3, and PC5 were also inversely associated with BMI, where each count increase was associated with a 10.1%, 10.5%, and 7.4% decrease in RR of obesity, respectively. Further analysis revealed that ACEs moderated the relationship between PCEs and three behavioral CVH indicators (secondhand smoke exposure, PA, and sleep), such that PCEs were protective in children exposed to ACEs. Race/Ethnicity also moderated the relationship between PCEs and all four CVH indicators. Trend analyses revealed differences year over year in PCEs, ACEs, and CVH indicators; when evaluating trends surrounding the COVID-19 pandemic, PCEs and ACEs decreased in the COVID-19 pandemic, with an increase in the early-post pandemic period.

Conclusion: PCEs identified by the HOPE framework demonstrate positive impact on a subset of CVH indicators. These findings suggest that the benefits of PCEs for cardiovascular health are not uniform, but shaped by adversity, age, and race/ ethnicity, underscoring the need for tailored prevention strategies. The pandemic highlighted the fragility of both protective and adverse experiences, as declines in PCEs and shifts in ACEs revealed how broader social disruptions can recalibrate children's developmental and health trajectories. The COVID-19 pandemic revealed how fragile these supports can be, with decreases in PCEs coinciding with shifting patterns of

ACEs. Together, this synthesis underscores that promoting child CVH requires not only enhancing PCEs but also addressing structural inequities and resilience in the face of widespread disruption. Further research is needed to better elucidate the mechanisms underlying these relationships and to inform the development of interventions that leverage PCEs to improve CVH in children.

Keywords: Positive Childhood Experiences, Protective Factors, Resilience, Adverse Childhood Experiences, Cardiovascular Health, Physical Activity, Sleep, Body Mass Index, Secondhand Smoke Exposure, Pediatric.

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Chapter 1: BACKGROUND & SIGNIFICANCE

Cardiovascular disease (CVD) is a leading cause of mortality globally (Genovesi et al., 2020; Kumar & Kelly, 2017), accounting for 17.4% of deaths in all racial/ethnic groups in 2021(Centers for Disease control and Prevention, 2023). The American Heart Association (AHA) guidelines state that cardiovascular health (CVH) is identified using eight health-related indicators ('Life's Essential 8'™): physical activity, sleep health, nicotine exposure, body mass index (BMI), diet, blood pressure, cholesterol, and glucose (Lloyd-Jones et al., 2022). These eight indicators can be subdivided into two categories: behavioral indicators (physical activity, sleep health, diet, nicotine exposure), and physiological indicators (blood pressure, cholesterol, BMI, and glucose). Children with elevated blood pressure, low levels of high-density lipoprotein cholesterol (HDL-c), and elevated levels of low-density lipoprotein cholesterol (LDL-c) and triglycerides are at higher risk for developing CVDs in adulthood (Kumar & Kelly, 2017; Vasan et al., 2020). Identifying CVH status early during childhood creates the opportunity to intervene before childhood CVH risk increases and maladaptive behaviors become engrained or result in the development of poor CVH outcomes and comorbidities (Weihrauch-Blüher et al., 2019).

Using a life-course approach, individual health trajectories highlight areas of vulnerability and resilience (i.e., the ability to overcome hardship) (Center on the Developing Child at Harvard University, 2023) that are impacted by an individual's family and social context (Perak et al., 2020). It is important to nurture resilience as well as identify and protect areas of vulnerability as early as possible for the child's overall wellbeing and to mitigate the impact of any CVH risk during childhood. Accordingly, there is a call to examine the family, social, and

physical environments in which a child develops to gain a more complete understanding of difference contexts and how they relate to CVH indicators (Crouch et al., 2022).

One avenue to examine the family, social, and physical environments in which a child develops is using the Healthy Outcomes from Positive Experiences (HOPE) framework (Sege & Harper Browne, 2017). The HOPE framework acknowledges the interplay of biological, behavioral, family/social, and physical environments in shaping a child's health, functioning, and quality of life outcomes. Further, it is a strength-based framework that emphasizes the importance of actively promoting positive childhood experiences (PCEs) that contribute to healthy development and wellbeing, while also preventing or mitigating children's susceptibility to or risk of exposure to Adverse Childhood Experiences (ACEs) and other negative environmental influences (Sege & Harper Browne, 2017). PCEs encompass experiences that promote positive assets in children, safe environments, community engagement, and support of families; they serve to promote healthy social and behavioral development, and exposure to PCEs is one way to help children develop resilience. PCEs are also mutually reinforcing, strengthening one another's influence on a desired outcome. The HOPE framework organizes PCEs into four broad categories: (1) stable and supportive relationships; (2) safe, equitable environments in which to live, learn, and play; (3) civic and social engagement that promotes children's sense that they matter to others; and (4) opportunities for social and emotional development.

Behavioral (physical activity, sleep health, nicotine exposure, & diet) and physiological (BMI, blood pressure, cholesterol, & glucose) CVH indicators and PCEs are important metrics to consider when assessing childhood health (Crouch et al., 2023; Huang et al., 2023; Lloyd-Jones et al., 2022; Suglia et al., 2018). Further, while the presence of PCEs may counter ACEs and

other risk factors (Crouch et al., 2023), it is also well documented that the presence of ACEs independently increases an individual's risk of poor CVH outcomes (Suglia et al., 2018). Research related to the impact of PCEs is still in its infancy; yet, it has already been shown that children who have experienced PCEs are more likely to flourish than children who have not (Crouch et al., 2023). Of note are two previous studies, each of which reported a negative relationship between a subset of PCEs (i.e., secure family attachment, involvement in social institution, safe and stable neighborhood, trusting relationship with adult) and childhood overweight or obesity (Crouch et al., 2022; Heerman et al., 2022); however, the relationship between PCEs and other CVH indicators, while accounting for ACEs, is inconclusive.

We therefore sought to answer the question: **"**What is the nature of the relationships between PCEs and a subset of physiological (BMI) and behavioral (physical activity, sleep duration, nicotine exposure) CVH indicators among U.S. children aged 6 to 17 years?" The National Survey of Children's Health (NSCH) is a publicly available dataset obtained from annual surveys of a representative sample of U.S. children aged 0-17 years since 2016. The dataset includes demographic questions, as well as comprehensive inquiries about children's overall health, CVH indicators, and PCEs (Child and Adolescent Health Measurement Initiative, 2023). The NSCH includes a subset of Life's Essential 8^{TM} (e.g. physical activity, sleep health, nicotine exposure, BMI); directly related to the HOPE framework, the NSCH also collects data on many PCEs, such as family strengths and problem solving, mental health status of caregiver, child attachment to friends and role models, trusting relationships with peers, neighborhood safety and stability, access to and quality of medical care, involvement in school and extracurricular activities, and positive character traits of the child.

In this study, we investigated children 6-17 years of age as they are the optimal age range for examining the relationship between PCEs as defined by the HOPE framework and CVH indicators. As children develop, their ability to change in response to experiences decreases exponentially along with the amount of effort such change requires increasing (Center on the Developing Child Child at Harvard University, 2023). Further, while early childhood development has traditionally focused on cognitive, emotional, and social capabilities, it is essential to recognize that developmental processes continue into adolescence and early adulthood (Center on the Developing Child Child at Harvard University, 2023). Thus, our study encompasses both school-age children and adolescents. This age range is ideal as it coincides with children's development of a sense of competence, belief in their skills, and increasing peer influence, which continues to remain pivotal in the context of identity development, and sense of belonging (Orenstein & Lewis, 2022).

Based on the current Bright Futures guidelines (Hagan et al., 2017), CVH indicators are clearly prioritized and evaluated at various points in childhood/adolescence during well-child visits. Current research and practice is also shifting toward ensuring children have safe, stable, and nurturing relationships (Garner & Yogman, 2021) rather than focusing only on adversity (Garner & Yogman, 2021). What remains under-investigated is whether the same level of attention is given to tracking PCEs and their influence on children's CVH indicators. As noted earlier, the science surrounding PCEs is still developing concerning if and how PCEs are associated with CVH indicators, and especially among children who are already identified at having a higher CVH risk. To answer our question, we conducted a secondary analysis of NSCH data (2018-2022) to address the following specific aims:

Specific Aim 1: Examine the associations between PCEs and CVH indicators.

Using variables from the 2021-2022 NSCH dataset, we operationalized PCEs as identified by the HOPE Framework. We examined PCEs in four categories (1) stable and supportive relationships; (2) safe, equitable environments in which to live, earn, and play; (3) civic and social engagement that promotes children's sense that they matter to others; and (4) opportunities for social and emotional development) identified by this framework, and examined the association between PCEs and CVH indicators (based on Life's Essential 8^{TM} guidelines) among U.S. children 6-17 years of age.

Working hypothesis: There would be a positive association between each of the four categories of PCEs and CVH indicators, such that the higher number of PCEs is associated with better CVH.

Specific Aim 2: Identify whether the association between PCEs and CVH indicators differs by the number of ACEs and/or child's demographics (i.e., age, sex, race/ethnicity).

Child's demographics (age group [6-9 yr., 10-14 yr., or 12-17 yr.], sex [biologically male or female], race/ethnicity [Non-Hispanic (NH) White, NH Black, Hispanic or Latino, and Multi-racial/Other, NH]) and the number of ACEs information collected from NSCH 2021-2022 were included to determine if the association between PCEs and CVH indicators differed by any of these variables.

Working hypothesis: Based on previous literature, we expected the association between PCEs and CVH indicators would significantly differ in children exposed to multiple ACEs (where more ACEs weakens the relationship between PCEs and CVH indicators), the child's age (adolescents would have a less favorable CVH than school-age children), and race/ethnicity

(where racial/ethnic minorities would have a less favorable CVH than Non-Hispanic (NH) White children). Due to the mixed findings in the literature regarding the impact of a child's sex, we did not hypothesize a significant difference in CVH between male and females.

Specific Aim 3 (Exploratory): Examine the changes in PCEs and CVH indicators over a 5-year period (2018-2022) presenting different trajectories.

Trends in PCEs and CVH indicators were evaluated using logistic and multinomial regression year over year. Trends in PCEs and CVH indicators were also evaluated by COVID period (pre-COVID, COVID, early post-pandemic).

Working hypothesis: We expected to see differences by year in CVH indicator and PCE variables. Of note, we expected there to be decreases in PCE exposure during the COVID pandemic (2020-2021), and less favorable CVH indicators during the COVID pandemic.

The short-term goal of this study is for pediatric health care providers to utilize the insights and knowledge gained to reinforce the use of strength-based frameworks and to emphasize the importance of actively promoting PCEs that contribute to healthy development and wellbeing, while also preventing or mitigating the susceptibility to or risk of exposure to ACEs and other negative environmental influences (Sege & Harper Browne, 2017). Building strengths in children, adolescents, and their caregivers lead to more resilient families, who in turn are better equipped to provide PCEs for their children (Frankowski, 2023). We expect the findings of this study will improve understanding of how some children thrive, or even flourish, regardless of their exposure to ACEs. This understanding can not only inform practice recommendations but also lead to effective policy and program recommendations aimed at promoting age-specific PCEs.

The long-term goal of this study is to understand the role(s) that specific and/or collective accumulation of PCEs contribute to CVH and other health outcomes during childhood and across the lifespan. This understanding has the potential to inform the development of tailored PCE-promoting strategies that are targeted at reducing CVH risk and other adverse health-related outcomes in childhood and across the lifespan.

Chapter 2: LITERATURE REVIEW

Introduction

This focused review of the literature begins with an overview of the *Healthy Outcomes from Positive Experiences* (HOPE) Framework. This overview is followed by a discussion of the recent shift in focus from *Adverse Childhood Experiences* (ACEs) toward including *Positive Childhood Experience*s (PCEs) when exploring child health outcomes. This initial focus then shifts to a review of *Cardiovascular Health* (CVH) indicators and what is currently known about the interplay of ACEs, PCEs and CVH. The chapter concludes with a summary of gaps in the literature that informed and framed this study.

Positive Childhood Experiences (PCEs) during Childhood

The literature continues to support a shift from solely focusing on individuals to a parallel focus on relational health approaches. This shift in focus emphasizes the need to examine the nature and quality of relationships that foster healthier states. Accordingly, PCEs are increasingly being recognized as central indicators of health and as strategies for building and maintaining optimal health during childhood and beyond (Roby et al., 2024). There is a growing body of literature supporting the positive impact of PCEs, highlighting that PCEs not only represent the ideal environment for children's optimal development, but they can also protect or offset the impact of ACEs by buffering the consequences of adversity (Bethell et al., 2019). Further, recent studies draw attention to the important role PCEs have in building protective factors and promoting healthy outcomes in childhood, while also protecting adults from poor mental and physical health conditions (Frankowski, 2023; Huang et al., 2023).

Other studies have examined PCEs in the U.S. using the National Survey of Children's Health (NSCH) (Crouch et al., 2021) in other contexts. One study evaluated PCEs in rural and

urban settings and reported that, compared to urban children, rural children were less likely to participate in PCEs (e.g., after-school activities), but more likely to volunteer in the community. Both observations reflect decreased opportunity for constructive social engagement, yet rural children were more likely to have a mentor for advice or guidance, which represent exposure to being in a nurturing, supportive relationship. Overall, school-age children had a greater likelihood of participation in after-school activities than adolescents. There were no significant differences in family resilience (as defined by National Survey of Child's Health guidelines), sharing ideas with a caregiver, living in a safe neighborhood. These findings suggest that participation in after-school activities may reflect family economics and/or caregiver resources, both time and financial, where children whose households have less financial resources are less likely to participate in after school programs, regardless of rural-urban location (Crouch et al., 2021).

This same team (Crouch et al., 2024) evaluated the prevalence of PCEs before and during the COVID-19 pandemic among school-age children (6-11 yr) and adolescents (12-17 yr). This pre-pandemic period was compared to early pandemic period using data from the 2018-2019 and 2020-2021 NSCH. Several PCEs were measured, and four PCEs reportedly declined between the two time points: 1) after-school activities, 2) community volunteerism, 3) having a guiding mentor, and 4) resilient family. They attributed much of this decline to closure of in-person activities, which represents yet another unintended consequence of the nationwide shut down.

One of the ongoing challenges with conducting PCE research is that while PCEs have been empirically shown to play an important role in promoting healthy physical, social, and cognitive development in children, measuring PCEs is complex and inconsistent. Further, the literature also underemphasizes physical health outcomes, focusing primarily on mental health outcomes

instead (Huang et al., 2023). In addition, most of the research to date has predominantly taken a retrospective approach in which both PCEs and health outcomes are measured via adult self-report. Accordingly, there are a few measures available (e.g., Positive Childhood Experiences Scale (Dogan & Aydin, 2020), but these are similarly intended to be retrospectively self-reported by adults. What is still needed is a study that assesses childhood data, rather than adult recall, and incorporates physical health outcomes, as well as PCEs across all four categories of the Healthy Outcomes from Positive Experiences (HOPE) framework.

The Healthy Outcomes from Positive Experiences (HOPE) Framework

The HOPE Framework (Sege & Harper Browne, 2017) is informed by Bronfenbrenner's Social-Ecological Model (1979) in that it delineates a broad cross-section of factors that influence child health and child health outcomes across multiple levels (i.e., individual, relational, community). As its name implies, its primary focus is on PCEs and is organized using four broad categories: 1) being in nurturing, supportive relationships, 2) living, developing, playing, and learning in safe, stable, protective, and equitable environments, 3) having opportunities for constructive social engagement and to develop a sense of connectedness, and 4) learning social and emotional competencies (Frankowski, 2023; Sege & Harper Browne, 2017). Each of the four categories has its own metrics that reflect optimal child health and build protective factors. Table 2.1 provides examples and potential variables for study. While each category and its metrics focus on different levels (i.e., individual, relational, community), it is also important to note that the categories are interrelated and can influence each other (Sege & Harper Browne, 2017).

Table 2.1

The HOPE Framework

Categories of HOPE Framework	Examples	Available Variables for Study
Being in nurturing, supportive relationships *At relational level*	• Secure attachments • Warm, responsive, sustained relationships • A physically and mentally healthy parents • A parent who can provide supportive care given their unique physical characteristics and circumstances • Trusting relationships with peers and other adults	• Family shares ideas • Family resilience • Making and keeping friends • Mental health status of caregiver • Physical health status of caregiver • Adult mentor
Living, developing, playing, and learning in safe, stable, protective, and equitable environments. *At community level*	• A safe and stable home • Adequate nutrition and sufficient sleep • High-quality learning opportunities • Opportunities for play and physical activity • Access to high-quality medical and dental care	• Neighborhood amenities • Presence of detracting neighborhood elements • Supportive neighborhood • Child receives care in a well-functioning system
Having opportunities for constructive social engagement and to develop a sense of connectedness *At relational and community level*	• Involvement in social institutions and environments • Fun and joy in activities with others • Success and accomplishment • Awareness of one's cultural customs and traditions • A sense of belonging and personal value	• Participation in organized activities • Participation in community service or volunteer work • School engagement
Learning social and emotional competencies *At individual level*	• Behavioral, emotional, and cognitive self-regulation • Executive function skills • Positive character traits • Self-awareness and social cognition • Functional, productive responses to challenges	• Flourishing for children and adolescents

Category 1: (Relational level) Being in nurturing, supportive relationships. This category focuses specifically on how being in a nurturing supportive relationship supports the developing brain in a child. The emphasis in this category is on the importance of developing secure

attachments, which are formed in the presence of responsive relationships; early, secure attachments contribute to the development of many competencies later in life and throughout childhood (Sege & Harper Browne, 2017). Child and caregiver wellbeing are therefore inextricably linked as children need adults and figures who care, encourage, and promote high expectations in them, are trustworthy, and provide them with a sense of belonging. Early and ongoing relationships provide each child with the foundation and scaffolding for further development.

Category 2: (Community level) Living, developing, playing, and learning in safe, stable, protective, and equitable environments. This category highlights how the environments children grow up in impact child health in the short- and long-term. Safe, stable, protective, and equitable environments are particularly beneficial for children's physical, emotional, social, cognitive, brain, and behavioral health and development. These benefits can endure across the lifespan. The examination of a child's environment includes access to food, health care, opportunities for learning, and safe places to be, whether to sleep or to play.

Category 3: (Relational/community level) Having opportunities for constructive social engagement and develop a sense of connectedness. This category focuses on both school and community contexts, as well as their interplay, looking at if and how institutions provide support for children's intellectual, social, emotional, moral, spiritual, and physical development. The primary emphasis is on the child's experience(s) within and across different contexts and if/how these experiences create a sense of connectedness for the child.

Category 4: (Individual level) Learning social and emotional competencies. This category highlights the importance of developing skills and traits that, acquired in childhood, ultimately enable individuals to identify, understand, and express their own feelings in socially and

culturally appropriate ways. These competencies cultivate self-awareness and confidence and lay the foundation for learning and problem-solving, identity development, communication skills, and effective interpersonal relationships in childhood and going forward.

There are two studies that have examined PCEs using the HOPE framework, all of which highlight the impact of PCEs on health outcomes (Guo et al., 2022; Huang et al., 2023). For example, Guo et al. (2022) used a four-construct model and confirmatory factor analysis to determine the association with mental health problems and academic difficulties of adolescents (14-15 yr) using longitudinal data to evaluate three of the four HOPE categories: 1) nurturing and supportive relationships, 2) safe and protective environments, and 3) constructive social engagement and connectedness. The four identified PCE constructs were: (1) positive parenting, (2) trusting and supportive relationships, (3) supportive neighborhood and home learning environments, and (4) social engagement and enjoyment. More exposure to PCEs across each construct was associated with lower reporting of mental health problems and academic difficulties in adolescence. The four-construct model of PCEs included was reported to have sufficient internal coherence and predictive validity to offer a potential useful way of conceptualizing and measuring PCEs in cohort studies (Guo et al., 2022).

Other studies using the HOPE framework highlight how PCEs during childhood are associated with lower risks of fair or poor adult health, fewer adult mental health problems, and a later age of onset of physical or mental health conditions (Huang et al., 2023). Using data from the Childhood Retrospective Circumstances Study, PCEs including comfort confiding in a caregiver, perception that caregiver understood their problems, rating of their relationship with caregiver, happiness at school, comfort with friends, and perception of neighbors' helpfulness were evaluated for the association with adult health outcomes. These items were dichotomized,

then summed and placed into categories (0-2, 3-4, or 5-6 PCEs) for an overall PCE score, reporting PCEs were independently associated with lower risk of fair or poor health, after adjusting for ACEs (Huang et al., 2023).

Cardiovascular Health (CVH) Indicators

The American Heart Association (AHA)'s expanded focus on CVH and disease, risk factors, and health-promoting strategies lead to creation of a set of CVH indicators (Lloyd-Jones et al., 2022). In 2022, AHA introduced Life's Essential 8 ™ guidelines which includes four *behavioral* CVH indicators—physical activity, sleep health, nicotine exposure, and diet—and four *physiologica*l CVH indicators—body mass index (BMI), blood pressure, total cholesterol, and glucose. Each indicator is measured and scored based on guidelines (0-100), where a higher score indicates better CVH. These guidelines replaced the previous Life Simple 7™ guidelines. Measuring these indicators allows for exploration and comparison within and across populations and communities. For example, one study (Virani et al., 2020) using these indicators to examine CVH in U.S. children between 1999-2000 and 2015-2016 found ideal levels of key CVH indicators declined for U.S. children (12–19 yr) including BMI (69.8% to 60.1%) and physical activity (38.4% to 25.4%); however, ideal levels for nicotine exposure (76.4% to 93.6%) improved. Cholesterol and blood pressure also improved.

Several other studies have reported CVH indicators among U.S. children using the Life's Essential 8™ guidelines. For example, Perng et al. (2023) assessed and described CVH status in children ages 4-7 using both Life's Essential 8™ and previous Life Simple 7™ criteria (which does not include the behavioral indicator of sleep health). In this study, CVH score agreement was measured between the two sets of guidelines. Children generally had high scores for physiological indicators and low-to-moderate scores for behavioral indicators; however, Life's

Essential 8™ yielded a greater percentage of high CVH score than the Life Simple 7™ (Perng et al., 2023). Without the measure of sleep, 4.3% of children were reclassified from high to moderate CVH. This finding highlights the significant impact of addressing and including assessment of sleep when examining CVH in young children. Shu et al. (2023) also examined Life's Essential 8™ indicators among school-aged children (6-10 yr), including all eight behavioral and physiological indicators and the cardiovascular structures of left ventricular mass (LVM), LVM index, and carotid intima-media thickness. On average, CVH scores in school-age children reportedly were moderate and declined with age (i.e., at baseline and at two years). Lower or suboptimal CVH scores were reported in children with abnormal cardiovascular structural measures (e.g., more carotid intima-media thickness, bigger LVM, higher LVM index).

Trends in CVH scores are relatively outdated in that they are lacking the important addition of sleep quality/duration. Further, past trend data does not reflect the historical impact of the COVID-19 pandemic.

Adverse Childhood Experiences

It is difficult to discuss PCEs without also considering adverse childhood experiences (ACEs). ACEs are stressful and potentially traumatic events and family challenges occurring in childhood and are often reported as a count of how many different types of ACEs a child is exposed to, rather than the degree. The nature and number of ACEs are a crucial area of assessment when conducting research in children, as ACEs are known to negatively influence children’s health. ACEs can also be challenging to address because they typically are reported only as the number of events, rather than the degree of adversity, and the list of what is considered an ACE continues to evolve.

The interplay of ACEs, PCEs and CVH

PCEs have the potential to influence CVH indicators through various pathways, both *direct* and *indirect* (Lloyd-Jones et al., 2022). *Direct* effects involve physiological pathways, such as the body's inflammatory response, glucose and lipid homeostasis, and stress-related coagulation. *Indirect* effects operate through behavioral pathways that influence CVH indicators without directly altering physiological processes. For example, neighborhood cohesion can impact childhood obesity rates, which impact CVH in childhood and well into adulthood if left unattended. Similarly, caregiver warmth has been linked to higher CVH scores extending into adulthood, highlighting the enduring influence of PCEs on long-term health outcomes. A comprehensive approach to the relationship of PCEs with CVH has been taken in children to evaluate the relationship with the CVH indicator of BMI, and in adults to evaluate the relationship with CVH in midlife.

To date, specific PCEs associated with CVH indicators include: 1) neighborhood cohesion (Alhansan et al., 2023), 2) caregiver warmth (Ortiz et al., 2024), 3) psychological characteristics, such as optimism and purpose in life (Kim et al., 2020; Stewart et al., 2020), and 4) positive parenting (Miadich et al., 2019). One study focusing on neighborhood cohesion (a measure of (2) living, developing, playing, and learning in safe, stable, protective, and equitable environments) and CVH reported that lower rates of neighborhood cohesion are associated with obesity among school-aged children (Alhasan et al., 2023). Certain characteristics like optimism, purpose in life, environment, reward from social roles, and resilient coping have been linked with more favorable CVH indicators in adults (Kim et al., 2020; Stewart et al., 2020). A longitudinal study that examined the association of caregiver warmth (a measure of (1) being in nurturing, supportive relationships) with CVH indicators over a 20-year longitudinal period,

tracking children into adulthood, reported that caregiver warmth was associated with higher CVH scores over multiple time points into adulthood, suggesting that stability of caregiver relationships experienced in childhood may be associated with better CVH in adulthood (Ortiz et al., 2024). Last, the longitudinal association of positive parenting and the CVH indicator of sleep in early to middle childhood was evaluated, reporting that positive parent personality was associated with longer sleep duration (Miadich et al., 2019), where positive parenting starting in infancy may have a protective influence on sleep later on.

Crouch et al. (2022) took a more comprehensive approach and measured four PCEs and a physiological CVH indicator, BMI, in children 10-17 years using NSCH data. Children with overweight/obesity were less likely to: participate in after school activities, volunteer in community/church (both a measure of (3) constructive social engagement and to develop a sense of connectedness), have a mentor they feel comfortable going to for guidance, live with a resilient family (both a measure of (1) being in nurturing, supportive relationships), live in a safe neighborhood, and live in a supportive neighborhood (both a measure of (2) living, developing, playing, and learning in safe, stable, protective, and equitable environments) compared to children with under/normal-weight (Crouch et al., 2022), demonstrating a positive association between PCEs and BMI. An earlier study examined the relationship between PCEs and ideal CVH in midlife, using retrospective reports of eight PCEs, and Life's Simple 7^{TM} scoring criteria. Their results suggest PCEs are associated with ideal CVH in midlife (Slopen et al., 2017).

Moving forward, it is also essential to consider demographic differences in both PCE and CVH indicators, as these factors can significantly influence health outcomes as favorable social indicators are associated with better CVH (Lloyd-Jones et al., 2022).

Demographic Differences

Race/Ethnicity

Difference in PCE exposures by race/ethnicity has been reported by only one study (Crouch et al., 2021). They reported that all racial/ethnic minority groups of children had a lower likelihood of mentorship, living in a safe neighborhood, or living in a supportive neighborhood, than NH White children (Crouch et al., 2021). Differences in CVH by race/ethnicity among U.S. children highlight that favorable indicator scores, according to the Life's Essential 8™ guidelines, are more prevalent among Non-Hispanic (NH) Whites and NH Asians, while undesirable health indicators were more prevalent among NH Blacks and/or Hispanics. To date, the literature examining race/ethnicity differences in PCEs is limited, but suggests that racial/ethnic minorities may have less exposure to PCEs (Lloyd-Jones et al., 2022). Further, the prevalence of meeting ≥5 CVH indicators of the Life Simple 7™ among U.S. children is highest for NH Asians (63.4%), followed by NH Whites (48.8%), Hispanics (40.6%), and NH Blacks (35.2%)(Virani et al., 2020).

When considering CVH indicators individually, the prevalence of obesity differs similarly by race/ethnicity according to 2013-2016 data from *National Health and Nutrition Examination Survey* (NHANES) (Virani et al., 2020). Specifically, the prevalence of obesity was significantly higher for NH Black males and females (17.9% and 23.0%, respectively) compared to NH White males and females (15.3% and 14.1%, respectively) and NH Asian males and females (11.9% and 7.4%, respectively). Crouch et al. (2022) also reported that NH Black children and Hispanic children were more likely to be overweight or obese than their NH White counterparts. Further, the prevalence of lifetime use of tobacco was highest among American Indians and Alaska natives, followed by NH Whites, Hispanics, Blacks, and Asians (opposite

trends of overweight/obesity) (Virani et al., 2020). Among males, the prevalence of meeting physical activity requirements was higher among NH White, NH Back, and Hispanic males, respectively. In a study reporting on racial/ethnic differences in sleep, it has been reported that that a short sleep duration is observed most often in Black children and adolescents (Crosby, 2005; Fuller-Rowell et al., 2021; Saelee et al., 2023). This racial differences in sleep duration have also been reported to be mediated by neighborhood safety in childhood (Fuller-Rowell et al., 2021).

Based on the existing literature, which shows suboptimal CVHs in racial/ethnic minority children and potential differences in PCE exposure by race/ethnicity, it is important to assess whether the association between PCEs and CVH indicators differs by race/ethnicity to understand this relationship more accurately.

Sex

Literature on the differences in PCEs and CVH by sex is primarily limited to CVH indicators and shows mixed results. Prevalence of overweight and obesity (measured by BMI) for both sexes has been mixed, while nicotine exposure score for males is reported to be lower than females, and physical activity score for males is reported to be higher than females. According to a study using the *Youth Risk Behavior Surveillance System* (YRBSS) 2015, the percentage of obesity was higher in males (16.8%) than females (10.8%). While Virani et al (2020) reported that that the prevalence of obesity varies by sex, another study reported no significant differences in overweight (including obesity) prevalence by sex (Crouch et al, 2021). Reports of nicotine exposure are reported to be higher in males than females, where there is a higher reported tobacco use in males than females, resulting in a lower nicotine exposure score for males (Virani et al., 2020). More males than females met physical activity requirement, with

males also being more likely to have adequate cardiorespiratory fitness than females (indicating a higher score in males than females) (Virani et al., 2020). Differences by sex in sleep were not detected among children in one study, however female adolescents were more likely to report short sleep duration than male adolescents(Elkhatib Smidt et al., 2021).

Current literature has not examined PCEs by a child's sex and has been limited to CVH indicators of physical activity, nicotine exposure, and BMI, with one study reporting on sleep.

Age

Our study encompasses both school-age children and adolescents, and it is important to consider age differences in exposure to PCEs and CVH indicators. Early childhood development has traditionally focused on cognitive, emotional, and social capabilities, and it is essential to recognize that the development process continues into adolescence and early adulthood (Center on the Developing Child Child at Harvard University, 2023). Using a life-course approach, individual health trajectories have areas of vulnerability that are impacted by one's family and social context starting from birth. Literature on age differences in PCEs and CVH is also limited primarily to CVH indicators, with data suggesting that CVH scores are lower in adolescents than in school-age children. According to 2015-2016 data from NHANES, the *overall* prevalence of obesity (≥95th percentile) among youth was 18.5%; however, the prevalence of obesity for children 6-11 years was 18.4%, while it increased for adolescents 12-19 years of age to 20.6%. (Lloyd-Jones et al., 2022). Another study reported 13.9% of U.S. adolescents had obesity and 16.0% were overweight (Virani et al., 2020), suggesting one reason that adolescents have a lower CVH score than their school-age counterparts may be because high school students are more likely to use any tobacco products. Another study reported higher child age has been associated with higher CVH (Perng et al., 2023); however, this study focused on a narrow and much

younger age group, with the oldest children in the study seven years. The existing data suggests that PCEs may have a downstream effect on CVH indicators, with much of the existing research focusing on adult outcomes. It is possible there is a more profound impact of PCEs on CVH indicators in the older age groups than the younger age group due to the cumulative nature of PCEs.

To our knowledge, only one study included differences in PCEs by age group in childhood, reporting that school-age children have a greater likelihood of participation in after-school activities than adolescents (Crouch et al., 2021). We anticipated that PCEs and CVH indicators would significantly differ for younger and older age groups, where adolescents (15-17 years) have a lower CVH score than school age children (6-9 and 10-14 years).

Other demographic variables included in analysis included family structure type, caregiver marital status, caregiver's highest education, and household income level. Family structure type and caregiver marital status are closely related to PCEs and are important factor to consider. The household income level can be measure by evaluating the federal poverty level (FPL) is a measure used in the U.S government to determine income eligibility for certain programs and benefits and varies by household size. The FPL sets a minimum income level deemed necessary for individuals and families to afford basic needs. For example, in a family of four in 2025, the minimum necessary income is $32,150 annually; a family at 200% of the FPL makes approximately $64,300 (U.S. Department of Health and Human Services, 2025). It is important to note that this threshold varies each year and has generally increased overtime.

In summary, there is a clear gap in understanding the complex interplay between PCEs and CVH indicators, especially when considering demographic variations. Another variable to

consider when examining the interplay between PCEs and CVH indicators is the impact of ACEs, especially when the ACE score is high.

Adverse Childhood Experiences? (ACEs) & CVH Indicators

The nature and number of ACEs are a crucial area of assessment when conducting health-related research in children, as ACEs are known to negatively influence children's health (American Heart Association, 2019; Crouch et al., 2022; Huang et al., 2023; Suglia et al., 2018). ACEs are stressful and potentially traumatic events and family challenges occurring in childhood (Huang et al., 2023) and are often reported as a 'count' of how many different types of ACEs a child is exposed to, rather than the degree. Notably the higher the number of ACEs reported, the greater the impact, where anything more than one ACE has a negative impact on health; while a score of 4 or more ACEs has also been associated with negative medical and social outcomes, a child with two ACEs may be a greater risk for negative outcomes or be more symptomatic than someone with 4 or more ACEs (Briggs et al., 2021).

The negative association between ACEs and CVH indicators have been studied previously, suggesting both indirect and direct mechanisms for the negative association between ACEs and CVH indicators (Crouch, 2022), with greater psychosocial stress and depression are associated with poorer CVH (Lloyd-Jones et al., 2022). The suggested mechanisms by which ACEs negatively influence CVH indicators are similar to the mechanisms by which PCEs can positively influence CVH indicators. These stressors can act *directly* on biologic pathways, including immune function and inflammatory response, which can also be *indirectly* impacted by environmental exposures such as air pollution. For this reason, it is important to assess the presence of both ACEs and PCEs when assessing CVH indicators. It is also important to understand the evolving literature on what represent ACEs, as the tool assessing these events has

expanded to include various forms of discrimination (e.g., race, weight) and the importance of simultaneously documenting social determinants of health.

A growing body of evidence has reported links between childhood ACEs and poor CVH in adulthood, with even one ACE being strongly and independently associated with poor CVH outcomes. In examining the relationship between exposure to one ACE - family member incarceration - during childhood and myocardial infraction, the odds of myocardial infarction among men with family member incarceration was significantly higher than women (White et al., 2016). Similarly, experiencing another ACE - family and neighborhood poverty - during childhood increased the risk for hypertension for adults 30 years later (Nikulina & Widom, 2014). Further, women raised in lower socioeconomic status (SES) families were found to have elevated markers of inflammation and hemostasis, increasing risk for poor CVH in adulthood (Matthews et al., 2016). Other studies have reported higher rates of childhood adversity are associated with increased risk of CVD in early adulthood and increased risk of hospitalization due to CVD in early adulthood (Kovacs et al., 2023).

Two studies reported on adolescent ACEs and CVH indicators. One study evaluated ACEs and a measure for vascular stiffness, demonstrating that adolescents with ≥1 ACEs had significantly higher vascular stiffness and ACEs were associated with increased risk for future cardiovascular disease (CVD) in this population (Kellum et al., 2023). In a recent longitudinal study evaluating eating behavior pathways and cardiometabolic risk in adolescence, more adversity in childhood and maternal depressive symptoms predicted greater emotional eating at 14 years and increased cardiometabolic risk at 15 years, measured using waist circumference, triglycerides, high-density lipoprotein (HDL), and glucose (Doom et al., 2024).

In summary, the relationship between ACEs and CVH indicators has been studied but focus primarily on the negative impact of ACEs on health outcomes. Further, studies have often taken a longitudinal approach, with CVH indicators measured in adulthood (Kovacs et al., 2023; Matthews et al., 2016; Nikulina & Widom, 2014; White et al., 2016). To date, no studies have evaluated the relationship between ACEs and CVH indicators as identified by Life's essential 8™ criteria in children and adolescents and no study has simultaneously examined the potential mitigating role of PCEs on health-related outcomes (e.g., CVH indicators).

Simultaneous Examination of ACEs and PCEs

The examination of PCEs is somewhat challenging in that they have been evaluated using various terms, such as flourishing, positive influences, resilience-building experiences, and positive social support (Hinojosa & Hinojosa, 2024). Flourishing is considered is considered a social construct characterized by engagement, positive relationships, competence, positive emotion, and self-worth, and is shown to be a positive building block of overall wellbeing (Agenor et al, 2017). Flourishing can occur without necessarily facing adversity, such as resilience. Resilience demonstrates the ability to adapt or do well in the face of adversity. As noted earlier, the examination of ACEs is also challenging in that they have typically been assessed only using the number of events, rather than the degree of adversity, and the list of what is considered an ACE continues to evolve. Further, ACEs have been typically understood as consequential, impacting poor health outcomes later in life, while PCEs are understood as protective (Huang et al., 2023).

Existing studies that include the exploration of co-occurring PCEs and ACEs are limited in scope and retrospective, primarily focusing on adult outcomes, as opposed to being more comprehensive and prospective, primarily focusing on children. For example, one study (Bethell

et al., 2019) aimed to understand how PCEs co-occur with and/or modulate the effects of ACEs on adult mental and relational health. The findings were significant in that they reported that adults with ≥6-7 PCEs had 72% lower odds of depression or poor mental health, and this association remained substantial even for adults reporting ACEs. This demonstration of PCEs dose-response association with depression and poor mental health was independent of ACE exposure.

Some studies involving children have evaluated how PCEs and ACEs influence each other using childhood flourishing, a HOPE framework metric, as the outcome measure (Bethell et al., 2019; Crouch et al., 2023). In one study (Bethell et al., 2019), the prevalence of flourishing increased in a graded fashion with increasing levels PCEs (for example, family resilience and connection). In another study (Yamaoka & Bard, 2019) examining the effects of positive parenting practices, a different HOPE framework metric, and ACEs on children's (ages 0-5 years) social-emotional skills and development, positive parenting practices also appeared to provide protective effects independent of the number of ACEs. Conversely, there was one study that reported that more ACEs resulted in lower odds of one PCE and that children with more ACEs had lower odds of participating in after-school activities, another HOPE framework metric, than children with less than four ACEs when adjusting for covariates (Crouch et al., 2021).

In a recent study, Ortiz and colleagues (2024) evaluated CVH across the lifespan and included a subset of HOPE framework metrics (i.e., family environment, caregiver warmth, family and household challenges) and childhood abuse. Risky family environment was assessed using a questionnaire about experiences in childhood, including ACEs and a subset of PCEs, such as adult affection and support. (Ortiz et al., 2024). They concluded that childhood exposures

and economic opportunity may play a crucial role in CVH across the life course. More specifically, for greater risky family environment, the odds of attaining high CVH decreased by 3.6%. Each unit greater child abuse and caregiver warmth score corresponded to 12.8% lower and 11.7% higher odds of ideal CVH, respectively across all 20 years of follow-up.

Two earlier studies (Crouch et al., 2022; Heerman et al., 2022) examined the association weight status (using BMI) and PCEs in children in the context of ACEs. Their findings suggest that PCEs potentially mitigate the risk of overweight and obesity status in children who experience ACEs. More specifically, among children exposed to ≥2 ACEs, those who experienced neighborhood support had a lower likelihood of being overweight or obese compared to children who did not experience any neighborhood support. The same study reported no significant association between PCEs and overweight or obesity among children who had experienced 0-1 ACE (Crouch et al., 2022). In another study with children exposed to ACEs, higher family resilience scores were associated with lower odds of being in a higher weight category, although family resilience did not have the same effect on the odds of childhood overweight and obesity among children who were not exposed to ACEs (Heerman et al., 2022). This latter study established a consistent trend towards a dose-response where children with more ACES tend to have higher odds of overweight and obesity, and among children with ACEs, higher family resilience weakens the of the odds ratios between ACEs and overweight/obesity. This study also evaluated the extent to which the relationships between ACEs, family resilience, and overweight/obesity vary by race/ethnicity, reporting that children who were Hispanic or NH Black experienced higher total ACEs and a higher proportion of being overweight/obese. However, the model failed to detect racial/ethnic differences in the way family resilience decreased the odds of a higher weight category at any level of ACEs.

One recent study is most closely aligned with the proposed study, completed by the same team that previously used CFA to create a four-construct model based on PCEs identified by the HOPE framework, and evaluate the relationship between PCEs and CVH in children (Guo et al., 2024). In this longitudinal study completed in Australia, ACEs and PCEs were assessed each year in children ages 0-11. CVH as defined by Life's Essential 8™ was measured at age 11-12; separate generalized linear models were used to estimate the effects of ACEs and PCEs. The presence of ACES and PCEs (indicated be ≥2 ACEs) were reported as dichotomous responses each year in order to capture the cumulative nature of these variables. A comprehensive approach was taken and considered 17 PCEs within the previously studied four construct model(Guo et al., 2022), and 9 types of ACES. In these findings, children exposed to multiple PCEs were more likely to have high CVH than those not exposed (RR=1.20, 95% CI 1.04-1.38). When examining the effects of multiple ACEs on high CVH stratified by whether the child was exposed to multiple PCEs or not, the magnitude of detrimental effects was somewhat smaller among children exposed to more PCEs. This may suggest that exposure to multiple PCEs could buffer the effects of ACEs on high CVH (Guo et al., 2024).

While existing literature supports PCEs are positively associated with CVH in children, only two studies have taken a comprehensive approach, one of which was adult recall (Slopen et al., 2017), and a second focusing on children in a longitudinal study (Guo et al., 2024). In childhood research, only one study has taken a comprehensive look at PCEs while simultaneously examining more than one CVH indicator (Guo et al., 2024). There is a clear need for a comprehensive approach to assess PCEs across all four categories of the HOPE framework, while evaluating their relationship with multiple CVH indicators, that focuses specifically on childhood rather than adult outcomes.

In summary, in the literature that evaluates PCEs and CVH indicators in the context of ACEs, PCEs and ACEs appear to interact. The literature also suggests that PCEs may play a protective role in CVH in children exposed to ACEs; however, the literature is limited in that it has not taken a comprehensive approach to measuring PCEs and CVH indicators when accounting for ACEs, often including specific PCEs of interest or overweight/obesity as the only CVH indicator outcome. In research specifically focused on children, CVH indicators only include overweight/obesity. What is needed is to incorporate a broad set of metrics that reflect the complexities surrounding PCEs, CVH indicators, and ACEs.

Current Gaps in Literature

This study addresses the gaps in literature identified in this focused review of the literature. The current study incorporates a broad set of metrics that reflect the complexities surrounding PCEs, CVH indicators, and ACEs, while considering demographic variables. By providing a contemporary and comprehensive look at CVH indicators for children and incorporating a comprehensive assessment of PCEs levels in the presence of ACEs, this study addresses key gaps in knowledge that have the potential to inform both targeted and tailored interventions.

Existing literature on ACEs rarely incorporates PCEs and has primarily focused on the negative impacts of ACEs on health. Literature that does include PCEs and ACEs demonstrates by in large that PCEs can have a protective effect on children when exposed to ACEs, with only one study reporting that ACEs predict less after-school participation. Literature that evaluates PCEs and CVH indicators in the context of ACEs demonstrates that PCEs and ACEs may influence each other when measuring CVH indicators, and PCEs may play a protective role for CVH in children exposed to ACEs. Further, there is only one study to our knowledge evaluating

the relationship between ACEs and CVH indicators as identified by Life's essential 8™ criteria in children and adolescents and simultaneously examined the potential mitigating role of PCEs on health-related outcomes (e.g., CVH indicators). This study aims to build on these findings by evaluating both a composite CVH score, and individual CVH scores to determine if one CVH indicator is more influenced by PCES than a combined score.

Existing literature has not taken a comprehensive approach to measuring PCEs and CVH indicators when accounting for ACEs, often including specific PCEs of interest or overweight/obesity as the only CVH indicator outcome. However, research suggests that Life's Essential 8™ is valid to assess CVH, highlighting its potential utility as a tool for preventing childhood cardiometabolic disorders and promoting CVH (Shu et al., 2023). The one study that has taken a comprehensive approach will be built upon by including a sample of U.S. Children, expanding on both ACE types included, and PCEs included (Guo et al., 2024). Further prospective studies nationally and internationally to build of previous findings. By focusing on these CVH indicators, this study aims to provide a more up-to-date and comprehensive understanding of CVH in children in more recent years; more specifically, this study will explore a broad cross-section of CVH indicators, including the Life's Essential 8™ guidelines. Trend data involving CVH scores are relatively outdated in that they are lacking the important addition of sleep duration. Further, the data does not reflect the historical impact of the COVID-19 pandemic. The current study is novel in its inclusion of both traditional measures (i.e., BMI physical activity, nicotine exposure) as well as a newer indicator (i.e., sleep). By focusing on multiple CVH indicators before and during the COVID pandemic, this study aims to provide a more up-to-date and comprehensive understanding of CVH in children.

Previous literature has established demographic differences in CVH indicators, with less available evidence on demographic differences in PCEs, particularly regarding race/ethnicity, and age group. To our knowledge, the difference in PCE exposures by race/ethnicity was reported by only one study (Crouch et al., 2021), reporting that all racial/ethnic minority groups of children had a lower likelihood of mentorship, living in a safe neighborhood, or living in a supportive neighborhood, than NH White children (Crouch et al., 2021). One study narrowly included differences in PCEs by age group in childhood, suggesting that school-age children have a greater likelihood of participation in after-school activities than adolescents (Crouch et al., 2021). Additional gaps being addressed in the current study include the lack of studies that assess childhood data, rather than rely on adult recall, and addresses the need for a comprehensive examination of PCEs by incorporating multiple categories from the HOPE framework.

This study uses the HOPE framework (Sege & Harper Browne, 2017) to both ground and scaffold data collection surrounding PCEs, and is a strength-based framework that emphasizes the importance of actively promoting PCEs that contribute to healthy development and wellbeing (Sege & Harper Browne, 2017). The HOPE framework's focus on positive experiences also provides a novel, prospective lens that begins with childhood. It is important to clarify the main risk factors, know when and how to assess these factors and discern how to manage them in children and adolescents (Lurbe & Ingelfinger, 2021). Although it is rare to suffer the adverse cardiovascular events in childhood that are experienced by adults, cardiovascular risk may already be present and related to the development of future adult CVD. Previous research reported that more than half the children had low or moderate CVH, highlighting the needs for early intervention to reduce subsequent CVD and related social costs (Guo et al., 2024). CVH

indicators are typically prioritized and discussed during well-child visits, based on Bright Futures guidelines (Hagan et al., 2017), and is one way this cardiovascular risk can be assessed throughout childhood by clinicians.

Current research and practice is also shifting toward ensuring children have safe, stable, and nurturing relationships (Garner & Yogman, 2021) rather than focusing only on adversity. There are several public health programs that aim to prevent and intervene in ACEs, and continued efforts are needed to implement these evidence-based strategies across family, school, and community levels to improve children's CVH from a life course perspective (Guo et al., 2024). Pediatric providers can incorporate this knowledge into practice and influence policy changes and pediatric guidelines to include PCEs into well-child visits throughout childhood.

Chapter 3: RESEARCH DESIGN & METHODS

Research Design

This study was a secondary analysis of the National Survey of Children's Health (NSCH) data. The NSCH collects data annually from U.S. children ages 0-17, utilizing a cross-sectional design (Child and Adolescent Health Measurement Initiative, 2023). The main goal of the analyses was to explore relationships between Positive Childhood Experiences (PCEs) and a subset of Cardiovascular Health (CVH) indicators (physical activity, sleep, secondhand smoke exposure, and body mass index [BMI]) among U.S. children 6-17 years. The Healthy Outcomes from Positive Experiences (HOPE) framework (Sege & Harper Browne, 2017) was used to categorize and operationalize the proposed PCEs.

Data Sources

The NSCH is a nationally representative dataset of children and adolescents ages 0-17 from all U.S. states and the District of Columbia (Child and Adolescent Health Measurement Initiative, 2023). This survey reflects multiple, intersecting aspects of children's lives, including their physical and mental health, access to quality health care, and the child's family, neighborhood, school, and social context. The NSCH is publicly available on the U.S. Census Bureau's NSCH page, with annual datasets available from 2016 onwards. Data from 2016 onward is comparable as the surveys were conducted with the same design and administration; some instruments were introduced or changed each year. The sample is weighted to be representative of the U.S. population of non-institutionalized children 0-17 years. The NSCH is funded and directed by the Health Resources and Services Administration (HRSA) Maternal and Child Health Bureau (MCHB). Data were collected as a mail and web-based survey by the U.S. Census Bureau (Child and Adolescent Health Measurement Initiative, 2024).

Study Sample

The NSCH uses an address-based sampling frame from an extract of the U.S. Census Bureau's Master Address File. The file is then stratified to include households with children, and children of different age ranges (i.e. young child, school-age child, adolescent). In each household, one child was randomly selected to be the subject of the survey completed by one caregiver. The survey oversampled children with special health care needs, and young children (0-5 years) (U.S. Census Bureau, 2018, 2019, 2020, 2021, 2022). The sampling technique was consistently used for the years 2018-2022.

We used a combined dataset of NSCH 2021-2022 for specific aims one and two, and a combined dataset spanning five consecutive years, from 2018-2022 to examine variables of interest and recent trends within the NSCH data. We have selected the five years (2018-2022) to address the specific aims to effectively evaluate trends in the selected variables in recent years. Additionally, this timeframe includes the historical event of the COVID-19 pandemic. The years include pre- COVID (2018-2019), COVID (2020-2021), and early post-pandemic (2022) periods. To date, only one study has examined PCEs throughout the pre-pandemic period and COVID pandemic period (through 2021); that study found that four of seven measured PCEs declined between the two time periods (after-school activities, community volunteerism, having a guiding mentor, and family resilience) (Crouch et al., 2024). We intend to extend this evaluation to evaluate the PCEs and CVH indicators during the early post- pandemic period of 2022.

During the five-year data collection period (2018-2022) between 29,433 and 54,103 surveys were completed annually, with weighted response rates ranging from 39.1 and 43.1% (Child and Adolescent Health Measurement Initiative, 2023). There was no strong or consistent

evidence of nonresponse bias after survey weights were applied (U.S. Census Bureau 2019, 2020, 2021, 2022, 2023).

In this study, participants were included if the child selected in the household was between the ages of 6-17 years of age; this age group was selected to address our specific aims, since many of our key indicators were not collected for the early childhood age group (0-5), including two of the four CVH indicators (physical activity and BMI), and four of the 16 included PCEs for the current study [(1) presence of an adult mentor, (2) school engagement, (3) participation in organized activities, and (4) participation in community service or volunteer work]. Respondents with missing data in the variables of interest were not included in analyses.

Sample Size

There were 138,384 respondents between the ages of 6-17 the years 2018-2022 (**Supplemental Material**). Children were excluded based on missing data on key indicators including PCEs, demographics, ACEs, and included CVH indicators. For Specific Aims 1 and 2, after data cleaning and eligibility criteria applied, 55,233 (~86%) of 64,535 respondents (2021-2022) were included for analyses. Years 2018-2022 were included for Specific Aim 3, including the 138,384 total respondents. After data cleaning and eligibility criteria were applied, there is a total eligible sample of 123,948 (~90%) for years 2018-2022.

Missing cases of all variables included in this analysis (other than BMI, collected for ages 6-17 only in NSCH 2021-2022) was less than 4%. We were thus adequately powered to address all our aims (Refer to **Power Analysis** section below).

Power Analysis

Power analysis was conducted using G*Power (version 3.1; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to inform the model for logistic and multinomial logistic

regression analyses. With an estimated final analytic sample size of 138,384, and significance level of 0.05, we determined that the analysis would have sufficient power to detect small effect sizes (Cohen, 1988). Given the number of variables included in analysis and the large sample size, our analyses allowed us to detect even small but potentially importation associations in our model. Observed effect sizes in our models ranged from small (RR=1.05) to large (RR >2.0) in magnitude (Chen et al., 2010).

Measures

Outcome Variable: Cardiovascular Health Indicators

The primary outcome variables for this study are CVH indicators, which include three behavioral indicators (physical activity, sleep duration, secondhand smoke exposure) and one physiological indicator (BMI). The original plan was to employ the scoring from the most recently published AHA Life's Essential 8^{TM} guidelines, assigning points to each indicator on a scale from 0-100 (where a higher score indicates better CVH) (Lloyd-Jones et al., 2022). However, the possible response options for the CVH indicators did not fit the range of score criteria. For example, BMI was unable to capture children with <5th percentile of weight, or children with morbid obesity, limiting the range of possible scores to assign. A similar case was true for sleep duration, physical activity, and secondhand smoke exposure. Therefore, CVH indicators were re-labeled (Table 3.1). The CVH indicator data are available for children 6-17 years of age except for BMI which were only collected for children 6-17 years in NSCH 2021-2022, with data for children 10-17 only available in NSCH 2018-2020.

With the categorical responses available, physical activity, sleep, and BMI were placed into three categories (Table 3.1), while secondhand smoke exposure was a binary response (yes/no).

Table 3.1

NSCH CVH Indicators

CVH Indicators	NSCH Variable	Life's Essential 8™ Scoring Guideline (Lloyd-Jones et al., 2022)
Physical Activity	▪ Physical activity (play a sport, or participate in physical activity for at least 60 minutes)	• Sufficient: Meets physical activity guidelines 7 days a week • Insufficient: Meets guidelines 1-6 days • Physically inactive: Meets guidelines 0 days
Sleep duration	▪ Hours of sleep during an average day (count both nighttime sleep and naps)	Average hours of sleep per night ▪ Age-appropriate optimal range ▪ Suboptimal: <1 h above optimal or <1 h below optimal range ▪ Very suboptimal: 2->3 h below optimal range
Secondhand Smoke Exposure	▪ Household member tobacco/nicotine use ▪ Tobacco/nicotine exposure inside home	Child exposed to secondhand smoke in the home: • Yes • No
BMI	▪ BMI	BMI percentile for age and sex ▪ Normal/ Underweight: <85th percentile ▪ Overweight: 85th-<95th percentile ▪ Obese: > 95th percentile

Predictor Variables

Positive Childhood Experiences (PCEs)

The predictor variables in this study are PCEs. The HOPE framework recognizes four categories of PCEs: (1) stable and supportive relationships; (2) safe, equitable environments in which to live, earn, and play; (3) civic and social engagement that promotes children's sense that they matter to others; and (4) opportunities for social and emotional development (Sege & Harper Browne, 2017). Variables from the NSCH dataset have been selected to represent PCEs within each category of this framework. PCEs were coded as suggested by the NSCH Codebook,

and each PCE was dichotomized. Among the 15 PCEs, 5 are already recorded as a binary response, 5 have Likert-type responses, and 6 have composite scores created from a series of yes-no or Likert-type responses. For PCEs with either a Likert-type response or composite score, the frequency distribution of responses or composite score was reviewed; binary variables were created based on the distribution of these scores.

Table 3.2

NSCH PCEs Available as Structured by the HOPE Framework

Category of HOPE Framework	HOPE Framework Metric	NSCH Indicator	Response Option
Being in nurturing, supportive relationships *It is an essential part of development to have caregivers who interact in a warm, affectionate, responsive and nurturing manner to a child. This helps create a secure attachment, and bugger stressors and support positive traits later in life.*	Secure attachments	**Family shares ideas** ▪ How well can you and this child share ideas or talk about things that really matter?	**Likert scale** very well somewhat well not very well not very well at all
	Secure attachments	**Family resilience** When your family faces problems, how often are you likely to do each of the following? ▪ Talk together about what to do ▪ Work together to solve our problems ▪ Know we have strengths to draw on ▪ Stay hopeful even in difficult times	**Likert scale** none of the time some of the time most of the time all of the time **Composite score of four items** (All or most of the time to 0-1 items; All or most of the time to 2-3 items; All or most of the time to all 4 items)
	Warm, responsive, sustained relationships	**Making and keeping friends** ▪ Compared to other children their age, how much difficulty does this child have making or keeping friends?	**Likert-Type scale** no difficulty a little difficulty a lot of difficulty
	A physically and mentally healthy parents	**Mental health status of caregiver** ▪ In general, how is your/this caregiver's mental or emotional health? **Physical health status of caregiver** ▪ In general, how is your/this caregiver's physical health?	**Likert-Type scale** excellent/very good goo good fair or poor

	Trusting relationships with peers and other adults	**Adult mentor** ▪ Other than you or other adults in your home, is there at least one other adult in this child's school, neighborhood, or community who knows this child well and who they can rely on for advice or guidance?	**Yes-No**
Living, developing, playing, and learning in safe, stable, protective, and equitable environments. *Safe, stable, protective, and equitable environments are beneficial for a child's health and development. These environments also promote the health and wellbeing of the family, and healthy habits included in this domain.*	A safe and stable neighborhood environment In your neighborhood, is/are there:	**Neighborhood amenities** ▪ Sidewalks or walking paths? ▪ A park or playground? ▪ A recreation center, community center, or boys' and girls' club? ▪ A library or bookmobile? ▪ Vandalism such as broken windows or graffiti? **Presence of detracting neighborhood elements** **Safe neighborhood** • The child is safe in our neighborhood	**Yes-No** (Neighborhood does not contain any amenities; Neighborhood contains 1 amenity; Neighborhood contains 2 amenities; Neighborhood contains 3 amenities; Neighborhood contains all 4 amenities) (Neighborhood does not have any detracting elements; Neighborhood has 1 detracting element; Neighborhood has 2 detracting elements; Neighborhood has all 3 detracting elements)
	A safe and stable neighborhood environment To what extent do you agree with these statements about your neighborhood or community?	**Supportive neighborhood** ▪ People in this neighborhood help each other out ▪ We watch out for each other's children in this neighborhood ▪ This child is safe in our neighborhood ▪ This child is sage at school	**Likert-Type scale** definitely agree. somewhat agree. somewhat disagree definitely disagree **(**Children are considered to live in supportive neighborhoods if their parents reported

		▪ When we encounter difficulties, we know where to go for help in our community	"definitely agree" to at least one of the items above and "somewhat agree" or "definitely agree" to the other two items.)
		System of care ▪ Does this child receive care in a well-functioning system?	**Yes-No** Determined from analysis of 39 variables with yes, no responses
Having opportunities for constructive social engagement and to develop a sense of connectedness *Opportunities for social engagement as well as a sense of connectedness to these institutions support children's development and belonging that is essential for the child to feel confident, valued, and secure*.	Involvement in social institutions and environments	**Participation in organized activities** During the past 12 months, did this child participate in: ▪ A sports team or did they take sports lessons after school or on weekends? ▪ Any clubs or organizations after school or on weekends? ▪ Any other organized activities or lessons, such as music, dance, language, or other arts? ▪ Any type of community service or volunteer work at school, place of worship, or in the community? **Participation in community service or volunteer work**	**Yes-No** (Child participated in one or more extracurricular activities; Child did not participate in extracurricular activities)
	Success and accomplishment	***[part of]* School engagement** How often did this child do all required homework?	**Likert-Type scale** always usually sometimes never
Learning social and emotional competencies *Social and emotional skills directly impact physical growth,*	Executive Function skills Positive Character traits	***[part of]* School engagement** ▪ How often did this childcare about doing well in school? ▪ How often did this child work to finish tasks they start?	**Likert-Type scale** always usually sometimes never **School engagement**

language development, and cognitive function. These skills influence development and competencies across the lifespan	Functional, productive response to challenges	**Flourishing for children and adolescents** ▪ How often did this child show interest and curiosity in learning new things? ▪ How often did this child stay calm and in control when faced with a challenge?	**(**Always engaged in school; Usually engaged in school; Sometimes or never engaged in school) **Flourishing for children and adolescents (**Meets 0-1 flourishing items; Meets 2 flourishing items; Meets all 3 flourishing items)

Demographics and Adverse Childhood Experiences (ACEs)

Covariates in the study included the child's race/ethnicity, child's age, child's sex, caregiver's sex, family structure type, caregiver's marital status, household income level, and child's current insurance status. Household income level was evaluated using a variable that determines the federal poverty level (FPL) of the family. A family meeting the basic income to cover necessities for their household size based on government guidelines would be at 100% FPL. As a family has increasing income, the indicator increased to 200%, 300%, or ≥400% of the FPL. This percentile is categorized and predetermined in the NSCH data each year and is based on income thresholds determine by the U.S. Department of Health and Human Services (2025); the income threshold may vary each year between 2018-2022; the variable is adjusted to match %FPL rather than income range. The presence and number of ACEs were examined. In Specific Aim 2, we included demographic data (i.e., child's sex, race/ethnicity, age) and the numbers of ACEs experienced by the child to determine if demographics or ACEs influences the association between PCEs and CVH indicators.

Table 3.3

NSCH Demographic Variables

Domain	NSCH Question	Response Options
Demographics	How are you/this other caregiver related to this child?	**Multiple-Choice response** Biological or Adoptive parent Stepparent Grandparent Foster parent Other: Relative Other: Non-Relative
	What is your/this caregiver's sex?	**Binary response** Male Female
	What is your/ this caregiver's age?	**Ratio scale**
	What is your/ this caregiver's marital status?	**Multiple- choice response** Married Not married, but living with a partner Never Married Divorced Separated Widowed
	What is this child's race?	**Multiple- choice response** White Black or African American American Indian or Alaska Native Asian Indian Chinese Filipino Japanese Korean Vietnamese Other Asian Native Hawaiian Guamanian or Chamorro Samoan Other Pacific Islander
	Is this child of Hispanic, Latino, or Spanish origin?	**Multiple- choice response** No, not of Hispanic, Latino, or Spanish origin Yes, Mexican, Mexican America, Chicano Yes, Puerto Rican Yes, Cuban

		Yes, another Hispanic, Latino, or Spanish origin
	Household Income Level (% Federal Poverty Level- FPL)	**Multiple-choice response** 100% FPL 200% FPL 300% FPL ≥400% FPL
	Current Insurance Status	**Yes-No** (Insurance through a current or former employer or union; purchased directly from an insurance company; Medicaid, Medical Assistance, or any kind of government assistance plan for those with low incomes or a disability; TRICARE or other military health care; Indian Health Service; Other)
ACEs	SINCE THIS CHILD WAS BORN, ▪ How often has it been very hard to cover basics, like food or housing, on your family's income? ▪ Parent or guardian divorced or separated ▪ Parent or guardian died ▪ Parent or guardian served time in jail or prison ▪ Saw or heard parent or adults slap, hit, kick, punch one another in the home ▪ Was a victim of violence or witnessed violence in their neighborhood? ▪ Lived with anyone who was mentally ill, suicidal, or severely depressed ▪ Lived with anyone who had a problem with alcohol or drugs ▪ Treated or judged unfairly because of their race or ethnic group ▪ Treated or judged unfairly because of their sexual orientation or gender identity*	**Yes-No** (No ACEs, 1 ACE, ≥2 ACEs)

	▪ Treated or judged unfairly because of a health condition or disability**

**Added in 2020 ** Added in 2021*

While nine ACEs questions remain the same, two new questions were introduced: first, in 2020, the 10th ACE "Was this child treated or judged unfairly because of sexual orientation or gender identity?" was introduced, and second, in 2021, the 11th ACE "Was this child treated or judged unfairly because of health condition or disability?" These new questions reflect important updates to include ACEs to include identity-based forms of early life adversity that were previously lacking. Accordingly, for all trend data analyses, we to only included the original nine ACE items that have been included across all five years. ACEs was created as both a categorical variable (No ACEs, 1 ACE, ≥2 ACEs) and count variable. Literature shows that there is a cumulative dose-effect of ACEs, where anything more than one ACE has a negative impact on health; while a score of ≥4 ACEs has also been associated with negative medical and social outcomes, a child with 2 ACEs may be a greater risk for negative outcomes or be more symptomatic than someone with ≥4 ACEs (Briggs et al., 2021). Based on this literature and the distribution of ACEs in the available dataset (<4% with ≥4 ACEs), a threshold of ≥2 ACEs was also placed for the distribution of ACEs in the sample.

We used the currently available data (2021-2022) for addressing Specific Aims 1 and 2 (*N*=55,233) and the five-year (2018-2022) data for addressing exploratory Specific Aim 3 (*N*=123,948) due to the differences in variable availability by year. BMI data was also updated to include children 6-9 years in NSCH 2021-2022 (previously on children 10-17 years), allowing for a larger scope of this physiological CVH indicator for Specific Aims 1 and 2.

Specific Aim 1: *Examine the association between PCEs and CVH indicators.*

Analysis Plan

We examined the association of 15 PCEs and individual CVH indicators (physical activity, sleep duration, secondhand smoke exposure, and BMI) (Table 3.1) using principal component analysis (PCA) and multivariable regression models from the NSCH 2021-2022. We hypothesized that there would be a positive association between each of the PCEs and CVH indicators, where higher number of PCEs is associated with a more favorable CVH.

PCE indicators include: (1) family shares ideas, (2) family resilience, (3) making and keeping friends, (4) adult mentor, (5) mental health status of caregiver, (6) physical health status of caregiver, (7) neighborhood amenities, (8) presence of detracting neighborhood elements, (9) supportive neighborhood, (10) system of care, (11) safe neighborhood, (12) participation in organized activities, (13) participation in community service or volunteer work, (14) school engagement, and (15) flourishing for children and adolescents. A total of 15 PCE indicators were thus included in this analysis.

Each PCE indicator was analyzed and scored using STATA version 17.0 (StataCorp, 2023), and dichotomized (See **Predictor Variables** section). First, descriptive statistics and correlation matrix of the observed variables were reviewed to understand the relationship of these PCE variables. We evaluated for collinearity (>0.8) among ordinal/continuous variables and determined that no variables were strongly correlated. Thus, all variables were kept for further analysis. The next step was to conduct a PCA to determine how related each PCE indicator was and determine any underlying factors. All PCEs were coded into binary variables, tetrachoric correlations were evaluated to measure the correlation between dichotomous variables and were also used to perform PCA on these variables. Eigenvalues greater than one were used to determine the number of factors or underlying variables that were inferred from the PCEs included to retain (StataCorp, 2025); sampling adequacy using Kaiser-Meyer-Olkin value was

also used to determine the best model fit. Factor loading, communality, and rotation were considered to determine which variables loaded highly on each factor. Factors were then named based on which variables load highly on them. The model loadings were rotated using Varimax rotation to enhance interpretability, allowing for a clearer delineation of component themes.

Information gathered from PCA was then used to explore the association between PCEs and CVH indicators. Using logistic and multinomial regression, the number or simple count of PCEs was used, as well as PCEs representing each identified component.

Specific Aim 2: *Identify whether the association between PCEs and CVH indicators differs by the number of ACEs and/or child's demographics (i.e., age group, sex, race/ethnicity).*

Analysis Plan

Child demographics (age group [6-9 yr, 10-14 yr, and 15-17 yr], sex [biologically male or female], race/ethnicity (Table 3.3) and the number of ACEs collected from NSCH 2021-2022 were included in this analysis to determine if the association between PCEs and CVH indicators were moderated by any of these variables. This analysis was conducted using logistic and multinomial regression models, with interaction terms included. We examined margins plots of significant interactions to enhance interpretability. We expected that that association between PCEs and CVH indicator would significantly differ by the total number of ACEs children were exposed to (where more ACEs weakens the relationship between PCEs and CVH indicators), the child's age (adolescents would have a weakened relationship with PCEs and CVH indicators than school-age children), and race/ethnicity (children from racial/ethnic minority groups would have lower CVH scores compared to Non-Hispanic (NH) White children). Due to the mixed

findings in the literature regarding the impact of a child's sex, we did not expect a significant difference in CVH score between males and females.

Specific Aim 3 (Exploratory): Examine the changes in PCEs and CVH indicators over a 5-year period (2018-2022) presenting different trajectories.

Analysis Plan

The trends in PCEs and CVH indicators from 2018 to 2022 were evaluated using logistic and multinomial regression models on cross-sectional data collected annually. For the five-year period, BMI was only evaluated for ages 10-17 due to data compatibility issues between 2018-2020 and 2021-22 – that is, BMI data for children aged six to nine years of age was only available starting in 2021. Five-year data were combined according to NSCH guidelines, and an average survey weight across the five years was applied. We created two eligible samples for the trend analysis; one that included all CVH indicator data for children ages 6-17 years (*N*=123,948) and one that contained BMI category data for children ages 10-17 years (*n*=86,056). Similarly, nine ACEs were available from 2018 to 2022 and were used for this trend analysis (See Table 3.3 for specific ACEs). Weighted prevalence estimates were produced for each year to evaluate differences in variables by year. For trend analyses, we ran logistic and multinomial regression models with survey year treated as a continuous variable to test for linear trends to assess whether changes over time were statistically significant after controlling for demographic variables. We adjusted trend models for child age, sex, race/ethnicity, household income level, caregiver's highest education, child's current insurance status, and family structure type to control for the possibility that changing demographic among the U.S. population might have driven any observed changes. Lastly, we evaluated potential changes in PCE and CVH indicators by comparing the pre-pandemic years (2018-2019) with the pandemic years (2020-

2021) and early post-pandemic (2022) to assess the possible influence of this historical event on these outcomes. Model-adjusted predicated probabilities were obtained and visualized for variables that demonstrated a significant linear trend. All analyses were completed using STATA version 17.0 (StataCorp, 2023). Statistical significance was determined using confidence intervals given the sample size rather than solely relying on p-value (<0.05).

Sensitivity Analysis

Sensitivity analyses were conducted to determine the robustness of findings. Because the ACEs questionnaires differ by NSCH survey year, only the original nine ACE items that were consistently included across all five years were used for the trend analysis (Aim 3). We used the currently available dataset (2021-2022) for addressing Specific Aims one and two and the five-year (2018-2022) data for addressing our exploratory Specific Aim 3. We conducted a sensitivity analysis to determine if the association between PCEs and CVH differ when all 11 ACEs, including the two newer, identity-based questions, were included and when only 9 ACEs were included.

Ethical Considerations

The NSCH data, being publicly available, are already de-identified, ensuring that no information capable of personally identifying respondents or households is released. Thus, the potential personal risks and confidentiality risks with this study are minimal. The de-identified data were saved on an encrypted server. We obtained IRB approval from OHSU prior to conducting this study.

Chapter 4: RESULTS

Sample Characteristics

The sample for Specific Aims 1 and 2 consisted of 55,233 children, with 28,709 (52.0%) male and 26,524 (48.0%) female, distributed across age groups 6–9 years (29.8%), 10–14 years (39.9%), and 15–17 years (30.3%). The racial/ethnic composition was predominantly White, non-Hispanic (NH) children (66.5%), followed by Hispanic children (13.9%), children of multi-racial/other (13.0%), and NH Black children (5.9%). Over half (62.9%) of primary caregivers held a college degree or higher, and 26.9% had attended some college or technical school. Just under half (42.3%) of households were at or above 400% of the Federal Poverty Level (FPL); the remaining 57.7% fell below this threshold, with 30.2% between 300–399%, 15.7% between 100–199%, and 11.8% below 100% of the FPL. Most primary caregivers were married (75.8%), with the others being divorced, widowed, or separated (13.9%), no married, living with a partner (4.9%), and never married (5.3%). Nearly all children were insured at the time of the survey (95.9%). A complete report of sample characteristics is reported in Table 4.1.

Regarding health behaviors, only 20.7% of children met the current physical activity (PA) guidelines; yet 68.5% achieved age-appropriate optimal sleep duration, 87.1% were not exposed to secondhand smoke and 69.9% were normal- or under-weight. Regarding the Adverse Childhood Experiences (ACEs), 56.0% had none, 21.9% had one, and 22.1% had ≥2 ACEs, with a mean ACE count of 0.93 (SD ±1.45) and a range of 0 to 11. Also of note was that the children experienced a high number of positive childhood experiences (PCEs), with a mean of 11.0 (±2.3) and a range of 0 to 15, with very few (<10%) reported fewer than eight PCEs.

The types of PCEs varied. The most endorsed experiences included living in a safe neighborhood (96.6%), having a family that shares ideas (94.9%), and a child's ability to make

and keep friends (94.3%). The least endorsed experiences were receiving care in a well-functioning system (17.7%), participation in community service or volunteer work (35.7%), and access to numerous neighborhood amenities (60.5%).

Table 4.1.

Weighted Sample Characteristics: National Survey of Children's Health, 2021-2022

	Total (*N*=55, 233)	
Characteristics	***n***	**%**
Sex		
Male	28,709	52.0%
Female	26,524	48.0%
Age		
6- 9 years	16,471	29.8%
10-14 years	22,029	39.8%
15-17 years	16,733	30.3%
Race/ethnicity		
Hispanic	7,683	13.9%
White, non-Hispanic	36,714	66.4%
Black, non-Hispanic	3,267	5.9%
Other, non-Hispanic	7,569	13.7%
Caregiver's Highest Education		
Less than high school	1,348	2.4%
High school degree or GED	7,090	12.8%
Some college or technical school	12,072	21.8%
College degree or higher	34,723	62.8%
Household Income Level		
<100% FPL	6,489	11.7%
100%–199% FPL	8,682	15.7%
200%–399% FPL	16,683	30.2%
400% FPL or greater	23,379	42.3%
Family Structure Type		
Two parents, currently married	38,690	70.0%

Two parents, not currently married	2,671	4.8%
Single parent (mother or father)	11,887	21.5%
Grandparent Household	1,470	2.7%
Other family type	515	0.93%
Caregiver's Marital Status		
Married	41,867	75.8%
Not Married, living with a partner	2,712	4.9%
Never Married	2,963	5.3%
Divorced/Separated/Widowed	7,691	13.9%
Current Insurance Status		
Insured at the time of survey	52,991	95.9%
Not insured	2,242	4.1%
Adverse Childhood Experience (ACEs)		
None	30,940	56.0%
1 ACE	12,093	21.9%
≥ 2 ACEs	12,200	22.1%
ACE Count (range: 0–11)	0.93(± 1.45)	
Physical Activity		
Sufficient	11,379	20.7%
Insufficient	38,521	69.7%
Inactive	5,333	9.7%
Secondhand Smoke Exposure		
No	48,125	87.1%
Yes	7,108	12.9%
Sleep (duration)		
Optimal	37,807	68.5%
Suboptimal	13,357	24.2%
Very Suboptimal	4069	7.4%
BMI		
Under/Normal	38,593	69.9%
Overweight	8,163	14.8%
Obese	8,477	15.4%
Positive Childhood Experiences (PCEs) (mean ± SD)		

0-3	220	0.40%
4-7	4,746	8.6%
8-11	23,577	42.7%
12-15	26,690	48.3%
PCE Count (range: 0–15)	11(±2.3)	

Note. FPL = federal poverty level; GED = general educational development

Physical Activity: Sufficient= ≥60 min exercise 7 days a week. Insufficient= meets guidelines 1-6 days a week. Inactive: meets guidelines 0 days a week.

Sleep: Optimal=meets age- appropriate sleep recommendations. Suboptimal=1-<2 hours below or ≥1 hour above optimal. Very suboptimal= 2->3 hour below optimal

BMI: Underweight/ Normal weight= <5-<85th percentile. Overweight= 5-<95th percentile. Obese= >95th percentile

Specific Aim 1*: Examine the associations between PCEs and Cardiovascular Health (CVH) indicators.*

Principal Component Analysis of Positive Childhood Experiences

Principal Component Analysis (PCA) was conducted on the 15 PCEs available in the NSCH dataset to explore their alignment with the HOPE framework (Sege & Harper Browne, 2017). While the HOPE framework identifies four key domains (Table 3.2), the PCA revealed five components, reflecting the underlying structure of PCEs in this dataset. The identified principal components were: (1) positive social and emotional engagement, (2) neighborhood characteristics, (3) overall caregiver health and family resilience, (4) community involvement and extracurricular participation, and (5) access to community and healthcare resources. The model loadings presented in Table 4.2 were rotated using Varimax rotation to enhance interpretability, allowing for a clearer delineation of component themes.

Overall, the PCA model demonstrated moderate sampling adequacy (Kaiser-Meyer-Olkin [KMO] = 0.7965), and both scree plot and eigenvalue criteria (>1) supported the retention of five components. All 15 variables were included in the final model, with each variable loading

significantly onto a single component (e.g., the lowest loading: adult mentor = 0.399; all others ≥ 0.455), except for one, family resilience, which showed low loadings across all components (maximum loading on Component 3 = 0.23). It was decided to retain family resilience due to its theoretical relevance and contribution to model adequacy, especially since alternative PCA models excluding 'family resilience' yielded nearly identical results (See **Supplemental material** for the alternative model).

For each item that loaded highly onto a principal component, a count variable was created including the variables relevant to each component. For example, the principal component 1 variable includes Family shares ideas (0-1), School Engagement (0-1), Making and keeping Friends (0-1) and Flourishing (0-1), for a possible count score of 0-4. This process was repeated for principal components 2-5, and these variables were used in regression analysis to enhance interpretability.

Table 4.2

Rotated Principal Component Findings on PCEs: National Survey of Children's Health, 2021-2022

	Total (*N*=55, 233)		
Rotated Principal Component (PC)	***n***	**%**	**Loading**
PC1. Positive Social and Emotional Engagement			
Family shares ideas	52,413	94.9%	0.47
School engagement	44,384	80.4%	0.48
Making and keeping friends	52,058	94.3%	0.46
Flourishing for children and adolescents	44,557	80.7%	0.49
PC2. Neighborhood Characteristics			
Safe neighborhood	53,345	96.6%	0.60
Low/ no neighborhood detracting elements	50,680	91.8%	0.59
Supportive neighborhood	33,651	60.9%	0.46

PC3. Overall Caregiver Health and Family Resilience			
Physically healthy caregiver	36,593	66.3%	0.66
Mentally healthy caregiver	38,323	69.4%	0.66
Family resilience	46,737	84.6%	0.24
PC4. Community Involvement/Extracurricular Participation			
Participation in organized activities	42,309	76.6%	0.58
Participation in community service or volunteer work	19,694	35.7%	0.71
PC5. Access to Community/Healthcare Resources			
Neighborhood amenities	33,423	60.5%	0.60
Well-Functioning system of care	9,772	17.7%	0.55
Adult mentor	49,963	90.5%	0.40

Association between PCEs and Secondhand Smoke Exposure

A multivariable logistic regression model indicated that several PCE components among U.S. children was associated with secondhand smoke exposure. The full model included five rotated principal components (PC1-5) derived from PCE items, along with covariates including child sex, age, race/ethnicity, ACE exposure, caregiver's highest education, caregiver marital status, household income level, current insurance status, and family structure type.

Three principal components (PC3, PC4, and PC5) were significantly associated with secondhand smoke exposure. Each one count increase in PC3, reflecting overall caregiver health and family resilience, was associated with a 21.4% decrease in the odds of secondhand smoke exposure (OR = 0.79, 95% CI [0.74, 0.83]). Similarly, each one count increase in PC4, representing community involvement and extracurricular participation, was associated with a 25.5% decrease in the odds (OR = 0.75, 95% CI [0.69, 0.80]). In contrast, each one count increase in PC5 (access to community and healthcare resources) were associated with an 8%

increase in the odds of secondhand smoke exposure (OR = 1.08, 95% CI [1.00, 1.17]) (Table 4.3A).

Table 4.3A

Association of PCEs and Secondhand Smoke Exposure: National Survey of Children's Health, 2021-2022

Variable	OR	95% CI
Secondhand Smoke Exposure *Compared to no exposure*		
PCEs		
Principal Component 1	1.0	[0.94,1.07]
Principal Component 2	0.96	[0.88,1.05]
Principal Component 3	**0.79***	[0.74,0.83]
Principal Component 4	**0.75***	[0.69,0.80]
Principal Component 5	**1.08***	[1.0,1.17]
Family Structure Type (*ref two parents married*)		
Two parents, not currently married	**1.74***	[1.19,2.55]
Single Parent	1.20	[0.92,1.57]
Grandparent	**1.57***	[1.19,2.09]
Other	1.02	[0.64,1.65]
Child Sex (*ref male*)	0.90	[0.81,1.00]
Reporting Caregiver Sex (*ref male)*	1.11	[0.98,1.26]
Child Age Group (*ref 6-9*)		
10-14 years	1.11	[0.98,1.26]
15-17 years	**1.22***	[1.06, 1.42]
Caregiver Marital Status (*ref married*)		
Not Married, living with partner	1.07	[0.74,1.56]
Never Married	0.78	[0.55,1.08]
Divorced/ Separated/ Widowed	**0.57***	[0.43,0.73]
Race / Ethnicity *(ref NH White)*		
Hispanic	**0.49***	[0.41,0.58]
NH Black	**0.64***	[0.52,0.78]
Multi-Racial/ Other NH	**0.82***	[0.70,0.95]

Household Income Level *(ref 0-99% FPL)*		
100-199%	0.86	[0.72,1.02]
200-399%	1.04	[0.88,1.24]
400% or above	**0.78***	[0.64,0.94]
Caregiver's Highest Education *(ref < high school)*		
High school or GED	1.14	[0.86,1.51]
Some college or technical school	0.94	[0.71,1.25]
College degree or higher	**0.43***	[0.32,0.58]
Not Insured *(ref insured)*	**1.32***	[1.02,1.70]
Adverse Childhood Experiences (ACEs) *(ref no ACES)*		
One ACE	**1.46***	[1.26,1.70]
≥2 ACEs	**2.74***	[2.32,3.24]

Note. OR = odds ratio

PC1= positive social and emotional engagement; PC2= neighborhood characteristics; PC3= overall caregiver health; PC4= community involvement/extracurricular participation; PC5= access to community/healthcare resources

NH = non-Hispanic; GED: general educational development; FPL = federal poverty level

Association between PCEs and Physical Activity

A multinomial logistic regression model indicated that all five PCE components were associated with physical activity among U.S. children. The full model included five rotated PC1-5 derived from PCE items, along with the same covariates aforementioned for the secondhand smoke exposure.

No PA: Each one count increase in PC1 and PC2 was associated with a 39.2% and a 25.4% decrease, respectively, in the relative risk of being physically inactive (RR = 0.61, 95% CI [0.56,0.66] for PC1; RR=0.75, 95% CI [0.67,0.83] for PC2). PC3, PC4, and PC5 also demonstrated significant inverse associations with the likelihood of being physically inactive, with the largest effect observed for PC4, which was associated with a 56.3% decrease in likelihood (RR = 0.44, 95% CI [0.39,0.49]).

Insufficient PA: Each one count increase in PC1- PC5 was associated with a reduced likelihood of insufficient PA (RR ranges from 0.78 to 0.92) (Table 4.3B).

Table 4.3B

Association of PCEs and Physical Activity: National Survey of Children's Health, 2021-2022

Variable	RR	95% CI	RR	95% CI
Physical Activity (PA) *Compared to those who meet PA guidelines*	**Insufficient PA**		**No PA**	
Positive Childhood Experiences				
Principal Component 1	**0.88***	[0.83,0.94]	**0.61***	[0.56,0.66]
Principal Component 2	**0.78***	[0.72,0.84]	**0.75***	[0.67,0.83]
Principal Component 3	**0.91***	[0.86,0.96]	**0.81***	[0.74,0.87]
Principal Component 4	**0.90***	[0.84,0.96]	**0.44***	[0.39,0.49]
Principal Component 5	**0.92***	[0.86,0.98]	**0.68***	[0.61,0.76]
Family Structure Type (*ref two parents married*)				
Two parents, not currently married	0.95	[0.65,1.38]	1.2	[0.73,2.2]
Single Parent	0.96	[0.75,1.23]	1.3	[0.89,1.80]
Grandparent	0.79	[0.59,1.04]	1.2	[0.75,1.80]
Other	0.79	[0.49,1.27]	1.2	[0.69,2.28]
Child Sex (*ref male*)	**1.6***	[1.47,1.75]	**2.5***	[2.20,2.94]
Reporting Caregiver Sex (*ref male)*	**0.82***	[0.74,0.90]	**0.66***	[0.56,0.78]
Child Age Group (*ref 6-9*)				
10-14 years	**2.05***	[1.86,2.27]	**5.04***	[4.14,6.13]
15-17 years	**2.40***	[2.12,2.72]	**11.0***	[8.99,13.5]
Caregiver Marital Status (*ref married*)				
Not Married, living with partner	1.00	[0.69,1.47]	0.61	[0.35,1.06]
Never Married	0.93	[0.68,1.27]	0.75	[0.49,1.14]
Divorced/ Separated/ Widowed	0.98	[0.74,1.28]	1.00	[0.69,1.47]
Race / Ethnicity *(ref NH White)*				
Hispanic	**1.50***	[1.31,1.72]	**1.63***	[1.33,2.00]
NH Black	**1.64***	[1.36,1.97]	**2.55***	[1.98,3.27]
Multi-Racial/ Other NH	**1.18***	[1.05,1.33]	**1.33***	[1.09,1.64]
Household Income Level *(ref 0-99% FPL)*				
100-199%	1.03	[0.87,1.22]	1.20	[0.93,1.56]
200-399%	**1.32***	[1.12,1.54]	**1.32***	[1.03,1.68]
400% or above	**1.40***	[1.19,1.64]	1.22	[0.95,1.57]

Caregiver's Highest Education *(ref < high school)*				
High school or GED	1.17	[0.89,1.55]	0.81	[0.56,1.16]
Some college or technical school	1.21	[0.93,1.58]	0.88	[0.61,1.28]
College degree or higher	**1.64***	[1.26,2.15]	1.35	[0.94,1.97]
Not Insured *(ref insured)*	0.85	[0.68,1.06]	**0.69***	[0.49,0.97]
Adverse Childhood Experiences (ACEs) *(ref no ACEs)*				
One ACE	**1.14***	[1.00,1.30]	1.16	[0.95,1.4]
≥2 ACEs	1.06	[0.92,1.23]	1.11	[0.92,1.4]

Note. RR = relative risk ratio

PC1= positive social and emotional engagement; PC2= neighborhood characteristics; PC3= overall caregiver health; PC4= community involvement/extracurricular participation; PC5= access to community/healthcare resources

Physical Activity: Meets Physical Activity guidelines= exercise 7 days a week. Insufficient= meets guidelines 1-6 days a week. Inactive: meets guidelines 0 days a week

NH = non-Hispanic; GED: general educational development; FPL = federal poverty level

Association between PCEs and Sleep

A multinomial logistic regression analysis indicated that several PCE components was associated with sleep among U.S. children, while controlling for the same covariates in the other CV health outcome models.

Very suboptimal sleep: Four principal components (PC1, PC2, PC3, and PC5) were significantly associated with very suboptimal sleep duration. For each one-count increase in PC1, the likelihood of obtaining very suboptimal sleep duration decreased by 30.4% (RR = 0.69, 95% CI [0.64,0.75]). Similarly, one-count increases in PC2, PC3, and PC5 were associated with decreases in the likelihood of obtaining very suboptimal sleep duration by 12.7%, 23.0%, and 10.2%, respectively.

Suboptimal sleep: Each one-count increase in PC3 and PC5 was associated with a 10.8% and 8.7% decrease in the likelihood of suboptimal sleep duration, respectively (See Table 4.3C).

Table 4.3C

Association of PCEs and Sleep: National Survey of Children's Health, 2021-2022

Variable	RR	95% CI	RR	95% CI
Sleep	**Suboptimal**		**Very Suboptimal**	
Compared to those with optimal sleep				
Positive Childhood Experiences				
Principal Component 1	0.99	[0.94,1.04]	**0.69***	[0.64,0.75]
Principal Component 2	1.0	[0.94,1.07]	**0.87***	[0.79,0.96]
Principal Component 3	**0.89***	[0.85,0.93]	**0.77***	[0.71,0.83]
Principal Component 4	0.94	[0.89,1.00]	0.98	[0.88,1.08]
Principal Component 5	**0.91***	[0.86,0.97]	**0.89***	[0.81,0.99]
Family Structure Type (*ref two parents married*)				
Two parents, not currently married	1.00	[0.72,1.39]	1.22	[0.72,2.07]
Single Parent	1.18	[0.96,1.47]	1.30	[0.94,1.80]
Grandparent	1.21	[0.93,1.60]	1.40	[0.92,2.13]
Other	1.43	[0.93,2.20]	1.43	[0.76,2.70]
Child Sex (*ref male*)	0.99	[0.91,1.07]	1.13	[0.97,1.30]
Reporting Caregiver Sex (*ref male)*	0.99	[0.90,1.08]	1.09	[0.92,1.28]
Child Age Group (*ref 6-9*)				
10-14 years	**1.16***	[1.05,1.28]	**1.65***	[1.37,1.98]
15-17 years	0.95	[0.85,1.06]	**1.88***	[1.54,2.30]
Caregiver Marital Status (*ref married*)				
Not Married, living with partner	1.21	[0.87,1.70]	0.99	[0.60,1.65]
Never Married	1.12	[0.87,1.44]	1.03	[0.69,1.54]
Divorced/ Separated/ Widowed	1.05	[0.85,1.31]	1.00	[0.71,1.42]
Race / Ethnicity *(ref NH White)*				
Hispanic	1.06	[0.94,1.19]	**1.28***	[1.06,1.55]
NH Black	**1.66***	[1.44,1.92]	**2.80***	[2.28,3.43]
Multi-Racial/ Other NH	**1.13***	[1.01,1.27]	**1.21***	[1.01,1.45]
Household Income Level *(ref 0-99% FPL)*				
100-199%	1.03	[0.89,1.21]	0.87	[0.70,1.08]
200-399%	0.91	[0.79,1.05]	0.86	[0.69,1.07]
400% or above	**0.77***	[0.67,0.90]	**0.74***	[0.56,0.97]
Caregiver's Highest Education *(ref < high school)*				

High school or GED	**1.29***	[1.00,1.66]	1.37	[0.94,2.02]
Some college or technical school	1.13	[0.89,1.44]	1.06	[0.72,1.56]
College degree or higher	1.01	[0.79,1.30]	0.86	[0.56,1.30]
Not Insured *(ref insured)*	1.01	[0.81,1.26]	1.16	[0.85,1.59]
Adverse Childhood Experiences (ACEs) *(ref no ACES)*				
One ACE	0.93	[0.83,1.04]	1.17	[0.97,1.42]
≥2 ACEs	0.97	[0.86,1.10]	**1.34***	[1.09,1.65]

Note. RR = relative risk ratio

PC1= positive social and emotional engagement; PC2= neighborhood characteristics; PC3= overall caregiver health; PC4= community involvement/extracurricular participation; PC5= access to community/healthcare resources

Sleep: Optimal=meets age- appropriate sleep recommendations. Suboptimal=1-<2 hours below or ≥1 hour above optimal. Very suboptimal= 2->3 hour below optimal

NH = non-Hispanic; GED: general educational development; FPL = federal poverty level

Association between PCEs and BMI

Multinomial logistic regression indicated that certain principal components of PCEs were associated with BMI.

Obese: Three principal components (PC1, PC3, and PC5) were significantly associated with the likelihood of being obese. Specifically, each one-count increase in PC1 was associated with a 10.1% decrease in the relative risk of obesity (RR = 0.89, 95% CI [0.85, 0.95]). Similarly, PC3 was associated with a 10.5% decrease (RR = 0.89, 95% CI [0.85, 0.95]), and PC5 with a 7.4% decrease (RR = 0.93, 95% CI [0.862, 0.995]).

Overweight*:* Only PC3 showed a significant association with the likelihood of being overweight. Each one-count increase in PC3 was associated with an 8.2% decrease in the relative risk of overweight (RR = 0.92, 95% CI [0.86,0.97]) (See Table 4.3D).

Table 4.3D

Association of PCEs and BMI: National Survey of Children's Health, 2021-2022

Variable	**RR**	**95% CI**	**RR**	**95% CI**
BMI		**Overweight**		**Obese**

Compared to those with normal/under- weight				
Positive Childhood Experiences				
Principal Component 1	0.94	[0.88,1.00]	**0.89***	[0.85,0.95]
Principal Component 2	1.04	[0.96,1.12]	1.00	[0.92,1.08]
Principal Component 3	**0.92***	[0.87,0.97]	**0.89***	[0.85,0.95]
Principal Component 4	0.95	[0.88,1.02]	0.93	[0.86,1.00]
Principal Component 5	0.97	[0.90,1.05]	**0.93***	[0.86,0.99]
Family Structure Type (*ref two parents married*)				
Two parents, not currently married	1.20	[0.78,1.83]	1.29	[0.89,1.87]
Single Parent	1.05	[0.79,1.40]	1.11	[0.86,1.44]
Grandparent	1.20	[0.87,1.68]	**1.55***	[1.14,2.11]
Other	0.79	[0.42,1.46]	1.29	[0.85,1.95]
Child Sex (*ref male*)	**0.86***	[0.78,0.95]	**0.71***	[0.64,0.78]
Reporting Caregiver Sex (*ref male)*	**1.25***	[1.11,1.40]	**1.18***	[1.04,1.32]
Child Age Group (*ref 6-9*)				
10-14 years	1.01	[0.89,1.14]	**0.80***	[0.71,0.90]
15-17 years	**0.72***	[0.63,0.83]	**0.58***	[0.51,0.67]
Caregiver Marital Status (*ref married*)				
Not Married, living with partner	1.13	[0.74,1.73]	1.06	[0.73,1.53]
Never Married	1.14	[0.82,1.59]	1.14	[0.85,1.53]
Divorced/ Separated/ Widowed	1.00	[0.75,1.34]	1.01	[0.78,1.31]
Race / Ethnicity *(ref NH White)*				
Hispanic	**1.38***	[1.19,1.59]	**1.63***	[1.43,1.85]
NH Black	**1.30***	[1.10,1.54]	**1.67***	[1.41,1.97]
Multi-Racial/ Other NH	0.95	[0.83,1.09]	**1.17***	[1.02,1.34]
Household Income Level *(ref 0-99% FPL)*				
100-199%	1.18	[0.98,1.43]	0.91	[0.77,1.08]
200-399%	1.11	[0.93,1.34]	0.98	[0.83,1.15]
400% or above	1.08	[0.89,1.31]	**0.73***	[0.61,0.87]
Caregiver's Highest Education *(ref < high school)*				
High school or GED	**0.73***	[0.55,0.98]	1.2	[0.92,1.59]
Some college or technical school	0.78	[0.59,1.04]	1.1	[0.81,1.40]
College degree or higher	**0.57***	[0.42,0.76]	**0.63***	[0.47,0.84]
Not Insured *(ref insured)*	0.86	[0.66,1.12]	0.90	[0.69,1.14]

Adverse Childhood Experiences (ACEs) *(ref no ACEs)*				
One ACE	1.07	[0.94,1.23]	1.1	[0.98,1.29]
≥2 ACEs	1.00	[0.87,1.17]	**1.1***	[1.00,1.35]

Note. RR = Relative risk ratio

PC1= Positive social and emotional engagement; PC2= Neighborhood characteristics; PC3= Overall caregiver health; PC4= Community involvement/extracurricular participation; PC5= Access to community/healthcare resources

BMI: Underweight/ Normal weight= <5-<85th percentile. Overweight= 5-<95th percentile. Obese= >95th percentile

NH = non-Hispanic; GED: general educational development; FPL = federal poverty level

Association between ACEs and CVH indicators

Exposure to any ACEs was significantly associated with secondhand smoke exposure. Compared to children with no ACEs, those with one ACE had 46% higher odds of secondhand smoke exposure (OR=1.46, 95% CI [1.26, 1.70], and those with ≥ 2 ACEs had 174% higher odds; (OR=2.74, 95% CI [2.32, 3.24]). For PA, children with one ACE had a 15% higher likelihood of being insufficiently physically active compared to those with no ACEs (RR=1.15, 95% CI [1.01, 1.30]); however, no significant association was observed for the physically inactive category. For sleep and BMI, only children with ≥2 ACEs demonstrated a significant difference in the outcome variable. Those with ≥ 2 ACEs had a 34% higher likelihood of obtaining very suboptimal sleep duration (RR=1.34, 95% CI [1.09,1.65]) and were more likely to be obese (RR=1.16, 95% CI [1.00,1.35]). No significant associations were found for the suboptimal sleep or overweight categories.

Association between demographic variables and CVH indicators

The following demographic variables (child sex, child age group, race/ethnicity, family structure type, reporting caregiver sex, caregiver marital status, household income level, caregiver's highest education, and current insurance status) were associated with CVH indicators.

Child sex: Child's sex was significantly associated with PA and BMI variables. Compared to males, females had a significantly higher likelihood of being physically inactive and insufficiently active. Females had a significantly lower likelihood of being overweight and obese.

Child age group: Child's age was significantly associated with secondhand smoke exposure, PA, sleep, and obesity. Compared to children aged 6-9 years, youth aged 15–17 had higher odds of secondhand smoke exposure. Children aged 10–14 and 15–17 were more likely to be physically inactive and insufficiently active. Both age groups also had a higher likelihood of experiencing very suboptimal sleep, and those aged 10–14 had a higher likelihood of experiencing suboptimal sleep. In contrast, children aged 10–14 and 15–17 had a decreased likelihood of being obese, and only those aged 15–17 had a significantly lower likelihood of being overweight compared to those aged 6-10.

Race/Ethnicity: Compared to NH White children, those identified as Hispanic, NH Black, or mixed/other racial groups had significantly lower odds of secondhand smoke exposure (ORs ranging from 0.49 to 0.83), suggesting potential disparities in exposure by race/ethnicity. NH Hispanic, NH Black, and Multi-racial/other children were had a higher likelihood of being physically inactive (RR ranging from 1.33 to 2.55) and insufficiently active (RR ranging 1.18 to 1.64). NH Black, and multi-racial/other children had a significantly higher likelihood of very suboptimal sleep and suboptimal sleep; Hispanic children had a significantly higher likelihood of very suboptimal sleep only. Hispanic, NH Black, and Multi-racial/other children were more likely to have obesity (RR ranging 1.17 to 1.67); this association persisted for the overweight category for those that identified as Hispanic (RR= 1.38) and NH Black (RR=1.30), but not the multi-racial/other group.

Family structure type*:* Compared to children living in two-parent headed households, those living with two unmarried parents or in grandparent-headed households had higher odds of secondhand smoke exposure*,* and an increased likelihood of being overweight (though this did not remain significant for obesity).

Reporting caregiver sex: Compared to children of male caregivers, children of female caregivers had a lower likelihood of being inactive and insufficiently active; yet also had an increased likelihood of being overweight and obese.

Caregiver marital status*:* Children whose caregivers were divorced/separated/widowed had lower likelihood of secondhand smoke exposure.

Household income level: Compared to the lowest income level, children from households in the highest income level (≥ 400% of FPL), had reduced likelihood of secondhand smoke exposure, suboptimal sleep, very suboptimal sleep, and obesity. Income level demonstrated an inverse association with PA; children from households 200–399% of FPL were significantly more likely to be physically inactive and insufficiently active. Similarly, children of households in the highest income level (≥ 400% of FPL) were also significantly more likely to be insufficiently active.

Caregiver's highest education: Compared to caregivers with less than a high school education*,* children of those with a high school education/ GED were significantly more likely to report suboptimal sleep. Children of caregivers with a college degree or higher were less likely to be overweight or obese; a high school education was also associated with a decreased likelihood of the child(ren) being overweight.

Current insurance status: Compared to children with health insurance at the time of survey, children without health insurance were more likely to be exposed to secondhand smoke.

It is important to note that only 4% of the sample did not have insurance at the time of the survey.

Specific Aim 2: *Identify whether the association between PCEs and CVH indicators differs by the number of ACEs and/or child's demographics (i.e., sex, age group, race/ethnicity).*

We next examined whether the associations between PCEs and CVH indicators differed by ACE exposure, child's sex, age group, or race/ethnicity. To evaluate potential moderating effects, we included interaction terms in the models between total PCE count and each of the following variables: ACE exposure, sex, age group, and race/ethnicity. Of the two approaches examined in this study, overall PCE count and individual PCE components, only the overall PCE count was presented in the main result section for Specific Aim 2. This decision was made to address the primary goal of this aim—examining whether demographic variables moderated the associations between PCEs and CVH indicators—while minimizing interpretive challenges. Focusing on the total PCE count enhanced interpretability and analytical clarity. Interactions of individual PCE components with child's demographics are included in the **Supplemental Material**.

Moderating effects of ACEs on the association between PCEs and CVH indicators

The moderating effects of ACES on the association between PCEs and CVH indicators were examined using logistic and multinomial regression using interaction terms. Each model was adjusted for covariates, including family structure type, child age, child sex, reporting caregiver sex, caregiver marital status, household income level, caregiver's highest education, child race/ethnicity, and current insurance status at time of survey completion.

Secondhand Smoke Exposure

A significant moderating effect of ACEs was observed in the association between the total number of PCEs and secondhand smoke exposure. A stronger (protective) association was observed among children with no ACEs, where the likelihood of secondhand smoke exposure decreased to a greater extent as PCEs increased, compared to those with 1 ACE, or ≥2 ACEs (1 ACE: OR=1.09, 95% CI [1.02,1.17], ≥2 ACEs: OR=1.09, 95%CI[1.02,1.15])(Table 4.4A, Figure 4.1).

Table 4.4A

Moderation effects of ACEs and Demographic Variables on the Association between PCEs and Secondhand Smoke: National Survey of Children's Health, 2021-2022

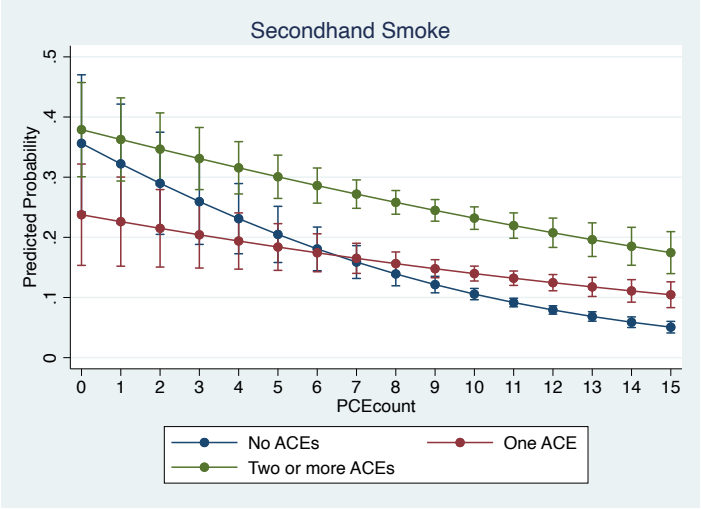
Secondhand Smoke		
Variables	**Interaction with the total number of PCEs**	
	OR	**95% CI**
Sex	1.00	[0.96,1.05]
Age (ref 6-9 years)		
10-14 years	0.99	[0.94,1.04]
15-17 years	0.96	[0.90,1.01]
Race/ Ethnicity		
Hispanic	**1.08***	[1.00,1.17]
NH Black	1.02	[0.95,1.09]
Multi-Racial/ Other NH	**1.07***	[1.01,1.13]
Adverse Childhood Experiences (ACEs) (ref no ACEs)		
1 ACE	**1.09***	[1.02,1.17]
≥2 ACEs	**1.09***	[1.02,1.15]

Note. RR = relative risk ratio; NH=Non-Hispanic

*Interaction with the total number of PCEs

Figure 4.1

Predictive Margins of ACEs on Secondhand Smoke and PCE count: National Survey of Children's Health, 2021-2022



Physical Activity

A significant moderating effect of ACEs was also observed in the association between PCEs and PA for children with ≥2 ACEs. In children with ≥2 ACEs, PCE count appears to influence the likelihood of physical inactivity (RR=1.11, 95% CI [1.04,1.20]) and insufficient activity (RR=1.05, 95% CI [1.00,1.11]) to a lesser extent than in children with no ACEs (Table 4.4B, Figure 4.2).

Table 4.4B

Moderation effects of ACEs and Demographic variables on the association between PCEs and Physical Activity: National Survey of Children's Health, 2021-2022

Physical Activity	**Interaction with the total number of PCEs**			
	Insufficient PA		**No PA**	
	RR*	**95% CI**	**RR***	**95% CI**
Sex	1.02	[0.97,1.06]	1.03	[0.97,1.09]
Age				
10-14 years	0.98	[0.93,1.02]	0.96	[0.89,1.04]
15-17 years	0.98	[0.91,1.04]	0.94	[0.86,1.02]
Race/Ethnicity				

Hispanic	**1.09***	[1.01,1.16]	1.05	[0.96,1.14]
NH Black	1.02	[0.94,1.11]	1.05	[0.95,1.16]
Multi-Racial/ Other NH	1.01	[0.96,1.07]	1.00	[0.93,1.07]
Adverse Childhood Experiences (ACEs)				
1 ACE	0.99	[0.93,1.07]	1.03	[0.94,1.13]
≥2 ACEs	**1.05***	[1.0,1.11]	**1.11***	[1.0,1.20]

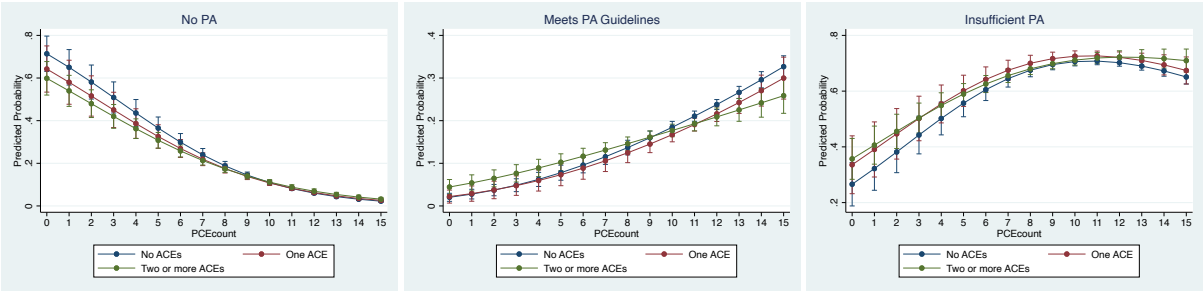
Note. RR = Relative risk ratio; NH=Non-Hispanic

Physical Activity: Meets Physical Activity guidelines= exercise 7 days a week. Insufficient= meets guidelines 1-6 days a week. Inactive: meets guidelines 0 days a week.

*Interaction with the total number of PCEs

Figure 4.2

Predictive Margins of ACEs on Physical Activity and PCE count: National Survey of Children's Health, 2021-2022



Sleep

A significant moderating effect of ACEs (≥2 ACEs) was observed in the association between PCEs and sleep duration. Specifically, among children with ≥2 ACEs, PCEs influenced the likelihood of suboptimal (RR=1.06, 95% CI [1.02,1.11]). and very suboptimal sleep (RR=1.09, 95% CI [1.01, 1.17]) to a lesser extent than in children with no ACEs. Interestingly, the slope of the association between PCE count and likelihood of suboptimal sleep demonstrated that the association became weakly positive in children exposed to ≥2 ACEs compared to children with no ACEs, while the association between PCE count and likelihood of very suboptimal sleep remained negative (Table 4.4C, Figure 4.3).

Table 4.4C

Moderating effects of ACEs and Demographic Variables on the Association between PCEs and Sleep: National Survey of Children's Health, 2021-2022

Sleep	**Interaction with total number of PCEs**			
	Suboptimal		**Very Suboptimal**	
	RR	**95% CI**	**RR**	**95% CI**
Sex	1.01	[0.98,1.05]	0.97	[0.92,1.03]
Age				
10-14 years	**1.05***	[1.01,1.10]	**1.07***	[1.00,1.15]
15-17 years	1.02	[1.02,1.12]	**1.15***	[1.07,1.24]
Race/Ethnicity				
Hispanic	1.04	[0.99,1.09]	1.01	[0.93,1.09]
NH Black	1.02	[0.96,1.07]	1.01	[0.94,1.09]
Multi-Racial/ Other NH	**1.05***	[1.00,1.10]	1.03	[0.97,1.11]
Adverse Childhood Experiences (ACEs)				
1 ACE	1.04	[0.99,1.09]	1.07	[0.99,1.16]
≥2 ACEs	**1.06***	[1.0,1.11]	**1.09***	[1.0,1.17]

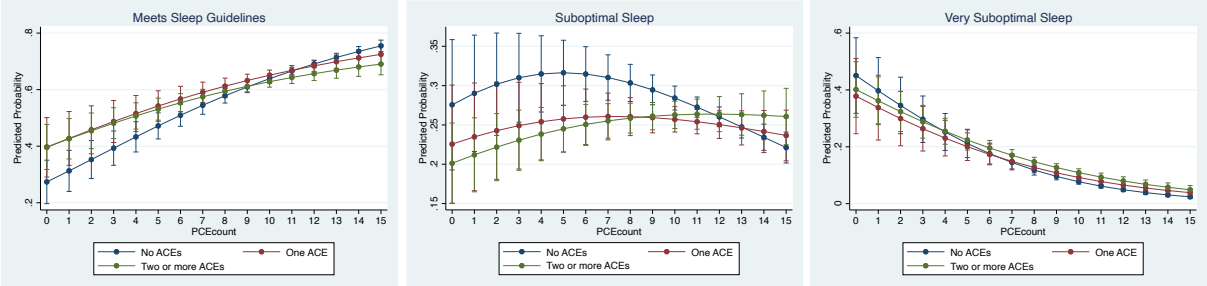
Note. RR = relative risk ratio; NH=Non-Hispanic

Sleep: Optimal=meets age- appropriate sleep recommendations. Suboptimal=1-<2 hours below or ≥1 hour above optimal. Very suboptimal= 2->3 hour below optimal

*Interaction with the total number of PCEs

Figure 4.3

Predictive Margins of ACEs on Sleep and PCE count: National Survey of Children's Health, 2021-2022



BMI

No significant moderating effects of ACEs were observed in the association between PCE count and BMI category (Table 4.4D).

Table 4.4D

Moderating Effect of ACEs and Demographic Variables on the Association between PCEs and BMI Category: National Survey of Children's Health, 2021-2022

BMI	**Interaction with the total number of PCEs**			
	Overweight		**Obese**	
Interaction	**RR**	**95% CI**	**RR**	**95% CI**
Sex	1.00	[0.96,1.05]	**0.96***	[0.92,0.99]
Age				
10-14 years	0.96	[0.91,1.01]	0.99	[0.94,1.03]
15-17 years	0.99	[0.94,1.05]	0.97	[0.92,1.02]
Race/Ethnicity				
Hispanic	0.99	[0.93,1.05]	1.03	[0.98,1.09]
NH Black	**1.06***	[1.00,1.13]	**1.10***	[1.04,1.17]
Multi-Racial/ Other NH	1.01	[0.96,1.08]	1.01	[0.96,1.06]
Adverse Childhood Experiences (ACEs)				
1 ACE	1.02	[0.97,1.09]	1.04	[0.99,1.11]
≥2 ACEs	1.01	[0.96,1.07]	1.03	[0.98,1.08]

Note. RR = Relative risk ratio; NH=Non-Hispanic

BMI: Underweight/ Normal weight= <5-<85th percentile. Overweight= 5-<95th percentile. Obese= >95th percentile

*Interaction with the total number of PCEs

Moderation of Demographic variables on PCEs and CVH indicators

Specific interaction effects between demographic variables and total PCE count are presented in Tables 4.4A–4D above.

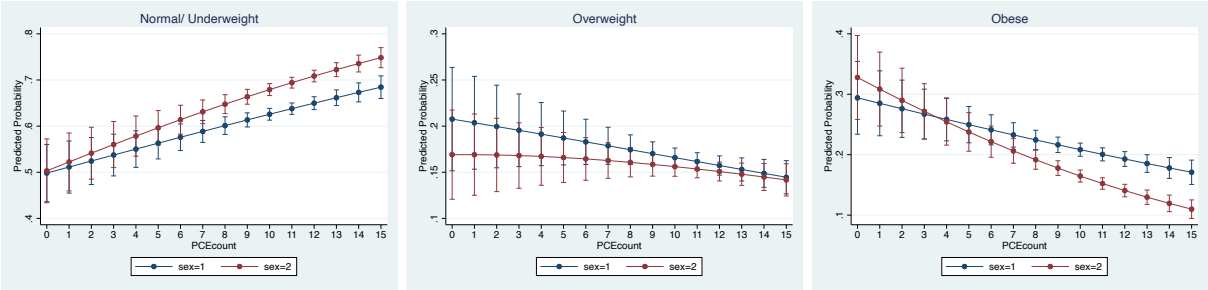
Child's Sex

Sex moderated the association between PCE count and CVH indicators only in the BMI category. The association between PCEs and the likelihood of obesity was significantly moderated by sex, with a stronger protective effect for females compared to males (RR=0.96,

95% CI [0.92,0.99]) (Figure 4.4). There was no significant moderating effect of sex on the association between PCE count and secondhand smoke, PA, or sleep duration observed.

Figure 4.4

Predictive Margins of Sex on BMI and PCE count: National Survey of Children's Health, 2021-2022

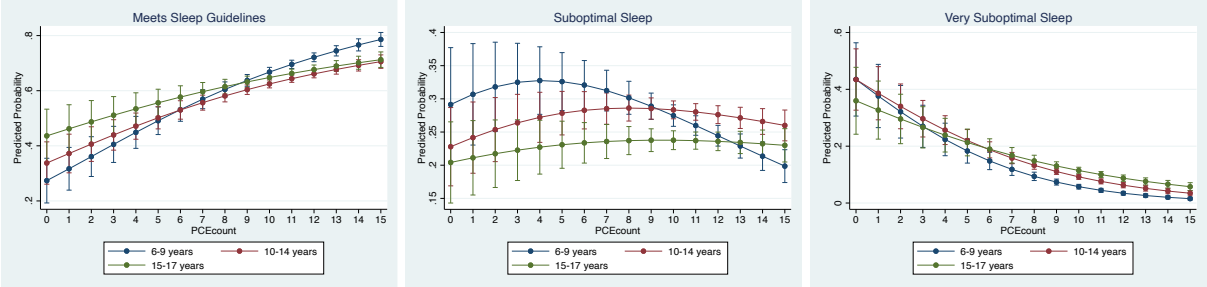


Child's Age

Age moderates the association between PCE count and CVH indicators only for sleep. The moderating effect of age on the association between a total number of PCEs and the likelihood of very suboptimal sleep was significant for children 10-14 years (RR=1.07, 95%CI [1.00,1.15]) and 15-17 age group (RR=1.15, 95%CI [1.07,1.24]), compared to children 6-9 years old. The inverse association between PCE count and likelihood of very suboptimal sleep is more gradual in children aged 10-14 years and 15-17 years than those 6-9 years old. Age also moderated the association between PCE count and likelihood of suboptimal sleep, though only for children 10-14 years. It appears the association between PCE count and likelihood of suboptimal sleep is weakly positive for all age groups, and this association is influenced to a lesser extent in children aged 10-14 years old compared to 6-9 years old (RR=1.05, 95% CI [1.01,1.10]). Age did not moderate the association between PCE count and secondhand smoke, PA, or BMI (Figure 4.5)

Figure 4.5

Predictive Margins of Age on Sleep and PCE Count: National Survey of Children's Health, 2021-2022



Race/ Ethnicity

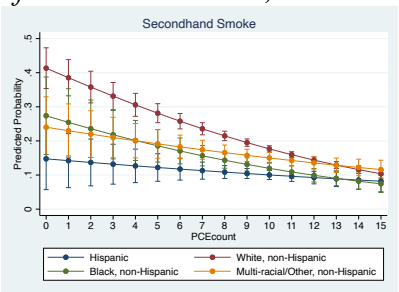
Race/ethnicity significantly moderated the association between PCEs and all four CVH indicators.

Secondhand Smoke

The moderating role of race/ethnicity on the relationship between PCEs and secondhand smoke exposure demonstrated an inverse relationship, where increasing PCEs was associated with decreasing likelihood of secondhand smoke exposure, that varied in slope by race/ethnicity. Compared to NH White children, the association between PCE count and likelihood secondhand smoke exposure is influenced to a lesser extent for children that identify as multi-racial/other (OR=1.07, 95% CI [1.01,1.13])). Hispanic children demonstrated a similar association, where the inverse association between PCE count and likelihood of secondhand smoke exposure is influenced to a lesser extent (OR=1.08, 95% CI [1.00,1.17]) (Figure 4.6).

Figure 4.6

Predictive Margins of Race/Ethnicity on Secondhand Smoke and PCE Count: National Survey of Children's Health, 2021-2022

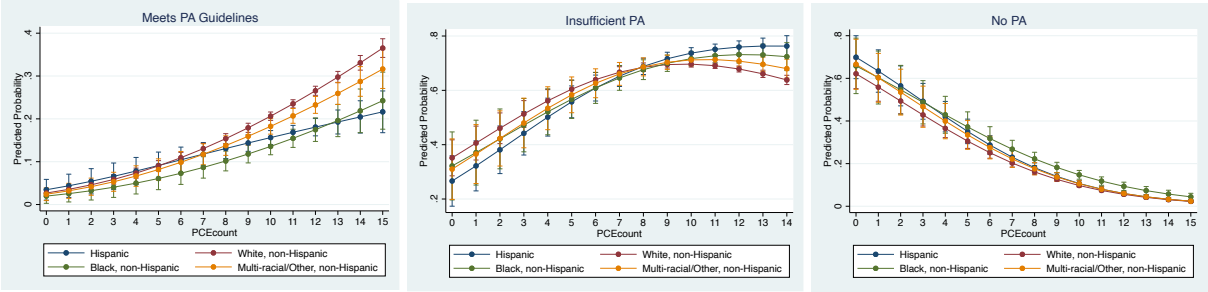


Physical Activity

Race/ethnicity moderated the association between PCE count and PA only for the insufficient PA group. Compared to NH White children, the association between PCE count and likelihood of insufficient PA was influenced to a lesser extent in children that are Hispanic (RR=1.09, 95% CI [1.01,1.16]) (Figure 4.7).

Figure 4.7

Predictive Margins of Race/Ethnicity on Physical Activity and PCE Count: National Survey of Children's Health, 2021-2022

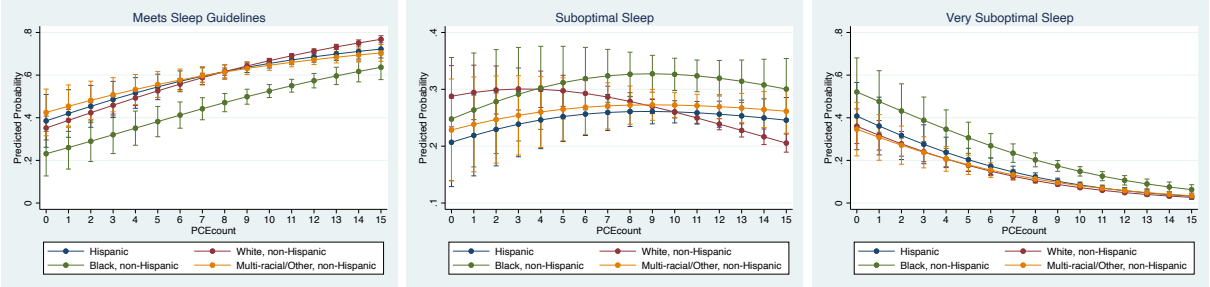


Sleep

Race/ethnicity appeared to moderate the association between PCE count and sleep only for those with suboptimal sleep. The association between PCE count and likelihood of suboptimal sleep appears demonstrate an inverse relationship in for NH white children, while this association becomes weakly positive for multiracial/ other children. Overall, the association between PCE count and likelihood of suboptimal sleep was influenced to a lesser extent in children that identified as multi-racial/other (RR=1.05, 95%CI [1.00,1.10]) (Figure 4.8), as the slope of this line is more gradual.

Figure 4.8

Predictive Margins of Race/Ethnicity on Sleep and PCE Count: National Survey of Children's Health, 2021-2022

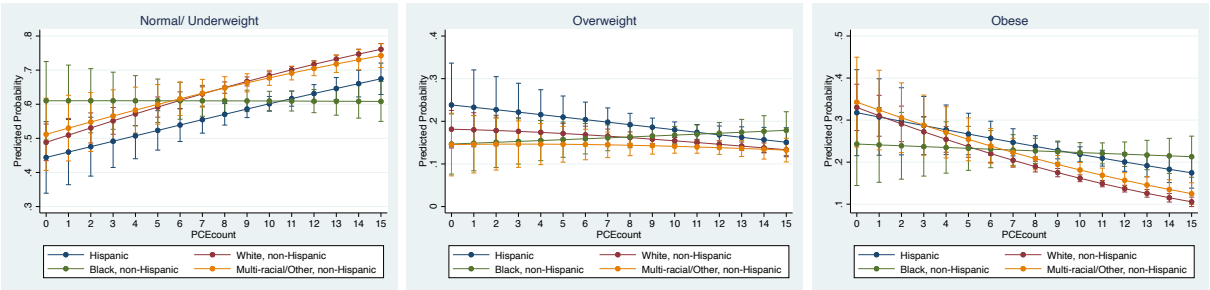


BMI

Compared to NH White children, the association between PCE count and BMI demonstrated a more gradual slope for the overweight (RR=1.06, 95% CI [1.00,1.13]) and obesity (RR=1.10, 95% CI [1.04,1.17]). In fact, the slope for these two weight categories appears to be almost zero in children that are NH black, and only sight inverse association for NH White children (Figure 4.9).

Figure 4.9

Predictive Margins of Race/Ethnicity on BMI and PCE Count: National Survey of Children's Health, 2021-2022



Specific Aim 3: *Examine the changes in PCEs and CVH indicators over a 5-year period (2018-2022) presenting different trajectories.*

In this exploratory aim, we combined NSCH data for years 2018-2022 and created a year variable to evaluate trends in PCEs (both PCE count and individual PCEs), ACEs (ACE count), and individual CVH indicators (secondhand smoke exposure, physical activity, sleep, and BMI category).

The eligible sample size from the years 2018-2022 ranged from 19,760 (2018) - 30,517 (2022), resulting in a final sample size of 123,948 (Table 4.5). Males represented a consistently larger proportion of the sample than females between 2018-2022 (52.3% in 2018 and 51.9% in 2022). School-age children represented the largest age group by year (ranging 39.4-41.4%). White, non-Hispanic children represented the largest racial/ethnic group each year, representing 65.2-70.3% of the sample. Primary caregivers had a college degree or higher for over half the sample each year (ranging 59.6-62.2%). Household income level shifted in 2022; between 2018-2021, the largest proportion of the sample was 400% or greater than the FPL (42.1%, 42.1%, 41.0%, and 40.8% respectively). In 2022, the largest portion was 200-399% the FPL at 29.4%. Caregiver marital status was consistently married (ranging 75.0%-76.2%). Children were consistently predominantly insured at the time of survey, with all values by year >95% (Table 4.5).

Table 4.5

Weighted Sample Characteristics: National Survey of Children's Health, 2018-2022

	2018 (***n***=19,760)	**2019** (***n***=19,132)	**2020** (n=27,704)	**2021** (***n***=26,835)	**2022** (***n***=30,517)	**Total** (***N***==123,948)
Characteristics	***N* (%)**	***N* (%)**	***N* (%)**	***N* (%)**	***N* (%)**	***N* (%)**
Sex						
Male	10,336 (52.3%)	9,905 (51.8%)	14,326 (51.7%)	14,005 (52.2%)	15,825 (51.9%)	64,397 (51.9%)
Female	9,424 (47.7%)	9,227 (48.2%)	13,378 (48.3%)	12,830(47.8%)	14,692 (48.1%)	59,551 (48.1%)
Age						
6- 9 years	5,385 (27.2%)	5,181 (12.4%)	7,620 (27.5%)	8,485(31.6%)	9,114 (29.9%)	35,785 (28.9%)
10-14 years	8,136 (41.2%)	7,939 (41.4%)	11,414(41.2%)	10,594 (39.4%)	12,070 (39.6%)	50,153(40.4%)
15-17 years	6,239 (31.6%)	6,012 (31.4%)	8,670(31.3%)	7,756(29.0%)	9,333 (30.5%)	38,010 (30.7%)
Race/Ethnicity						
Hispanic	2,285 (11.6%)	2,189 (11.5%)	3,627 (13.1%)	3,584(13.4%)	4,573(15.0%)	16,258 (13.1%)
White, non-Hispanic	13,885(70.2%)	13,451 (70.3%)	18,595 (67.1%)	17,843(66.5%)	19,886 (65.2%)	83,660 (67.5%)
Black, non-Hispanic	1,215(6.1%)	1,187(6.2%)	1,804 (6.5%)	1,726(6.4%)	1,841 (6.0%)	7,773 (6.3%)
Other, non-Hispanic	2,375(12.1%)	2,305 (12.0%)	3,678 (13.3%)	3,678(13.7%)	4,217 (13.8%)	16,257 (13.1%)
Caregiver's Highest Education						
Less than high school	522 (2.6%)	441 (2.3%)	738 (2.7%)	724 (2.7%)	832 (2.7%)	3,257 (2.6%)
High school degree or GED	2,661 (13.5%)	2,437 (12.7%)	3,603 (13.0%)	3,574 (13.3%)	4,004 (13.1%)	16,279 (13.1%)
Some college or technical school	4,802 (24.3%)	4,543 (23.8%)	6,469 (23.3%)	5,937 (22.1%)	6,695 (22.0%)	28,446 (23.0%)
College degree or higher	11,775 (59.6%)	11,711 (61.2%)	16,894 (61.0%)	16,600 (61.9%)	18,986 (62.2%)	75,966 (61.3%)
Household Income Level						

<100% FPL	2,229 (11.2%)	1,957 (10.2%)	3,256 (11.8%)	3,331 (12.4%)	3,748 (12.2%)	14,521 (11.7%)
100%–199% FPL	3,176 (16.1%)	3,058 (16.0%)	4,579 (16.5%)	4,305 (16.0%)	4,875 (16.1%)	19,993 (16.1%)
200%–399% FPL	6,034 (30.6%)	6,067 (31.7%)	8,512 (30.7%)	8,257 (30.8%)	8,983 (29.4%)	37,853 (30.5%)
400% FPL or greater	8,321 (42.1%)	8,050 (42.1%)	11,357 (41.0%)	10,942 (40.8%)	12,911 (12.3%)	51,581 (41.7%)
Caregiver Marital Status						
Married	15,053 (76.2%)	14,572 (76.1%)	20,810 (75.1%)	20,107 (75.0%)	23,095 (75.6%)	93,637 (75.6%)
Not Married, living with partner	857 (4.3%)	830 (4.4%)	1,398 (5.1%)	1,413 (5.3%)	1,457 (4.8%)	5,955 (4.8%)
Never Married	927 (4.7%)	955 (5.0%)	1,480 (5.3%)	1,458 (5.4%)	1,764 (5.8%)	6,584 (5.3%)
Divorced/Separated/Widowed	2,923 (14.8%)	2,775 (14.5%)	4,016 (14.5%)	3,857 (14.3%)	4,201 (13.8%)	17,772 (14.3%)
Current Insurance Status						
Insured at the time of survey	18,843 (95.5%)	18,269 (95.5%)	26,361 (95.2%)	25,647 (95.6%)	29,279 (96.0%)	118,399 (95.5%)
Not insured	917 (4.64%)	863 (4.5%)	1,343 (4.8%)	1,188 (4.4%)	1,238 (4.0%)	5,549 (4.5%)
Adverse childhood experience (ACEs)						
No ACEs	11,026 (55.8%)	10,695 (55.9%)	15,655 (56.5%)	15,332 (57.1%)	17,509 (57.4%)	70,217 (56.7%)
1 ACE	4,525 (22.9%)	4,295 (22.4%)	6,261 (22.6%)	5,893 (22.0%)	6,740 (22.1%)	27,714 (22.3%)
≥ 2 ACEs	4,209 (21.3%)	4,142 (21.7%)	5,788 (20.9%)	5,610 (20.9%)	6,268 (20.5%)	26,017 (21.0%)
ACE Count (range: 0-11)	0.897(± 1.3)	0.899(± 1.39)	0.873(± 1.36)	0.869(± 1.36)	0.861(± 1.36)	0.877(± 1.37)
Physical Activity						
Sufficient physical activity	1,745 (8.8%)	1,621 (8.5%)	3,138 (11.4%)	2,648 (9.9%)	2,974 (9.7%)	12,126 (11.8%)
Insufficient physical activity	13,718 (69.4%)	13,435 (70.2%)	18,958 (68.4%)	18,276 (68.1%)	21,587 (70.7%)	85,974 (69.4%)
Inactive	4,297 (21.8%)	4,076 (21.3%)	5,608 (20.2%)	5,911 (22.0%)	5,956 (19.6%)	23,848 (18.8%)
Secondhand Smoke Exposure						
No	16,638 (84.2%)	16,303 (85.2%)	23,799 (85.9%)	23,208 (86.5%)	26,668 (87.4%)	106,616 (86.0%)
Yes	3,122 (15.8%)	2,829 (14.8%)	3,905 (17.1%)	3,627 (13.5%)	3,849 (12.6%)	17,332 (14.0%)

Sleep						
Optimal	13,476 (68.2%)	12,997 (68.0%)	19,409 (70.1%)	18,563 (69.2%)	20,468 (67.1%)	84,913 (68.5%)
Suboptimal	4,865 (24.6%)	4,704 (24.6%)	6,355 (23.9%)	6,234 (23.2%)	7,751 (25.4%)	29,909 (24.1%)
Very Suboptimal	1,419 (7.2%)	1,431 (7.4%)	1,940 (7.0%)	2,038 (7.6%)	2,298 (7.5%)	9,126 (7.4%)
BMI (10-17 years)						
Under/normal	10,097 (72.5%)	9,776 (71.9%)	14,010 (71.3%)	12,520 (69.8%)	14.979 (71.6%)	61,382 (71.3%)
Overweight	2,014 (14.5%)	2,010 (14.8%)	2,896 (14.7%)	2,718 (15.1%)	3,019 (14.4%)	12,657 (14.7%)
Obese	1,816 (13.0%)	1,819 (13.4%)	2,750 (14.0%)	2,704 (15.1%)	2,928 (14.0%)	12,017 (14.0%)
Positive Childhood Experiences (PCEs) (mean ± SD)						
0-3	54 (0.3%)	74 (0.4%)	114 (0.4%)	113 (0.4%)	114 (0.4%)	469 (0.4%)
4-7	1,004 (5.1%)	1,227 (6.4%)	2,167 (7.8%)	2,465 (9.2%)	2,433 (8.0%)	9,296 (7.5%)
8-11	7,598 (38.4%)	7,737 (40.4%)	11,761 (42.4%)	12,198 (45.5%)	13,829 (45.3%)	53,123 (42.9%)
12-14	11,104 (56.2%)	10,094 (52.8%)	13,662 (49.3%)	12,059 (45.0%)	14,141 (46.3%)	61,060 (49.2%)
PCE Count (range: 0 – 14)	11.4(±2.08)	11.2(±2.19)	11.20(±2.25)	10.79(±2.29)	10.90(±2.23)	11(±2.23)

Note. Dataset did not have BMI for 6-9 years old, so total sample for BMI included only children 10-17, total sample size=86,056; GED= general educational development; FPL= federal poverty level; For this exploratory aim, 14 of the original 15 PCEs were included; system of care was not consistent across years and thus not included.

Physical Activity: Sufficient= ≥60 min exercise 7 days a week. Insufficient= meets guidelines 1-6 days a week. Inactive: meets guidelines 0 days a week.

Sleep: Optimal=meets age- appropriate sleep recommendations. Suboptimal=1-<2 hours below or ≥1 hour above optimal. Very suboptimal= 2->3 hour below optimal

BMI: Underweight/ Normal weight= <5-<85th percentile. Overweight= 5-<95th percentile. Obese= >95th percentile

GED: general educational development; FPL = federal poverty level

We evaluated CVH indicators, ACEs, and PCEs for a linear trend between 2018-2022. All models were adjusted for child age group, sex, race/ethnicity, current insurance status, reporting caregiver sex, and household income level, caregiver's highest education, and family structure type; models evaluating trends in CVH indicators and PCEs also controlled for ACEs.

Trends in CVH Indicators by year

Trend analysis revealed a statistically significant linear trend ($p < 0.001$) in physical activity level across years (2018–2022) (Table 4.6A, Figure 4.10). Adjusted models reported significant differences by year for those with no PA, and insufficient PA compared to those meeting PA guidelines. In other words, from 2018 to 2022, the prevalence estimate of children meeting the PA guideline increased by 1.7% (95% I [9.3, 11.0%]), while those insufficiently meeting guidelines increased by 2.2%, and those with No PA decreased from 22.9% (95% CI [21.6,24.2]) to 18.9% (95% CI [68.9-71.1]) (Table 4.6A, Figure 4.10). Similarly, BMI category demonstrated a significant linear trend (p=0.0027) in at least one category across years. Adjusted models reported a significant difference in obese category compared to normal/underweight, but not the overweight category. The prevalence estimates for children classified as normal/underweight decreased from 70.0% to 68.6%, and children classified as obese increased from 14.5% to 16.2% (Table 4.6A, Figure 4.10). Secondhand smoke and sleep did not demonstrate a significant linear trend over time.

Table 4.6A

Prevalence Estimates for CVH Indicators and linear trend: National Survey of Children's Health, 2018-2022

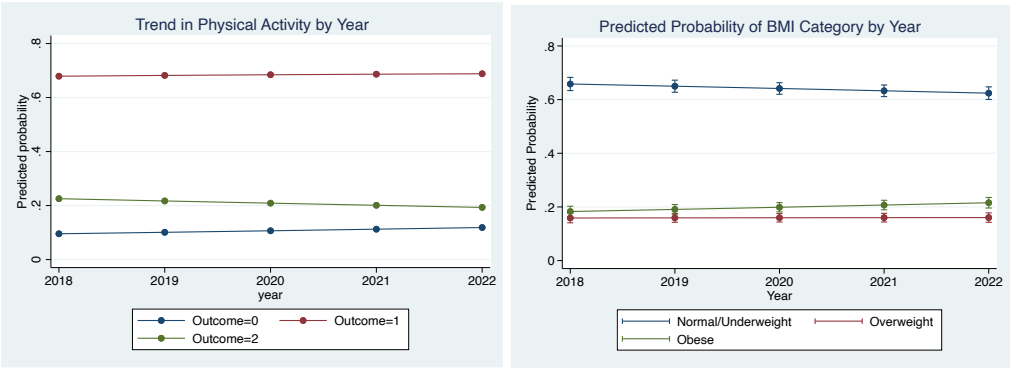
CVH Indicator	**2018**		**2022**		
	Prevalence Estimate	**95% CI**	**Prevalence Estimate**	**95% CI**	**p-value**

Secondhand smoke	15.8%	[14.7-16.9]	13.5%	[12.7-14.3]	0.0529
Physical activity					
Meets guidelines	9.3%	[8.4-10.2]	11.0%	[10.3-11.9]	<0.001
Insufficient PA	67.8%	[66.3-69.1]	70.0%	[68.9-71.1]	
No PA	22.9%	[21.6-24.2]	18.9%	[18.0-19.7]	
Sleep					
Meets guidelines	64.1%	[62.6-65.6]	64.1%	[63.0-65.2]	0.7811
Suboptimal	26.9%	[25.5-28.3]	27.2%	[26.2-28.2]	
Very Suboptimal	8.90%	[8.0-9.8]	8.7%	[7.9-9.4]	
BMI category					
Normal/ Underweight	70.0%	[68.2-71.8]	68.6%	[67.2-70.0]	0.0027
Overweight	15.4%	[14.1-16.8]	15.1%	[14.1-16.1]	
Obese	14.5%	[13.2-15.9]	16.2%	[15.2-17.4]	

Note: 2019-2021 prevalence estimates can be found in supplemental material

Figure 4.10

Trends in Individual CVH Indicators for Significant Linear Trends: National Survey of Children's Health, 2018-2022



Trends in PCEs by Year

PCE count and individual PCEs demonstrated significant linear trends between 2018-2022 (Table 4.6B, Figure 4.11). There was a significant linear trend in overall PCE numbers or count by year, decreasing from 11.11% (95% CI [11.0-11.12]) to 10.7% (95% CI [10.7-10.8]) ($p<0.001$), demonstrating a decreasing trend (Figure 4.11). Trends in individual PCEs revealed a

primarily decreasing linear trend between 2018-2022. There was a significant decrease in participation of after school activities (79.8%, 95%CI [78.4-81.1] to 73.4%, 95% CI [72.4-74.4], p<0.001) and participation in community service or volunteer work (11.4% decrease from 2018 to 2022, p<0.001). Similar findings were reported for child flourishing (p<0.001), having an adult mentor (p<0.001), school engagement (p<0.001), volunteering in the community (p<0.001), having a physically and mentally healthy caregiver (both p<0.001), and neighborhood amenities (p<0.001) (Table 4.6B., Figure 4.11). Family resilience was the only PCE that demonstrated a linear increase year over year (92.9%, 95% CI [92.0-93.7] to 93.5%, 95% CI [92.9-94.1], p=0.008). Prevalence estimates for 2019-2021 can be found in **Supplemental Material**.

Neighborhood detracting elements, neighborhood support, neighborhood safety, sharing ideas, and making and keeping friends did not demonstrate a significant linear trend.

Table 4.6B

Prevalence Estimates for PCEs and Linear Trend: National Survey of Children's Health, 2018-2022

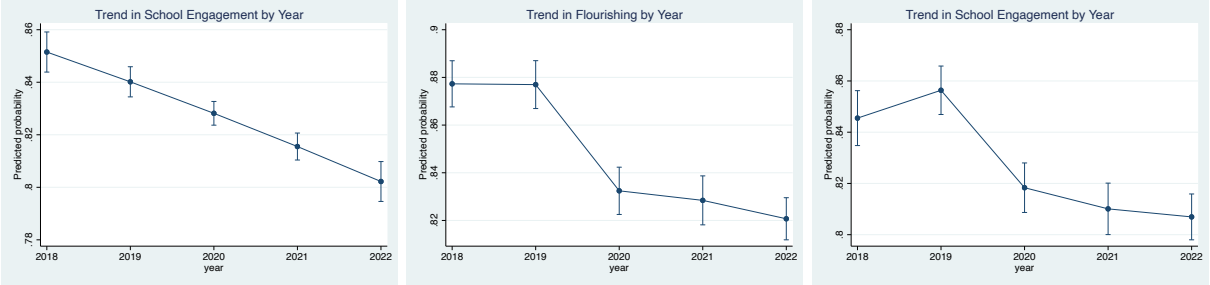
PCEs	2018		2022		
	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	p-value
PC1. Positive Social and Emotional Engagement					
Family shares ideas	94.8%	[94.1-95.4]	94.6%	[94.0-95.1]	0.071
School engagement	84.4%	[83.3-85.5]	80.9%	[80.0-81.8]	<0.001
Making and keeping friends	95.1%	[94.3-95.6]	94.9%	[94.4-95.4]	0.319
Flourishing for children and adolescents	86.3%	[85.3-87.3]	80.9%	[80.0-81.8]	<0.001
PC2. Neighborhood Characteristics					
Safe neighborhood	95.0%	[94.1-95.8]	95.2%	[94.6-95.6]	0.433
Low/ no neighborhood detracting elements	90.5%	[89.3-91.6]	91.4%	[90.7-92.0]	0.113

Supportive neighborhood	56.5%	[55.0-58.0]	56.1%	[55.0-57.2]	<0.001
PC3. Overall Caregiver Health and Family Resilience					
Physically healthy caregiver	65.3%	[63.9-66.8]	63.9%	[62.8-64.9]	0.004
Mentally healthy caregiver	75.2%	[73.8-76.5]	68.7%	[67.6-69.7]	<0.001
Family resilience	92.9%	[92.0-93.7]	93.5%	[92.9-94.1]	0.008
PC4. Community Involvement/Extracurricular Participation					
Participation in after school activities	79.8%	[78.4-81.1]	73.4%	[72.3-74.4]	<0.001
Participation in community service or volunteer work	44.5%	[43.1-46.0]	33.1%	[32.1-34.1]	<0.001
PC5. Access to Community/Healthcare Resources					
Neighborhood amenities	61.5%	[60.0-62.9]	59.4%	[58.3-60.5]	<0.001
Adult mentor	89.1%	[87.8-90.2]	86.7%	[85.7-87.6]	<0.001
PCE Count	11.11%	[11.0-11.2]	10.7%	[10.7-10.8]	<0.001

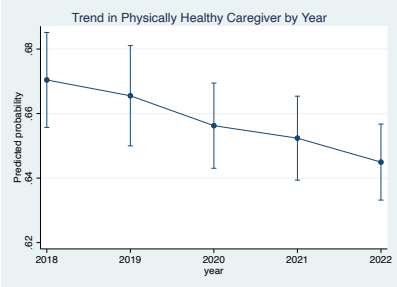
Figure 4.11

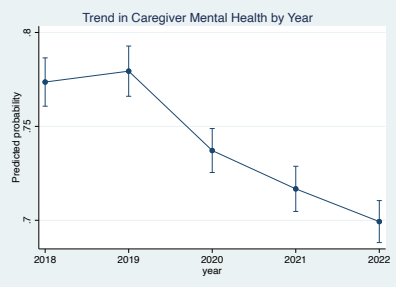
Trends in Individual PCEs for Significant Linear Trends: National Survey of Children's Health, 2018-2022

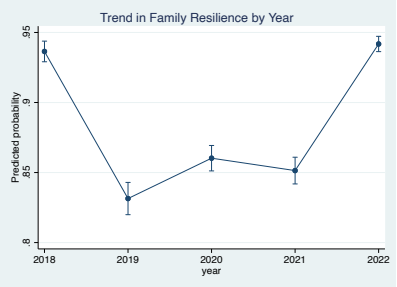
PC1. Positive Social and Emotional Engagement



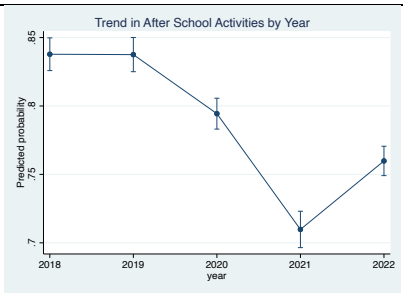
PC3. Overall Caregiver Health and family resilience

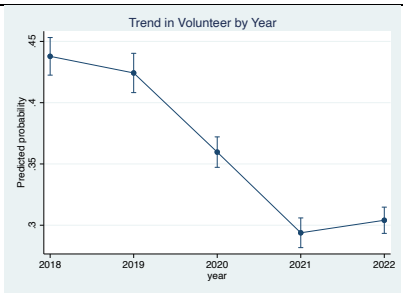




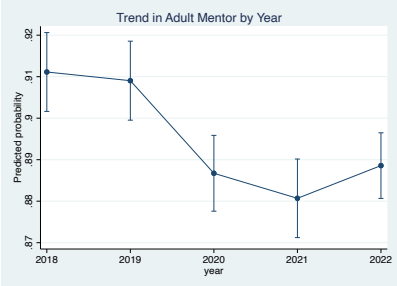


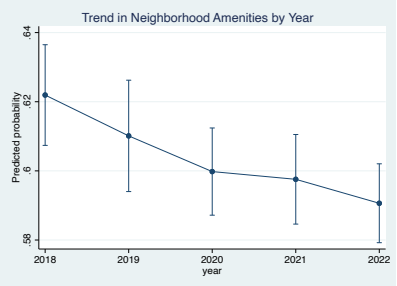
PC4. Community Involvement/Extracurricular Participation



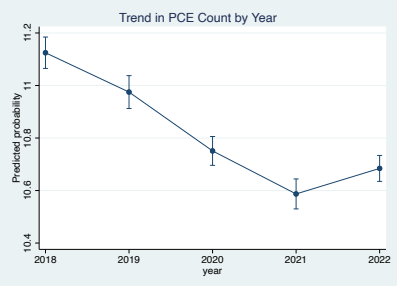


PC5. Access to community/healthcare resources





Total PCE Count

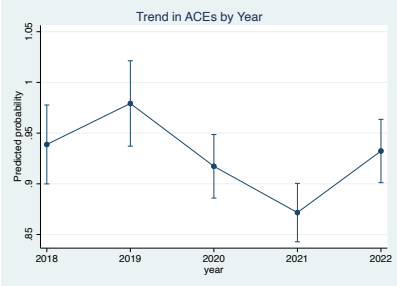


Trends in ACEs by year

ACEs demonstrated a significant linear trend (p<0.001) by year, with a decreasing slope. This model was run evaluating ACEs as a continuous variable. The average ACE count decreased from 0.94 (95%CI [0.90-0.98]) in 2018 to 0.91(95%CI [0.87-0.94]) in 2022 (Figure 4.12**)**

Figure 4.12

Trends in ACEs: National Survey of Children's Health, 2018-2022



3-4 Sensitivity Analysis: Trends in CVH indicators by COVID period

Trend analysis was completed to evaluate for trends in PCEs, ACEs and CVH indicators by COVID period. For this analysis, significant differences by the pre-COVID (2018-2019), COVID (2019-2021), and early post-pandemic (2022) were evaluated. Analysis revealed a significant difference for physical activity, sleep, and BMI category (Table 4.7A, Figure 4.13). Trend analysis revealed at least one category was significantly different between the pre-COVID, COVID, and early post-pandemic period for physical activity. In the adjusted model, the distribution of PA categories differed significantly by COVID period. Children with insufficient PA decreased from 68.5% (95% CI [67.4,69.5]) in the pre-COVID period to 67.7% (95%CI [66.9,68.6] during the COVID period, and then increased to 70.0% (95% CI [68.9,71.1]) in early post-pandemic period. In contrast, the proportion of children meeting PA guidelines showed an opposite trend, increasing from pre-COVID to COVID period, then decreasing in the

early post-pandemic period. The proportion of children with no PA decreased consistently across the time periods, from 22.3% (95%CI [21.4-23.2]) in the pre-COVID to 18.8% (95% CI [18.0-19.7]) in the early post-pandemic period (Figure 4.13)

Trends in sleep were like those observed for physical activity among children meeting guidelines. Children meeting sleep guidelines increased by 1.3% from pre-COVID to the COVID period 1.3% and then decreased by 2.1% from the COVID to early post-pandemic. Children with suboptimal sleep decreased from pre-COVID to the COVID by 1.4% and increased by 2.3% from the COVID to early post-pandemic (p=0.004) (Figure 4.13).

Trend analysis revealed a significant difference was observed by period for BMI category (*p*=0.003) in at least one category. Adjusted models showed significant differences for the overweight and obese categories compared to those that are normal/underweight. Children were normal/ underweight decreased from 69.6% (95% CI [68.4,70.9]) to 66.7 (95% CI [65.6,67.8]) from pre-COVID to COVID period and increased to 68,6% (95%CI [67.2,69.9]) in the early post-pandemic period. An opposite trend was observed for the overweight category, with a slight (0.9%) increase in overweight category from pre-COVID to COVID period, and 1.1% decrease from COVID to early post-pandemic period. This trend was similar for the obese category, with a 2% increase in obesity from pre-COVID to COVID period, and a 0.7% decrease to early-post COVID period.

Table 4.7A

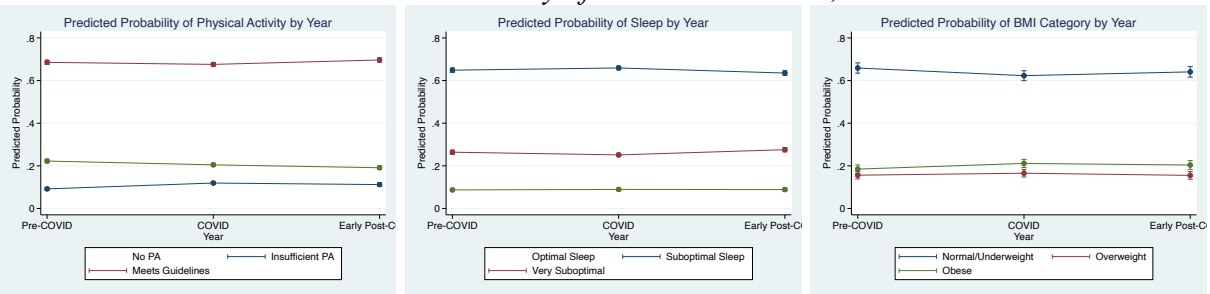
CVH Indicator Prevalence Estimates for COVID Trend Analysis: National Survey of Children's Health, 2018-2022

CVH Indicator	Pre-COVID		COVID		Early Post-Pandemic		
	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	p-value
Secondhand Smoke	15.2%	[14.4-15.9]	14.3%	[13.7-15.0]	13.5%	[12.7-14.3]	0.21

Physical activity							
Meets Guidelines	9.2%	[8.5-9.9]	11.7%	[11.1-12.3]	11.0%	[10.2-11.9]	<0.001
Insufficient PA	68.5%	[67.4-69.5]	67.7%	[66.9-68.6]	70.0%	[68.9-71.1]	
No PA	22.3%	[21.4-23.2]	20.4%	[19.7-21.2]	18.8%	[18.0-19.7]	
Sleep							
Meets guidelines	64.9%	[63.8-65.9]	66.2%	[65.3-67.1]	64.1%	[62.9-65.2]	0.004
Suboptimal	26.3%	[25.3-27.3]	24.9%	[24.1-25.7]	27.2%	[26.2-28.2]	
Very Suboptimal	8.7%	[8.1-9.4]	8.7%	[8.2-9.3]	8.7%	[7.9-9.4]	
BMI Category							
Normal/ Underweight	69.6%	[68.4-70.9]	66.7%	[65.6-67.8]	68.6%	[67.2-69.9]	0.003
Overweight	15.3%	[14.3-16.2]	16.2%	[15.4-17.2]	15.1%	[14.1-16.1]	
Obese	14.9%	[13.9-16.0]	16.9%	[16.1-17.8]	16.2%	[15.2-17.4]	

Figure 4.13

Trends in CVH Indicators: National Survey of Children's Health, 2018-2022

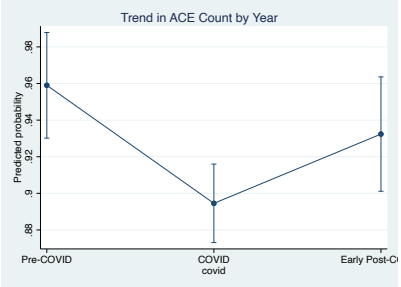


Sensitivity Analysis: Trends in ACEs by COVID period

ACEs demonstrated a significant trend by COVID period. This model was run evaluating ACEs as a continuous variable. The average ACE count decreased from 0.95 (95%CI [0.92-0.98]) to 0.87 (95%CI [0.85-0.90]) from pre-COVID to COVID, and increased to 0.90 (95% CI [0.87, 0.94]) in early post-pandemic period (p=0.0013) (Figure 4.14).

Figure 4.14

Trends in ACEs, COVID Period: National Survey of Children's Health, 2018-2022



Sensitivity Analysis: Trends in PCEs by COVID period

Significant differences were observed by COVID period for PCE count and many individual PCEs. PCE count decreased from pre-COVID to COVID period (11.0, 95% CI [10.9-11.0] to 10.7, 95% CI [10.6,10.7], p<0.001) and remained about the same from COVID to early post-pandemic (Table 4.7B, Figure 4.15).

A family that shares ideas and school engagement demonstrated a significant decrease from pre-COVID to COVID periods, with a leveling out from COVID to early post-pandemic period (p=0.024 and p<0.001, respectively). Flourishing also showed a similar relationship, with a significant decrease from pre-COVID to COVID (4.4% drop), and a more gradual decrease of 1% from COVID to early post-pandemic (p<0.001).

The absence of neighborhood detracting elements and neighborhood support showed opposite trends overtime. Having low or no detracting elements increased slightly from pre-COVID to COVID (0.3%), with a more pronounced increase into the early post-pandemic period (1.1%) (p=0.045). Having a supportive neighborhood increased by 1.9% into the COVID period, followed by a decrease of 1.4% into the early post-pandemic period (p=0.029).

The proportion of children with physically and mentally healthy caregivers differed significantly by period, showing a consistent decline over time. The percentage of children with a physically healthy caregiver decreased from 65.1% (95%CI [64.0, 66.1]) to 64.5% (95%CI [63.6,65.4]), and then to 63.8% (95% CI [62.7,64.9]) in the early post-pandemic period

(p=0.0017). A similar decreasing trend was observed for mentally healthy caregivers (p<0.001) (Figure 4.7B). Family resilience first declined by 2.7%, then increased by 8.9% in the early post-pandemic period (p<0.001).

Both participation in afterschool activities and participation in community service and volunteer work had a decline from pre-COVID to COVID period (7.9% and 9.2%, respectively). Participation in after-school activities recovered slightly into the early post-pandemic period (1.3%), while participation in volunteer work decreased a further 1.8% into this period (both p<0.001).

Neighborhood amenities showed a significant difference by period (p=0.005), with a gradual decrease in each period (Figure 4.7B). Adult mentor similarly decreased from 89.1% (95%CI [88.3,89.9]) to 86.2% (95%CI [85.4,86.9], with a slight increase to 86.7% [85.7, 87.6]) in the post-pandemic period (p<0.001) (Figure 4.15)

Neighborhood safety and making and keeping friends were the only PCEs that did not demonstrate a significant trend by COVID period.

Table 4.7B

PCE Prevalence Estimates for COVID Trend Analysis: National Survey of Children's Health, 2018-2022

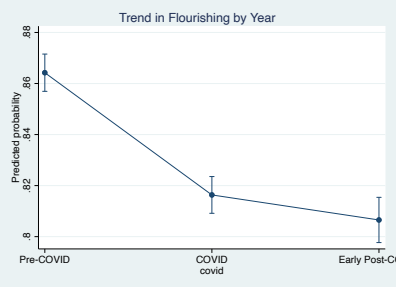
PCEs	Pre-COVID		COVID		Early Post-Pandemic		
	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	p-value
PC1. Positive Social and Emotional Engagement							
Family shares ideas	95.2%	[94.8-95.6]	94.6%	[94.2-95.1]	94.6%	[94.0-95.1]	0.024
School engagement	84.9%	[84.2-85.6]	81.6%	[80.8-82.3]	80.9%	[80.0-81.8]	<0.001
Making and keeping friends	95.2%	[94.7-95.6]	95.3%	[94.9-95.7]	94.9%	[94.4-95.4]	0.463

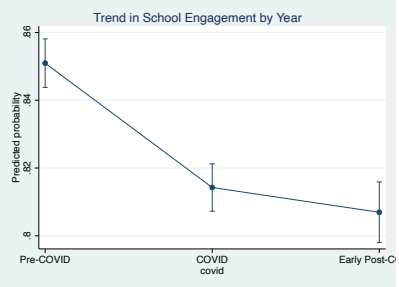
Flourishing for children and adolescents	86.2%	[85.5-87.0]	81.8%	[81.1-82.5]	80.8%	[79.9-81.7]	<0.001
PC2. Neighborhood Characteristics							
Safe neighborhood	94.6%	[93.9-95.1]	95.1%	[94.6-95.5]	95.1%	[94.6-95.6]	0.598
Low/ no neighborhood detracting elements	90.0%	[89.1-90.7]	90.3%	[89.6-90.9]	91.4%	[90.7-92.0]	0.045
Supportive neighborhood	55.6%	[54.5-56.7]	57.5%	[56.6-58.4]	56.1%	[55.0-57.2]	0.029
PC3. Overall Caregiver Health and family resilience							
Physically healthy caregiver	65.1%	[64.0-66.1]	64.5%	[63.6-65.4]	63.8%	[62.7-64.9]	0.0017
Mentally healthy caregiver	75.3%	[74.4-76.3]	71.2%	[70.4-72.0]	68.6%	[67.6-69.7]	<0.001
Family resilience	87.3%	[86.6-88.0]	84.6%	[83.9-85.3]	93.5%	[92.9-94.1]	<0.001
PC4. Community Involvement/Extracurricular Participation							
Participation in afterschool activities	80.0%	[79.0-80.9]	72.1%	[71.2-73.0]	73.4%	[72.3-74.4]	<0.001
Participation in community service or volunteer work	44.1%	[43.0-45.2]	34.9%	[34.0-35.7]	33.1%	[32.1-34.1]	<0.001
PC5. Access to community/healthcare resources							
Neighborhood amenities	61.0%	[59.9-62.0]	59.6%	[58.7-60.5]	59.4%	[58.3-60.5]	0.005
Adult mentor	89.1%	[88.3-89.9]	86.2%	[85.4-86.9]	86.7%	[85.7-87.6]	<0.001
PCE Count	11.0%	[10.9-11.0]	10.7%	[10.6-10.7]	10.7%	[10.6-10.7]	<0.001

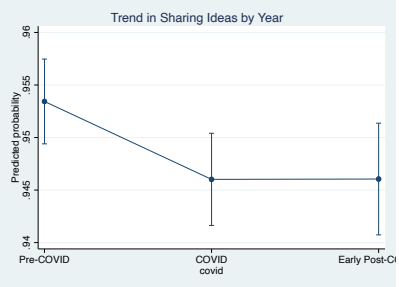
Figure 4.15

Trends in Individual PCEs, COVID Period: National Survey of Children's Health, 2018-2022

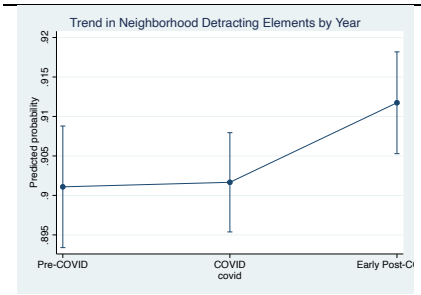
PC1. Positive Social and Emotional Engagement

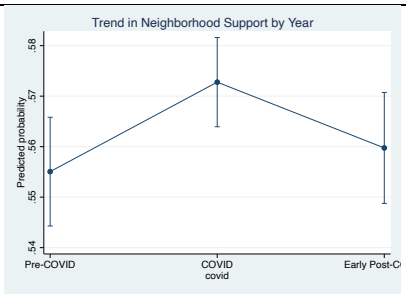




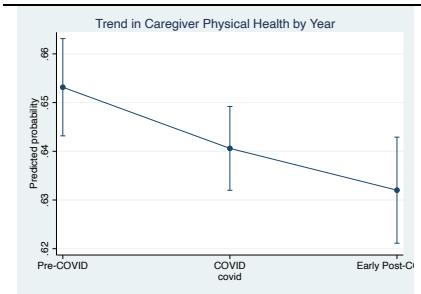


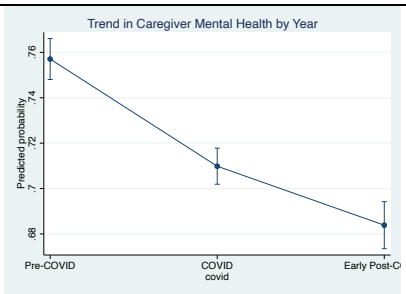
PC2. Neighborhood Characteristics

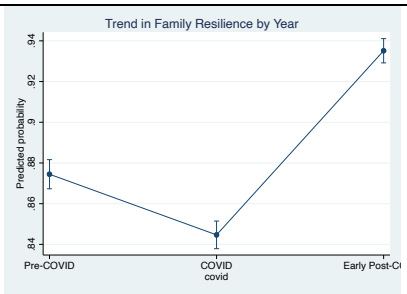




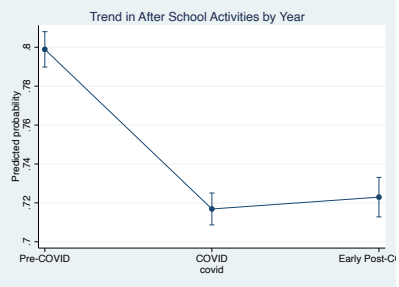
PC3. Overall Caregiver Health and family resilience

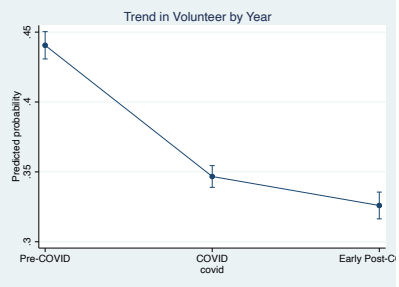




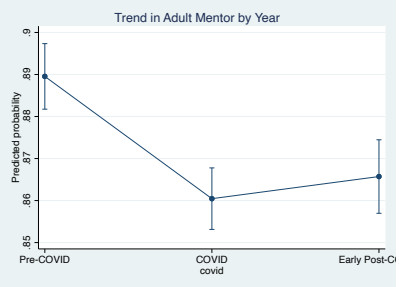


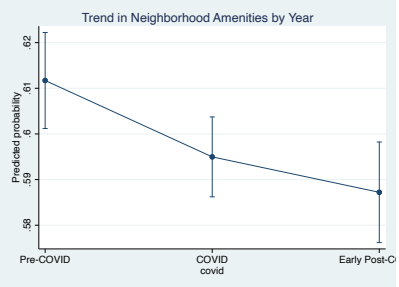
PC4. Community Involvement/Extracurricular Participation



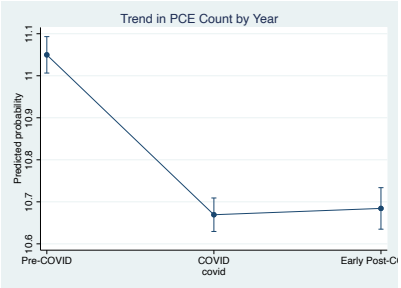


PC5. Access to community/healthcare resources





Total PCE Count



Chapter 5: DISCUSSION

This chapter begins with an overview and review of the primary findings regarding the association between PCEs and CVH indicators, followed by an examination of how this relationship is moderated by ACE exposure and demographic characteristics. Next, we discuss observed trends in CVH indicators and PCEs over a five-year study period, including patterns potentially associated with the COVID-19 pandemic. The chapter concludes with a discussion of the study's strengths, limitations, implications, and recommendations for future research.

The overall objective of this study was to examine the relationship between Positive Childhood Experiences (PCEs) and cardiovascular health (CVH) indicators among U.S. children aged 6–17 years. To achieve this, we addressed three primary aims: (1) to examine the associations between PCEs and CVH indicators; (2) to assess whether the associations between PCEs and CVH indicators differed by the number of Adverse Childhood Experiences (ACEs) and/or demographic characteristics (child's age group, child's sex, race/ethnicity); and (3) to explore five-year trends (2018–2022) in PCEs and CVH indicators, capturing possible shifts over time. To guide this work, we operationalized the HOPE (Healthy Outcomes from Positive Experiences) framework using PCE indicators available in the National Survey of Children's Health (NSCH). To our knowledge, this was the first study to apply the HOPE framework to evaluate the associations between PCEs and CVH indicators in a nationally representative sample of U.S. children.

Our findings revealed a significant inverse association between PCEs and several CVH indicators, including secondhand smoke exposure, physical activity, sleep, and body mass index (BMI). The protective effect of PCEs was particularly evident for secondhand smoke exposure,

physical activity, and sleep, in the context of high ACE exposure. Trend analyses indicated a decreasing linear trend in three CVH indicators—physical activity, sleep, and BMI—over the study period. Additionally, both PCE and ACE counts showed declining trends from 2018-2022, though these patterns varied in relation to the COVID-19 pandemic. These findings contribute to a growing body of literature emphasizing the importance of positive relational and environmental factors in shaping children's long-term health outcomes.

Before addressing the findings by specific aims, we briefly discuss how we examined PCEs using two approaches: (1) Principal Component Analysis (PCA), which identified five components, and (2) an overall PCE count, representing the total number of PCEs (out of 15) each child experienced.

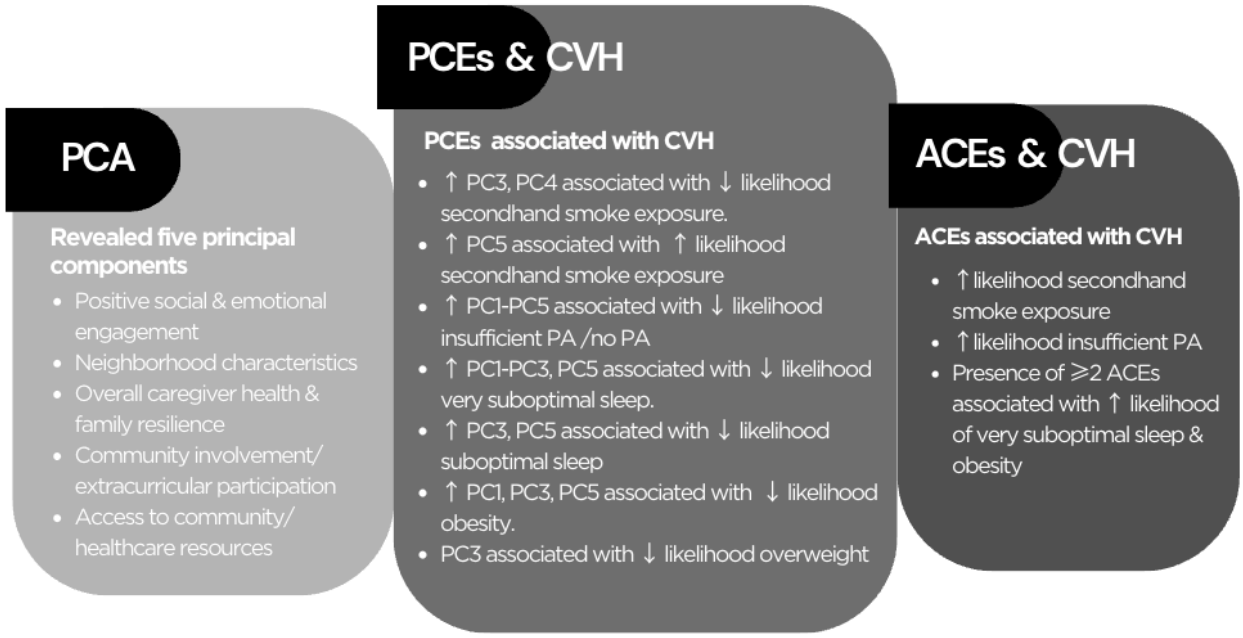
The PCA revealed that the PCEs components aligned well with the HOPE framework. PC1, positive social and emotional engagement, corresponds closely with the HOPE category of "Social and emotional competencies." Multiple components, PC3, PC5 and PC1 ('overall caregiver health and family resilience', 'access to community, healthcare resources', and 'positive social and emotional engagement'), align with the category "Nurturing, Supportive Relationships," (Table 2.1) reflecting both relational and caregiving supports. PC2, which capture neighborhood characteristics, aligns with the HOPE domain of "Safe, Stable, Protective, and Equitable Environments." PC4, focused on Community involvement and extracurricular participation, corresponds well with the HOPE category "Opportunities for Constructive Social Engagement." The five principal components derived from the PCA broadly reflect the domains of the HOPE framework. While individual variables in the NSCH data set aligned well with the category "Learning social and emotional competencies," it does not appear that any principal component aligns directly with this category. Overall, the principal components map on the

relational, environmental, and developmental competencies described in the HOPE framework, supporting the theoretical foundation of the PCE constructs used in this study.

Regarding the PCE count, most previous studies have examined PCEs as a total score, summing the number of positive experiences reported. However, this study was among the few that assess PCEs more comprehensively—both by examining the total count and by exploring underlying dimensions through PCA.

Figure 5.1

Specific Aim 1 Key Findings: Associations of PCEs and CVH Indicators



All five principal components derived from the PCE variables demonstrated significant associations with at least one CVH indicator. Most notably, the component representing (PC3) '*caregiver health and family resilience'* emerged as the most robust protective factor, showing significant inverse associations across all four CVH indicators: secondhand smoke exposure, physical activity, sleep, and BMI. This finding underscores the critical role of nurturing and

resilient caregiving environments, whether through primary caregivers or family, in shaping children's health trajectories and supports the potential of caregiver-focused/family-based interventions to promote CVH in children. These findings are consistent with previous literature examining caregiver warmth and nurturing, and strength-based approaches for caregivers (Bethell et al., 2019; Ortiz et al., 2024; Williams et al., 2019).

When examining the findings by individual CVH indicators, both '*caregiver health and family resilience'* (PC3) and '*community involvement/extracurricular participation'* (PC4) were consistently associated with a decreased likelihood of child's secondhand smoke exposure. However, an unexpected finding emerged: '*access to community and healthcare resources'* (PC5), while protective for other outcomes, was associated with an increased likelihood of secondhand smoke exposure. This paradox may reflect unmeasured neighborhood-level variables such as housing density or caregiver health variables such as caregiver smoking behavior and warrants further investigation. It is interesting to note that neighborhood characteristics are not significantly associated with secondhand smoke exposure, while PC5 shows a significant association. Previous literature has demonstrated that families with secondhand smoke exposure tend to have lower neighborhood amenities, and higher neighborhood detracting elements (Mahabee-Gittens et al., 2022). This contrasts our findings and is interesting as this study also used the NSCH data; however, this analysis used only 2018-2019 NSCH data and was limited to ages 6-11 years old. The COVID-19 Pandemic and trends observed in neighborhood characteristics during this time may explain the differences.

Our finding that '*access to community/healthcare resources'* was associated with increased likelihood of secondhand smoke exposure highlights the complexity of contextual

factors in interpreting PCE data. It is possible that access to services co-occurs with high-risk environments, such as densely populated housing or multigenerational living situations where smoking behavior is more prevalent. There may be unmeasured confounding variables that explain the positive association between this principal component and secondhand smoke exposure. This is particularly plausible given that secondhand smoke exposure is a less direct outcome compared to others such as physical activity, sleep, obesity, which showed more expected patterns.

Physical activity was significantly associated with all five PCE principal components, with the strongest relationship observed for '*community involvement and extracurricular participation*.' This aligns with the understanding that engagement in organized activities and recreational sports directly supports higher levels of physical activity in youth. In contrast, the likelihood of very suboptimal sleep was significantly reduced in association with all principal components except '*community involvement/extracurricular participation'*. The magnitude of these associations warrants further investigation.

Children with higher scores in '*positive social and emotional engagement' (PC1)*, '*caregiver health and family resilience' (PC3)*, and '*access to community/healthcare resources'* (PC5) were less likely to have obesity. These findings are consistent with prior research linking PCEs, such as neighborhood cohesion, caregiver warmth, and supportive parenting, to improved CVH outcomes in both children and adults. For example, prior studies have shown that lower levels of neighborhood cohesion are associated with increased obesity risk in school-age children (Alhasan et al., 2023), while caregiver warmth and resilience are positively linked to higher CVH indicators and scores (Ortiz et al., 2024; Slopen et al., 2017). Additionally, psychological

traits, such as optimism and purpose in life, often nurtured by positive social emotional engagement, have been associated with ideal CVH in adulthood (Kim et al., 2020; Stewart et al., 2020).

While existing literature has broadly supported the link between positive PCEs and improved CVH outcomes, this study offers a more comprehensive and domain-specific examination of these relationships in children. The most comparable studies to date include Slopen et al. (2017), which used retrospective recall among adults to assess PCEs, and Guo et al. (2024), which conducted a longitudinal analysis evaluating multiple CVH indicators in childhood. Of these, only Guo's study simultaneously examined more than one CVH indicator in children.

Our findings align with and extend this literature (e.g., Slopen et al., 2017) by demonstrating that PCEs are significantly associated with ideal CVH profiles during childhood. Importantly, this study illustrates that the influence of PCEs is observable in real time during developmental years, rather than retrospectively. Specifically, our study indicates that school engagement (as a PCE) may serve as protective in childhood, with implications for long-term CVH.

This study addresses a critical gap by comprehensively applying the HOPE framework to assess multiple categories of PCEs in relation to four key CVH indicators during childhood. Moreover, a recent scoping review (Hero et al., 2025) reported that most research to date has evaluated the cumulative effects of PCEs or caregiver support alone, without distinguishing between HOPE categories or exploring individual PCE components. Our findings contribute to a

more nuanced understanding of how distinct domains of PCEs may differentially impact various aspects of CVH.

By advancing beyond PCE counts to examine domain-specific patterns, this study contributes novel insights into the pathways through which childhood experiences shape early markers of CVH. The consistent protective role of '*positive social and emotional engagement'*, and '*caregiver health and family resilience'* suggests these two domains may be a pivotal target for early prevention efforts.

Figure 5.2

Specific Aim 2 Key Findings: Interplay of ACEs on the Relationship between PCEs and CVH Indicators

It is known that ACEs demonstrate independent and significant associations with several less favorable CVH in children, including in our study. We found that exposure to ACEs was positively associated with secondhand smoke exposure and insufficient physical activity, although not with physical inactivity. Children exposed to ≥2 ACEs also had significantly higher odds of very suboptimal sleep and obesity, though ACE exposure was not significantly associated with intermediate categories, such as suboptimal sleep or overweight. These findings

reinforce previous research suggesting that exposure to even a single ACE can negatively impact children's CVH, and that experiencing two or more ACEs may place them at an even greater risk for poor CVH.

Much of the existing research on ACEs and CVH has been conducted using longitudinal designs with outcomes measured in adulthood, highlighting the contribution of this study in examining these associations in children using the Life's Essential 8™ framework (Kovacs et al., 2023; Matthews et al., 2016; Nikulina & Widom, 2014; White et al., 2023). A recent analysis using the NSCH dataset similarly found that children with higher number of ACEs were more likely to have higher BMI, and that higher levels of weekly physical activity were associated with lower BMI among those with ≥3 ACEs (Mihaila, 2025); these findings reinforce the role of ACEs in CVH indicators including physical activity and BMI. Promoting PCEs may be one avenue to mitigate the impact of ACEs on CVH in children.

Beyond these independent associations – specifically, PCEs with CVH indicators in SA 1 and ACEs with CVH indicators as noted above – we also examined whether ACEs moderated the relationship between PCEs and CVH outcomes. Our analyses revealed that ACEs moderated the association between total PCEs and select CVH indicators, specifically secondhand smoke exposure, physical activity, and sleep (duration). For all three outcomes, the protective effects of higher PCEs on favorable CVH indicators was weaker among children with ≥2 ACEs. For example, while PCEs were associated with lower odds of secondhand smoke exposure and insufficient physical activity, these effects were reduced among children with greater adversity. Similarly, the inverse association between PCEs and very suboptimal sleep was weaker among children exposed to ≥ 2 ACEs. Interestingly, no moderating effect of ACEs was found in the

relationship between PCEs and BMI, suggesting that the moderating effect of ACEs were no equal across all CVH outcomes.

These findings are consistent with a small but growing body of research examining the interplay between ACEs and PCEs in predicting child health outcomes. Huang et al. (2022) reported similar moderating effects in adult populations, where ACEs moderated the relationship between PCEs and poor physical health. Specifically, the association between PCEs and health conditions was lessened among those exposed to a higher number of ACEs. Two studies focused specifically on child weight status, ACEs, and neighborhood support and family resilience, but used specific PCEs as a moderator; one study reported that among children with ≥2 ACEs, those with neighborhood support had lower odds of being overweight or obese (Crouch et al., 2022). The second study reported that among children who experienced ≥1 ACEs, stronger family resilience attenuated the risk of being in a higher BMI category (Heerman et al., 2022). This effect was not observed in children with no ACEs. While these findings reinforce the importance of PCEs in the face of adversity, as demonstrated in this study, prior work has focused on the moderating role of specific PCEs rather than ACEs.

A longitudinal study by Guo et al. (2024) most closely parallels the present work, including PCEs in a moderating role on the association between ACEs and CVH indicators. In that study, ACEs and PCEs were assessed annually in children from ages 0–11, and CVH was evaluated at age 11–12 using Life's Essential 8™ indicators. Their findings demonstrated that exposure to multiple PCEs was associated with higher (i.e., more favorable) CVH scores, and that ACE exposure was associated with less favorable CVH scores. Stratified analysis revealed that exposure to PCEs may buffer the detrimental effects of ACEs. Like our results, Guo et al.

used a cumulative model of adversity and protection, suggesting that resilience-building environments can offer meaningful, though sometimes limited, protection in the context of childhood adversity. Taken together, these findings emphasize the value of addressing both risk and protective factors in childhood and support a prevention model that strengthens positive environments while identifying and mitigating exposure to adversity.

Interplay of age, sex, and race/ethnicity on the association between PCEs and CVH indicators

Direct Effects of Demographic Characteristics: Our analyses revealed that demographic factors including sex, age, and race/ethnicity had independent associations with CVH indicators in children. For example, females were more likely to be physically inactive or insufficiently active but had a lower likelihood of being overweight or obese. These divergent patterns align with prior literature reporting mixed findings on sex differences in both PCEs and CVH outcomes (Crouch et al., 2021; Virani et al., 2020). Interestingly, children of reporting female caregivers were less likely to be inactive or insufficiently active, yet more likely to be overweight or obese. Such trends may reflect underlying differences in cultural norms or behavioral modeling between caregivers and children that influence physical activity and dietary behaviors. Additionally, race/ethnicity were the only demographic variables consistently associated with all four CVH indicators, consistent with both previous research and national surveillance data. Children from racially and ethnically minoritized backgrounds face systemic barriers including limited access to safe neighborhoods, and supportive communities that may reduce the protective potential of PCEs. These disparities likely stem from broader structural inequities, such as racism, neighborhood disadvantage, and unequal access to health-promoting resources.

Moderating Effect of Age: Age moderated the association between PCEs and sleep, with the protective effect of PCEs appearing to diminish among older children. This supports our hypothesis that the influence of PCEs on CVH indicators may be developmentally sensitive. Consistent with developmental frameworks, younger children may be more responsive to nurturing caregiving environments that help establish healthy sleep routines. As children age, however, external factors such as peer influence, academic demands, and increased exposure to technology may begin to attenuate the benefits of earlier positive experiences. These findings emphasize the importance of early intervention, particularly for CVH behaviors that are strongly shaped by routine and structure in early childhood.

Moderating Effect of Sex: Sex also moderated the association between PCEs and body mass index (BMI), with a stronger protective effect observed in females. Although prior studies have not consistently identified sex differences in the relationship between PCEs and BMI Crouch et al., 2021; Virani et al., 2020), our results suggest that females may experience greater benefit from PCEs in terms of reduced obesity risk. This finding points to potential sex-specific mechanisms, such as differences in emotional processing, socialization, or caregiver-child interaction styles, that may enhance the buffering effects of PCEs for females. Future studies should explore these pathways and consider stratified analyses to better understand how child and/or caregiver sex may condition the relationship between PCEs and health outcomes.

Moderating Effect of Race/Ethnicity: Race and ethnicity significantly moderated the relationship between PCEs and CVH risk, where racial/ethnic minorities appear to have a weaker effect of PCEs on CVH indicators. Our findings suggest that the protective effect of PCEs is not uniform across racial and ethnic groups. These findings are consistent with previous literature reporting significant differences in PCEs by race/ethnicity (Crouch et al., 2021; Crouch et al.,

2022; Lloyd-Jones et al., 2022) and CVH indicators by race/ ethnicity (Fuller-Rowell et al., 2021; Saelee et al., 2023; Virani et al., 2020). Our findings are novel in that it is the first, to our knowledge, to examine race/ethnicity in a moderating role in the relationship between PCEs and CVH indicators. Structural and cultural factors, such as differential access to community resources, experiences of discrimination, and contextual stressors, may limit the extent to which PCEs can buffer adversity in some populations. These results reinforce existing calls to contextualize protective experiences within the broader social environments in which children live. The consistent moderating effects of race/ethnicity across multiple CVH indicators highlight the need for equity-centered research and interventions that account for these structural and sociocultural influences.

Together, these findings offer novel insights into the complex ways demographic factors shape resilience and health in childhood. PCEs were not only independently associated with improved CVH outcomes, but their protective effects varied significantly by age, race/ethnicity, and more selectively, sex. These patterns suggest that efforts to promote resilience through PCEs must be attuned to the broader developmental and sociocultural context. Public health strategies that promote PCEs should be coupled with efforts to address the structural inequities that influence how, and for whom, those experiences are most effective in promoting CVH.

Trends in PCEs and CVH indicators

From 2018-2022, clear linear trends emerged in several CVH indicators, as well as in ACEs and PCEs, with notable differences by historical period corresponding to the COVID-19 pandemic (Pre-COVID, COVID, early post-pandemic period). Physical activity and BMI both demonstrated significant linear trends over time, while secondhand smoke exposure did not; for example, the proportion of children with reported no PA decreased consistently across time

periods. Sleep duration, although not linearly associated with year, differed significantly when analyzed by COVID time period, underscoring the unique influence of the pandemic on sleep health. Both ACE and PCE counts exhibited linear trends, and these trends remained significant when analyzed by COVID time periods. Specifically, most individual PCEs demonstrated downward trends over the study period, with exceptions including sharing ideas, making and keeping friends, and indicators related to neighborhood support and detracting elements. Family resilience stood out as the only PCE that showed an overall increase from 2018 to 2022. When examined across historical periods, a general decrease in PCEs was evident during the COVID period, followed by a rebound in the early post-pandemic years. The findings of a decrease heading into the COVID-19 pandemic are consistent with previous literature (Crouch et al., 2023) Interestingly, trends in neighborhood-related PCEs (PC 2) did not follow a linear pattern by year, but sensitivity analyses suggested subtle but differing shifts in this category associated with the COVID period. Neighborhood support increased during the COVID pandemic, with a decrease in the early-post pandemic period, which is also consistent with existing literature (Crouch et al., 2023). Neighborhood detracting elements remained stable from pre-COVID to the COVID pandemic period but interestingly increased in the early post-pandemic period.

ACEs demonstrated a similar trend to PCEs, with a decrease heading into COVID period, and a rebound increase in the early post-pandemic period. The linear trend appears to be an overall decrease between 2018-2022, with the most obvious decreasing slope occurring between 2019 and 2021. The existing literature demonstrates that some ACEs increased during COVID, while others may have decreased (Crouch et. al. 2021); because our trend analysis included only an ACE count, it is difficult to know if this is consistent with existing literature.

Compared to the existing literature, our findings highlight some unique patterns. Prior trend analyses of CVH in children and adolescents are somewhat outdated, often excluding sleep quality and duration from overall CVH metrics and predating the COVID-19 pandemic. Yang et al. (2024) reported that from 2007–2018, the overall mean CVH score in adolescents aged 12–19 improved, with improvement in nicotine exposure and sleep scores, no significant change in physical activity, and decreasing BMI. These findings are not directly consistent with our results, which focused on a more recent and historically unique time period, including the COVID-19 pandemic. A systematic review by (Núñez-Cortés et al., 2025) evaluating Life's Essential 8 CVH metrics during the pandemic across 42 countries found that physical inactivity was most prevalent during COVID, alongside 9% nicotine exposure, 33.5% sleep disorder prevalence, and 16.2% obesity prevalence. In contrast, our analysis observed an increase in the proportion of children meeting physical activity and sleep guidelines during the COVID period, diverging from broader international trends. This discrepancy may reflect contextual differences in measurement, policy responses, or population characteristics; this discrepancy may also be a result of historical events (COVID-19), and its impact on health. Taken together, our findings emphasize that both ACEs and PCEs, and their associations with CVH, are dynamic and historically contingent, reinforcing the importance of incorporating historical context and life course considerations into child health surveillance and intervention strategies.

Implications

The findings from this study have important implications for research, clinical practice, and public health. As the field shifts from a sole focus on childhood adversity toward a more holistic framework that emphasizes safe, stable, and nurturing relationships (Garner & Yogman,

2021), our study adds to a growing body of evidence highlighting both the independent role of PCEs and their interaction with child adversity (i.e., ACEs) in shaping children's CVH. Our results largely support the hypothesis that PCEs are associated with better CVH outcomes across multiple domains, whereas ACEs are linked to worse outcomes. Importantly, caregiver physical and mental health, along with family resilience, emerged as consistently protective and may represent particularly valuable targets for intervention among children at risk for poor CVH.

This study is among the first to examine how distinct, empirically derived domains of PCEs are differentially associated with multiple CVH indicators using a nationally representative sample. Compared to prior studies that have focused on individual PCEs or summed scores, our data-driven, theory-based framework allowed for a more nuanced understanding of the pathways linking positive experiences to physical health. While our findings are generally aligned with previous research emphasizing the benefits of family and community support (Guo et al., 2024) we also identified associations that differed by demographic. For example, certain demographic subgroups demonstrated different patterns in the relationship between PCEs and CVH, such as stronger associations in females for BMI, or diminished protective effects of PCEs with increasing age, which merit further exploration.

Alternative explanations for these findings may include differential recall or reporting biases among caregivers, unmeasured structural or environmental factors, or limitations in how PCEs and CVH indicators are operationalized in large-scale surveys. The observed variation in associations by race/ethnicity, for instance, likely reflects broader inequities in access to social and structural supports, as suggested by previous work (Crouch et al., 2021; Heerman et al., 2022). Furthermore, while family resilience was protective across all CVH indicators, other

neighborhood-level PCEs showed inconsistent associations, highlighting the need for future research to account for contextual and policy level determinants that shape both exposure to PCEs and health outcomes.

For pediatric providers and health systems, these findings reinforce the value of integrating PCE screening and promotion into routine care, particularly during well-child visits. Principal components in analysis demonstrated the importance of targeting specifically the individual and relational level for intervention. Promoting caregiver health and fostering family resilience could be key clinical levers for improving CVH from early life. This may include integrating caregiver mental health screening and support in pediatric settings, offering caregiver and resilience-building programs, or promoting family-based health behavior change. At a systems level, the implementation and scaling of evidence-based, multilevel interventions aimed at enhancing family, school, and community supports will be essential. Ultimately, improving children's CVH through the promotion of positive relational and environmental experiences aligns with a life course approach to prevention and offers a powerful, strengths-based complement to efforts that focus on mitigating adversity.

Strengths

This study offers several notable strengths. First, the use of a large, nationally representative sample allowed for robust analysis of the relationships between PCEs, ACEs and CVH indicators across diverse demographic groups. By incorporating a wide range of variables, including both psychosocial and physical health factors, this study provides a comprehensive examination of the complex and multifaceted contributors to childhood CVH.

One of the most significant contributions of this study is its focus on the co-occurrence of PCEs and ACEs in childhood. Much of the existing literature remains limited in scope, often retrospective and focused on adult outcomes, whereas this analysis addresses a critical gap by examining these relationships prospectively in a pediatric population. Our approach also addresses a common limitation in the PCE literature: the lack of a standardized or comprehensive framework for measurement. Rather than examining PCEs in isolation, we used a data-driven, principal component analysis approach to identify meaningful domains of PCEs, offering a more nuanced understanding of how different types of positive experiences relate to health outcomes. Although our findings on PCE components are not fully aligned with the HOPE framework, this discrepancy warrants further investigation in future studies.

Additionally, this study goes beyond static associations by evaluating linear trends over a five-year period and accounting for the impact of a major historical event—the COVID-19 pandemic. This temporal analysis provides important context for understanding how patterns in CVH indicators and psychosocial experiences have shifted during and after the pandemic, offering insights that are both timely and relevant for informing policy and intervention efforts. Together, these strengths position the current study as a valuable contribution to the growing field of child health equity and life course research.

Limitations

This study has several important limitations that should be considered when interpreting the findings. First, the years included in this analysis span the historical event of the COVID-19 pandemic. Changes in health behaviors during this period may not be fully accounted for due to the absence of a specific COVID-19 indicator in the NSCH dataset. To minimize the impact on

internal validity, we incorporated data from the pre-COVID-19 period, the COVID-19 period, and the early post-pandemic period, and conducted sensitivity analyses. However, the full impact of the pandemic on behavioral and environmental health changes remains difficult to isolate, particularly given likely disruptions to family routines, healthcare access, and stress exposure. Second, the NSCH's address-based sampling design may exclude transient or unstably housed families—populations at elevated risk for adversity and reduced access to protective environments. As such, both ACE and PCE prevalence may be underestimated, limiting generalizability to highly vulnerable populations.

Third, the cross-sectional design of the NSCH limits our ability to assess causality and the timing, frequency, or chronicity of childhood experiences. Because this study included more than one developmental stage, we were unable to determine when ACEs or PCEs occurred or how timing influenced cardiovascular health (CVH) outcomes. Furthermore, newer ACEs or PCEs that occurred after the survey year could not be captured.

Measurement constraints also impact interpretation. The NSCH lacks validated tools for measuring PCEs, particularly for key domains within the HOPE framework (e.g., "fun and joy in activities with others"). The survey relies on caregiver-reported data, which may be subject to recall or social desirability bias. Additionally, children's own perceptions of their experiences, which are crucial for understanding psychological impact, are not included. Both ACEs and PCEs were assessed using unweighted counts, which do not account for variation in severity, domain, or cumulative burden. While we used a ≥2 ACE threshold based on the sample distribution and existing literature, we could not evaluate the more commonly cited ≥4 ACE risk threshold due to a small proportion of such cases (<4%). Further, our trend analysis was unable to include two ACEs that were evaluated in Specific Aim 1 regarding the unfair treatment due to

sexual orientation and unfair treatment due to a health condition or disability. The exclusions of these two ACEs may have impacted observed trends over time or across COVID periods, potentially underestimating the overall prevalence of adversity and limiting our ability to fully capture how these specific forms of discrimination evolved over the study period.

Biological and developmental variables such as pubertal status, which may influence BMI, sleep, and physical activity, were not measured. Although we compared outcomes between school-age and adolescent children as an indirect proxy, future studies should include pubertal markers to more accurately assess developmental stage.

The demographic composition of the sample was predominantly non-Hispanic White, limiting generalizability to racially and ethnically diverse populations. Although models adjusted for race/ethnicity, we did not fully explore how structural or intersectional inequities, such as under-resourced schools or inequitable transportation access, may moderate relationships between childhood experiences and health outcomes.

We evaluated four CVH indicators aligned with the American Heart Association's Life's Essential 8™ framework but were unable to generate a composite CVH score due to limitations in available NSCH variables. Indicators such as diet, blood pressure, cholesterol, and glucose were not available. Additionally, the NSCH does not allow us to identify specific subcomponents (e.g., moderate vs. vigorous activity), which limited our interpretation of trends. Finally, we were unable to address the remaining CVH indicators due to availability in the NSCH data set, including blood pressure, total cholesterol, glucose, and diet. Information gathered from these four indicators would provide a more comprehensive understanding of CVH in U.S. children according to Life's Essential 8™ framework. While trend analyses from 2018–2022 were

conducted, the behavioral mechanisms driving changes in CVH indicators could not be fully isolated.

Recommendations for Future research

Future research is needed to build upon the findings of this study and address current gaps in the literature. One important direction is the more comprehensive evaluation of CVH in children and adolescents. Although this study used four indicators aligned with the Life's Essential 8™ framework, future studies should strive to incorporate all eight metrics**,** including more objective physiological measures such as blood pressure, cholesterol, and glucose levels. A more complete assessment of CVH would allow for better alignment with established guidelines and improved comparability across studies.

Another critical area for future investigation is the timing, frequency, and duration of PCEs. Understanding when and how often children are exposed to protective experiences could help clarify sensitive periods and cumulative effects, offering a more nuanced picture of how these exposures shape long-term health. This is particularly relevant given the evidence suggesting that the impact of PCEs may vary depending on developmental stage or life circumstances.

A recent scoping review by Hero et al. (2025) underscores the need for more nuanced and disaggregated approaches to studying PCEs. Most existing research has relied on cumulative PCE scores, limiting our understanding of how specific domains, such as caregiver health, community support, or neighborhood safety, may differentially influence child health outcomes. Findings from this study highlight the value of domain-specific analyses, particularly those focused on caregiver health and family resilience, in identifying key intervention points that may

be obscured by aggregate scoring methods. Future research should continue to operationalize PCEs using structured frameworks like the HOPE framework and evaluate their applicability across diverse populations and settings. Notably, this study consistently found that caregiver health and family context were significantly associated with children's CVH indicators. These findings suggest that the physical and mental health of primary caregivers, as well as broader family resilience, warrant further investigation as potential targets for improving child health outcomes.

By expanding both the scope and specificity of research on PCEs and CVH, future studies can more effectively inform clinical guidelines, public health policy, and family-centered interventions aimed at improving child and adolescent health across the life course.

Conclusions

In summary, this study adds to a growing body of literature suggesting that PCEs are significantly associated with better CVH outcomes in children, while controlling for ACEs and demographics. While existing research has recognized the potential for PCEs to buffer the negative effects of ACEs, few studies have taken a comprehensive approach to measuring both constructs, especially in the context of multiple CVH indicators beyond overweight and obesity. The current study addresses this gap by evaluating PCEs across structured domains and CVH outcomes defined by the Life's Essential 8™ framework, offering a more holistic understanding of these relationships in U.S. children aged 6–17 years.

Our findings demonstrate that PCEs are independently associated with favorable outcomes in physical activity, sleep, secondhand smoke exposure, and BMI. PCEs also appear to

mitigate the negative health consequences of ACEs, particularly in domains such as physical activity and sleep. However, this protective effect is diminished in the presence of high ACE exposure, emphasizing the need for dual strategies that both foster protective environments and reduce childhood adversity. Demographic characteristics, particularly race/ ethnicity, also moderated these associations, pointing to broader structural and contextual factors that shape children's experiences and health outcomes.

This study is, to our knowledge, the first to simultaneously examine ACEs as a moderator in the relationship between PCEs and multiple CVH indicators, using a nationally representative dataset in childhood. The PCA-derived, domain-specific analysis of PCEs strengthens the evidence base by moving beyond cumulative scoring and highlighting key intervention targets—most notably, caregiver health and family resilience. The observed COVID-related dip in PCE exposure and partial rebound in the early post-pandemic period further emphasize the dynamic nature of protective experiences and their vulnerability to historical and social disruption.

Taken together, these findings have important implications for clinical practice, public health, and policy. Strengthening PCEs may offer a powerful, strengths-based approach to promoting pediatric CVH, particularly when tailored to the unique needs of children facing adversity. However, these efforts must be implemented alongside broader strategies to reduce ACE exposure and address structural inequities. Future research should continue to develop and evaluate resilience-building interventions that are comprehensive, context-specific, and equity-oriented—ensuring that all children have the opportunity to thrive.

References

Alhasan, D. M., Gaston, S. A., Gullett, L. R., Braxton Jackson, W., Stanford, F. C., & Jackson, C. L. (2023). Neighborhood social cohesion and obesity in the United States. *Endocrine and Metabolic Science, 11*, 100129. https://doi.org/https://doi.org/10.1016/j.endmts.2023.100129

American Heart Association (2019). *The Relationship between Adverse Childhood Experiences (ACEs) and Health: Factors that Influence Individuals with or At Risk of CVD* https://www.heart.org/-/media/Files/About-Us/Policy-Research/Policy-Positions/Social-Determinants-of-Health/ACEs-Policy-Statement.pdf

Bethell, C., Jones, J., Gombojav, N., Linkenbach, J., & Sege, R. (2019). Positive Childhood Experiences and Adult Mental and Relational Health in a Statewide Sample. *JAMA Pediatrics, 173*(11), e193007. https://doi.org/10.1001/jamapediatrics.2019.3007

Bethell, C. D., Gombojav, N., & Whitaker, R. C. (2019). Family Resilience And Connection Promote Flourishing Among US Children, Even Amid Adversity. *Health Affairs, 38*(5), 729-737. https://doi.org/10.1377/hlthaff.2018.05425

Briggs, E. C., Putnam, F. W., & Purbeck, C. (2021). Why two can be greater than four or more: What mental health providers should know. *National Center for Child Traumatic Stress*. https://www.nctsn.org/sites/default/files/resources/report/data-at-a-glance-synergy-why-two-can-be-greater-than-four-or-more.pdf

Child and Adolescent Health Measurement Initiative. (2023). *The National Survey of Children's Health*. Retrieved December 1, 2023 from https://www.childhealthdata.org/learn-about-the-nsch/NSCH

Centers for Disease Control and Prevention. (2023). *Heart Disease Facts*. U.S. Department of Health and Human Services. Retrieved December 5, 2023 from https://www.cdc.gov/heartdisease/facts.htm#:~:text=One%20person%20dies%20every%2033,United%20States%20from%20cardiovascular%20disease.&text=About%20695%2C000%20people%20in%20the,1%20in%20every%205%20deaths.

Center on the Developing Child at Harvard University. (2023). *Center on the Developing Child*. https://developingchild.harvard.edu/

Chen, H., Cohen, P., & Chen, S. (2010). How Big is a Big Odds Ratio? Interpreting the Magnitudes of Odds Ratios in Epidemiological Studies. *Communications in Statistics - Simulation and Computation, 39*, 860-864. https://doi.org/10.1080/03610911003650383

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2 ed.). Lawrence Erlbaum Associates.

Crosby, B. (2005). Racial Differences in Reported Napping and Nocturnal Sleep in 2- to 8-Year-Old Children. *Pediatrics, 115*(1), 225-232. https://doi.org/10.1542/peds.2004-0815d

Crouch, E., Radcliff, E., Brown, M. J., & Hung, P. (2023). Association Between Positive Childhood Experiences and Childhood Flourishing Among US Children. *J Dev Behav Pediatr, 44*(4), e255-e262. https://doi.org/10.1097/dbp.0000000000001181

Crouch, E., Radcliff, E., Kelly, K., Merrell, M. A., & Bennett, K. J. (2022). Examining the influence of positive childhood experiences on childhood overweight and obesity using a national sample. *Preventive Medicine, 154*, Article 106907. https://doi.org/10.1016/j.ypmed.2021.106907

Crouch, E., Radcliff, E., Merrell, M. A., & Bennett, K. J. (2021). Rural-Urban Differences in Positive Childhood Experiences Across a National Sample [Article]. *Journal of Rural Health, 37*(3), 495-503. https://doi.org/10.1111/jrh.12493

Crouch, E., Radcliff, E., Merrell, M. A., Brown, M. J., Ingram, L. A., & Probst, J. (2021). Racial/ethnic differences in positive childhood experiences across a national sample. *Child Abuse & Neglect, 115*, 105012. https://doi.org/10.1016/j.chiabu.2021.105012

Crouch, E., Radcliff, E., & Probst, J. (2024). Changes in Positive Childhood Experiences During the COVID-19 Pandemic. *Acad Pediatr, 24*(2), 254-257. https://doi.org/10.1016/j.acap.2023.06.020

Dogan, T., & Aydin, T. (2020). The Development of the Positive Childhood Experiences Scale. *HAYEF Journal of Education, 17*, 1-19.

Doom, J. R., Deer, L. K., Mickel, T., Infante, A., & Rivera, K. M. (2024). Eating behaviors as pathways from early childhood adversity to adolescent cardiometabolic risk. *Health Psychology, 43*(6), 448-461. https://doi.org/10.1037/hea0001340

Elkhatib Smidt, S. D., Hitt, T., Zemel, B. S., & Mitchell, J. A. (2021). Sex differences in childhood sleep and health implications. *Ann Hum Biol, 48*(6), 474-484. https://doi.org/10.1080/03014460.2021.1998624

Frankowski, B. L. (2023). Encouraging Strengths in Parents and Youth to Promote Positive Childhood Experiences. *Pediatrics, 152*(1). https://doi.org/10.1542/peds.2023-061264

Fuller-Rowell, T. E., Nichols, O. I., Robinson, A. T., Boylan, J. M., Chae, D. H., & El-Sheikh, M. (2021). Racial disparities in sleep health between Black and White young adults: The role of neighborhood safety in childhood. *Sleep Med, 81*, 341-349. https://doi.org/10.1016/j.sleep.2021.03.007

Garner, A., & Yogman, M. (2021). Preventing Childhood Toxic Stress: Partnering With Families and Communities to Promote Relational Health. *Pediatrics, 148*(2). https://doi.org/10.1542/peds.2021-052582

Genovesi, S., Antolini, L., Orlando, A., Gilardini, L., Bertoli, S., Giussani, M., Invitti, C., Nava, E., Battaglino, M. G., Leone, A., Valsecchi, M. G., & Parati, G. (2020). Cardiovascular Risk Factors Associated With the Metabolically Healthy Obese (MHO) Phenotype Compared to the Metabolically Unhealthy Obese (MUO) Phenotype in Children. *Frontiers in endocrinology, 11*, 27-27. https://doi.org/10.3389/fendo.2020.00027

Guo, S., O'Connor, M., Mensah, F., Olsson, C. A., Goldfeld, S., Lacey, R. E., Slopen, N., Thurber, K. A., & Priest, N. (2022). Measuring Positive Childhood Experiences: Testing the Structural and Predictive Validity of the Health Outcomes From Positive Experiences (HOPE) Framework [Article]. *Academic Pediatrics, 22*(6), 942-951. https://doi.org/10.1016/j.acap.2021.11.003

Guo, S., Wijesuriya, R., O'Connor, M., Moreno-Betancur, M., Goldfeld, S., Burgner, D., Liu, R., & Priest, N. (2024, Sep 15). The effects of adverse and positive experiences on cardiovascular health in Australian children. *Int J Cardiol, 411*, 132262. https://doi.org/10.1016/j.ijcard.2024.132262

Hagan, J. F., Shaw, J., & Duncan, P. (2017). *Bright futures*. American Academy of Pediatrics Itasca, IL.

Heerman, W. J., Samuels, L. R., González Peña, T., Van Wyk, C., Mayberry, L. S., Lounds Taylor, J., & Martin, N. C. (2022). Family resilience and childhood obesity among children exposed to adverse childhood experiences in a national survey. *Obesity Science & Practice, 8*(1), 3-11. https://doi.org/10.1002/osp4.497

Hero, J., Gallant, L., Burstein, D., Newberry, S., Qureshi, N., Feistel, K., Anderson, K. N., Hannan, K., & Sege, R. (2025). Health Associations of Positive Childhood Experiences: A Scoping Review of the Literature. *International Journal of Environmental Research and Public Health, 22*(1), 59. https://doi.org/10.3390/ijerph22010059

Hinojosa, M. S., & Hinojosa, R. (2024, Mar). Positive and adverse childhood experiences and mental health outcomes of children. *Child Abuse Negl, 149*, 106603. https://doi.org/10.1016/j.chiabu.2023.106603

Huang, C. X., Halfon, N., Sastry, N., Chung, P. J., & Schickedanz, A. (2023). Positive Childhood Experiences and Adult Health Outcomes. *Pediatrics, 152*(1). https://doi.org/10.1542/peds.2022-060951

Kellum, C. E., Kemp, K. M., Mrug, S., Pollock, J. S., Seifert, M. E., & Feig, D. I. (2023). Adverse childhood experiences are associated with vascular changes in adolescents that are risk factors for future cardiovascular disease. *Pediatric Nephrology, 38*(7), 2155-2163. https://doi.org/10.1007/s00467-022-05853-2

Kim, J. H., Islam, S. J., Topel, M. L., Ko, Y.-A., Mujahid, M. S., Vaccarino, V., Liu, C., Sims, M., Mubasher, M., Searles, C. D., Dunbar, S. B., Pemu, P., Taylor, H. A., Quyyumi, A.

A., Baltrus, P., & Lewis, T. T. (2020). Individual Psychosocial Resilience, Neighborhood Context, and Cardiovascular Health in Black Adults. *Circulation: Cardiovascular Quality and Outcomes, 13*(10). https://doi.org/10.1161/circoutcomes.120.006638

Kovacs, A. H., Vervoort, D., & Lopez, K. N. (2023). Moving beyond lifestyle: the case for childhood adversity, social determinants of health, and psychosocial factors in cardiovascular risk prediction. *European Heart Journal, 44*(7), 594-597. https://doi.org/10.1093/eurheartj/ehac697

Kumar, S., & Kelly, A. S. (2017). Review of Childhood Obesity. *Mayo Clinic Proceedings, 92*(2), 251-265. https://doi.org/10.1016/j.mayocp.2016.09.017

Little, R. J. A., & Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed.). Wiley. Contributor biographical information http://www.loc.gov/catdir/bios/wiley043/2002027006.html

Lloyd-Jones, D. M., Allen, N. B., Anderson, C. A. M., Black, T., Brewer, L. C., Foraker, R. E., Grandner, M. A., Lavretsky, H., Perak, A. M., Sharma, G., & Rosamond, W. (2022). Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association. *Circulation, 146*(5). https://doi.org/10.1161/cir.0000000000001078

Lloyd-Jones, D. M., Ning, H., Labarthe, D., Brewer, L., Sharma, G., Rosamond, W., Foraker, R. E., Black, T., Grandner, M. A., Allen, N. B., Anderson, C., Lavretsky, H., & Perak, A. M. (2022). Status of Cardiovascular Health in US Adults and Children Using the American Heart Association's New "Life's Essential 8" Metrics: Prevalence Estimates From the National Health and Nutrition Examination Survey (NHANES), 2013 Through 2018. *Circulation, 146*(11), 822-835. https://doi.org/10.1161/circulationaha.122.060911

Lurbe, E., & Ingelfinger, J. (2021). Developmental and Early Life Origins of Cardiometabolic Risk Factors. *Hypertension, 77*(2), 308-318. https://doi.org/10.1161/hypertensionaha.120.14592

Mahabee-Gittens, E. M., Vidourek, R. A., King, K. A., & Merianos, A. L. (2022). Disparities in Neighborhood Characteristics among U.S. Children with Secondhand and Thirdhand Tobacco Smoke Exposure. *International Journal of Environmental Research and Public Health, 19*(7), 4266. https://doi.org/10.3390/ijerph19074266

Matthews, K. A., Chang, Y., Bromberger, J. T., Karvonen-Gutierrez, C. A., Kravitz, H. M., Thurston, R. C., & Montez, J. K. (2016). Childhood Socioeconomic Circumstances, Inflammation, and Hemostasis Among Midlife Women. *Psychosomatic medicine, 78*(3), 311-318. https://doi.org/10.1097/psy.0000000000000283

Miadich, S. A., Doane, L. D., Davis, M. C., & Lemery-Chalfant, K. (2019). Early parental positive personality and stress: Longitudinal associations with children's sleep. *Br J Health Psychol, 24*(3), 629-650. https://doi.org/10.1111/bjhp.12372

Nikulina, V., & Widom, C. S. (2014). Do race, neglect, and childhood poverty predict physical health in adulthood? A multilevel prospective analysis. *Child Abuse & Neglect, 38*(3), 414-424. https://doi.org/10.1016/j.chiabu.2013.09.007

Núñez-Cortés, R., López-Bueno, R., Torres-Castro, R., Calatayud, J., & Del Pozo Cruz, B. (2025). Prevalence of cardiovascular risk factors according to Life's Essential 8 in children and adolescents during the COVID-19 pandemic: A systematic review and meta-analysis including 1 526 173 participants from 42 countries. *Pediatr Obes, 20*(1), e13190. https://doi.org/10.1111/ijpo.13190

Orenstein, G., & Lewis, L. (2022). *Eriksons Stages of Psychosocial Development*. https://www.ncbi.nlm.nih.gov/books/NBK556096/

Ortiz, R., Kershaw, K. N., Zhao, S., Kline, D., Brock, G., Jaffee, S., Golden, S. H., Ogedegbe, G., Carroll, J., Seeman, T. E., & Joseph, J. J. (2024). Evidence for the Association Between Adverse Childhood Family Environment, Child Abuse, and Caregiver Warmth and Cardiovascular Health Across the Lifespan: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Circulation: Cardiovascular Quality and Outcomes, 17*(2). https://doi.org/10.1161/circoutcomes.122.009794

Perak, A. M., Ning, H., Khan, S. S., Bundy, J. D., Allen, N. B., Lewis, C. E., Jacobs, D. R., Jr., Van Horn, L. V., & Lloyd-Jones, D. M. (2020). Associations of Late Adolescent or Young Adult Cardiovascular Health With Premature Cardiovascular Disease and Mortality. *J Am Coll Cardiol, 76*(23), 2695-2707. https://doi.org/10.1016/j.jacc.2020.10.002

Perng, W., Aris, I. M., Slopen, N., Younoszai, N., Swanson, V., Mueller, N. T., Sauder, K. A., & Dabelea, D. (2023). Application of Life's Essential 8 to assess cardiovascular health during early childhood. *Annals of epidemiology, 80*, 16-24. https://doi.org/https://doi.org/10.1016/j.annepidem.2023.02.004

Roby, E., Canfield, C. F., Seery, A. M., Dreyer, B., & Mendelsohn, A. L. (2024). Promotion of Positive Childhood Experiences and Early Relational Health in Pediatric Primary Care: Accumulating Evidence. *Acad Pediatr, 24*(2), 201-203. https://doi.org/10.1016/j.acap.2023.09.008

Saelee, R., Haardörfer, R., Johnson, D. A., Gazmararian, J. A., & Suglia, S. F. (2023). Racial/Ethnic and Sex/Gender Differences in Sleep Duration Trajectories From Adolescence to Adulthood in a US National Sample. *American journal of epidemiology, 192*(1), 51-61. https://doi.org/10.1093/aje/kwac156

Sege, R. D., & Harper Browne, C. (2017). Responding to ACEs With HOPE: Health Outcomes From Positive Experiences. *Academic Pediatrics, 17*(7), S79-S85. https://doi.org/10.1016/j.acap.2017.03.007

Shu, W., Li, M., Xiao, H., Amaerjiang, N., Khattab, N. M., Zunong, J., Guan, M., Vermund, S. H., & Hu, Y. (2023). Validation of "Life's Essential 8" Metrics With Cardiovascular Structural Status in Children: The PROC Study in China. *Journal of the American Heart Association, 12*(12). https://doi.org/10.1161/jaha.122.029077

Slopen, N., Chen, Y., Guida, J. L., Albert, M. A., & Williams, D. R. (2017). Positive childhood experiences and ideal cardiovascular health in midlife: Associations and mediators. *Preventive Medicine, 97*, 72-79. https://doi.org/10.1016/j.ypmed.2017.01.002

Stewart, A. L., Magnani, J. W., Barinas-Mitchell, E., Matthews, K. A., El Khoudary, S. R., Jackson, E. A., & Brooks, M. M. (2020). Social Role Stress, Reward, and the American Heart Association Life's Simple 7 in Midlife Women: The Study of Women's Health Across the Nation. *J Am Heart Assoc, 9*(24), e017489. https://doi.org/10.1161/jaha.120.017489

Suglia, S. F., Koenen, K. C., Boynton-Jarrett, R., Chan, P. S., Clark, C. J., Danese, A., Faith, M. S., Goldstein, B. I., Hayman, L. L., Isasi, C. R., Pratt, C. A., Slopen, N., Sumner, J. A., Turer, A., Turer, C. B., & Zachariah, J. P. (2018). Childhood and Adolescent Adversity and Cardiometabolic Outcomes: A Scientific Statement From the American Heart Association. *Circulation, 137*(5), CIR.00000000000. https://doi.org/10.1161/cir.0000000000000536

U.S. Census Bureau. (2018). *2018 National Survey of Children's Health Methodology Report*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2018-NSCH-Methodology-Report.pdf

U.S. Census Bureau. (2019). *2018 National Survey of Children's Health Nonresponse Bias Analysis*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/nonresponse/2022-NSCH-Nonresponse-Bias-Analysis.pdf

U.S. Census Bureau. (2019). *2019 National Survey of Children's Health Methodology Report*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2019-NSCH-Methodology-Report.pdf

U.S. Census Bureau. (2020). *2019 National Survey of Children's Health Nonresponse Bias Analysis*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/nonresponse/2022-NSCH-Nonresponse-Bias-Analysis.pdf

U.S. Census Bureau. (2020). *2020 National Survey of Children's Health Methodology Report*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2020-NSCH-Methodology-Report.pdf

U.S. Census Bureau. (2021). *2020 National Survey of Children's Health Nonresponse Bias Analysis*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/nonresponse/2022-NSCH-Nonresponse-Bias-Analysis.pdf

U.S. Census Bureau. (2021). *2021 National Survey of Children's Health Methodology Report*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2021-NSCH-Methodology-Report.pdf

U.S. Census Bureau. (2022). *2021 National Survey of Children's Health Nonresponse Bias Analysis.* https://www2.census.gov/programs-surveys/nsch/technical-documentation/nonresponse/2022-NSCH-Nonresponse-Bias-Analysis.pdf

U.S. Census Bureau. (2022). *2022 National Survey of Children's Health Methodology Report*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2022-NSCH-Methodology-Report.pdf

U.S. Census Bureau. (2023). 2022 *National Survey of Children's Health Nonresponse Bias Analysis*. https://www2.census.gov/programs-surveys/nsch/technical-documentation/nonresponse/2022-NSCH-Nonresponse-Bias-Analysis.pdf

U.S. Department of Health and Human Services. (2025). *2025 poverty guidelines: 48 contiguous states and the District of Columbia*. https://aspe.hhs.gov/sites/default/files/documents/dd73d4f00d8a819d10b2fdb70d254f7b/detailed-guidelines-2025.pdf

Vasan, R. S., Zachariah, J. P., & Xanthakis, V. (2020, Dec 8). Life Course Developmental Approach to Cardiovascular Health and Cardiovascular Disease Prevention: Opportunities and Unanswered Questions. *J Am Coll Cardiol, 76*(23), 2708-2711. https://doi.org/10.1016/j.jacc.2020.10.011

Virani, S. S., Alonso, A., Benjamin, E. J., Bittencourt, M. S., Callaway, C. W., Carson, A. P., Chamberlain, A. M., Chang, A. R., Cheng, S., Delling, F. N., Djousse, L., Elkind, M. S. V., Ferguson, J. F., Fornage, M., Khan, S. S., Kissela, B. M., Knutson, K. L., Kwan, T. W., Lackland, D. T., Lewis, T. T., Lichtman, J. H., Longenecker, C. T., Loop, M. S., Lutsey, P. L., Martin, S. S., Matsushita, K., Moran, A. E., Mussolino, M. E., Perak, A. M., Rosamond, W. D., Roth, G. A., Sampson, U. K. A., Satou, G. M., Schroeder, E. B., Shah, S. H., Shay, C. M., Spartano, N. L., Stokes, A., Tirschwell, D. L., Vanwagner, L. B., & Tsao, C. W. (2020). Heart Disease and Stroke Statistics—2020 Update: A Report From the American Heart Association. *Circulation, 141*(9). https://doi.org/10.1161/cir.0000000000000757

Weihrauch-Blüher, S., Schwarz, P., & Klusmann, J.-H. (2019). Childhood obesity: increased risk for cardiometabolic disease and cancer in adulthood. *Metabolism, 92*, 147-152. https://doi.org/10.1016/j.metabol.2018.12.001

White, B. A., Cordie-Garcia, L., & Fuller-Thomson, E. (2016). Incarceration of a family member during childhood is associated with later heart attack: Findings from two large, population-based studies. *Journal of Criminal Justice, 44*, 89-98. https://doi.org/https://doi.org/10.1016/j.jcrimjus.2015.12.006

White, L. K., Barzilay, R., Moore, T. M., Calkins, M. E., Jones, J. D., Himes, M. M., Young, J. F., Gur, R. C., & Gur, R. E. (2023). Risk and Resilience Measures Related to Psychopathology in Youth. *Child Psychiatry & Human Development, 54*(4), 961-972. https://doi.org/10.1007/s10578-021-01296-2

Williams, R. C., Biscaro, A., & Clinton, J. (2019). Relationships matter: How clinicians can support positive parenting in the early years. *Paediatrics & Child Health, 24*(5), 340-347. https://doi.org/10.1093/pch/pxz063

Yamaoka, Y., & Bard, D. E. (2019). Positive Parenting Matters in the Face of Early Adversity. *Am J Prev Med, 56*(4), 530-539. https://doi.org/10.1016/j.amepre.2018.11.018

Supplemental Material

Table 6.1

Principal Component Descriptive Statistics

Principal Component	Count	Mean (SD)
1 Positive Social and Emotional Engagement	4	3.50 (0.889)
2 Neighborhood Characteristics	3	2.49 (0.678)
3 Overall caregiver health and Family Resilience	3	2.20(0.960)
4 Community Involvement/ Extracurricular Participation	2	1.12 (0.715)
5 Access to community/ Healthcare Resources	3	1.68(0.717)

Table 6.2

Alternative PCA Model retaining 14 PCEs

	Total (n=55, 233)		
Rotated Principal Component	**n**	**%**	**Loading**
1. Positive social and emotional engagement			
Family Shares Ideas (PC1)	52,413		0.317
School engagement (PC1)	44,384		0.335
Making and keeping friends (PC1)	52,058		0.326
Flourishing for children and adolescents (PC1)	44,557		0.352
2. Neighborhood			
Safe Neighborhood (PC2)	53,345		0.4492
Low/ no neighborhood detracting elements (PC2)	50,680		0.439
Supportive neighborhood (PC2)	33,651		0.366
3. Community involvement/ extracurriculars			
Participation in organized activities (PC4	42,309		0.484

Participation in community service or volunteer work (PC4)	19,694	0.570
Adult Mentor (PC5)	49,963	0.379
4. Overall caregiver health		
Physically healthy caregiver (PC3)	36,593	0.592
Mentally healthy caregiver (PC3)	38,323	0.544
5. Access to community/ healthcare resources		
Neighborhood Amenities (PC5)	33,423	0.560
Well-Functioning System of Care (PC5)	9,772	0.614

Table 6.3

Moderation of ACEs and Demographic variables on the relationship between PCEs and CVH Indicators

Secondhand Smoke

	PC1		PC2		PC3		PC4		PC5		PCE Count	
Interaction	**OR**	95% CI	**OR**	95% CI	**OR**	95% CI	**OR**	95% CI	**OR**	95% CI	**OR**	95% CI
Sex	1.020	[0.904,1.15]	1.060	[0.903,1.25]	1.030	[0.934,1.14]	1.000	[0.865,1.15]	0.905	[0.782,1.04]	1.000	[0.961,1.05]
Age												
10-14 years	0.960	[0.841,1.09]	0.913	[0.775,1.07]	1.000	[0.889,1.13]	0.980	[0.823,1.16]	1.020	[0.867,1.21]	0.988	[0.939,1.03]
15-17 years	0.910	[0.786,1.05]	0.844	[0.675,1.05]	0.955	[0.838,1.08]	0.923	[0.761,1.11]	1.060	[0.882,1.27]	0.959	[0.904,1.01]
Race/Ethnicity												
Hispanic	1.010	[0.835,1.23]	1.090	[0.854,1.40]	1.150	[0.982,1.34]	1.220	[0.972,1.53]	**1.5***	[1.21,1.87]	**1.08***	[1.00,1.17]
NH Black	0.971	[0.825,1.14]	**1.32***	[1.06,1.65]	0.962	[0.813,1.13]	0.934	[0.740,1.17]	1.140	[0.899,1.46]	1.020	[0.955,1.09]
Multi-Racial/ Other	**1.14***	[1.00,1.31]	1.090	[0.903,1.31]	1.050	[0.918,1.21]	**1.22***	[1.00,1.49]	**1.26***	[1.03,1.55]	**1.07***	[1.01,1.13]
ACEs												
1 ACE	**1.27***	[1.07,1.51]	1.230	[0.969,1.57]	1.100	[0.956,1.26]	1.170	[0.979,1.41]	1.030	[0.854,1.25]	**1.09***	[1.02,1.17]
≥2 ACEs	**1.26***	[1.09,1.46]	1.190	[0.962, 1.49]	1.040	[0.918,1.19]	1.170	[0.994,1.39]	1.040	[0.878,1.23]	**1.09***	[1.02,1.15]

Physical Activity

	PC1		PC2		PC3		PC4		PC5		PCE Count	
Interaction	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI
Insufficient PA												
Sex	0.931	[0.818,1.06]	1.05	[0.909,1.21]	1.01	[0.918,1.13]	**1.23***	[1.08,1.39]	0.988	[0.875,1.11]	1.02	[0.975,1.06]
Age												
10-14 years	**0.864***	[0.759,0.985]	1.05	[0.898,1.24]	1.04	[0.933,1.17]	0.914	[0.793,1.05]	0.942	[0.822,1.08]	0.979	[0.932,1.02]
15-17 years	**0.775***	[0.647,0.927]	1.04	[0.865,1.25]	1.13	[0.981,1.31]	0.863	[0.725,1.02]	0.958	[0.817,1.12]	0.978	[0.915,1.04]
Race/Ethnicity												
Hispanic	1.1	[0914,1.32]	1.16	[0.955,1.41]	**1.30***	[1.11,1.52]	0.956	[0.791,1.15]	**1.20***	[1.00,1.44]	**1.09***	[1.01,1.16]
NH Black	**1.28***	[1.05,1.55]	0.933	[0.732,1.18]	**1.25***	[1.05,1.49]	0.867	[0.682,1.10]	0.839	[0.681,1.03]	1.02	[0.944,1.11]

Multi-Racial/ Other	0.993	[0.850,1.16]	1.11	[0.913,1.35]	1.09	[0.963,1.24]	0.986	[0.837,1.16]	0.984	[0.837,1.15]	1.01	[0.961,1.07]
ACEs												
1 ACE	1	[0.849,1.19]	1.19	[0.976,1.45]	0.919	[0.799,1.05]	0.895	[0.761,1.05]	1.05	[0.899,1.24]	0.999	[0.931,1.07]
≥2 ACEs	1.13	[0.989,1.30]	**1.23***	[1.05,1.45]	1.03	[0.914,1.18]	1	[0.861,1.17]	1.08	[0.932,1.26]	**1.05***	[1.00,1.11]
No PA												
Sex	0.912	[0.779,1.06]	0.926	[0759,1.13]	0.935	[0.806,1.08]	**1.59***	[1.30,1.95]	1.12	[0.908,1.38]	1.03	[0.968,1.09]
Age												
10-14 years	0.858	[0.713,1.03]	1.01	[0.795,1.30]	1.03	[0.863,1.24]	1.04	[0.778,1.41]	0.867	[0.652,1.15]	0.965	[0.892,1.04]
15-17 years	**0.725***	[0.582,0.903]]	1.01	[0.784,1.30]4	1.04	[0.856,1.27]	1.05	[0.780,1.43]	0.889	[0.668,1.18]	0.94	[0.861,1.02]
Race/Ethnicity												
Hispanic	1.10	[0.894,1.37]	1.16	[0.911,1.50]	1.12	[0.918,1.38]	1.000	[0.749,1.34]	1.06	[0.820,1.38]	1.05	[0.965,1.14]
NH Black	**1.39***	[1.11,1.75]	1.07	[0.806,1.44]	**1.24***	[1.00,1.54]	**0.692***	[0.494,0.968]	1.000	0.723,1.38]	1.05	[0.949,1.16]
Multi-Racial/ Other	1.06	[0.868,1.29]	**1.39***	[1.03,1.89]	0.972	[0.807,1.17]	0.999	[0.751,1.32]	0.865	[0.623,1.20]	1.00	[0.928,1.07]
ACEs												
1 ACE	1.07	[0.877,1.31]	**1.40***	[1.06,1.84]	0.868	[0.712,1.05]	0.956	[0.725,1.26]	1.04	[0.797,1.37]	1.03	[0.941,1.13]
≥2 ACEs	**1.41***	[1.181.69]	1.21	[0.966,1.52]	1.01	[0.844,1.21]	1.05	[0.838,1.33]	1.17	[0.920,1.50]	**1.11***	[1.04,1.20]

Sleep

	PC1		**PC2**		**PC3**		**PC4**		**PC5**		**PCE Count**	
Interaction	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI
Suboptimal												
Sex	0.959	[0.869,1.05]	0.993	[0.882,1.11]	1.03	[0.948,1.11]	1.09	[0.974,1.22]	1.09	[0.973,1.23]	1.01	[0.981,1.05]
Age												
10-14 years	1.02	[0.915,1.15]	1.11	[0.968,1.28]	0.996	[0.901,1.10]	**1.17***	[1.01,1.35]	**1.25***	[1.09,1.44]	**1.05***	[1.01,1.10]
15-17 years	0.917	[0.808,1.04]	1.15	[0.989,1.34]	1.01	[0.912,1.13]	**1.45***	[1.25,1.69]	**1.31***	[1.12,1.53]	1.02	[1.02,1.12]
Race/Ethnicity												
Hispanic	1.02	[0.891,1.17]	**1.18***	[1.01,1.38]	1.11	[0.995,1.25]	1.01	[0.865,1.19]	1.01	[0.894,1.22]	1.04	[0.998,1.09]
NH Black	1.01	[0.872,1.18]	1.04	[0.868,1.25]	0.945	[0.824,1.08]	1.08	[0.913,1.28]	1.17	[0.975,1.42]	1.02	[0.963,1.07]
Multi-Racial/ Other	**1.16***	[1.02,1.32]	1.06	[0.904,1.24]	**1.17***	[1.04,1.31]	1.05	[0.890,1.25]	0.939	[0.792,1.11]	**1.05***	[1.00,1.10]
ACEs												

1 ACE	0.969	[0.853,1.10]	1.09	[0.932,1.27]	1.05	[0.946,1.17]	1.04	[0.908,1.19]	**1.23***	[1.06,1.43]	1.04	[0.999,1.09]
≥2 ACEs	1.08	[0.962,2.21]	1.06	[0.925,1.22]	1.05	[0.950,1.16]	**1.24***	[1.08,1.42]	1.05	[0.913,1.22]	**1.06***	[1.02,1.11]
Very Suboptimal												
Sex	0.878	[0.766,1.00]	1.02	[0.857,1.21]	0.946	[0.825,1.08]	0.963	[0.800,1.15]	0.917	[0.760,1.10]	0.975	[0.921,1.03]
Age												
10-14 years	1.06	[0.900,1.26]	1.06	[0.863,1.31]	1.18	[0.990,1.41]	1.22	[0.951,1.58]	1.13	[0.908,1.42]	**1.07***	[1.00,1.15]
15-17 years	1.14	[0.960,1.36]	1.11	[0.880,1.40]	**1.31***	[1.08,1.59]	**1.36***	[1.04,1.77]	**1.33***	[1.05,1.68]	**1.15***	[1.07,1.24]
Race/Ethnicity												
Hispanic	0.98	[0.808,1.18]	1.04	[0.836,1.30]	0.988	[0.816,1.19]	0.969	[0.760,1.23]	**1.38***	[1.09,1.75]	1.01	[0.935,1.09]
NH Black	1.02	[0.855,1.23]	1.04	[0.837,1.30]	1.04	[0.878,1.23]	0.982	[0.762,1.26]	1.02	[0.782,1.34]	1.01	[0.939,1.09]
Multi-Racial/ Other	**1.22***	[1.04,1.42]	0.913	[0.720,1.15]	0.946	[0.791,1.13]	1.15	[0.907,1.46]	**1.27***	[1.00,1.60]	1.03	[0.973,1.11]
ACEs												
1 ACE	1.11	[0.930,1.33]	1.1	[0.864,1.42]	**1.21***	[1.00,1.46]	1.07	[0.841,1.36]	0.967	[0.749,1.24]	1.07	[0.991,1.16]
≥2 ACEs	**1.27***	[1.08,1.49]	1.03	[0.832,1.28]	1.17	[0.992,1.39]	1.01	[0.832,1.24]	1.15	[0.946,1.40]	**1.09***	[1.01,1.17]

BMI

	PC1		**PC2**		**PC3**		**PC4**		**PC5**		**PCE Count**	
Interaction	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI	**RR**	95% CI
Overweight												
Sex	0.98	[0.868,1.10]	1.08	[0.935,1.24]	1.07	[0.970,1.18]	0.925	[0.805,1.06]	0.955	[0.819,1.11]	1.00	[0.963,1.05]
Age												
10-14 years	0.912	[0.780,1.06]	0.892	[0.747,1.06]	0.948	[0.839,1.07]	0.881	[0.740,1.04]	105	[0.878,1.27]	0.964	[0.912,1.01]
15-17 years	0.96	[0.820,1.12]	1.00	[0.824,1.22]	0.97	[0.844,1.11]	1.02	[0.848,1.23]	0.98	[0.795,1.20]	0.993	[0.937,1.05]
Race/Ethnicity												
Hispanic	0.953	[0.801,1.13]	0.995	[0.831,1.1]	1.04	[0.906.1.20]	0.967	[0.795,1.17]	0.954	[0.781,1.16]	0.992	[0.935,1.05]
NH Black	1.06	[0.897,1.25]	**1.25***	[1.00,1.56]	1.08	[0.944.1.25]	1.1	[0.891,1.35]	1.11	[0.893,1.40]	**1.06***	[1.00,1.13]
Multi-Racial/ Other	0.958	[0.821,1.11]	1.09	[0.890,1.35]	1.06	[0.931.1.21]	1.12	[0.926,1.35]	0.97	[0.797,1.18]	1.01	[0.961,1.08]
ACEs												
1 ACE	0.982	[0.846,1.14]	1.16	[0.952,1.41]	0.975	[0.853,1.11]	1.06	[0.898,1.27]	1.11	[0.914,1.36]	1.02	[0.968,1.09]

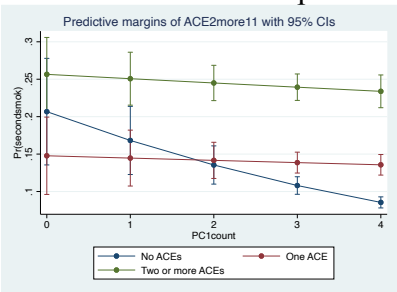
≥2 ACEs	0.978	[0.844,1.13]	1.03	[0.878,1.22]	0.997	[0.884,1.12]	1	[0.844,1.19]	1.16	[0.972,1.38]	1.01	[0.965,1.07]
Obese												
Sex	**0.821***	[0.736,0.916]	0.909	[0.786,1.05]	0.959	[0.870,1.05]	0.874	[0.758,1.00]	1.10	[0.970,1.26]	**0.957***	[0.919,0.996]
Age												
10-14 years	0.941	[0.8281.07]	0.971	[0.831,1.13]	1.03	[0.918,1.15]	0.952	[0.804,1.12]	0.989	[0.851,1.15]	0.99	[0.946,1.03]
15-17 years	**0.857***	[0.744,0.987]	0.906	[0.738,1.11]	0.95	[0.838,1.07]	1.04	[0.868,1.26]	1.09	[0.921,1.30]	0.974	[0.924,1.02]
Race/Ethnicity												
Hispanic	1.04	[0.905,1.21]	1.07	[0.894,1.29]	1.06	[0.940,1.21]	1.12	[0.933,1.35]	1.08	[0.912,1.28]	1.03	[0.985,1.09]
NH Black	1.13	[0.975,1.31]	**1.35***	[1.12,1.63]	**1.19***	[1.02,1.38]	1.07	[0.971,1.33]	1.2	[0.987,1.48]	**1.10***	[1.04,1.17]
Multi-Racial/ Other	1.02	[0.897,1.16]	1.03	[0.860,1.23]	1.03	[0.916,1.17]	0.937	[0.770,1.14]	1.12	[0.949,1.34]	1.01	[0.963,1.06]
ACEs												
1 ACE	1.07	[0.922,1.25]	1.11	[0.913,1.35]	1.02	[0.899,1.16]	1.04	[0.874,1.25]	1.14	[0.970,1.35]	1.04	[0.989,1.11]
≥2 ACEs	1.1	[0.968,1.25]	0.902	[0.857,1.22]	0.941	[0.832,1.06]	1.14	[0.970,1.35]	1.11	[0.947,1.30]	1.03	[0.982,1.08]

Figure 6.1

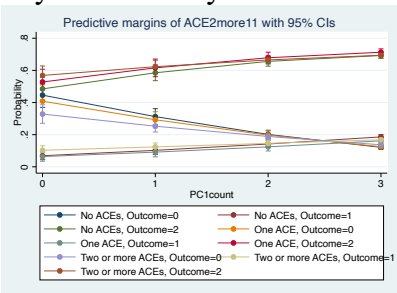
Predictive margins of significant interactions with separated principal components

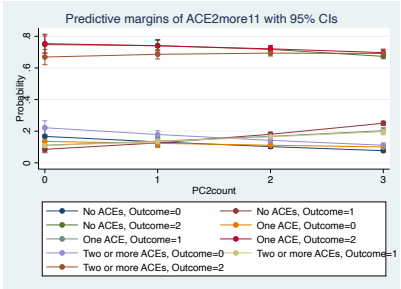
ACEs

Secondhand Smoke Exposure

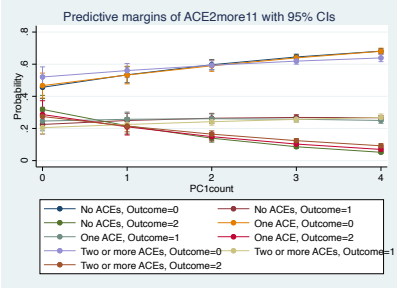


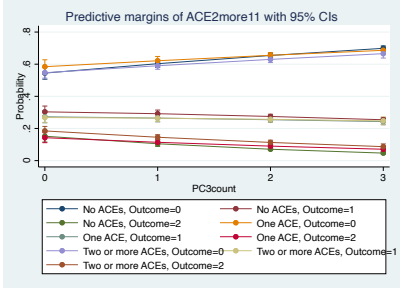
Physical Activity

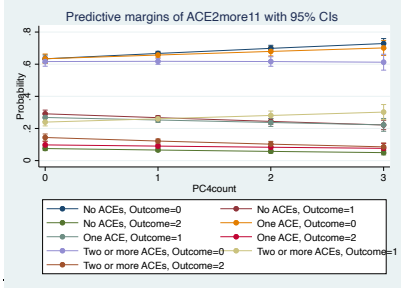


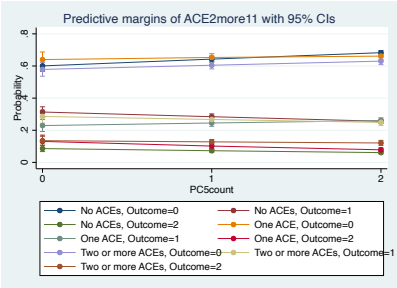


Sleep





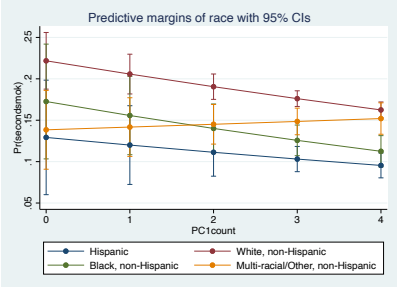


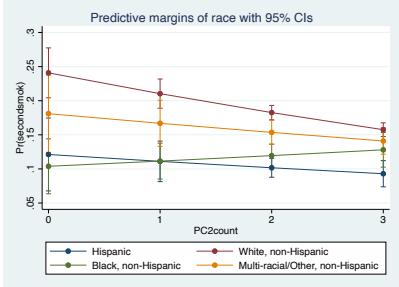


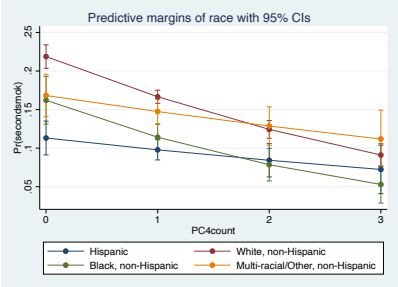
Demographic Interactions

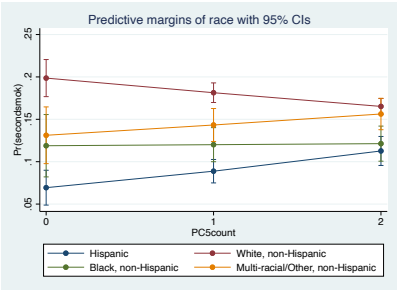
Race/Ethnicity

Secondhand Smoke Exposure

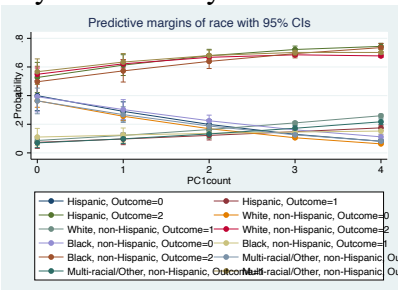


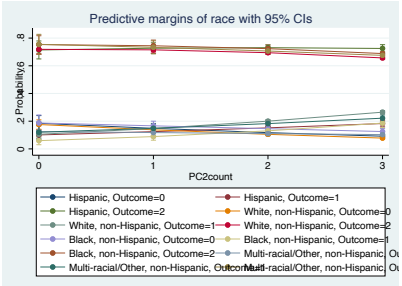


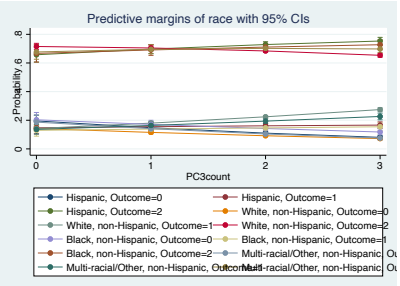


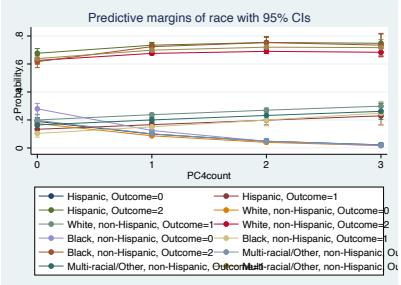


Physical Activity

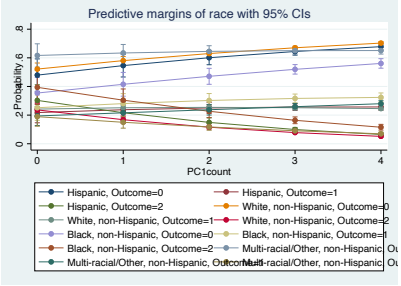


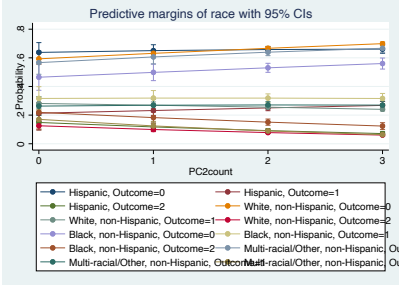


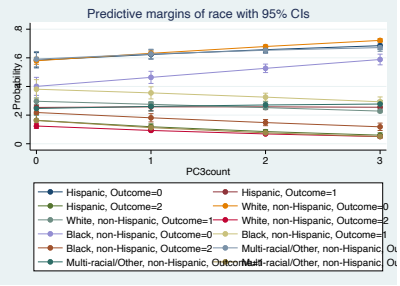


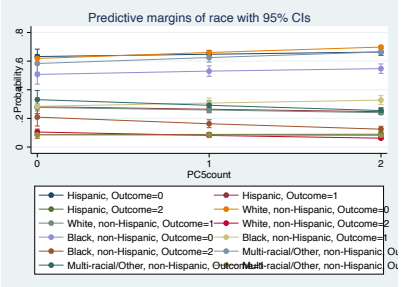


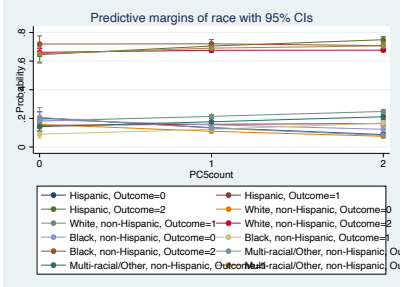
Sleep



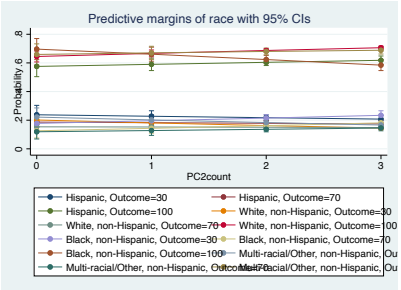


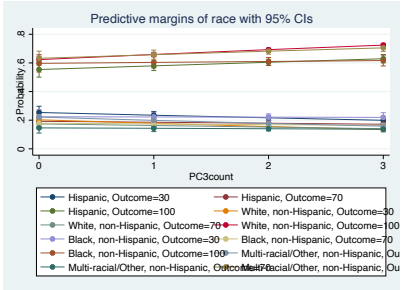






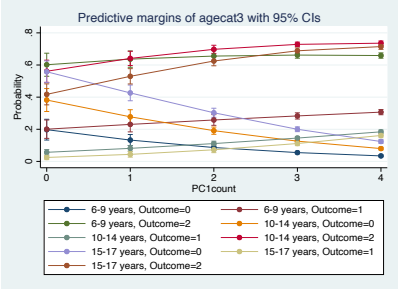
BMI



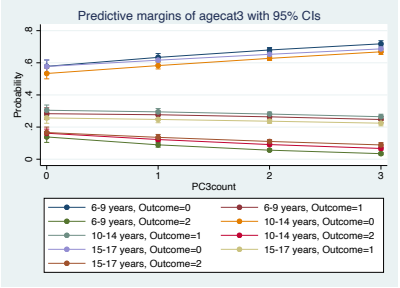


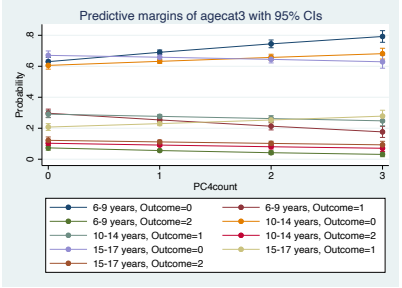
Age

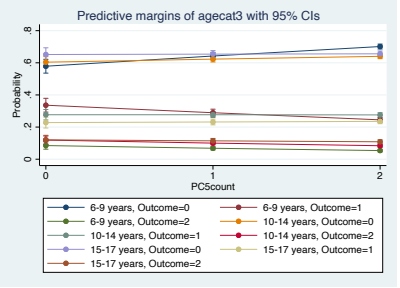
Physical Activity



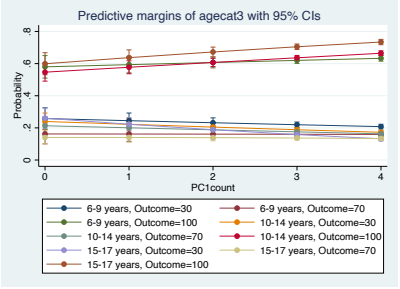
Sleep





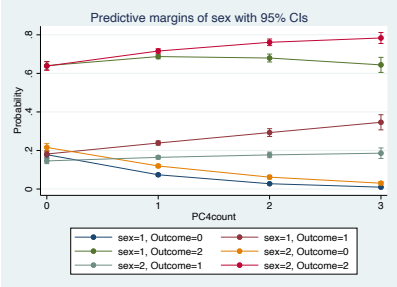


BMI

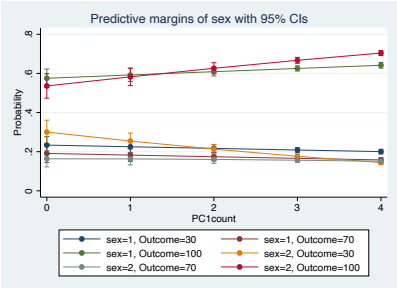


Sex

Physical Activity



BMI



5-year Trend Analysis: Prevalence estimates for 2019-2021

Table 6.4

Prevalence estimates for CVH Indicators 2019-2021

CVH Indicator	2019		2020		2021	
	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI
Secondhand Smoke	14.5%	13.5-15.6	14.7%	13.8-15.7	13.9%	12.7-14.3
Physical activity						
Meets Guidelines	9.0%	[8.1-10.1]	12.6%	[11.8-13.6]	10.7%	[9.9-11.6]
Insufficient PA	69.2%	[64.7-70.6]	67.4%	[66.2-68.6]	68.1%	[66.9-69.3]
No PA	21.7%	[20.5-23.0]	19.9%	[18.9-20.8]	21.1%	[18.0-19.7]
Sleep						
Meets guidelines	65.6%	[64.1-67.1]	66.0%	[64.7-67.3]	66.4%	[65.2-67.6]
Suboptimal	25.8%	[24.4-27.2]	25.6%	[24.4-26.7]	24.3%	[23.3-25.4]
Very Suboptimal	8.5%	[7.70-9.5]	8.3%	[7.6-9.2]	9.2%	[8.4-10.0]
BMI Category						
Normal/ Underweight	69.3%	[67.4-71.1]	67.4%	[65.9-68.9]	66.1%	[64.4-67.6]
Overweight	15.2%	[13.9-16.5]	16.4%	[15.3-17.7]	16.1%	[14.9-17.4]
Obese	15.4%	[13.9-17.1]	16.1%	[14.9-17.3]	17.8%	[15.2-17.4]

Table 6.5

Prevalence estimates for PCEs 2019-2021

PCEs	2019		2020		2021	
	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI	Prevalence Estimate	95% CI
PC1. Positive Social and Emotional Engagement						
Family shares ideas	95.7%	95.1-96.2	94.5%	93.9-95.1	94.7%	94.1-95.4
School engagement	85.4%	84.4-86.3	81.8%	80.8-82.8	81.3%	80.2-82.3
Making and keeping friends	95.4%	94.7-96.0	95.6%	95.1-96.0	95.0%	94.4-95.6
Flourishing for children and adolescents	86.1%	85.0-87.2	81.8%	80.8-82.8	81.7%	80.7-82.7
PC2. Neighborhood Characteristics						
Safe neighborhood	94.1%	93.1-94.9	94.8%	94.0-95.5	95.4%	94.7-96.0
Low/ no neighborhood detracting elements	89.4%	88.3-90.5	89.6%	88.6-90.5	91.0%	90.7-92.0
Supportive neighborhood	54.7%	53.1-56.2	56.6%	55.3-57.9	58.4%	57.1-59.7
PC3. Overall Caregiver Health and family resilience						
Physically healthy caregiver	64.8%	63.3-66.4	64.4%	63.1-65.6	64.6%	63.3-65.9
Mentally healthy caregiver	75.5%	74.1-76.8	71.9%	70.7-73.1	70.6%	69.4-71.7
Family resilience	81.8%	80.6-82.9	84.9%	84.0-85.8	84.3%	83.3-85.2
PC4. Community Involvement/Extracurricular Participation						
Participation in organized activities	80.2%	78.8-81.5	75.9%	74.6-77.1	68.4%	67.1-69.6
Participation in community service or volunteer work	43.7%	42.2-45.2	37.8%	36.6-39.0	31.9%	30.8-33.1
PC5. Access to community/healthcare resources						
Neighborhood amenities	60.5%	58.9-62.0	59.6%	58.3-60.8	59.6%	58.3-60.9
Adult mentor	89.2%	88.1-90.2	86.6%	85.5-87.6	85.8%	84.7-86.9
PCE Count	10.9	10.9-11.0	10.7	10.7-10.8	10.6	10.5-10.7