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The Impact of Adverse Childhood Experiences on Household Resources, Intergenerational Risk of Adversity, and Behavior Problems in Subsequent Generations

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The Impact of Adverse Childhood Experiences on Household Resources, Intergenerational Risk of Adversity, and Behavior Problems in Subsequent Generations

A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Health Policy and Management

by

Adam Schickedanz

2018

ABSTRACT OF THE DISSERTATION

The Impact of Adverse Childhood Experiences on Household Resources, Intergenerational Risk of Adversity, and Behavior Problems in Subsequent Generations

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Adam Schickedanz

Doctor of Philosophy in Health Policy and Management

University of California, Los Angeles, 2018

Professor Paul J. Chung, Chair

Adverse childhood experiences (ACEs) have well-described life-course health correlates including higher risk of common chronic mental and physical illnesses. There is little evidence on the potential medical costs associated with experiencing more ACEs, nor on the associations between ACEs in parents and maltreatment or behavioral health problems in their children. Using the Panel Study of Income Dynamics (PSID) and its supplements, this series of studies examines 1) the differences in household out-of-pocket medical costs by the number of ACEs that individuals have experienced, 2) intergenerational associations and mediators between parents' reported ACEs and ACEs reported by their adult children, and 3) the risk of child behavioral problems as a function of parent ACE counts. I find that increases in self-reported ACE scores are associated with increases in out-of-pocket medical expenses, showing a novel link within individuals between health care costs to the ACE score. Across generations, I find that parent mental health and parenting attitudes partially mediate the associations between parents' and children's ACE scores. I show that children's behavioral health problems, including attention deficit hyperactivity disorder and childhood emotional disturbance diagnoses, are positively associated with their parents' ACE scores with partial mediation by parent mental health and parenting attitudes as well. These findings extend the growing literature on ACEs and suggest opportunities to improve clinical practice through risk stratification based on ACE scores. These studies also validate an approach for studying ACEs and their financial and health consequences using the PSID.

The dissertation of Adam Schickedanz is approved.

José J. Escarce

Neal Halfon

Narayan Sastry

Paul J. Chung, Committee Chair

University of California, Los Angeles

2018

This work is dedicated to Judy and David Schickedanz for their guidance, to Aria Schickedanz for her empathy, and to Heather Bennett Schickedanz for her patience.

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Biographical Summary: Adam Schickedanz

"The child is the father of the man"

~William Wordsworth

From "My Heart Leaps Up", written 1802

I am a pediatrician and researcher whose parents left small towns in Illinois when they were young to dedicate their lives to helping children achieve their full potential. My mother knew her father for just a few years before she and her three siblings lost him and their home on the farm. My maternal grandmother, a teacher in the single-room schoolhouse in town, made do through grit, good sense, and a great community. She raised my mother and her brothers and sister, who are now all retired professionals. I suspect my mother's experience as the eldest daughter raising her younger siblings had everything to do with her choice to pursue a doctoral degree in child development and teach generations of teachers to foster the brilliance of young children. My father's father told me stories of growing up witnessing his father's violence fueled under the influence of alcohol. Quite deliberately, my father and grandfather chose the opposite path in life from that man whose abuse was so indelible in our family history. After my parents got their degrees, my father began his practice as a child psychologist in a working-class factory town in northern Massachusetts where he worked with families for the next thirty years.

There is no denying that I carry my family history – which on balance carries much more joy than struggle, despite what I have shared here -- with me, whether in the clinic or at home with my daughter. The continuum of these past and present experiences animates the work described in this document. Thank you for reading this latest result of generations of effort.

Chapter One

Introduction

Adverse childhood experiences (ACEs) are stressful and potentially traumatic events, including abuse, neglect, and exposure to household dysfunction, that occur any time before age eighteen. Adverse childhood experiences are associated with higher risk of worse mental and physical health in adulthood and have been shown to predict a number of significant adverse outcomes over the lifecourse, including greater risk-taking behavior, worse mental health, riskier health-related behaviors, greater chronic disease burden, and premature mortality.[1] [2] [3] Evidence on the impact of ACEs over the lifecourse also suggests they are associated with earlier appearance of biochemical and physiologic markers of cardiovascular and metabolic disease.[4] [5] [6]

The implications for health care costs associated with higher ACE count over the lifecourse, the risk due to a parent's ACEs of intergenerational transmission of adversity, nor the risk of behavioral problems for children in subsequent generations associated with parents' ACEs have not been explored. Below I describe gaps in the literature regarding costs of ACEs over the lifecourse and intergenerational risks associated with ACE exposure. In so doing, I provide a rationale for the three studies undertaken through the dissertation research that will address these evidence gaps. I will begin with an overview of the effects of child adversity, the utility and

evolution of ACEs, and explanation of how the terms "ACEs" and "adversity" will be used throughout the dissertation.

Adversity, Adverse Childhood Experiences, and Our Use of Overlapping Terminology

Childhood adversity is a broadly inclusive construct that has been applied to a host of stressful experiences early in life, from growing up in an overcrowded home to personally experiencing physical abuse. Consideration of childhood adversity as a risk factor for worse health – especially mental health – later in life is not new (see Freudian psychoanalytic theories[7], for instance), but our understanding of which adverse experiences have health impacts and how the stress they can create gets under the skin has been evolving over the last fifty years. This evolution will only continue as our ability to measure adversity and its consequences improves.

In fields such as pediatrics, a very distilled measure of adversity has emerged and taken hold: the Adverse Childhood Experiences (ACEs) score. Much of the current discussion of childhood adversity and its health effects in pediatrics, child psychology, child welfare, and public health has focused on ACEs, which are typically defined as a subset of abuse, neglect, or household dysfunction experiences subsumed under the umbrella of childhood adversity more broadly. Widespread adoption of ACEs and their binned count (the ACE score) as the accepted index of childhood adversity has taken place in the clinical literature, but based on the ACEs literature's dearth of references to prior studies of childhood adversity it appears this change has occurred with little attention to the theories, concepts, and constructions of adversity measures that came before. While the studies I propose below utilize the ACEs framework to measure childhood adversity as the primary predictor variable, it is important to acknowledge and clarify up front how and why the ACE score construct overlaps with, synthesizes, and omits concepts from the broader

childhood adversity literature. By clarifying these distinctions between ACEs and broader construct(s) of childhood adversity, I hope to make clear how this work fits into literatures on both ACEs and childhood adversity broadly.

A substantial evidence base had linked "stressful" life events to physical and mental health outcomes at least half a century before the first ACEs study was published.[8] Research on stress examined the short- and medium-term effects of various stressors on acute physiologic events (e.g. cardiac events) and severity of chronic medical conditions, but little research focused on early stresses on children and their later health effects until longitudinal studies, such as the series of British Birth Cohort studies, measured early life conditions and environments that predicted later life mental and physical health. In addition to detailing relationships such as links between low birthweight, stunted early life height and weight velocity, and later hypertension, important associations were found between lower childhood socioeconomic position and worse adult health.[9] The 1946 British Birth Cohort study investigators attempted to quantify childhood adversity using a summative adversity scale, compiling variables such as family socioeconomic status, school circumstances, parents' age, childhood health problems, household structure (including parental separation and parental death), and somewhat outdated concepts of neuroticism that may have represented parental mood disorder symptomatology. The overall childhood adversity scale and its components were found to have somewhat inconsistent overall relationships with later adult affective disorders and emotional disturbance, but parental separation and mothers' nervous symptoms showed strong links with children's later mental health, especially when the children who experienced them were female and younger at the time of exposure.[10] Those whose parents separated were also more likely to engage in unhealthy behaviors such as alcohol consumption and smoking, suggesting that they had adopted these behaviors as coping strategies for lingering

emotional distress.[11] [12] Since the explosion of the ACEs literature, birth cohort studies subsequent to the first British Birth Cohort have aged up sufficiently to identify links between early adversity and mid-life risk of somatic pain, obesity, adult-onset diabetes, cancer, and other health outcomes.[13] [14] [15]

Contemporaneous with longitudinal studies showing higher risk of mental health problems and unhealthy habits for adults who had grown up in low socioeconomic status households with greater parental dysfunction, literatures on the health effects of specific types of childhood adversity (such as sexual abuse, physical abuse, etc.) emerged in parallel over the three decades preceding the Felitti ACEs study. Mood disorder, other psychiatric illnesses, and behavioral health problems (including substance use) were each individually shown to be associated with childhood exposure to physical abuse,[16] [17] [18] sexual abuse,[19] [20] [21] [22] [23] and loss of a parent.[24] [25] [26] [27] [28] [29] Smaller literatures with consistent evidence suggested that similar adult psychiatric comorbidities were predisposed by exposure to intimate partner violence[30] and parental substance abuse.[31] [32] [33] Literature on the impact of divorce and parental separation showed more varied effects that depended largely on resilience factors and individual family coping styles.[34] By the mid-1990s and the years immediately preceding the Felitti ACEs study, it had become clear that the cumulative "social stress" of multiple adverse events experienced by children ought to be examined, rather than focusing on single adverse events, to better estimate the child's risk of later psychiatric illness.[35] [36] [37] Other key concepts were also beginning to emerge shortly before the Felitti ACEs study, such as the capacity for resilience factors to buffer against mental health problems after childhood adverse events.[38] [39]

When Vincent Felitti's ACEs study[40] grouped adverse child experiences across domains of abuse, neglect, and household dysfunction, it represented a key advance in the field of childhood adversity studies for multiple reasons. First, the study successfully bundled adverse childhood experiences into an easily-measurable ACEs scale *and* showed that the scale was related to a host of well-defined physical and mental health outcomes (including leading causes of mortality such as heart disease, cancer, and chronic lung disease). The notion that the health impact of multiple early adversity events could be cumulative had been proposed almost two decades earlier,[41] but in that time period there had been no large study showing an association between cumulative adverse events of a wide variety (i.e. inclusive of abuse, neglect, and household dysfunction experiences) and physical health outcomes. While the Felitti study was not the first study to attempt to aggregate these sources of childhood adversity across domains,[42] prior studies (aside from the birth cohort studies) often had limited the length of retrospective recall (to "in the last year…", for example)[43] to minimize the risk of recall bias or omissions, which may have inadvertently masked the extent of associations between child adversity and adult health and that we now recognize has substantial lag. The Felitti ACE score gave equal weight to each of the adverse experiences it queried without a clear evidentiary rationale for this weighting scheme. In fairness, no clear evidentiary rationale for an alternative weighting existed either. In addition to the adverse event bundling innovation, the study took advantage of strong objective health outcome data and relied on a longer recall time to uncover substantially lagged health effects of adversity.

Since the Felitti study, the literature on ACEs has seen tremendous growth, with the number of articles indexed on by the U.S. National Library of Medicine containing the phrase "adverse childhood experiences" growing over fifty-fold between 1999 and 2017. New datasets measuring ACEs have emerged and different constructions of the individual ACEs have been developed.

Large scale studies have been launched to measure ACEs prospectively from childhood, while other ACE measures have been adopted piecemeal in other studies. Currently, various versions of the ACE question items and their compilation have emerged in the literature. Table 1-1 has compiled some of the most often-cited or recently published ACE questions and scales. While the ACE scales differ to some extent in terms of ACE domains covered and ACE question phrasing, they all encompass multiple domains of childhood abuse, neglect, and household dysfunction. Despite the variation found in published ACE scales, what has emerged from the literature is a remarkably consistent pattern showing that a range of ACE score constructions yield similar patterns of association with long-term risks to health and well-being. For the studies described in this dissertation, the ACE domains chosen when constructing the ACE count and score matched the Felitti domains whenever feasible in an attempt to adhere as closely as possible to the original conventional ACE score.

The equal weighting of all the ACEs within the Felitti ACE score was consistent with the contemporary notion of a final common neuroendocrine stress pathway linking the health effects of disparate adverse childhood experiences, though it distilled adversity down to its most basic, punctuating experiences and left alone details around timing, intensity, and adaptation or resilience.[44] [45] [46] The stress pathway from increased allostatic load and "toxic" stress to dysregulation of the hypothalamic-pituitary-adrenal axis is now seen as a key mechanism by which various types of childhood adversity impact adult mental and physical health. But other pathways and downstream physiologic mechanisms of biological embedding are also emerging, such as earlier cell senescence with shortened telomere length, increased inflammation, selective epigenetic changes through methylation patterns, and emotional dysregulation corresponding to changes in neural structure in children exposed to adversity (from various adverse experiences and

events) in utero or early in life.[47 48 49 50 51 52] It remains unclear whether these neurobiological mechanistic pathways are part of a single process or run in parallel in response to stress, but it appears that now the field studying the health impacts of childhood adversity has accepted that various forms of adversity and increased allostatic load culminate in ill health over the long term if the resultant stress is sufficient. Whether a child experiences health-threatening stress from any given adverse experience depends on how he or she copes with or internalizes the stress, what resources are at his or her disposal to manage (physiologically, socially, cognitively, etc), and how any coping strategies and resources he or she employs impinge upon the opportunity to avail himself or herself of other health-promoting opportunities.

In parallel to the rise of the ACEs literature, basic and longitudinal research on adversity (broadly-defined) within animal models, individuals, and families have continued to evolve and inform much of the current understanding of these biological adversity embedding pathways, as well as an understanding of the longitudinal consequences of childhood adversity more generally.[53 54 55 56 57] These literatures (both in the basic science of the stress response and longitudinal studies of children exposed to early life stress) have cultivated a broad view of what childhood adversity encompasses, including interpersonal experiences similar to the ACEs framework, household social and economic marginalization (i.e. poverty, financial strain, and discrimination), and neighborhood level disadvantage (in terms of economic resources, social capital, and community cohesion).[58] In addition, they have demonstrated the existence of sensitive developmental periods during which stressful environments or experiences are more likely to result in a lasting and harmful effect, whether in terms of epigenetic chromosomal methylation patterns or higher order processes such as the development of mental illness.[59 60 61 62 63] However, for other evident harms of early life adversity such as adult cardiovascular disease risk,[64] the weight of the evidence has

suggested that adversity timing matters less than cumulative adversity dose.[65] [66] One particularly important insight from basic animal models of early adversity for the present dissertation studies has been the consistent finding that early life stress is particularly disruptive to the normal development of the neurocognitive threat-response and neuroendocrine stress-response systems,[67] [68] [69] and these disruptions explain the finding in longitudinal human studies of particularly elevated risk of worse developmental and behavioral health outcomes in adults exposed to early adversity.[70] [71] [72] Though the basic science and longitudinal studies in the contemporary fields of research on early adversity have yielded tremendous insights, they have not arrived at a gold standard for or universal agreement on what the concept of adversity encompasses,[73] and attempts by researchers in the field to nail down what adversity means have yielded only very abstract definitions, such as "social conditions or stressors that threaten, or are perceived to threaten, physiological equilibrium."[74]

Since the organization of childhood adverse events into the ACEs framework and its widespread adoption as a standard scale of childhood adversity, one could say that the broader field of childhood adversity has been both advanced greatly and shoehorned by the ACE framework's success. Adverse Childhood Experiences (ACEs), as I will refer to the defined set of adverse events that comprise the ACE score in the dissertation studies, are not a comprehensive list of all sources of childhood adversity and they do not account for protective and resilience factors. While defining adversity and what it encompasses is beyond the scope of this dissertation, as indeed there are different perspectives on what constitutes adversity depending on the field in which one sits, for the purposes of this dissertation I will use the term "adversity" throughout the descriptions of the studies below primarily to refer to children's cumulative exposure to ACEs, though I recognize that there are other types of adversity they may experience (low socioeconomic status or mismatch

of support with needs, to name just two examples). In doing so, I am adopting the lens on adversity of most pediatricians and many policymakers, among whom ACEs have become an entry point into awareness of the impact of adversity on health. While ACEs are the measure of choice for quantifying adversity in the current studies consistent with the fungible nature of the biological stress in the face of various potential childhood stressors, I recognize their inability to quantify all of the sources of adversity children can (and often do) experience. As I will return to in the concluding chapter of this dissertation, while understanding the lifecourse and intergenerational associations between ACEs and various hazards to health and well-being is an important foundation for the research described in this dissertation and elsewhere to lay, future work should build on this foundation to reconcile the simplicity of the ACE score with a more complex reality of how childhood adversity is experienced, managed, and lived.

Exploring Patterns of Adverse Childhood Experiences in A National Sample

To begin to build the foundation of knowledge on ACEs, I will next examine their prevalence in the United States. The Panel Study of Income Dynamics (PSID) and its Childhood Retrospective Circumstances Study (CRCS) offers a unique opportunity to not only explore the study aims that the remaining chapters of this dissertation are dedicated to but also the chance to describe the prevalence of retrospectively reported ACEs in a national sample of adults from various backgrounds, geographies, and walks of life. This section will present information on retrospectively reported ACE scores among participants in the CRCS by various sociodemographic characteristics as part of the introduction to the three primary dissertation studies.

The adult respondents who participated in the PSID and CRCS, the PSID's supplement exploring childhood environments and experiences including maltreatment and adversity, provide a national snapshot of ACEs in America. Unlike prior surveys that have explored ACEs prevalence, the PSID and CRCS are not limited to narrow age- or geographically-defined cohorts but span the adult lifecourse and a wide sociodemographic range. I will describe estimates of the relative prevalence of ACE scores – binned into four categories of 0 ACEs, 1 ACE, 2-3 ACEs, and 4 or more ACEs consistent with previous studies – according to common sociodemographic factors already linked to risk of ACEs, as well as some additional variables afforded by the PSID and CRCS whose relationship with ACEs has not been described, such as family financial status in childhood, neighborhood characteristics, geographic moves in childhood, and urbanicity. This information, including estimated population rates of ACE scores along with 95% confidence intervals calculated using unadjusted, population-weighted (based on CRCS' cross-sectional weights) survey estimation techniques in Stata, will both inform an understanding ACE risk factors and show previously undescribed disparities in ACE prevalence.

Beginning with ACE prevalence stratified by demographic characteristics, I find that women are slightly more likely to report four or more ACEs compared to men while also being less likely to report zero ACEs (Figure 1-1, showing the point estimate proportions in each sociodemographic category with a given ACE score and error bars representing those estimates' 95% confidence intervals). Examining ACE scores by age category, respondents in the youngest age category (18-44 years) appear to be more likely to report four or more ACEs and less likely to report none than those in older groups (Figure 1-2). Compared to white respondents, African Americans are less likely to report zero ACEs but equally likely to report four or more, while Asian/Pacific Islanders are less likely to report four or more. Hispanic and Latino respondents are less likely to report no

ACEs and more likely to report four or more ACEs compared to white respondents (Figure 1-3). Respondents with educational attainment less than high school graduation or equivalent were less likely to report no ACEs and more likely to report four or more, compared to those with higher educational attainment (Figure 1-4). In all, these findings support the known associations between higher rates of ACEs and greater social marginalization, social status, and racial/ethnic discrimination.

Turning to ACE prevalence by various measures of economic status, respondents' ACE scores in the PSID and CRCS sample exhibit a well-documented relationship with the household income gradient, with rates in the zero ACE category rising across income levels and rates in the four-or-more category steadily declining (Figure 1-5). Retrospective adult assessment of relative family financial status in childhood shows even more marked differences in ACE prevalence. As respondents rate their family financial status in childhood worse, fewer and fewer report having experienced no ACEs and more and more report four-or-more ACEs. Those who rate their family financial status as much worse than the average family had no ACEs just 5.5% of the time, compared to 48% of those who rated their family financial circumstances much better than average (Figure 1-6). This confirms that economic position, and especially one's assessment of relative economic position in childhood, is an important predictor of ACE score.

Exploring geographic and neighborhood relationships with ACE score prevalence yielded some notable findings, again with strong associations between ACE score and circumstances in childhood. Living in close knit, cohesive neighborhoods during childhood was highly protective against higher ACE scores. Those who grew up in neighborhoods that they described as not close knit at all reported no ACEs one third as often and four-or-more ACEs almost five times as often

as those who grew up in the most cohesive communities (Figure 1-7). Somewhat higher rates of ACEs were reported by respondents who had had least one geographic move during childhood (Figure 1-8). Rural-urban differences in ACE prevalence were not found (Figure 1-9), nor were differences by childhood region within the United States, but respondents who were raised abroad had substantially fewer ACEs than their domestic counterparts, on average (Figure 1-10). This indicates the quality of a community, rather than size or location in the U.S., influences ACE risk.

Overall, this national sample from the PSID and CRCS demonstrates that respondents who experience various forms of social and economic disadvantage and disruption, especially during childhood, report more ACEs and exhibit higher ACE scores. Protective factors against ACEs appeared to be related to indicators such as neighborhood cohesion, the absence of geographic displacement, and being raised in a foreign country before residing in the United States in adulthood. Against this backdrop, the following chapters will explore the implications of these differences in exposure to these measures of childhood adversity, specifically whether differences in ACE scores among adults in the PSID CRCS sample are 1) associated with their household medical expenses, 2) associated across generations with the likelihood of ACEs in their adult children, and 3) associated across generations with behavioral health problems in their children during childhood.

Table and Figures

Table 1-1. Comparison of Published Adverse Childhood Experiences (ACE) Measures with the Panel Study of Income Dynamics

PSID CRCS	ACE Category	Description Based on ACE Survey Item	Weighted Percentage Positive
ACE Type	Emotional Abuse	The combination of the respondent rating their relationship as poor with their mother and/or father and indicating that the relationship involved the highest degree of emotional tension	3%
	Physical Abuse	Whether the mother and/or father sometimes or often slapped, threw things at, or otherwise physically harmed the respondent	23.1%
	Sexual Abuse	Whether the respondent reported being the victim of a crime classified as assault or rape in childhood	3.6%
	Intimate Partner Violence	Whether the respondent reported that his/her mother and father often, sometimes, or not very often pushed, threw things at, or were otherwise physically harmful toward one another	20.8%
	Household Substance Abuse	Whether the respondent reported his/her mother and/or father abused drugs or alcohol	19.5%
	Mental Illness in Household	Whether the respondent reported his/her mother and/or father had any mental health problems (panic attacks, depression)	21.4%
	Parental Separation or Divorce	Whether the respondent reported his/her parents were separated or divorced	27%
	Emotional Neglect	Whether the respondent reported that his/her mother or father displayed no affection or parenting effort	7.2%
	Deceased or Absent Parent	Whether the respondent reported that his/her mother or father was deceased or unknown to him/her at a time in the childhood of the respondent	5%
ACE Count	0 ACEs		36.4%
	1 ACE		27.5%
	2 ACEs		15.9%
	3 ACEs		9.7%
	4 ACEs		5.4%
	5 ACEs		3.4%
	6 ACEs		1.1%
	7 ACEs		0.5%
	8 ACEs		0.1%
	9 ACEs		0.0%
OVERALL		Sample with Complete ACE Information: 7223, US national sample	
CDC-Kaiser ACE Study	Emotional Abuse	Did your parent, step-parent, or an adult living in your home swear at you, insult you, put you down, or act in a way that made you afraid that you might be physically hurt?	10.6%

	Physical Abuse	Did your parent, step-parent, or an adult living in your home push, grab, slap, throw something at you, or hit you so hard that you had marks or were injured?	28.3%
	Sexual Abuse	Did any adult, relative, family friend, or stranger who was at least 5 years older than you ever touch or fondle your body in a sexual way, make you touch his/her body in a sexual way, or attempt to have any type of sexual intercourse with you?	20.7%
	Mother Treated Violently	Was your mother or stepmother pushed, grabbed, slapped, had something thrown a, kicked, bitten, hit with a fist, hit with something hard, repeatedly hit for over at least a few minutes, or ever threatened or hurt by a knife or gun by your father (or stepfather) or mother's boyfriend?	12.7%
	Household Substance Abuse	Was a member of your household a problem drinker or alcoholic or was a member of your household using street drugs?	26.9%
	Mental Illness in Household	Was a member of your household depressed or mentally ill or did a member of your household attempt suicide?	19.4%
	Parental Separation or Divorce	Were your parents ever separated or divorced?	23.3%
	Criminal Household Member	Did a member of your household ever go to prison?	4.7%
	Emotional Neglect	Did people in your family help you feel important or special, help you feel loved, look out for each other, and provide a source of strength and support? (Reverse Coded)	14.8%
	Physical Neglect	Was there someone to take care of you, protect you, and take you to the doctor if you needed it? (Reverse Coded) Did you ever not have enough to eat, were your parents too drunk or too high to take care of you, or did you ever have to wear dirty clothes?	9.9%
	OVERALL	Count of all ACEs Reference: Centers for Disease Control and Prevention, Kaiser Permanente. The ACE Study Survey Data [Unpublished Data]. Atlanta, Georgia: U.S. Department of Health and Human Services, 2016. https://www.cdc.gov/violenceprevention/acestudy/about.html Sample size: 17,337	0 – 36.1% 1 – 26.0% 2 – 15.9% 3 – 9.5% 4+ - 12.5%
Behavioral Risk Factor Surveillance Survey (BRFSS)	Emotional Abuse	How often did a parent or adult in your home ever swear at you, insult you, or put you down? (Never, Once, More than Once)	35%
	Physical Abuse	Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking. (Never, Once, More than Once)	15.9%

	Sexual Abuse	How often did anyone at least 5 years older than you or an adult, ever touch you sexually? How often did anyone at least 5 years older than you or an adult, try to make you touch sexually? How often did anyone at least 5 years older than you or an adult, force you to have sex? (Never, Once, More than Once)	10.9%
	Intimate Partner Violence	How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up? (Never, Once, More than Once)	14.9%
	Household Substance Abuse	Did you live with anyone who was a problem drinker or alcoholic? Did you live with anyone who used illegal street drugs or who abused prescription medications?	25.1%
	Mental Illness in Household	Did you live with anyone who was depressed, mentally ill, or suicidal?	16.3%
	Parental Separation or Divorce	Were your parents separated or divorced?	22.8%
	Incarcerated Household Member	Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	5.7%
	Emotional /Physical Neglect	[Not Asked in BRFSS]	NA
	OVERALL	Count of all ACEs Reference: Centers for Disease Control and Prevention. *Behavioral Risk Factor Surveillance System Survey ACE Module Data, 2010*. Atlanta, Georgia: U.S. Department of Health and Human Services,; 2015. Available from https://www.cdc.gov/violenceprevention/acestudy Sample size: 53,784	0 ACEs – 40.7% 1 ACE – 23.6% 2 ACEs – 13.3% 3 ACEs – 8.1% 4+ ACEs – 14.3%
National Survey of Children's Health (NSCH)	Emotional Abuse	[Not asked]	NA
	Physical Abuse	[Not asked]	NA
	Sexual Abuse	[Not asked]	NA
ALL ITEMS ARE PARENT REPORTED	Intimate Partner Violence	Did [SAMPLE CHILD] ever see or hear any parents, guardians, or any other adults in [his/her] home slap, hit, kick, punch, or beat each other up? (Yes/No)	7%

	Household Substance Abuse	Did [SAMPLE CHILD] ever live with anyone who had a problem with alcohol or drugs? (Yes/No)	11%
	Mental Illness in Household	Did [SAMPLE CHILD] ever live with anyone who was mentally ill or suicidal, or severely depressed for more than a couple of weeks? (Yes/No)	9%
	Parental Separation or Divorce	Did [SAMPLE CHILD] ever live with a parent or guardian who got divorced or separated after [SAMPLE CHILD] was born? (Yes/No)	20%
	Incarcerated Household Member	Did [SAMPLE CHILD] ever live with a parent or guardian who served time in jail or prison after [SAMPLE CHILD] was born? (Yes/No)	7%
	Death of a Parent	Did [SAMPLE CHILD] ever live with a parent or guardian who died? (Yes/No)	3%
	Neighborhood Violence	Was [SAMPLE CHILD] ever the victim of violence or witnessed any violence in [his/her] neighborhood? (Yes/No)	9%
	Financial Hardship	Since [SAMPLE CHILD] was born, how often has it been very hard to get by on your family's income, for example, it was hard to cover the basics like food or housing? (1: Very Often, 2: Somewhat Often, 3: Not Very Often, 4: Never)	26%
	OVERALL	Count of ACEs Reference: Overview of Adverse Child and Family Experiences Among US Children. http://www.childhealthdata.org/docs/drc/aces-data-brief_version-1-0.pdf?Status=Master https://www.childtrends.org/wp-content/uploads/2014/07/Brief-adverse-childhood-experiences_FINAL.pdf Sample Size: 95,677	0 ACEs – 52.1% 1 ACE – 25.3% 2+ ACEs- 22.6%
Chicago Longitudinal Study (Pediatrics April, 2016)	Family Conflict	Indicate if any of these events have occurred in your life (check yes/no)… …Frequent family conflict	15.8%
	Physical Abuse	[Obtained from court and county records]	2.8%
	Sexual Abuse	[Obtained from court and county records]	1.7%
	Intimate Partner Violence	[Not asked]	NA
	Household Substance Abuse	…Problems of substance use of parent	10.9%
	Mental Illness in Household	[Not asked]	NA

	Parental Separation or Divorce	…Prolonged absence of parent …Divorce of parent	32.1%
	Death of a Household Member	…Death of parent …Death of brother or sister …Death of a close friend or relative	29.2%
	Witness to Violent Crime	…Witness to shooting or stabbing	13.5%
	Victim of Violent Crime	...Being a victim of a violent crime	6.0%
	Emotional /Physical Neglect	[Obtained from court and county records]	7.3%
	OVERALL	Count of ACEs Reference: Giovanelli, Alison, et al. "Adverse childhood experiences and adult well-being in a low-income, urban cohort." *Pediatrics* (2016): peds-2015. Sample size: 1202 adults who were enrolled in Chicago Public Schools in childhood, followed into early adulthood (20s)	0 ACEs – 37.6% 1 ACE – 25% 2 ACEs – 15% 3 ACEs – 10% 4+ ACEs – 13%
National Survey of Children's Exposure to Violence	Emotional Abuse	At any time in your life, did you get scared or feel really bad because grown-ups in your life called you names, said mean things to you, or said they didn't want you?"	17.7%
	Physical Abuse	Children who answered yes to any of 10 screeners were coded as having experienced physical abuse if the incident was perpetrated by a parent, adult relative, or other caregiver.	14.9%
	Sexual Abuse	Four screeners ask about child's experience of sexual assault or attempted rape by a known adult, an adult stranger, or a peer or sibling. Any yes response was coded as sexual abuse.	6.6%
	Intimate Partner Violence	Children who answered yes to any of 12 screeners on specific kinds of violence and abuse and who reported that their mother was the victim were coded positive.	13.1%
	HH Substance Abuse	"Has there ever been a time that a member of your family drank or used drugs so often that it caused problems?"	16.8%
	Mental Illness in Household	Parent or sibling was diagnosed with depression, bipolar disorder, anxiety, or "other psychiatric disorder" (information obtained from the parent interview) or "someone close" attempted suicide.	27.9%

	Parental Separation or Divorce	Respondents not living with both biological or adoptive parents were coded as having experienced parental separation or divorce.	41.2%
	Incarceration	Parent or guardian ever sent to prison.	11.1%
	Emotional Neglect	Four questions about family social support were used: “My family really tries to help me,” “My family lets me know that they care about me,” “I can talk about my problems with my family,” and “My family is willing to help me make decisions.” Response choices ranged from 1 – never to 4 – always. Total score range = 4 to 16. Scores of 10 or lower were coded emotional neglect.	7.7%
	Physical Neglect	"When someone is neglected, it means that the grown-ups in their life didn’t take care of them the way they should. They might not get them enough food, take them to the doctor when they are sick, or make sure they have a safe place to stay. At any time in your life, were you neglected?”	4.0%
	OVERALL	Count of ACEs Reference: Finkelhor, David, et al. "Improving the adverse childhood experiences study scale." *JAMA pediatrics* 167.1 (2013): 70-75. Sample Size: 2030, nationally representative	Not reported in reference (aim was to report novel ACE domains)

Figure 1-1. ACE Score Rate Estimates by Gender

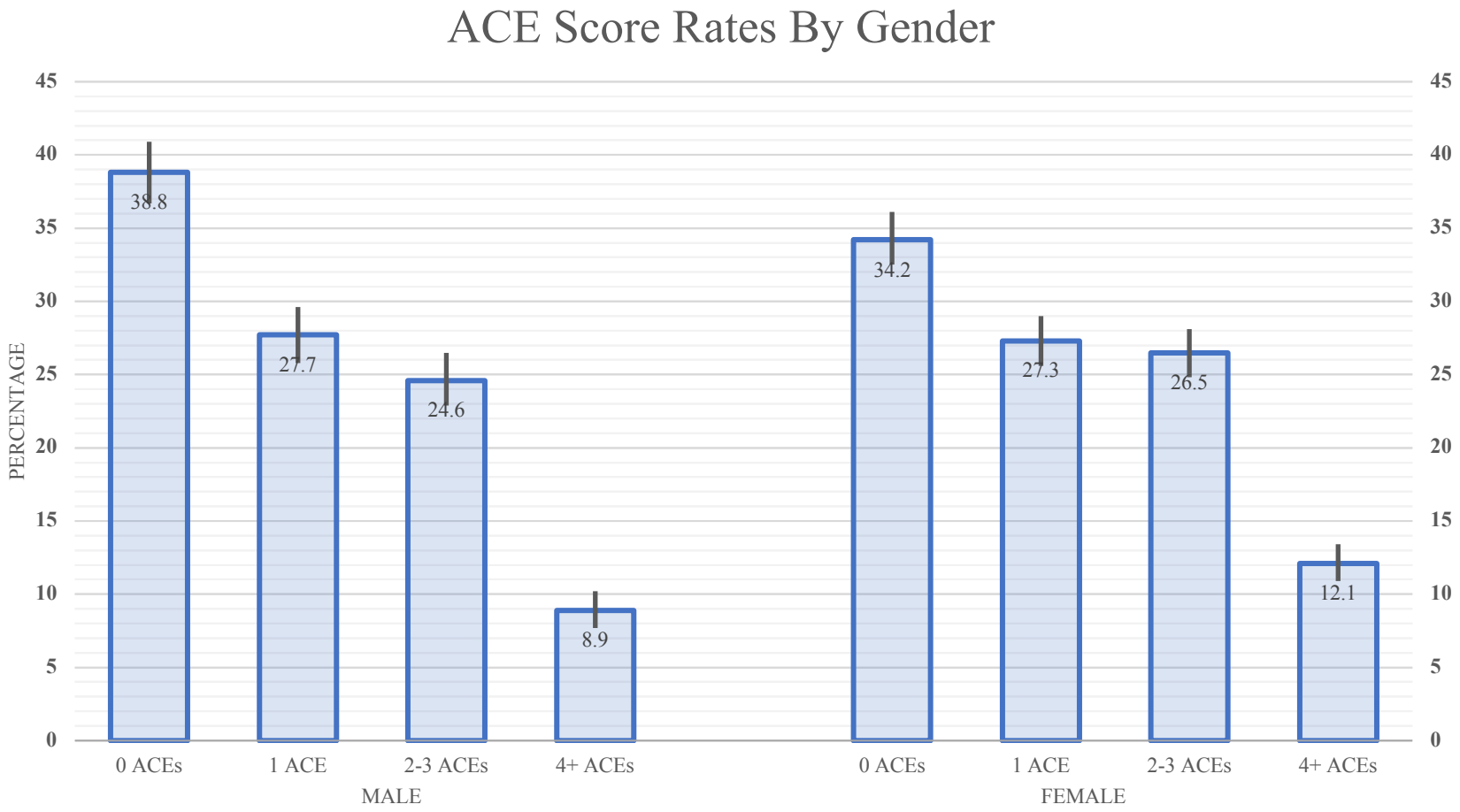


Figure 1-2. ACE Score Rate Estimates by Age Group

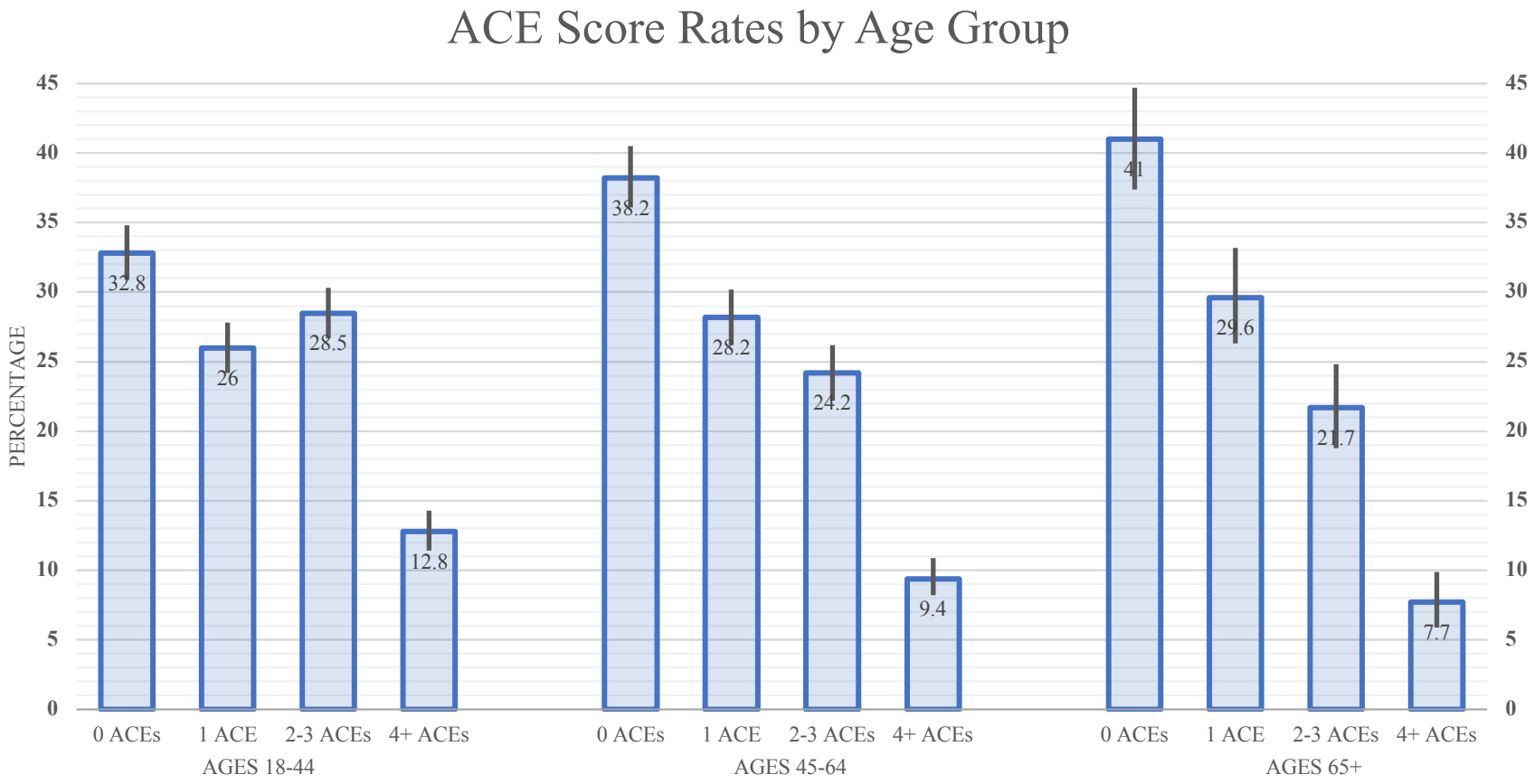


Figure 1-3. ACE Score Rate Estimates by Race and Ethnicity

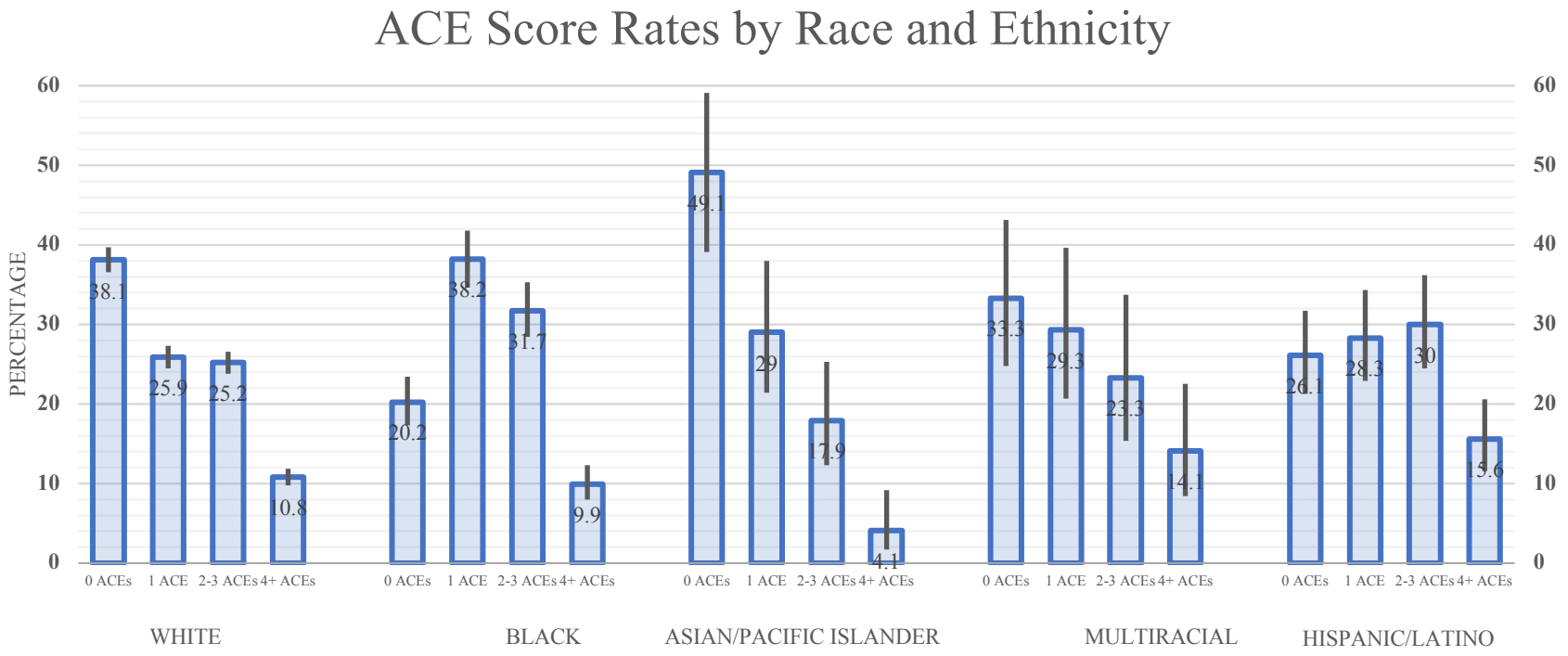


Figure 1-4. ACE Score Rate Estimates by Education Level in Adulthood

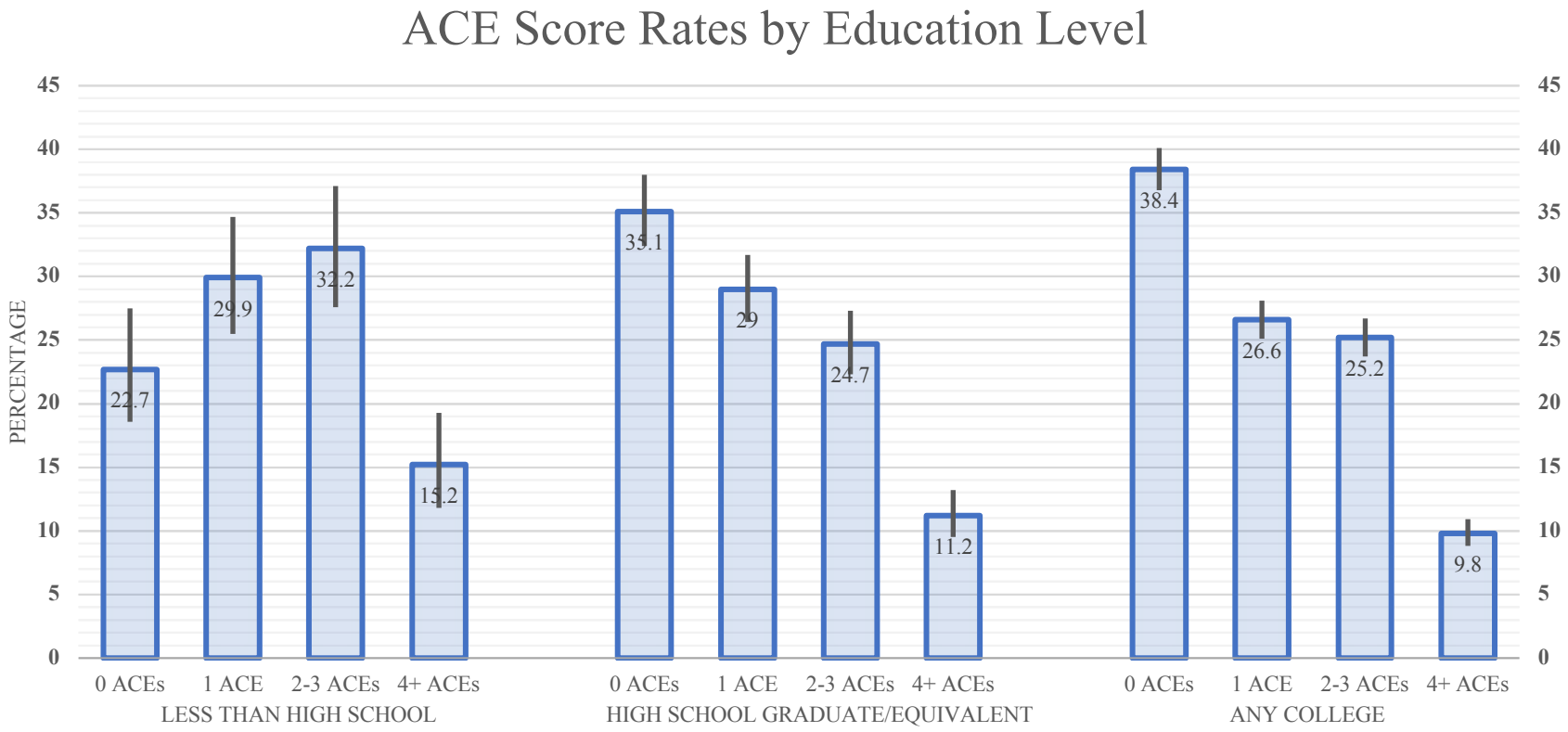


Figure 1-5. ACE Score Rate Estimates by Current Household Income

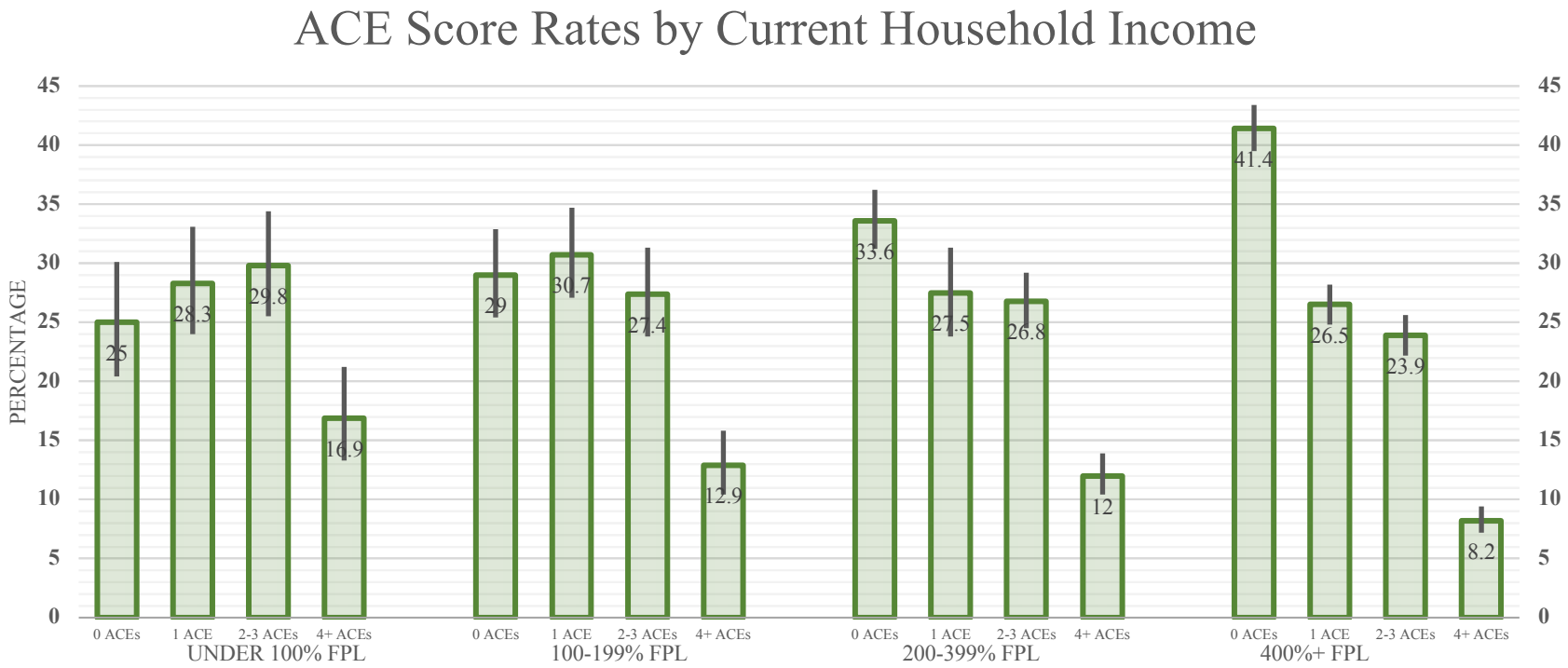


Figure 1-6. ACE Score Rate Estimates by Retrospective Family Financial Status in Childhood Compared to Average

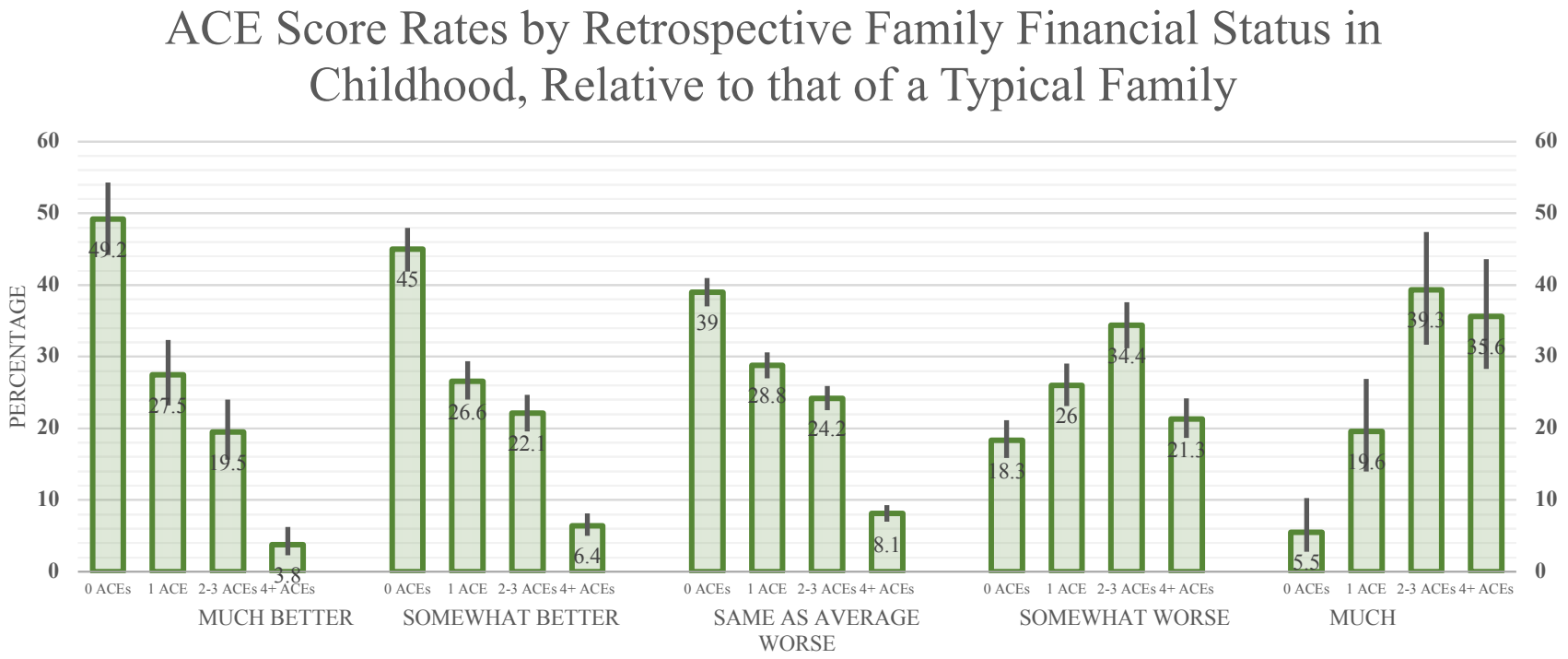


Figure 1-7. ACE Score Rate Estimates by Childhood Neighborhood Cohesion

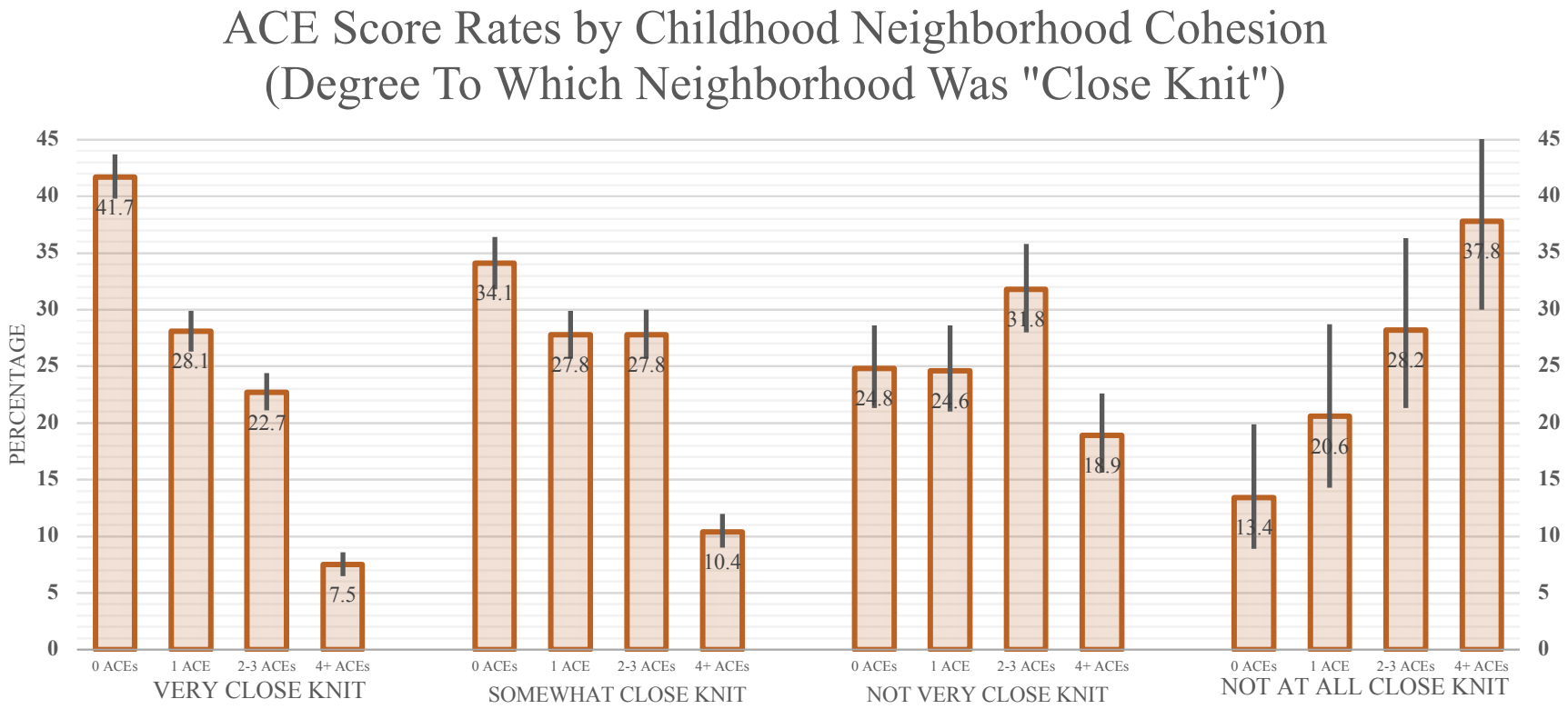


Figure 1-8. ACE Score Rate Estimates by Whether Respondent Moved Homes in Childhood at Least Once

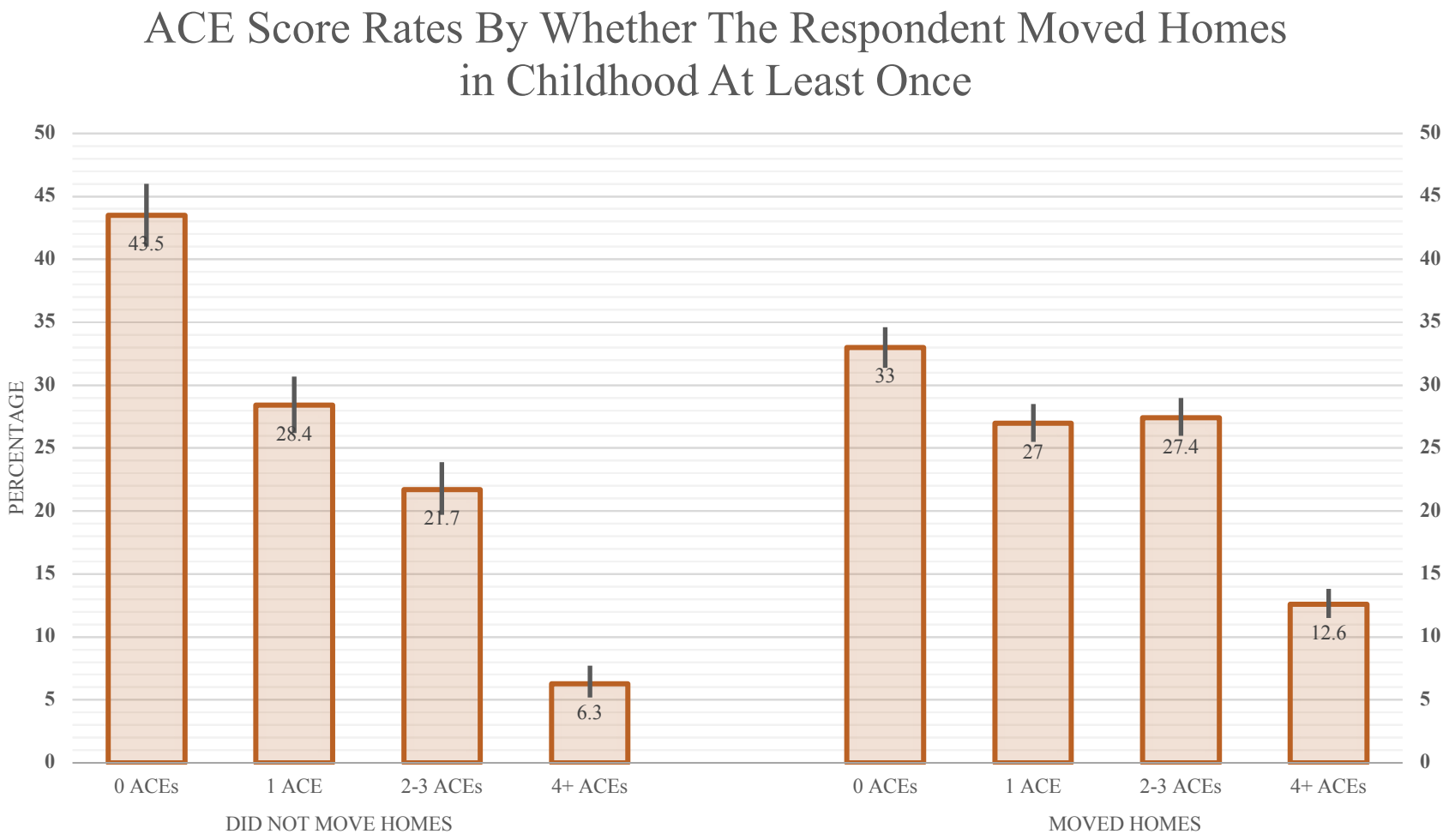


Figure 1-9. ACE Score Rate Estimates by Urbanicity

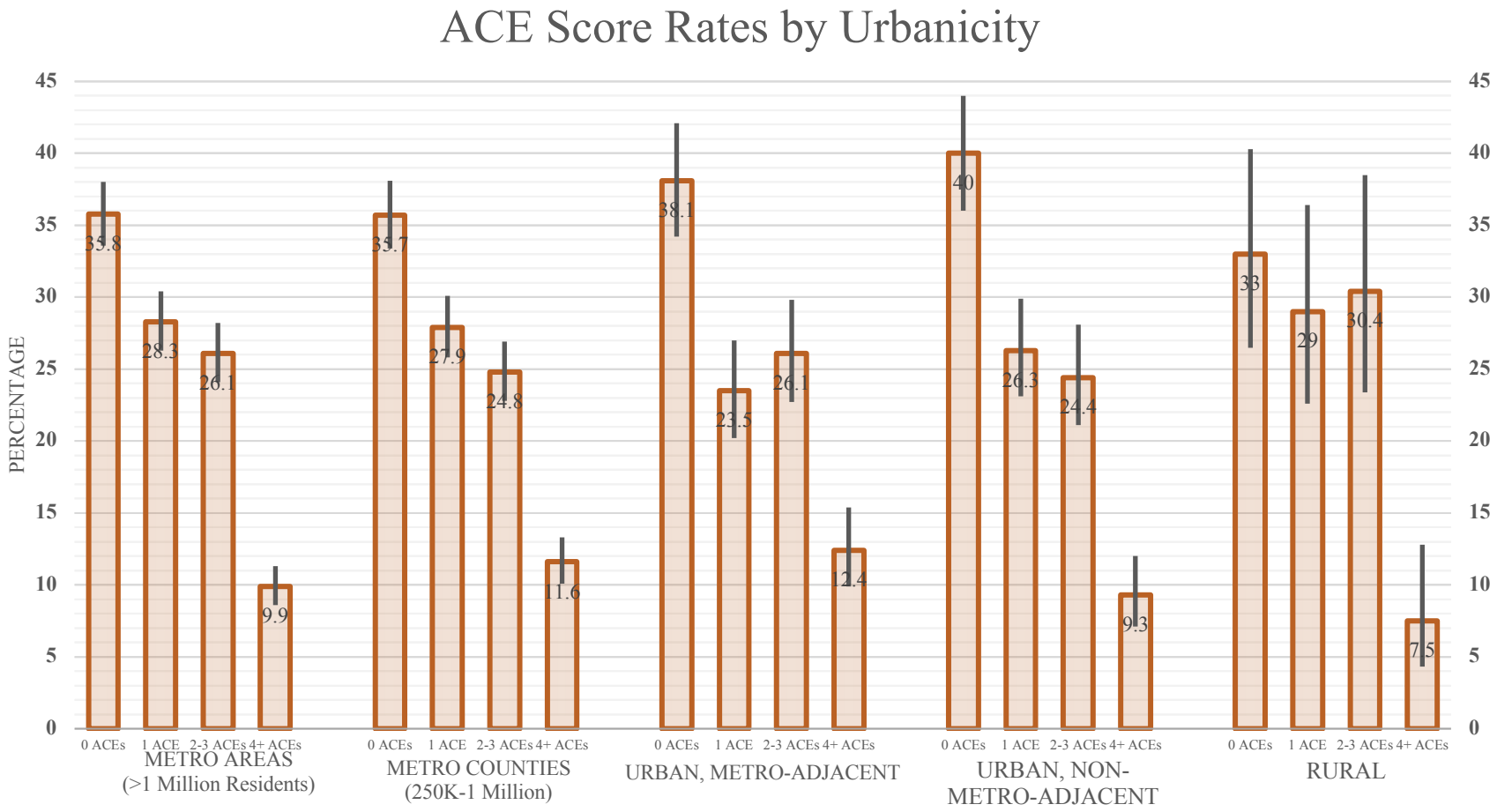
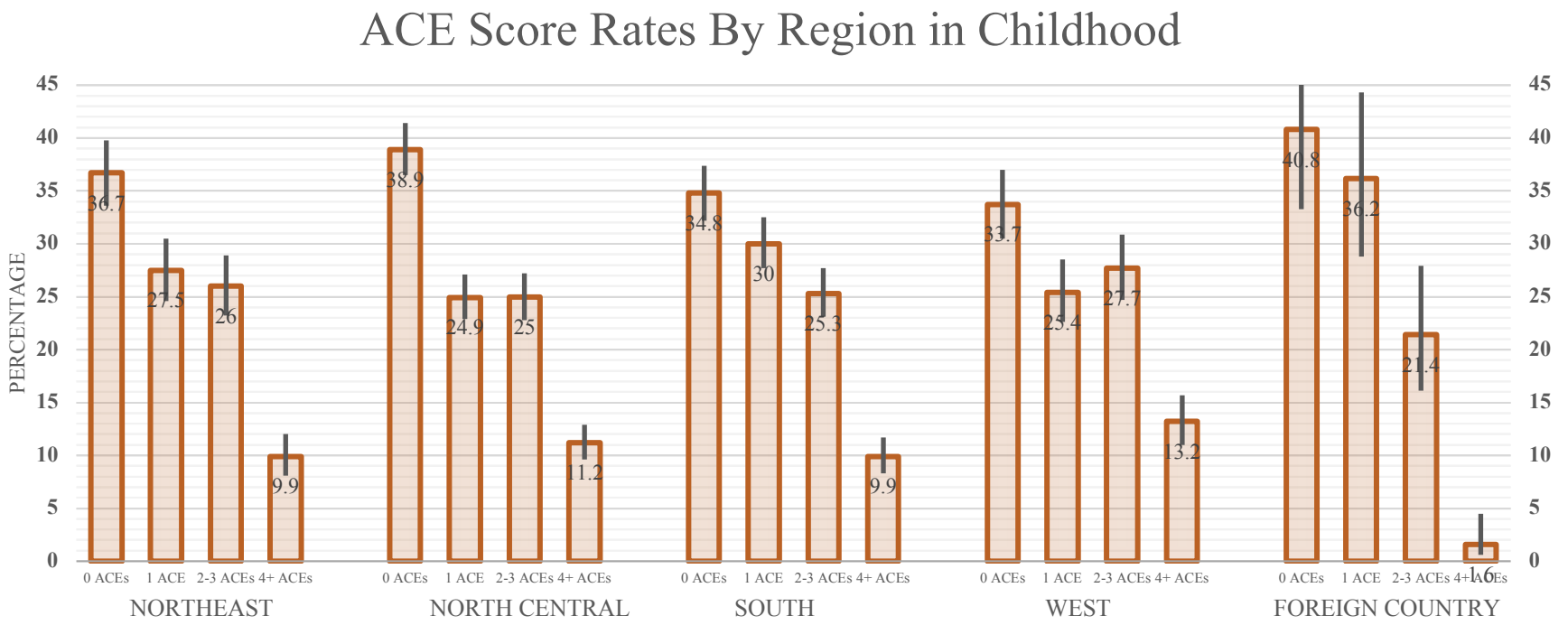


Figure 1-10. ACE Score Rate Estimates by Region in Childhood



Chapter Two

Adverse Childhood Experiences and Out of Pocket Health Care Costs for Individuals and Households

As stated in the first chapter, adverse childhood experiences (ACEs) are a defined group of difficult and potentially traumatic events that occur any time before age eighteen and have been linked to higher risk of poor mental and physical health, chronic disease, and utilization of medical care in adulthood.[75] [76] [77] Adverse childhood experiences fall into three domains -- abuse, neglect, and household dysfunction – which are thought to place children at higher risk for disruptions in optimal cognition, behavioral problems, and dysregulation of the neuroendocrine systems that respond and adapt the body to stress.[78] [79] Experiencing ACEs may directly influence downstream health risk or serve as a measure of more pervasive, latent social risk. A well-established body of evidence on the impact of ACEs over the lifecourse suggests they are associated with substantial downstream health risks, which have been associated with earlier appearance of biochemical and physiologic markers of cardiovascular and metabolic disease, as well as premature mortality.[80] [81] [82] A smaller literature has found that the adverse adult health outcomes predisposed by higher ACE scores also lead to greater health care utilization, specifically more frequent outpatient visits and emergency department use.[83] Few studies have examined the costs of specific ACEs – not an overall ACE count score -- to health systems, and no study has assessed the health-related out-of-pocket costs of ACEs to the adults who experienced them or to others in their households.

A study of differences in OOP costs associated with ACE scores would provide an estimate of the economic burden of elevated ACE counts, which would be expected to be higher given the higher rates of illness and utilization described for individuals with higher ACE counts above. No study to date has attempted to quantify the economic burden due to health care costs associated with increased ACEs. Out of pocket costs are often used as a measure of the economic burden of health care to individuals,[84] [85] [86] and previous studies have shown that low-income populations (with the exception of those publicly insured) experience a greater economic burden in the face of health care utilization despite having lower average out-of-pocket expenses than wealthier groups.[87] [88] [89] This greater economic burden can create disincentives to medical adherence, further exacerbating health inequities.[90] [91] [92]

Previous studies that estimated the costs of specific adverse childhood events have focused primarily on health care system costs attributable to physical and sexual abuse among women.[93] One study found that medical costs from ambulatory, inpatient, and mental health service use in a managed care system were over a third higher for women with histories of both sexual and physical abuse compared to no abuse history.[94] A second study found that reported childhood sexual abuse was a stronger predictor of increases in costs than physical abuse.[95] Two other studies focused on services in the primary care setting also found increases in self-reported health costs for women who experienced childhood physical or sexual abuse, and one of these two reported medical costs among women reporting sexual and physical abuse that were nearly twice that of women who did not report any childhood abuse.[96] [97] The health care costs attributable to other ACE domains and total ACE count remain unexamined, and no study has reported the health care costs attributable to ACEs that the individual patient bears out-of-pocket. This latter outcome is of particular interest because it directly impacts patient finances and may

directly compound adverse social determinants of health in patients who are already of low socioeconomic status and at higher risk for ACE exposure.

Estimates of the out-of-pocket (OOP) costs associated with increases in total ACE exposures would provide a way to quantify the long-term economic burden childhood adversity places on individuals and households. These OOP cost estimates could potentially also serve as an indirect measure of the proportional increase in total health care costs attributable to childhood ACEs if the type of patient insurance cost sharing is controlled. These estimates could also yield insight into intergenerational cycles that reinforce economic hardship, childhood trauma, and worse health within families. Primarily, however, interest in quantifying the long-term economic burden of ACEs provides the rationale for dissertation study number one, with aims described below.

This study – the first of three included in the dissertation -- examines differences in self-reported OOP medical costs associated with differences in overall retrospective ACE scores in a national sample of adults. I aim to answer two distinct study questions regarding additional OOP health care costs of ACEs independent of sociodemographic factors and health insurance type: 1) What is the additional OOP health care cost borne by an individual adult associated with elevations in his/her own ACE score? and 2) What is the additional OOP health care cost and financial burden borne by the entire household of an adult's increased ACE score? The hypotheses are that higher ACE counts reported by individuals in single or multi-person households are associated with higher OOP medical costs, holding other factors associated with individuals' social and health risk constant.

In the study I will assess the association between ACE scores and OOP costs overall and for specific health care services including inpatient, ambulatory, and prescription and in-home care. Patterns of association stratified by household structure, insurance coverage, and between individual ACE categories and OOP costs are explored. I also examine the associations between ACE count categories and likelihood of high OOP cost burden (defined by costs in excess of ten percent of income) and likelihood of carrying household medical debt. Lastly, I examine whether household OOP cost associations are compounded when considering the combined ACE scores of married adults.

PARTICIPANTS AND METHODS

I used data from the Panel Study of Income Dynamics (PSID), a national panel survey of household economic well-being containing a host of health and sociological information, composed on main individual and family files plus linked sub-sample supplements. Data collected by phone from the 2011 and 2013 PSID main family interview included information on health, education, income, health insurance, family structure, OOP health care expenditures, and demographic characteristics for adult heads of household and, if present, their spouses or partners and their children and other family members. Among PSID participants, 12,985 English-speaking adult heads of household and their spouses were eligible for the PSID Childhood Retrospective Circumstances Study (CRCS) supplement, which retrospectively assessed childhood experiences including nine ACEs. Eight thousand seventy-two individuals completed the CRCS via web-based or mailed survey between May, 2014, and January, 2015, for an unweighted response rate of 62 percent (weighted response rate 67%), similar to web-based supplements to other national panel studies.[98] Those who completed the CRCS received a

$20 incentive after participation. A visual representation of the analytic sample is provided in Figure 2-1.

Of the PSID 2013 main interview participants who responded to the CRCS, those who reported information on each of the nine ACEs and provided OOP household health care costs were included in our analytic sample. Household-level associations between adults' ACE counts and household OOP costs were assessed for: 1) households consisting of one adult (with and without children) throughout the study period, 2) households with two adults (with and without children), and 3) the entire sample of individuals of all household structures. Because the PSID OOP medical cost information is collected only at the household level, I chose this approach of analyzing the two nested groups within the larger sample as a way to disaggregate individual from household costs and understand whether the ACE scores of male and female adults within households have joint influence. I aimed to answer the following question: What is the average additional OOP health care cost borne by households associated with their higher ACE scores of adults in those households, independent of covariates and insurance coverage?

Construction of Adverse Childhood Experience Predictor

Complete ACE information was provided by 7,223 adults who reported the presence or absence of adverse experiences prior to age eighteen. Parental divorce or separation, sexual abuse against the respondent, and parental substance abuse were constructed from single CRCS items. Parent mental health was constructed from four items that separately indicated anxiety and depression in the respondents' mothers and fathers. Parent substance abuse combined two items that separately assessed drug or alcohol problems in each of the respondents' parents. Physical abuse of the respondent collapsed and dichotomized a series of items that assessed whether either of

the respondents' parents ever pushed/shoved, threw things at, slapped, or otherwise physically harmed the respondent as a child. The neglect ACE indicator was coded positive if either of the respondents' parents were reported through two separate items to have given no parenting effort and no affection to the respondent. Emotional abuse was coded positive if the respondent indicated that, for either of his/her parents, there was the most extreme degree of emotional tension in the relationship with the respondent during childhood. Exposure to domestic violence was constructed from four items that separately assessed whether the respondents' parents ever pushed/shoved, threw things at, slapped, or otherwise physically harmed each other. Descriptions and prevalence of each ACE in the CRCS sample are provided in Chapter One. For analysis, adverse childhood experience counts were constructed for each adult in a household and binned into three categories – zero, 1-2, and 3 or more ACEs -- similar to prior studies.[99] [100] [101] I confirmed that retrospective ACEs were associated with adult health outcomes and early life measures of childhood stress and home environment, consistent with literature from other datasets (Appendix I).

Outcomes

I constructed a total OOP health care cost outcome from responses to three component OOP health care cost items in the 2011 and 2013 PSID:

1) Inpatient visit OOP costs: About how much did [you/you and your family] pay out of pocket for nursing home and hospital bills in the prior year?
2) Ambulatory visit OOP costs: About how much did [you/you and your family] pay out of pocket for doctor, outpatient surgery, and dental bills in the prior two years?

3) Prescription and other OOP health care costs: About how much did [you/you and your family] pay out of pocket for prescriptions, in-home medical care, and other services in the prior two years?

The OOP cost variables were annualized to yield average yearly costs from 2009-2012. To increase response rate and reliability, the PSID interviewers asked a series of questions to identify bracketed ranges of health expenditures when participants could not provide precise dollar amounts. Average household OOP health care costs in the PSID main interview track closely with averages reported in the Consumer Expenditure Survery.[102] [103] As a validation check, I confirmed that total annual OOP medical costs showed an average linear increase of $241.82 for each additional chronic condition an individual reported,[1] adjusted for covariates described in the next section.

To determine whether any increases in ACE count category also put households at greater risk for high financial burden, we examined secondary outcomes of whether household OOP medical costs exceeded certain proportions of households' average annual income or liquid assets (wealth excluding debts and home equity) over the years of data included in the study. I used a frequently cited threshold for burdensome financial hardship due to medical expenses: ten percent of average annual income spent on OOP medical costs.[104] [105] [106] [107] [108] I also used a threshold of 100 percent of the average annual cash value of each households' liquid assets after finding a range of wealth thresholds all behaved similarly. In another secondary analysis, an indicator of households carrying any medical debt in the last year of the study (the only year it was available

[1] The constructed chronic condition count variable included participant report of a clinician giving him/her a diagnosis of diabetes, hypertension, heart disease, arthritis, lung disease, cancer, asthma, or "other chronic conditions".

from the PSID) was assessed to understand whether the increases in OOP costs might lead directly to greater debt to cover health care expenses.

Covariates

Covariates for each adult in any given household included three-category participant educational attainment (less than high school, high school graduate/GED, and any college); continuous years of age; four-category race (Caucasian, African American, Asian/Pacific Islander, and Multiracial/Other); Latino/Hispanic ethnicity; sex; marital status; five-category income level (<100%, 100-199%, 200-299%, 300-399%, and ≥400% of the Federal Poverty Line); six-category health insurance (uninsured, employer sponsored, privately purchased, Medicare/Medi-Gap/Supplemental, Medicaid, and veterans and other government coverage types); number of household members and children; cigarette smoking; and alcohol consumption. Alternate specifications of binned age categories by decade of life, years of education, log-transformed household income, age-by-gender, and ACE count-by-marriage interactions were tested individually in the model and found to have minimal effect on coefficient estimates.

Statistical Analyses

I regressed average annual total, inpatient, ambulatory, and prescription/other household OOP health care costs on ACE count using multvariable generalized linear models (GLM), adjusted for covariates. I assessed model fit using the Modified Park Test according to published methods.[109] Park test lambda values for each of the OOP cost outcomes indicated that a GLM with Poisson family and log link was the preferred model, though the results were similar across models tested (Appendix 2-A). I stratified the analyses by household structure to estimate the relationship between ACE count and OOP medical costs to 1) single-person households; 2)

households with single adult and one or more children; 3) households with two married or partnered adults and no children; and 4) households with two married/partnered adults and one or more children. For each of these stratifications and the primary analyses, I used predictors of either 1) the single highest of all ACE scores among any adults in a household or 2) ACE score predictors (up to two) for each adult respondent in sample households by gender (male and female ACE scores). For the subset of households with two adults, I ran a model interacting the ACE scores of the two adults and, though the interaction terms were not statistically significant, I used this to estimate average OOP costs at each combination of male and female adults' ACE counts. Analyses stratified by health insurance coverage did not reveal a disproportionately affected category of coverage. Models were weighted to accommodate the complex survey design, achieve population representation, and adjust for nonresponse. Estimates employed survey-robust standard errors. Approximately fifteen percent of observations had missing data for any of the variables included in the regressions analyses. See Appendix II for the results of analyses for this study and the subsequent studies after multiple imputation, which yields results that are substantially similar to the main analyses presented in the dissertation chapters. Covariate-adjusted dollar value OOP cost predictions and differences in costs by ACE count were estimated using the delta method. I examined the association between ACE categories and secondary outcomes of OOP costs exceeding ten percent of income, OOP costs exceeding various proportions of liquid wealth, and the presence of household medical debt using logistic regression models and the covariates above.

I performed additional secondary analyses to assess whether participants' mental illness symptom scores on the Kessler-6 twenty-four-point scale of emotional distress[110] and their chronic condition counts mediated any relationships between ACE scores and total OOP health

care costs. To perform these mediation analyses, we added chronic condition count and the Kessler-6 score into the primary GLM regression models and observed changes in the magnitude of the ACE category coefficient. I used Sobel-Goodman tests of mediation to estimate the proportion of the ACE score effect on total OOP medical costs mediated by individuals' mental illness symptom scores on the Kessler-6 twenty-four-point scale of emotional distress[111] and separately by individuals' chronic condition counts.

In further secondary sensitivity analyses I included in the primary regression models a 5-point Likert scale variable for retrospectively reported childhood socioeconomic status, a key potential confounder related to both childhood trauma and worse adult health. This variable encoded the participant response to the prompt "When you were a child before age 17, compared to the average family at the time, how was the financial situation of the family that you lived with?" using a five-point scale from "A lot better off than the average family" to "A lot worse off than the average family". Additional sensitivity analyses examined results of the model with household health insurance premium expenses as a covariate.

As a further validation of our GLM regression estimates we performed sensitivity analyses to estimate differences in OOP costs by ACE score using treatment effects models and inverse probability weighting of households in the sample using the covariates listed to construct treatment weights at each level of the primary ACE score predictor. We estimated the probability of treatment (highest ACE count category of household adults) using data reported by the adults in the sample on their own parents' education levels, their self-rated socioeconomic status in childhood, their race and ethnicity, and childhood family structure as reported for each household adult (head or spouse) in the PSID. The covariates used in the main regression

analyses were also used in these doubly robust treatment effects models as regression adjustment covariates, given that there was limited choice of variables available to construct the treatment probability weights and the variance ratios for certain variables showed imperfect balance with differences up to thirty percent between the groups at each ACE treatment level. The estimates and differences in OOP costs by ACE score category for households in the sample obtained through this inverse probability weighting approach were similar to those obtained through the conditional GLM models.

The data were housed at the University of Michigan's Institute for Social Research. All analyses were carried out in Stata, version 14 (StataCorp), via an online data enclave. The UCLA Institutional Review Board approved this study.

RESULTS

The study sample included 4,784 households (6,775 adults) with complete data, of which 2,738 households had two adults, 659 were single-person households, and the remainder included other arrangements such as single-parent households with children. One fifth of adults in the sample reported having experienced three or more ACEs. Just over half were female, over one fifth were non-Caucasian or of Latino ethnicity, a third had a high school education or less, and under fifteen percent lived in poverty. The sub-sample living in single-person households was slightly older, diagnosed with more chronic illness, more likely to have mental illness symptoms in the severe range, and more often poor, while the sub-sample of two-adult households had lower rates of poverty, chronic illness, and severe mental illness symptoms (Table 2-1).

A positive association between OOP costs and higher reported ACEs was seen in the sample overall (Table 2-2). Households in which adult respondents reported three or more ACEs were found to have higher annual household OOP costs in total, inpatient care, and ambulatory care. Higher OOP costs in total and prescription/other services were found among those with one or two ACEs compared to none. In childless households, adults reporting three or more ACEs had higher OOP ambulatory care, prescription/other services, and overall medical costs compared to households with no reported ACEs. Two-adult households showed higher total and inpatient household OOP costs associated with ACEs above zero.

When examining the associations between ACE counts and household OOP costs in terms of the gender of the adult respondents, female respondents' ACE counts were more frequently and strongly associated with OOP costs than their male counterparts' (Table 2-3). Sensitivity analyses including retrospective childhood socioeconomic status in our analytic models, whether in addition to the adult income category variable or in place of it, or adding health insurance premium costs as a covariate yielded only minimal differences in the regression coefficients.

Across all households in the sample, total OOP medical costs were $184 (1.18 fold) higher when adult respondents in those households reported 1-2 ACEs, and $311 (1.30 fold) higher when reporting 3 or more ACEs, respectively, compared to none (baseline annual OOP costs $1042).. See Appendix 2-B for detailed household OOP cost findings. Predicted OOP cost estimates showed single, childless adults reporting three or more ACEs spent an average of $505 more per year overall compared to those with none; (a 1.83-fold increase; baseline of $607). When examined individually, predicted annual OOP inpatient, ambulatory care, and prescription/other

medical services costs were on average $119, $251, and $116 higher, respectively, for single adults with 3 or more ACEs compared to none.

In models examining two-adult households and including interaction terms for male and female respondents' ACE scores, households in which female adults reported 3 or more ACEs and males reported 1-2 ACEs spent an estimated average of $504 more per year overall (a 1.38 fold increase), and households in which both adults reported 3 or more ACEs spent an estimated average of $372 more per year overall (a 1.28 fold increase) compared to households in which neither adult reported an ACE (Figure 2-2).

Households with adults reporting three or more ACEs had over twice the odds of annual medical costs exceeding ten percent of household income or exceeding the entirety of household liquid assets, on average. Odds of carrying any household medical debt were 2-fold higher when 3 or more ACEs were reported. A history of 1-2 ACEs was associated with a roughly one-and-one-half-fold higher odds of OOP health care costs outpacing all of one's household savings and higher odds of carrying medical debt. These associations were stronger for adult women's ACEs but positive associations were observed for men as well (Table 2-4).

Mediation analyses introducing indices of mental and physical illness into the analytic models found an attenuation of the association between ACE count and total OOP costs for individuals in the overall sample and the individual and married household sub-samples. Sobel-Goodman mediation analyses including the entire sample found that 41.3% of the association between total OOP costs and highest household adults' ACE count was mediated by chronic condition count

(including mental and physical illness) and 27.4% was mediated by emotional distress or mental illness symptoms measured on the Kessler-6 scale (Table 2-5).

Analyses examining which of the component ACEs contributed to increases in OOP medical expenses found that report of physical abuse, emotional abuse, exposure to parental mental health problems, and exposure to parental intimate partner violence was each separately associated with higher OOP costs among single individuals, whereas sexual abuse, exposure to parental mental health problems, and exposure to intimate partner violence were associated with higher OOP costs among married households (Table 2-6).

The results of inverse probability of treatment weighted secondary analytic models with regression adjustment were similar to the results of the main analyses and are presented in Table 2-7 and 2-8.

DISCUSSION

In a national study of households, we found that adults with a higher number of adverse childhood experiences (ACEs) have higher household out-of-pocket medical costs. This association is seen among single adults and among couples jointly contributing to their household medical expenses. Differences in estimated costs revealed that medical expenses were over fifty percent more for single individuals with a history of three or more ACEs and thirty percent more for two-parent households in which the higher of the two adult's ACE count was three or more, compared to no ACEs. Women's ACE counts showed a much stronger association with OOP costs than men's. A sizeable proportion of the additional costs associated with higher

ACE counts was mediated by chronic illness burden and emotional distress (a proxy for mental illness burden).

Given the existing literature linking ACEs and chronic disease in adulthood, our finding that ACEs correlate with out-of-pocket medical costs is not unexpected. Out-of-pocket costs are driven by a mix of factors including mental and physical ailments that require health care, degree of health care seeking behavior determining the extent of discretionary care sought, and health insurance coverage for health care services rendered. In these analyses, we controlled for insurance coverage and showed that the main effects were largely mediated by the greater burden of chronic mental and physical illness. We did not have access to measures of care seeking behavior, but this might mediate the remaining fraction of the relationship we found between ACE score and OOP costs.

The magnitude of the difference in average OOP costs between no ACE and highest ACE levels demonstrates how sizeable a difference in costs may be attributable to childhood adversity. These financial effects have the potential to impact the family finances, with the largest increases in costs to households of single individuals. This difference between single and married households in the proportional increase in OOP costs as ACE score rises could be because social connection is protective against OOP costs or because individuals with high numbers of ACEs and their behavioral consequences could more often remain unmarried. This possible effect of childhood adversity on likelihood of family formation may be due to smaller social networks and poorer quality social relationships found among survivors of child maltreatment.[112] [113] Future work to examine the impact of ACEs on one's social development and future pair-bonding could help sort out these possible explanations.

While prior literature has shown that women have greater health care utilization and costs than men[114] and health care utilization among women with a history of childhood maltreatment is known to be higher than women without such histories,[115] the finding that the relationship between ACEs and women's OOP medical expenses is stronger than that for men has not been previously reported. This stronger ACE-OOP cost relationship could be the product of women reporting a higher average number of ACEs combined with their already higher health care costs, but other mechanisms are also worth considering. For instance, the ACEs reported by women in our study are likely surrogates for lifelong risk of abuse,[116] and women with ongoing abuse and victimization from intimate partner violence have considerably higher health care utilization and costs than women without such exposures,[117] and because men are less likely to be victims of domestic abuse this may be why they do not display the same strong ACE-OOP cost relationship. The data in this study does not offer information on current abuse exposures, but future studies should examine whether ongoing abuse mediates the relationship between women's ACEs and their medical expenses.

Greater exposure to ACEs was associated with higher likelihood of OOP costs exceeding household savings and ten percent of income, as well as likelihood of carrying medical debt, likely as a result of the greater OOP cost burden. This confluence of financial burden and debt combined with the higher prevalence of chronic physical and mental health conditions suggests that the health and financial tolls of early childhood adversity are compounding, with the worsening of financial health likely to imperil physical health, and vice versa, in a self-perpetuating spiral. Given that the participants in our sample were only in middle age, on average, one would expect that the compounding effects of ACEs on health and household

finances through medical expenses would continue with age as participants acquired more chronic conditions. Future studies should examine the long-term interplay between the financial and health effects of ACEs, which one would predict could cause an acceleration toward physical and mental illness and financial strain over time relative to those unexposed to childhood trauma.

Our results lend further evidence supporting the notion that upstream, early childhood trauma and toxic stress may have lifelong economic consequences.[118] When considering where to make long-term investments in health promotion and disease prevention that will have the highest impact to reduce future costs, our study suggests that the economic benefit to families of reducing the occurrence of ACEs may be substantial. Our results contribute to a growing literature suggesting that evidence-based approaches to reduce abuse and neglect, especially early childhood interventions to build resilience and prevent maltreatment, may yield significant cost savings for families over the long-term.[119] [120] [121] [122] Clinically validated and implemented approaches to preventing child maltreatment and exposure to violence may represent strategies for not only reducing trauma within families but also improving their financial outlook in the long-term.[123] Initiatives to reduce child maltreatment and other ACEs may represent underdeveloped opportunities in this regard.

Limitations

Despite being the only study to our knowledge with OOP medical expense and ACEs information, our study is limited in that it is retrospective with respect to ACEs. Even when controlling for depression and anxiety symptoms, which could conceivably cloud one's retrospective outlook and lead to recall bias, the correlations between ACEs and OOP spending

were evident. Reverse causality is a potential threat, although the possibility that better or worse OOP expenses would prompt participants to misremember or misreport childhood trauma seems unlikely. Unmeasured confounding factors could play a role in linking the predictors and outcomes in our study, though we have attempted to account for likely individual and household confounders. Our analyses had no way to account for children in households that had significant and expensive medical issues. Future studies examining medical expenses related to ACEs may want to carefully consider household structure as a medical cost modifier based on our findings.

CONCLUSION

This is the first study to find that overall ACE score – a measure of greater reported exposure to adversity in childhood – is associated with adults' OOP medical expenses, as well as greater financial strain due to medical costs and higher likelihood of medical debt. Our results are consistent with prior literature showing that chronic illness burden and health care utilization increase with ACE score. The association between ACE score and OOP costs was largely mediated by the number of chronic medical and mental health conditions. This suggests a life course cascade beginning with adverse, potentially traumatic events during sensitive periods of childhood, predisposing adults to chronic disease that, in turn, leads to more health care spending and greater financial burden. Health system interventions designed to reduce the out-of-pocket cost burden of medical care, and perhaps even those designed to reduce the overall costs of care, should consider upstream approaches to reducing ACEs.

Tables and Figures

Table 2-1. Sample Characteristics, 2013 Panel Study of Income Dynamics Main Interview and Childhood Retrospective Circumstances Study.

Individual Level Variables	All Adults Percentage or Mean (SD) (n = 6,775)	Single Adults Percentage or Mean (SD) (n=659)	Married/Partnered Adults Percentage or Mean (SD) (n=4,680)
Adverse Childhood Experiences			
0	36.5	33.7	39.3
1-2	43.1	43.3	41.8
3 or more	20.3	23.0	18.8
Race			
Caucasian	84.9	83.0	88.0
African American	10.0	13.6	6.4
Asian/Pacific Islander	2.6	1.8	2.9
Ethnicity			
Latino/Hispanic	6.2	2.6	6.6
Male	46.9	45.1	50.8
Health Insurance			
Uninsured	12.2	20.0	7.8
Employer Sponsored	59.0	42.8	66.3
Privately Purchased Individual	6.6	6.9	6.8
Medicare	14.6	24.7	12.7
Medicaid	4.2	3.6	2.5
Tricare/Veterans Admin/Other	3.4	2.1	3.9
Education			
Less Than High School	7.5	7.2	6.7
High School Graduate/GED	24.7	25.7	24.3
Any College/Vocational School/Graduate School	67.9	67.0	69.0
Age	48.3 years (SD 15.7)	52.3 years (SD 16.6)	48.8 years (SD 14.7)

Years of Education	14.2 (SD 2.2)	14.1 (SD 2.2)	14.3 (SD 2.3)
Self-Rated Health Status			
Excellent	17.6	12.8	19.2
Very Good	39.9	32.6	42.3
Good	29.6	34.4	28.1
Fair	10.0	15.1	8.2
Poor	3.0	5.1	2.3
Chronic Condition Count			
0	43.4	33.6	45.6
1	28.7	27.1	29.7
2 or More	27.9	40.4	24.7
Mental Illness Symptom Burden			
None-Mild	81.7	74.0	85.3
Moderate (Subclinical)	14.9	19.7	12.8
Severe (Equivalent to Major Mental Illness)	3.4	6.3	1.9
Household Level Variables	**All Households Percentage or Mean (SD)** (n = 4,784)	**Single Member Households Percentage or Mean (SD)** (n=659)	**Two Adult Households Percentage or Mean (SD)** (n=2,738)
Income Level			
>400% FPL	40.8	30.8	54.6
300-400% FPL	13.2	11.9	14.8
200-299% FPL	16.0	18.1	14.5
100-199% FPL	16.6	19.6	11.1
<100% FPL	13.3	19.7	4.9
Annual Out-of-Pocket Medical Costs	$1055	$686	$1359
Total	$294	$154	$381
Inpatient	$471	$318	$614
Outpatient	$304	$212	$386
Prescription & In Home Care			

Annual Total Out-of-Pocket Medical Costs Exceeding 10% of Income	3.7%	6.5%	2.0%
Annual Total Out-of-Pocket Medical Costs Exceeding 100% of Liquid Assets	23.3%	25.6%	19.4%
Currently Carrying Medical Debt	10.0%	9.6%	9.5%

Table 2-2. Changes in Annual Out-of-Pocket Medical Expenses for Households by Adverse Childhood Experience Count, Stratified by Number of Adults and Presence of Children in the Household

Regression Coefficients (95% CI)	Highest of Household Adult Respondent ACE Scores		
	0 ACEs (Ref)	1-2 ACEs	3 or More ACEs
All Households (n=4,784)			
Overall Household OOP Medical Costs	--	**0.16 (0.04, 0.29)***	**0.26 (0.13, 0.40)*****
Inpatient Care OOP Costs	--	0.20 (-0.05, 0.46)	**0.35 (0.09, 0.62)****
Ambulatory Care OOP Costs	--	**0.16 (0.04, 0.28)***	**0.25 (0.11, 0.39)*****
Prescription/Other Services OOP Costs	--	**0.21 (-0.03, 0.46)†**	0.18 (-0.04, 0.39)
Single Member Households (n=659)			
Overall Household OOP Medical Costs	--	0.15 (-0.18, 0.47)	**0.61 (0.29, 0.92)*****
Inpatient Care OOP Costs	--	-0.49 (-1.08, 0.10)	**0.58 (-0.05, 1.22)†**
Ambulatory Care OOP Costs	--	0.17 (-0.24, 0.58)	**0.63 (0.24, 1.03)****
Prescription/Other Services OOP Costs	--	**0.40 (0.02, 0.79)***	**0.49 (0.16, 0.81)****
Single Adult Households with Children (n=411)			
Overall Household OOP Medical Costs	--	0.23 (-0.18, 0.64)	**0.53 (0.11, 0.94)***
Inpatient Care OOP Costs	--	0.62 (-0.36, 1.59)	0.52 (-0.60 1.63)
Ambulatory Care OOP Costs	--	0.17 (-0.38, 0.73)	**0.54 (0.9, 0.99)***
Prescription/Other Services OOP Costs	--	-0.05 (-0.59, 0.50)	0.41 (-0.13, 0.95)
Households with Two Adults and No Children (n=1,325)			
Overall Household OOP Medical Costs	--	**0.20 (0.03, 0.37)***	**0.26 (0.06, 0.46)***
Inpatient Care OOP Costs	--	0.25 (-0.19, 0.70)	**0.45 (-0.01, 0.92)†**
Ambulatory Care OOP Costs	--	**0.18 (0.001, 0.35)***	**0.23 (0.04, 0.43)***
Prescription/Other Services OOP Costs	--	**0.36 (0.01, 0.72)***	0.23 (-0.09, 0.54)

Regression Coefficients (95% CI)	**Highest of Household Adult Respondent ACE Scores**		
	0 ACEs (Ref)	1-2 ACEs	3 or More ACEs
Households with Two Adults and Any Children (n=1,199)			
Overall Household OOP Medical Costs	--	0.08 (-0.10, 0.26)	**0.24 (0.03, 0.45)***
Inpatient Care OOP Costs	--	0.09 (-0.23, 0.42)	**0.35 (-0.05, 0.76)**†
Ambulatory Care OOP Costs	--	0.11 (-0.13, 0.34)	0.13 (-0.12, 0.39)
Prescription/Other Services OOP Costs	--	0.00 (-0.23, 0.23)	0.15 (-0.11, 0.42)

Table 2-3. Changes in Annual Out-of-Pocket Medical Expenses for Individuals and Families by Adverse Childhood Experience Count and by Gender, Stratified by Household Size

Regression Coefficients (95% CI)		**Adult Household Respondent ACE Score Predictors by Gender**			
	0 ACEs (Ref)	Female: 1-2 ACEs	Female: 3 or More ACEs	Male: 1-2 ACEs	Male: 3 or More ACEs
All Households (n=4,784)					
Overall Household OOP Medical Costs	--	**0.17 (0.06, 0.28)****	**0.29 (0.15, 0.42)*****	0.03 (-0.08, 0.15)	0.03 (-0.10, 0.16)
Inpatient Care OOP Costs	--	**0.21 (-0.03, 0.44)†**	**0.35 (0.09, 0.60)****	0.02 (-0.23, 0.27)	0.14 (-0.15, 0.44)
Ambulatory Care OOP Costs	--	**0.16 (0.04, 0.28)****	**0.28 (0.14, 0.43)*****	-0.004 (-0.12, 0.11)	-0.01 (-0.15, 0.14)
Prescription/Other Services OOP Costs	--	**0.27 (0.02, 0.52)***	**0.24 (0.04, 0.44)***	0.11 (-0.07, 0.29)	-0.06 (-0.23, 0.12)
Single Member Households (n=659)					
Overall Household OOP Medical Costs	--	0.27 (-0.11, 0.65)	**0.78 (0.44, 1.11)*****	-0.11 (-0.46, 0.25)	0.22 (-0.33, 0.77)
Inpatient Care OOP Costs	--	-0.37 (-1.08, 0.34)	**0.80 (0.10, 1.5)***	-0.60 (-1.3, 0.12)	0.34 (-0.68, 1.37)
Ambulatory Care OOP Costs	--	0.27 (-0.21, 0.76)	**0.86 (0.45, 1.28)****	-0.12 (-0.51, 0.27)	-0.14 (-0.63, 0.34)
Prescription/Other Services OOP Costs	--	**0.55 (0.09, 1.00)***	**0.56 (0.22, 0.90)*****	0.09 (-0.34, 0.51)	0.38 (-0.14, 0.90)
Single Adult Households with Children (n=411)					
Overall Household OOP Medical Costs	--	0.17 (-0.28, 0.62)	**0.46 (0.01, 0.91)***	0.37 (-0.29, 1.03)	**0.74 (-0.03, 1.51)†**
Inpatient Care OOP Costs	--	0.57 (-0.42, 1.56)	0.23 (-0.92 1.39)	0.60 (-0.62, 1.8)	**1.47 (0.27, 2.68)***
Ambulatory Care OOP Costs	--	0.25 (-0.36, 0.87)	**0.65 (0.14, 1.17)***	-0.03 (-0.71, 0.64)	-0.14 (-1.1, 0.83)
Prescription/Other Services OOP Costs	--	-0.34 (-0.84, 0.17)	0.27 (-0.25, 0.78)	0.70 (-0.19, 1.59)	0.70 (-0.50, 1.90)
Households with Two Adults and No Children (n=1,325)					
Overall Household OOP Medical Costs	--	**0.17 (0.00, 0.34)***	**0.23 (0.03, 0.44)***	0.11 (-0.05, 0.26)	0.11 (-0.07, 0.30)
Inpatient Care OOP Costs	--	0.31 (-0.08, 0.70)	**0.48 (0.06, 0.91)***	0.02 (-0.33, 0.36)	0.29 (-0.16, 0.74)

Regression Coefficients (95% CI)		**Adult Household Respondent ACE Score Predictors by Gender**			
	0 ACEs (Ref)	Female: 1-2 ACEs	Female: 3 or More ACEs	Male: 1-2 ACEs	Male: 3 or More ACEs
Ambulatory Care OOP Costs	--	0.09 (-0.08, 0.27)	0.13 (-0.07, 0.33)	0.06 (-0.11, 0.23)	0.17 (-0.06, 0.39)
Prescription/Other Services OOP Costs	--	**0.45 (0.002, 0.90)***	**0.39 (0.03, 0.75)***	0.15 (-0.09, 0.39)	-0.23 (-0.48, 0.03)
Households with Two Adults and Any Children (n=1,199)					
Overall Household OOP Medical Costs	--	0.09 (-0.07, 0.26)	**0.25 (0.02, 0.48)***	-0.06 (-0.24, 0.11)	-0.02 (-0.23, 0.19)
Inpatient Care OOP Costs	--	-0.02 (-0.27, 0.23)	0.28 (-0.15, 0.72)	0.01 (-0.34, 0.36)	0.02 (-0.38, 0.42)
Ambulatory Care OOP Costs	--	0.12 (-0.09, 0.33)	0.17 (-0.9, 0.42)	-0.06 (-0.26, 0.15)	-0.08 (-0.28, 0.13)
Prescription/Other Services OOP Costs	--	0.08 (-0.13, 0.29)	0.20 (-0.09, 0.49)	-0.06 (-0.29, 0.18)	0.02 (-0.28, 0.32)

Regression model is a generalized linear model with Poisson family and log link.
* indicates significant difference from referent group with p-value <0.05, ** indicates significant difference from referent group with p-value <0.01, *** indicates significant difference from referent group with p-value <0.001. † indicates difference from referent group with p-value <0.10.

Table 2-4. Adverse Childhood Experiences Count and Measures of Burdensome Out-of-Pocket (OOP) Medical Costs

	Adverse Childhood Experience Count Categories Adjusted Odds Ratios (95% CI)					**Adverse Childhood Experience Count Categories Adjusted Odds Ratios (95% CI)**	
	0 ACEs (Ref)	Male Adult 1-2 ACEs	Male Adult 3 or More ACEs	Female Adult 1-2 ACEs	Female Adult 3 or More ACEs	Higher of All Adult Respondents ACE Scores 1-2 ACEs	Higher of All Adult Respondents ACE Scores 3 or More ACEs
Total Out-of-Pocket Medical Costs Exceeding Ten Percent of Income Threshold, All Households (n=4,378)							
Total OOP Costs Over 10% of Income	--	1.09 (0.58, 2.07)	1.48 (0.64, 3.40)	1.32 (0.76, 2.29)	**2.50 (1.38, 4.53)****	1.36 (0.81, 2.29)	**2.48 (1.40, 4.38)****
Total Out-of-Pocket Medical Costs Exceeding Wealth Thresholds, All Households (n=4,499)							
Total OOP Costs Over 100% of Liquid Asset Wealth	--	**1.65 (1.22, 2.23)*****	**2.22 (1.54, 3.18)*****	**1.54 (1.19, 2.01)*****	**1.78 (1.32, 2.39)*****	**1.73 (1.32, 2.26)*****	**2.25 (1.69, 2.99)*****
Carrying Medical Debt, All Households (n=4,793)							
Any Household Medical Debt	--	1.37 (0.90, 2.08)	**2.08 (1.26, 3.41)****	**1.86 (1.30, 2.67)*****	**2.07 (1.40, 3.06)*****	**1.73 (1.20, 2.49)****	**2.29 (1.56, 3.34)*****

* indicates significant difference from referent group with p-value <0.05, ** indicates significant difference from referent group with p-value <0.01, *** indicates significant difference from referent group with p-value <0.001.

Table 2-5. Mediation Regression Analyses: Effect of Including Chronic Condition Count and Mental Health Scale (Kessler-6 Emotional Distress Score) as Downstream Mediators of Adverse Childhood Experiences' Impact on Out-of-Pocket Medical Costs.

Total Out of Pocket Medical Cost Coefficient (95% CI) in Main GLM Model plus Independent and Mediating Variables Included in Model	Plus Kessler-6 Emotional Distress Score[a]	Plus Chronic Condition Count[b]	Plus Chronic Condition Count and Kessler-6 Score[ab]
All Households (n=4,593)			
Primary Adult Respondent's ACE Score			
0 ACEs Reported	(Referent)	(Referent)	(Referent)
1-2 ACEs Reported	0.08 (-0.03, 0.19)	0.07 (-0.04, 0.18)	0.06 (-0.05, 0.17)
3 or More ACEs Reported	**0.17 (0.04, 0.30)***	**0.18 (0.002, 0.26)***	0.10 (-0.03, 0.23)
Chronic Disease			
One condition increase in chronic conditions	--	**0.17 (0.13, 0.21)*****	**0.16 (0.11, 0.20)*****
Mental Health			
One point increase in Kessler-6 score	**0.04 (0.02, 0.05)*****	--	**0.03 (0.01, 0.04)*****
Single Individual Households (n=659)			
Highest Household ACE Score			
0 ACEs Reported	(Referent)	(Referent)	(Referent)
1-2 ACEs Reported	0.11 (-0.20, 0.43)	0.02 (-0.27, 0.31)	0.02 (-0.27, 0.32)
3 or More ACEs Reported	**0.57 (0.25, 0.90)*****	**0.36 (0.04, 0.68)***	**0.33 (0.004, 0.65)***
Chronic Disease			
One condition increase in chronic conditions	--	**0.33 (0.24, 0.43)*****	**0.33 (0.23, 0.43)*****
Mental Health			
One point increase in Kessler-6 score	**0.04 (0.01, 0.07)****	--	0.02 (-0.01, 0.05)
Individuals in Married Households (n=1,735)			
Highest Household ACE Score			
0 ACEs Reported	(Referent)	(Referent)	(Referent)
1-2 ACEs Reported	**0.15 (0.01, 0.30)***	**0.15 (0.009, 0.29)***	**0.14 (0.001, 0.29)***
3 or More ACEs Reported	**0.25 (0.10, 0.41)****	**0.22 (0.06, 0.37)****	**0.20 (0.04, 0.36)***
Chronic Disease			
One condition increase in chronic conditions	--	**0.08 (0.04, 0.13)*****	**0.07 (0.03, 0.12)****
Mental Health			
One point increase in Kessler-6 score	**0.03 (0.01, 0.06)*****	--	**0.03 (0.001, 0.05)***

* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold.

[a] For analysis of married households, the primary respondent's Kessler-6 score and partner's Kessler-6 score were included in the model.

[b] For analysis of married households, the primary respondent's chronic condition count and the partner's chronic condition count were included in the model

Table 2-6. Associations Between Specific Adverse Childhood Experiences and Out-of-Pocket Medical Costs†

Adverse Childhood Experience	Total Out of Pocket Cost Coefficient (95% CI)	
	Single Individual Households (n=659)	**Married Households with ACE Information from Both Spouses (n=3,986)**
Divorce of Parents	0.15 (-0.18, 0.48)	0.04 (-0.08, 0.16)
Physical Abuse	**0.28 (0.01, 0.56)***	0.08 (-0.03, 0.19)
Sexual Abuse	0.39 (-0.08, 0.86)	**0.27 (0.01, 0.54)***
Emotional Abuse	**0.36 (0.07, 0.65)***	**0.14 (0.01, 0.27)***
Neglect	0.03 (-0.33, 0.40)	0.02 (-0.11, 0.17)
Exposure to Parental Mental Illness	**0.67 (0.39, 0.94)*****	**0.14 (0.03, 0.25)****
Exposure to Parental Substance Abuse	0.12 (-0.17, 0.42)	0.09 (-0.02, 0.20)
Exposure to Intimate Partner Violence in Home	**0.32 (0.06, 0.59)***	0.08 (-0.04, 0.20)
Death or Estrangement of Parent	0.31 (-0.21, 0.82)	-0.08 (-0.25, 0.09)

†All coefficients reported from results of primary generalized linear models with Poisson family distribution and log link using identical covariates as models in the main analyses.
* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold.

Table 2-7. Inverse Probability of Treatment Weighted Models with Regression Adjustment: Changes in Annual Out-of-Pocket Medical Expenses for Households by Adverse Childhood Experience Count

	Average Treatment Effect in Absolute Dollars Highest of Household Adult Respondent ACE Scores		
	0 ACEs (Ref)	1-2 ACEs	3 or More ACEs
All Households (n=4,148)			
Overall Household OOP Medical Costs	--	**$191 (60, 322)****	**$325 (175, 476)*****
Inpatient Care OOP Costs	--	**$59 (-8, 126)†**	**$106 (30, 182)****
Ambulatory Care OOP Costs	--	**$81 (16, 146)***	**$141 (56, 225)*****
Prescription/Other Services OOP Costs	--	**$87 (3, 170)***	**$64 (4, 125)***

Table 2-8. Balance of Groups By Propensity Weighting Variables in Inverse Probability of Treatment Weighted Models with Regression Adjustment Used to Estimate Changes in Annual Out-of-Pocket Medical Expenses for Households by Adverse Childhood Experience Count

	Variance Ratio Highest of Household Adult Respondent ACE Scores		
	0 ACEs (Ref)	1-2 ACEs	3 or More ACEs
All Households (n=4,148)			
Respondent's Mother's Education Level	--	0.95	0.85
Respondent's Father's Education Level	--	0.98	0.89
Respondent's Childhood Socioeconomic Status	--	1.05	1.02
Presence of Both Parents in Respondent's Childhood Home	--	1.12	1.02
Respondent's Race	--	0.87	1.13
Respondent's Ethnicity	--	0.89	0.91
Respondent's Number of Brothers	--	0.78	0.73
Respondent's Number of Sisters	--	0.82	0.82

Figure 2-1. Visual Representation of the Analytic Samples In Dissertation Study One

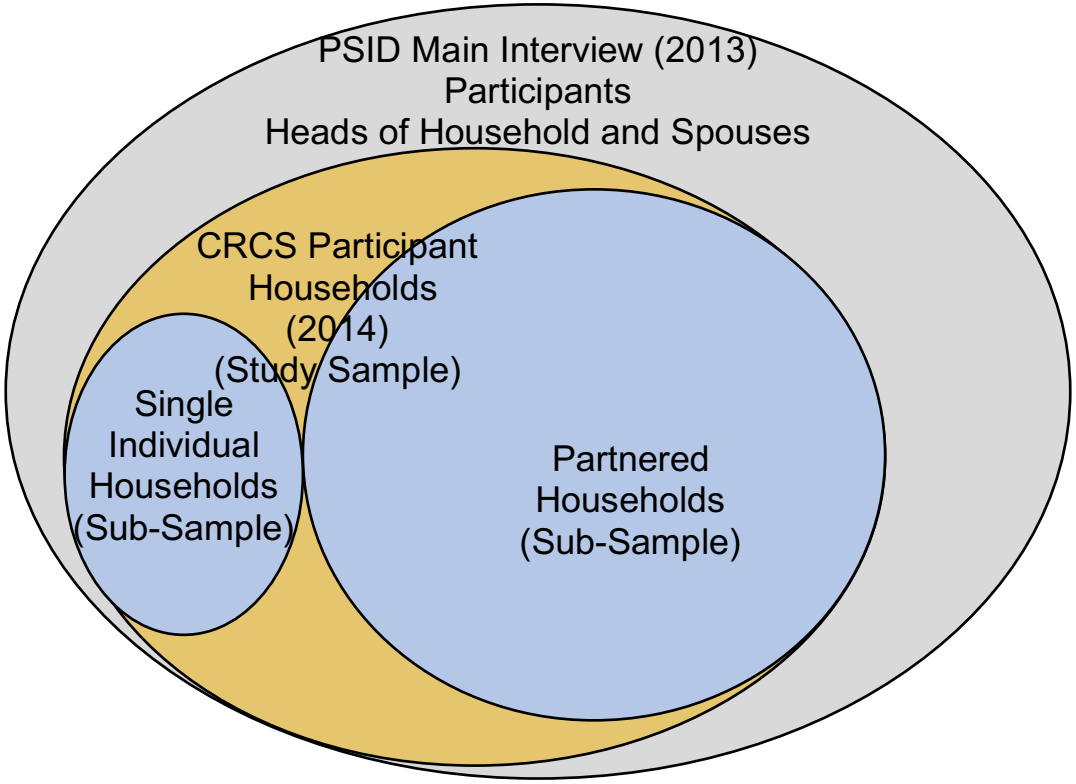
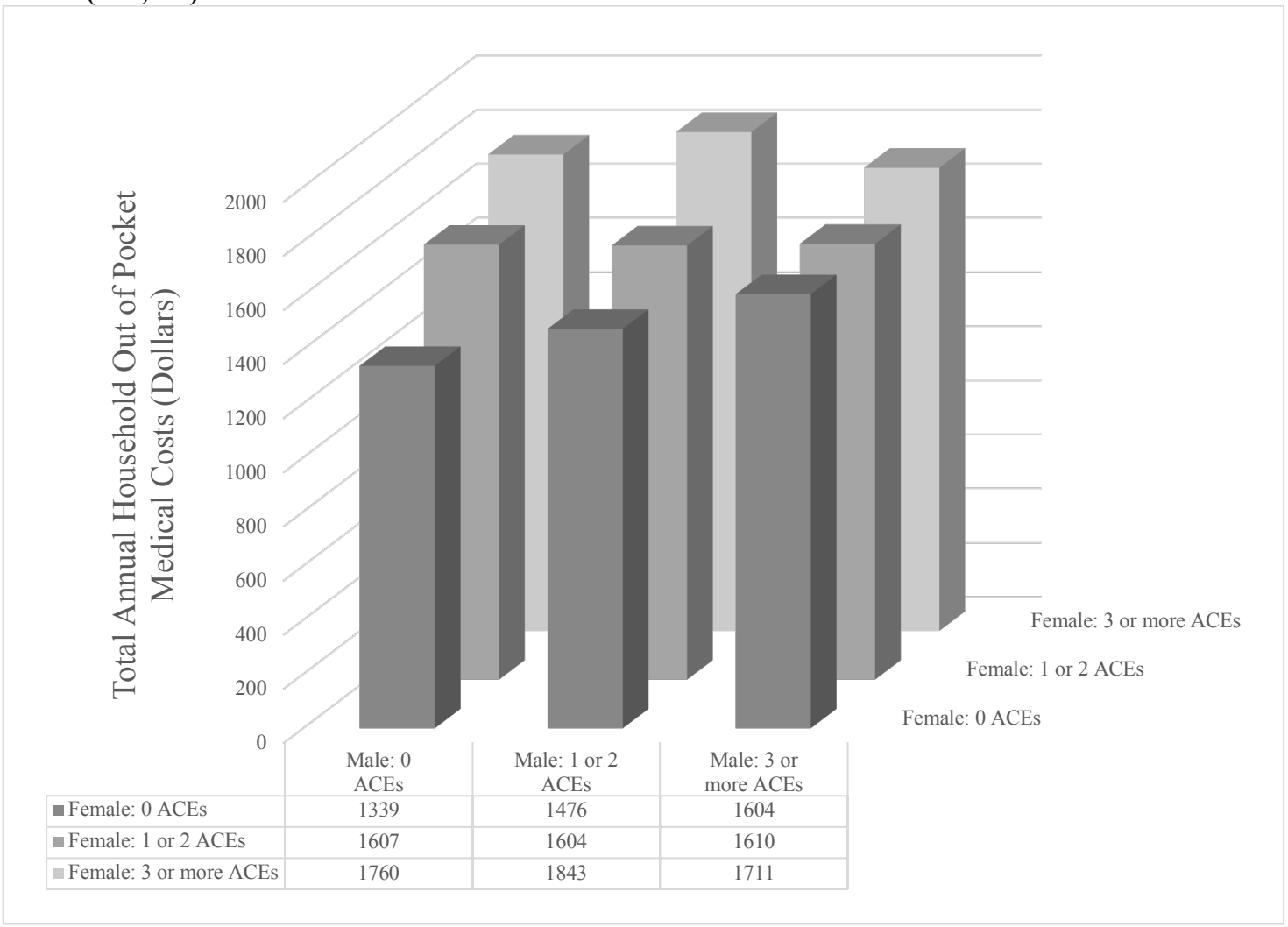


Figure 2-2: Two-Adult Household Total Annual Out of Pocket Medical Costs, Accounting for Male & Female Respondents' ACE Scores (n=2,524)



	Male: 0 ACEs	Male: 1 or 2 ACEs	Male: 3 or more ACEs
Female: 0 ACEs	1339	1476	1604
Female: 1 or 2 ACEs	1607	1604	1610
Female: 3 or more ACEs	1760	1843	1711

APPENDIX A: RESULTS OF COMPARABLE REGRESSION MODELS

Table 2-A-1. Comparison of Results of Three Models - Individual Level Changes in Annual Out-of-Pocket Medical Expenses for Individuals and Families by Adverse Childhood Experience Count

Regression Coefficients (95% CI)		**GLM, Poisson Family, Log Link**		**GLM, Gamma Family, Log Link**		**OLS, Log-Transformed Cost Outcomes**	
	0 ACEs (Reference for all models)	1-2 ACEs	3 or More ACEs	1-2 ACEs	3 or More ACEs	1-2 ACEs	3 or More ACEs
Participants in All Households (n=4,499)							
Overall Household OOP Medical Costs	--	**0.16 (0.04, 0.29)***	**0.26 (0.13, 0.40)*****	**0.15 (0.02, 0.28)***	**0.28 (0.13, 0.42)*****	**0.20 (0.03, 0.37)***	**0.42 (0.23, 0.61)*****
Individual Participants in Single Member Households (n=659)							
Overall Individual OOP Medical Costs	--	0.12 (-0.19, 0.44)	**0.64 (0.31, 0.96)*****	0.13 (-0.18, 0.45)	**0.63 (0.29, 0.98)*****	0.35 (-0.08, 0.77)	**1.0 (0.52, 1.46)*****
Participants in Married Households (n=2,524)							
Overall Household OOP Medical Costs	--	**0.16 (0.03, 0.29)***	**0.25 (0.11, 0.39)*****	0.10 (-0.03, 0.23)	**0.22 (0.07, 0.37)****	0.04 (-0.14, 0.21)	**0.23 (0.04, 0.42)***

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

APPENDIX B: COST ESTIMATES

Table 2-B-1. Adjusted Dollar Value Estimates of Annual Out-of-Pocket Medical Costs for Individuals and Families by Adverse Childhood Experience Count, Stratified by Presence of Children in the Household

Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)	Highest of All Household Adults' Adverse Childhood Experience (ACE) Score		
	0 ACEs	1-2 ACEs	3 or More ACEs
All Households (n=4,784)			
Overall Household OOP Medical Costs	$1042 (936-1148)	$1226 (1132-1320)	$1353 (1238-1468)
Inpatient Care OOP Costs	$247 (198-296)	$302 (254-350)	$351 (289-413)
Ambulatory Care OOP Costs	$484 (438-529)	$568 (524-612)	$623 (561-684)
Prescription/Other Services OOP Costs	$313 (256-370)	$388 (329-447)	$375 (332-417)
Single Member Households (n=659)			
Overall Household OOP Medical Costs	$607 (474-740)	$702 (543-860)	$1112 (862-1361)
Inpatient Care OOP Costs	$150 (80-220)	$92 (55-129)	$269 (145-393)
Ambulatory Care OOP Costs	$285 (208-363)	$338 (240-436)	$536 (386-686)
Prescription/Other Services OOP Costs	$185 (143-227)	$277 (195-360)	$301 (232-370)
Single Adult Households with Children (n=411)			
Overall Household OOP Medical Costs	$506 (340-673)	$635 (475-796)	$856 (655-1057)
Inpatient Care OOP Costs	$103 (17-189)	$191 (101-281)	$173 (75-271)
Ambulatory Care OOP Costs	$257 (149-365)	$306 (210-402)	$441 (326-556)
Prescription/Other Services OOP Costs	$149 (85-214)	$143 (91-194)	$224 (139-309)
Households with Two Adults but No Children (n=1,325)			

Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)	Highest of All Household Adults' Adverse Childhood Experience (ACE) Score		
	0 ACEs	1-2 ACEs	3 or More ACEs
Overall Household OOP Medical Costs	$1408 (1219-1596)	$1717 (1536-1897)	$1823 (1589-2056)
Inpatient Care OOP Costs	$262 (166-358)	$338 (263-414)	$413 (307-520)
Ambulatory Care OOP Costs	$667 (575-759)	$796 (708-885)	$843 (732-955)
Prescription/Other Services OOP Costs	$448 (357-539)	$645 (489-802)	$562 (444-680)
Households with Two Adults and Any Children (n=1,199)			
Overall Household OOP Medical Costs	$1240 (1065-1415)	$1347 (1201-1493)	$1571 (1330-1812)
Inpatient Care OOP Costs	$380 (277-484)	$418 (344-491)	$542 (372-713)
Ambulatory Care OOP Costs	$615 (506-725)	$685 (591-780)	$702 (589-815)
Prescription/Other Services OOP Costs	$264 (214-315)	$264 (229-300)	$308 (249-367)

Table 2-B-2. By Primary and Secondary Adult Respondent: Adjusted Dollar Value Estimates of Annual Out-of-Pocket Medical Costs for Individuals and Families by Adverse Childhood Experience Count, Stratified by Household Size

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
All Households (n=4,644)			
Overall Household OOP Medical Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $1119 (1027-1211) $1164 (1093-1235)	 $1231 (1133-1331) $1295 (1153-1437)	 $1340 (1207-1474) $1365 (1163-1566)
Inpatient Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $277 (230-324) $282 (247-317)	 $303 (253-353) $333 (258-407)	 $338 (273-404) $406 (250-562)
Ambulatory Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $517 (479-555) $549 (512-587)	 $571 (523-618) $568 (502-634)	 $623 (549-696) $603 (513-692)
Prescription/Other Services OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $332 (286-379) $343 (310-376)	 $391 (328-454) $437 (352-522)	 $367 (318-416) $391 (306-477)
Single Member Households (n=659)			
Overall Household OOP Medical Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $607 (474-740) --	 $686 (467-906) --	 $957 (451-1462) --
Inpatient Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $150 (80-220) --	 $92 (55-129) --	 $269 (145-393) --
Ambulatory Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $285 (208-363) --	 $338 (240-436) --	 $536 (386-686) --
Prescription/Other Services OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $185 (143-227) --	 $277 (195-360) ---	 $301 (232-370) --
Single Adult Households with Children (n=411)			

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
Overall Household OOP Medical Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$506 (340-673) --	$635 (475-796) --	$856 (655-1057) --
Inpatient Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$103 (17-189) --	$191 (101-281) --	$173 (75-271) --
Ambulatory Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$257 (149-365) --	$306 (210-402) --	$441 (326-556) --
Prescription/Other Services OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$149 (85-214) --	$143 (91-194) --	$224 (139-309) --
Households with Two Adults but No Children (n=1,325)			
Overall Household OOP Medical Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$1549 (1394-1704) $1546 (1359-1697)	$1711 (1514-1908) $1837 (1599-2075)	$1890 (1565-2216) $1792 (1532-2051)
Inpatient Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$301 (225-376) $304 (234-373)	$326 (247-405) $387 (280-494)	$466 (323, 609) $393 (234-551)
Ambulatory Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$724 (649-800) $756 (671-841)	$813 (710-915) $781 (673-888)	$837 (689-984) $867 (707-1027)
Prescription/Other Services OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$522 (448-595) $495 (426-565)	$638 (466-811) $748 (544-951)	$550 (406-693) $603 (416-790)
Households with Two Adults and Any Children (n=1,199)			
Overall Household OOP Medical Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	$1378 (1195-1561) $1329 (1194-1463)	$1366 (1205-1527) $1378 (1193-1563)	$1445 (1185-1706) $1662 (1224-2101)

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
Inpatient Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $473 (336-609) $401 (327-476)	 $428 (344-512) $457 (346-568)	 $438 (298-579) $666 (283-1050)
Ambulatory Care OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $670 (587-752) $655 (573-736)	 $673 (574-773) $680 (569-791)	 $676 (527-824) $733 (588-878)
Prescription/Other Services OOP Costs Adult One (Primary Respondent) Adult Two (Secondary Respondent)	 $255 (217-293) $285 (243-328)	 $285 (242-327) $253 (208-298)	 $307 (232-383) $295 (217-372)

Table 2-B-3. By Gender: Adjusted Dollar Value Estimates of Annual Out-of-Pocket Medical Costs for Individuals and Families by Adverse Childhood Experience Count, Stratified by Household Size

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
All Households (n=4,644)			
Overall Household OOP Medical Costs Male Female	 $1191 (1114-1270) $1083 (1003-1163)	 $1231 (1115-1347) $1284 (1172-1395)	 $1231 (1089-1372) $1441 (1287-1594
Inpatient Care OOP Costs Male Female	 $294 (252-335) $262 (225-300)	 $299 (241-357) $323 (261-386)	 $340 (252-427) $371 (291-450)
Ambulatory Care OOP Costs Male Female	 $560 (521-597) $503 (469-537)	 $557 (507-607) $590 (534-645)	 $554 (484-624) $667 (583-750)
Prescription/Other Services OOP Costs Male Female	 $353 (313-394) $318 (278-359)	 $395 (332-457) $417 (333-501)	 $335 (285-384) $406 (346-467)
Single Member Households (n=659)			
Overall Household OOP Medical Costs Male Female	 $765 (655-875) $612 (505-719)	 $686 (467-906) $799 (541-1056)	 $957 (451-1462) $1330 (980-1680)
Inpatient Care OOP Costs Male Female	 $163 (111-215) $137 (84-190)	 $89 (32-146) $94 (42-147)	 $230 (6-455) $305 (137-473)
Ambulatory Care OOP Costs Male Female	 $373 (306-440) $283 (222-343)	 $332 (216-449) $371 (217-525)	 $324 (177-471) $670 (449-891)
Prescription/Other Services OOP Costs Male Female	 $240 (199-280) $195 (160-230)	 $262 (157-367) $337 (200-475)	 $351 (176-524) $340 (248-433)
Single Adult Households with Children (n=411)			

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
Overall Household OOP Medical Costs Male Female	 $623 (517-729) $551 (385-717)	 $900 (323-1479) $654 (458-849)	 $1304 (331-2277) $872 (633-1112)
Inpatient Care OOP Costs Male Female	 $148 (96-200) $124 (46-203)	 $269 (-40-579) $220 (90-349)	 $647 (-139-1433) $156 (46-267)
Ambulatory Care OOP Costs Male Female	 $325 (258-392) $249 (150-347)	 $314 (123-505) $321 (199-442)	 $282 (18-546) $477 (342-612)
Prescription/Other Services OOP Costs Male Female	 $151 (116-186) $175 (114-237)	 $303 (38-569) $125 (80-171)	 $304 (-51-659) $229 (137-322)
Households with Two Adults but No Children (n=1,325)			
Overall Household OOP Medical Costs Male Female	 $1581 (1425-1737) $1506 (1359-1653)	 $1757 (1557-1957) $1779 (1549-2010)	 $1770 (1499-2041) $1911 (1589-2232)
Inpatient Care OOP Costs Male Female	 $324 (254-395) $276 (204-348)	 $329 (245-413) $376 (279-473)	 $432 (263, 601) $448 (313-583)
Ambulatory Care OOP Costs Male Female	 $744 (657-830) $735 (664-807)	 $793 (701-885) $808 (691-924)	 $878 (717-1040) $837 (694-979)
Prescription/Other Services OOP Costs Male Female	 $555 (451-659) $455 (385-526)	 $646 (514-778) $715 (461-968)	 $442 (352-533) $671 (482-861)
Households with Two Adults and Any Children (n=1,199)			
Overall Household OOP Medical Costs Male Female	 $1417 (1257-1578) $1274 (1142-1406)	 $1334 (1159-1508) $1401 (1229-1573)	 $1390 (1152-1626) $1635 (1296-1974)

	Generalized Linear Regression Model, Poisson Family, Log Link Each Cell Presents Predicted Annual Out-of-Pocket Costs (95% CI)		
	0 ACEs	1-2 ACEs	3 or More ACEs
Inpatient Care OOP Costs Male Female	 $444 (339-549) $422 (343-500)	 $448 (338-558) $414 (338-491)	 $452 (315-559) $561 (325-796)
Ambulatory Care OOP Costs Male Female	 $692 (608-776) $624 (545-703)	 $653 (548-759) $704 (595-813)	 $641 (531-752) $737 (578-896)
Prescription/Other Services OOP Costs Male Female	 $282 (237-326) $259 (226-291)	 $266 (223-308) $281 (235-327)	 $287 (219-355) $315 (233-397)

Chapter Three

Intergenerational Associations Between Parents' and Children's Adverse Childhood Experience Scores

Adverse childhood experiences (ACEs) are stressful and potentially traumatic events, including abuse, neglect, and exposure to household dysfunction, that occur any time before age eighteen. Adverse childhood experiences are associated with higher risk of worse mental and physical health in adulthood and have been shown to predict a number of significant adverse outcomes over the lifecourse, including greater risk-taking behavior, worse mental health, riskier health related behaviors, greater chronic disease burden, and premature mortality.[124] [125] [126] In addition to conferring health risk upon individuals who experience adversity that ACEs measure, there is also evidence to suggest that the experience of adversity in childhood can result in a higher likelihood of perpetuating cycles of adversity for one's children when in a parenting role. Certain ACEs may have intergenerational associations with parenting practices, their potential for child abuse and neglect of their own children,[127] and their children's mental health and substance abuse.[128] While these studies have focused on intergenerational associations for a few specific ACEs, the aggregation of different types of adverse childhood experiences into the ACE score provides a more comprehensive tool to assess risk for cross-generational transmission of adversity from parents to children. There is also rationale for considering the full ACE score – not just individual ACEs -- when measuring the sum of adversity an individual's experiences

because various types of adversity are thought to impact health hazards through overlapping risk pathways, such as the final common pathways of the endocrine stress response and increased allostatic load.[129] [130] [131]

No published study has measured the intergenerational associations between overall ACE scores in parents and their children. If it were shown to be linked across generations, the well-established ACE score measure could be used as an early indicator of childhood risk of adversity, maltreatment, and household dysfunction. Unlike many screening and intervention approaches for risk of child maltreatment that are implemented in pediatric practices,[132] [133] [134] parent ACE score is measurable even before birth and could be implemented in the prenatal setting or earlier to help target interventions to reduce the risk of intergenerational transmission of adversity.

Parental history of maltreatment in childhood has been shown to correlate strongly with parenting behaviors and risk of intergenerational transmission of child maltreatment.[135] [136] [137] [138] [139] Parenting frustration, anger, and psychological distress have all been shown to function as mediators that increase the risk that parents will display adverse parenting behaviors.[140] [141] [142] [143] These associations suggest that maltreatment and other experiences of adversity may be the result of behaviors that have the potential to be transmitted across generations, perhaps modeled on exposures to adverse parenting behaviors and facilitated by psychological responses to those exposures.

A plausible, albeit simplistic, way of conceptualizing the cascade of intergenerational adversity is depicted in Figure 3-1 showing parental experience of early life adversity (measured by ACEs) predisposing to emotional distress and harmful behaviors in parenthood, which in turn lead to a higher likelihood of adverse experiences and a higher risk of elevated ACEs in one's children. To date there has been no examination of this full cascade of intergenerational ACE transmission including its mediators.

In this study, I examine the increase in likelihood of adult children reporting elevated ACE scores associated with their parents' retrospective ACE scores in a national sample of families. I separately examine the links between mothers' and fathers' retrospectively reported ACE scores and the retrospectively reported ACE scores of their adult children. I explore potential mediators of these associations including parental mental health, parenting aggravation, and parent disagreement.

PARTICIPANTS AND METHODS

Design and Participants

I used data from the Panel Study of Income Dynamics (PSID), a panel survey with genealogic design containing household economic, health, and sociologic information from a nationally representative sample of U.S. families beginning in 1968. Data collected by phone from the 2013 PSID main interview family and individual surveys included information on health, education, income, insurance, family structure (i.e. household size, marital status), and demographic characteristics for adult heads of household, their spouses, and their children or other cohabitants from households in the active sample. All 2013 PSID participant heads of household and their spouses were invited to participate in a supplement, the 2014 Childhood Retrospective

Circumstances Study (CRCS), from which data on parents and child ACEs were obtained. Information on parent mental health (Kessler-6 emotional distress scale), Aggravation in Parenting scores, and Parent Disagreement scores were obtained from PSID's 1997, 2002, and 2014 waves of the PSID's Child Development Supplement (CDS) for parents participating in the CRCS. The 1997 and 2002 waves of the CDS collected information from a single cohort of children from PSID families, and the 2014 wave followed an entirely new cohort. All waves of the CDS employed phone and in-person interviews to survey children's behavior, psychological and social well-being, health status, family environment, education, and caregiver characteristics.

Twelve thousand nine hundred eighty-five individuals who were age 19 or older and English-speaking heads of household or their spouses in the PSID 2013 main interview were eligible for the CRCS, which retrospectively assessed childhood experiences, including nine ACEs. Eight thousand seventy-two individuals completed the CRCS via web-based or mailed paper survey between May, 2014, and January, 2015, for an unweighted response rate of 62 percent (weighted response rate 67%) similar to response rates for web-based supplements to other national panel studies.[144] Those who completed the CRCS survey received a $20 incentive after participation.

Among the 8,703 PSID CRCS participants whose ACEs information was collected (Table 3-1), 2,205 (27%) had a mother, father, or both who were also CRCS participants. These parent-child dyads formed the primary analytic sample for this study and allowed us to answer the primary study question: what is the associations between parents' ACEs and ACE scores in their children, independent of sociodemographic factors? A visual representation of the analytic sample is provided in Figure 3-2.

To examine mediators of intergenerational parent-child ACE correlations, I examined samples that included parent-child dyads in which parent mood and behavior data were collected through any wave of the CDS. Of children participating in the CDS-2014, 2,466 (63%) had a mother, father, or both who participated in the CRCS. This sample allowed us to examine associations between parents' ACEs and parent mood, aggravation, and disagreement during childrearing. Of the 2,205 parent-child dyads with ACE information in the CRCS, 660 (30%) of those dyads included children who participated in the 1997 and 2002 CDS. This sub-sample allowed us to examine the degree to which parent mood, aggravation, and disagreement mediated the parent-child ACE association. As one would expect, this sub-sample was younger than the overall sample (Table 3-2) because in order to be included in the CRCS the children, who were between 0 and 12 years old in 1997, participants had to have established independent economic households just 17 years later.

Construction of Adverse Childhood Experience Variable

Complete conventional ACE information in the CRCS was collected from adults who reported experiences prior to age eighteen including physical abuse, emotional abuse, sexual abuse or assault, emotional neglect, witnessing intimate partner violence in the home, witnessing household substance use, having a parent with mental illness, any parental separation or divorce, and having a deceased parent or a parent they never knew. See Table 1-1 for the proportion of participants with each count of ACEs from 0-9 and the proportion with each individual type of ACE. Adverse childhood experience counts were binned into four categories – zero, 1, 2-3, and 4 or more ACEs -- for analysis, similar to prior studies.[145] [146] [147] This ACE variable construction was how both the parent ACE predictor and child ACE outcome were specified.

The parent ACEs predictor variable was specified primarily as the highest of either parent's ACE score category, allowing for those children with only one parent in the household or only one parent who responded to the CRCS to be included in the main analyses. For analyses examining the relationship between each parent's ACE score and child ACEs, I included the ACE score of each parent (if present) in the model along with an indicator variable for the presence of each parent.

While direct confirmation in childhood of the retrospectively reported ACEs was not possible using the data available in the PSID and its supplements, the validity of the retrospective ACEs was interrogated indirectly by assessing correlations between retrospective ACE count and measures of the stress of the CRCS participants' parents and the home environment in which they were raised. Within the full CRCS sample, using logistic regression models adjusted for covariates described in our main study below, we validated relationships between ACEs and individual chronic conditions that have been shown using other datasets and published in the literature, including elevated risk of diabetes, hypertension, heart disease, arthritis, and lung disease (Appendix I).

Covariates

The PSID main interview collected parents' years of total education, household income, self-identified race and ethnicity, age in years, health insurance coverage and type, household size, and marital status, among other socioeconomic and demographic characteristics. The PSID CDS collected child age, race, and ethnicity. Covariate specifications in the analytic models described in the next section included a five-category education variable for each parent (less than high school, high school graduate/GED, some college or vocational school, competed college, and

graduate degree); a continuous child years of age variable; a four-category child race variable (Caucasian, African American, Asian/Pacific Islander, and Multiracial/Other); a five-category household income level variable (<100%, 100-199%, 200-299%, 300-399%, and ≥400% of the Federal Poverty Line); count variables for the number of household members and children; and binary indicator variables for child Latino/Hispanic ethnicity.

Among participants in parent-child dyads in the CRCS, 455 (21%) were missing primary predictor or outcome data. We found no significant differences in covariate composition of the sample with or without these individuals. After performing multiple imputation to replace the missing ACE information among the adult children, I was able to recover roughly a third of these missing observations and confirm that the results of the main analyses did not differ after multiple imputation (Appendix II). Based on these findings, the missing observations from the parent-child dyads were excluded from the primary analyses and results described below rather than relying on the multiply imputed dataset, since there may have been systematic biases introduced through the process of imputation. We present demographic differences between the sub-sample of children in parent-child dyads (2,205), those in CRCS parent-child dyads with mediator data captured in the CDS (660), and the overall CRCS sample (8,705) to identify differences in sample composition.

Statistical Analyses

For the main analyses, I regressed children's binned ACE counts on their parents' ACE counts using multvariable multinomial logistic regression models, adjusted for the covariates above, which allowed me to examine the intergenerational associations without imposing the assumptions of linear relationships between the predictors and outcome. Estimates of absolute

risk and relative risk of child ACE counts by parent ACE counts were calculated via postestimation by the delta method. Models were weighted using the CRCS individual sampling weights to accommodate the complex survey design, achieve population representation, and adjust for nonresponse in the CRCS. To determine which weights to use in the analyses including those who participated in both the CRCS and CDS waves, I ran models with the CDS-2014 child level sample weights as well. The model results did not differ substantially regardless of which weights were applied, so we chose to use the CRCS weights for analyses. Estimates employed survey-robust standard errors. I used similar multinomial logistic regression models to examine the relationship between mothers' ACE scores and fathers' ACE scores separately as predictor variables for the child ACE outcome. Multinomial logistic regression models that included interaction terms to determine whether higher paternal and maternal ACE counts synergistically increased child ACE risk over-and-above the risk conferred by their main effects did not find that the interaction terms were statistically significant.

Secondary analyses examined linear relationships between parents' ordinal ACE counts (not top coded) and their children's ordinal ACE counts. The analyses with parents' and children's ordinal ACE counts included a term for the interaction of the mother's ACE count by the father's ACE count and indicators of the presence of both parents. In additional secondary analyses, gender-specific associations between parents' ACEs and their children's ACEs were undertaken to examine whether children of one gender or another may be more likely to have experienced ACEs if their one or either of their parents had higher ACE scores.

I performed mediation analyses to assess whether parents' mental illness symptom scores on the Kessler-6 twenty-four-point scale of emotional distress,[148] their scores on the Aggravation in

Parenting Scale (APS), or their scores on the Parental Disagreement Scale (PDS) mediated any relationships between parent ACE scores and behavioral health outcomes. The Kessler-6 (K6) measures psychological distress, particularly anxiety and depression symptoms, based on responses to six items each scored on a 5-point Likert scale. The K6 was derived from a ten-item scale (the Kessler 10) developed for the National Health Interview Survey using item response theory models with subsequent clinical revalidation to differentiate mild-moderate (sub-clinical) and severe (clinically diagnosable) mood disorder symptomatology.[149] [150] The Aggravation in Parenting Scale is a composite average of responses between 1 (not at all true) and 5 (completely true) to each of seven items based on items from the Parenting Stress Index, asking parents how much they felt the child was harder to care for than expected, did things that bother the parent, and how much the parent feels he/she is giving up much more of life to be a parent than expected, among other negative sentiments .[151] The APS has been validated in a number of studies and found to have high reliability.[152] [153] [154] The Parental Disagreement Scale consists of 13 items assessing the extent of disagreement between the primary child caregiver and her/his spouse or partner. The items were derived from the National Longitudinal Survey of Youth and combined as the average score on a five-point Likert scale.[155] See Appendix 3-A for the full scales. To perform these mediation analyses, I conducted formal Sobel-Goodman tests of mediation to estimate the proportion of the parent ACE score effect on child ACE scores that was mediated by continuous score on each of the PDS, APS, and Kessler-6 scores. I focused on maternal ACE scores as the parent ACE score of interest for these analyses because of its stronger relationship with child ACE counts. We confirmed findings of partial mediation by loading PDS, APS, and Kessler-6 score separately into our main regression models and observed changes in the magnitude of the parent ACE score coefficient.

All analyses were carried out in Stata, version 14 (StataCorp). The UCLA Institutional Review Board approved this study, which used both restricted and publicly available data obtained under contract from the University of Michigan's Institute for Social Research where the PSID data is housed.

RESULTS

The study sample for our main analyses included 2,205 adult children in parent-child dyads for which the child's ACE score and one or more parent's ACE score was captured through the PSID Childhood Retrospective Circumstances Study (CRCS). A tenth of the adult children in the sample reported experiencing four or more ACEs, while approximately a third did not report any ACEs. The distribution of ACE counts in the children was similar to the ACE count distributions of their parents, though on average the children reported more ACEs than either group of parents. Mothers reported more ACEs than fathers. Most individuals in the sample were Caucasian, about two thirds had some education beyond a high school degree (similar to their parents), and almost half rated their socioeconomic status while growing up as about average (Table 3-2). Compared to the demographics of the overall CRCS cohort, the study sample of adult children was on average slightly more educated and was ten years younger. The sub-sample of CRCS parent-child dyads that participated in the CDS in 1997/2002 was more diverse racially and ethnically, better educated, more often well-to-do in childhood, contained a larger proportion of women, and was made up of some of the youngest participants in the CRCS.

Among CRCS parent-child dyads, absolute risks of child ACE count categories by highest of either parent's ACE count are presented in Table 3-3 (adjusted relative risk ratios produced by the source multinomial logit model are reported in Appendix Table 3-B-1). Increased risk of

higher child ACE counts was observed when parents had ACE counts above two, with the largest shift in distribution of child ACE counts found when parents reported experiencing four or more ACEs. Compared to children whose parents reported no ACES, those whose parents the highest ACE counts were one third less likely to report no ACEs (adjusted absolute difference of 15.8 percentage points [95% CI 6.9-24.6], p< 0.001) and 3.3 times more likely to have four or more ACEs themselves (adjusted absolute risk difference of sixteen percentage points [95% CI 8.3-23.7], p<0.001).

When including separate ACE count variables for mothers and fathers in our multinomial logistic model we found mothers' ACE counts were more strongly associated with their children's ACE counts than were fathers' ACE counts (Table 3-4). Children whose mothers reported four or more ACEs were forty percent less likely to report no ACEs (RR 0.59, 95% CI 0.37, .81, p<0.001; adjusted absolute difference of 17.4 percentage points [95% CI 7.5, 27.4], p= 0.001) and 4.76-fold more likely to report four or more ACEs themselves (RR 95% CI 2.5, 7.0, p<0.001; adjusted absolute risk difference of 22.0 percentage points [95% CI 12.6, 31.5], p<0.001), compared to those whose mothers reported no ACEs. Paternal ACE counts showed an overall positive association with their children's ACE counts, but the effect was less pronounced than for mothers' ACE counts and did not reach statistical significance in most comparisons examined (see Appendix Table 3-B-2 for multinomial logit model results). The combination of maternal and paternal ACE counts predicted large changes in risk of children's ACE counts reaching four or more (Figure 3-3). For children with four or more maternal ACEs and four or more paternal ACEs, the likelihood of reporting zero ACEs was 0.42-fold (95% CI 11.9, 72.6; p=0.006) and 25.3 percentage points (95% CI 10.9, 39.7; p=0.001) lower than for children whose parents both reported no ACEs. Children whose parents both reported four or more ACEs had a

7.7-fold (95%CI 2.1, 13.4; p=0.007) and 40.5 percentage point (95%CI 15.9, 65.1, p=0.001) increased risk of reporting four or more ACEs themselves compared to children whose parents experienced no ACEs between them. Figure 3-3 plots the absolute risk of children reporting four or more ACEs by paternal ACE counts and maternal ACE counts. Overall, there are clear differences seen in risk of child ACE counts that vary by maternal and paternal ACE counts, with fewer maternal and paternal ACEs being generally protective and greater maternal and paternal ACEs generally increasing the likelihood of child ACEs.

In secondary analyses using linear models with ordinal child ACE counts as the outcome and interacting mothers' ACEs by fathers' ACEs, each additional maternal ACE was associated with an average increase of one quarter of an ACE in their children (0.25, 95%CI [0.17, 0.33], p<0.001), while each additional paternal ACE was associated with an average increase of just under one fifth of an ACE (0.19, 95% CI [0.08, 0.30], p=0.001). The coefficient on the mother's-ACE-count-by-father's-ACE-count interaction variable in the model was negative (-0.09, 95% CI [-0.14, -0.05], p<0.001), indicating that there is a dampening in the unit change in the effect of one parent's ACE count on a child's ACE count outcome associated with an increase in the ACE count of the other parent. In linear models examining child sub-samples by gender, similar results were found separately among male children (mothers' ACE count coefficient 0.27, 95% CI [0.14, 0.40], p<0.001; fathers' ACE count coefficient 0.14, 95% CI [-0.02, 0.31], p=0.09; mother-ACE-count-by-father-ACE-count interaction term -0.11, 95% CI [-0.19, -0.02], p=0.01) and female children (mothers' ACE count coefficient 0.25, 95% CI [0.15, 0.35], p<0.001; fathers' ACE count coefficient 0.22, 95% CI [0.07, 0.37], p=0.003; mother-ACE-count-by-father-ACE-count interaction term -0.08, 95% CI [-0.13, -0.27], p=0.003).

Among parents of children in the 2014 CDS, parent ACE count was positively associated with scale scores on each of the three mediator variables - the Kessler-6 scale of psychological distress, the Aggravation in Parenting Scale, and the Parental Disagreement Scale. Mothers who reported four or more ACEs were found to have Kessler-6 scale scores that were 1.34 points higher, on average, than mothers who reported experiencing no ACEs ($p<0.001$), and the analogous comparison in fathers found that reporting four or more ACEs carried an increase in psychological distress score of 1.44 points. Higher paternal ACE counts were not as consistently associated with changes in Aggravation in Parenting scale scores but higher maternal ACE counts were. Only maternal ACE counts showed a positive association with or Parent Disagreement Scale scores at all levels of maternal ACE counts (Table 3-5).

The Kessler-6 psychological distress scale score, Aggravation in Parenting scale score, and Parental Disagreement Scale score were found to partially mediate the association between parental ACE counts and their children's ACE counts in the sub-sample of CRCS parent-child dyads that also participated in the Childhood Development Supplement almost two decades prior. Formal Sobel-Goodman mediation analyses showed that 21% of the association between child ACE count and maternal ACE count was mediated by the children's primary caregivers' (typically their mothers) scores on the Aggravation in Parenting Scale, 31% of the association was mediated by Kessler-6 scale of emotional distress scores, and 44% of the association was mediated by scores on the Parental Disagreement Scale.

DISCUSSION

In this study of a national sample of parent-child dyads I found that parents' ACE counts were positively correlated with their children's ACE counts adjusted for the adult children's

demographics, parent education, and socioeconomic status. Parent ACE scores were positively associated with their children's ACE scores, and the strength of this association seemed to be strongest when parents had four or more ACEs. Maternal ACE counts showed a stronger association with children's ACE counts than paternal ACE counts, though paternal ACE counts also appeared to track with children's ACE counts. The combination of both parents' ACE count information was especially predictive of child ACE count risk.

This is the first report showing a relationship between overall parental ACE count and children's ACE counts, and it extends a literature showing that certain kinds of adversity, such as physical abuse and mental health problems, can be linked across generations within families. The findings build on a large literature demonstrating the influence of childhood experiences on later parenting,[156] [157] [158] [159] and an even larger evidence base on parent factors that put children at risk for early life adversity.[160] [161] [162] [163]

In addition to quantifying the extent to which childhood adversity may yield greater risk of adversity and poor health for subsequent generations, I confirm likely mediators of this transmission including parental mental health (measured based on depression and anxiety symptom burden), attitudes toward their children (such as aggravation in parenting), and measures of parenting conflict and behavior each partially mediating the observed parent-child ACE association. The mediation analyses demonstrated partial mediation by these factors, suggesting that other factors not measured in our data set also play important roles. Future studies should examine not only adversity risks as mediators of intergenerational ACE associations but also protective factors, such as positive measures of parenting support and measures of child resilience.

Maternal ACE counts were more strongly associated with child ACE counts than paternal ACE counts, which could be due to differences in parenting roles, differences in parenting behaviors, greater likelihood of mothers remaining the sole parent in single-parent households in the sample compared to fathers, or hereditary transmission of risk factors in utero.[164] [165] The dampening of intergenerational ACE associations when both parents report higher ACE counts (as seen in our secondary linear models with the negative coefficient on the mother-ACE-by-father-ACE interaction term), suggests that two-parent households are protective against ACE transmission to children or, perhaps, that in households where both parents have experienced more childhood adversity there are other factors that reduce this association, such as greater resilience or coping despite this history of adversity.

In 2012 the American Academy of Pediatrics issued broad recommendations for a two-generation approach to identifying high risk families that encompassed asking children and parents about experiences of early adversity, which could include screening for ACEs.[166] A recent survey of general pediatricians, however, found that only fifteen percent regularly screen for more than two parent ACEs.[167] This study's findings lend further evidence in support of screening for parents' ACE scores to risk-stratify children according to their likelihood of experiencing adversity, maltreatment, household dysfunction, and their downstream consequences. Screening parents for a full set of ACEs could provide opportunities to anticipate and interrupt the intergenerational cycle of adversity that ACEs may initiate and perpetuate, as well as the downstream health consequences of childhood adversity such as greater burden of chronic illness, mental health issues, substance use, and premature mortality. If these hazards to lifelong success can be traced back, even just in part, to parent ACEs, this could help target

prevention early in an at-risk child's life, perhaps by equipping parents with parenting skills to minimize the risk of maltreatment before children are even born.

A growing evidence base has demonstrated the effectiveness of interventions designed to prevent child maltreatment in high-risk families in which parents have experienced significant early childhood adversity themselves.[168] Among such interventions, the most widely-studied are home visitation and parenting programs, which are particularly effective if implemented early after birth but are resource intensive.[169] [170] [171] Parental ACE screening could be used to risk-stratify and focus limited home visitation program resources on children in families with the highest likelihood of ACE transmission. Given the relative ease of collecting parent ACE information and the utility it shows for predicting increased risk of high ACE counts in children, it is worth exploring how parent ACEs might be used as screening and risk-stratification tools in such clinical settings.

This study further supports a growing literature on family-based, two-generation approaches to mental illness treatment. Intervention during the perinatal period has been suggested as a method to reduce adult mental illness burden, and our finding of intergenerational associations between ACE scores (including measures of mental illness) suggest that focusing behavioral and mental health resources very early on children whose parents had high ACE counts could be an effective and efficient strategy for reducing the burden of mental illness.[172] Clinically validated and implemented approaches to preventing child maltreatment and exposure to violence may represent strategies to not only minimize harms to the child in the short term but also prevent ACEs in future generations.[173] The mediation results suggest that interventions that focus primarily on treating parent mental illness, helping parents cope with aggravation in parenting,

and reducing parental discord may be especially effective for interrupting the intergenerational transmission of childhood adversity.

Limitations

The study has a number of limitations. Despite being the only study to our knowledge with child and parent ACE information from each of the conventional ACE domains (abuse, neglect, and household dysfunction), I relied on sub-samples of the CRCS to estimate intergenerational parent-child ACE associations and their mediators because no complete sample exists with all the requisite data for this study. Restricting our sample to those CRCS participants who were part of parent-child dyads could have introduced selection bias affecting our results. Sub-samples used to examine mediation relationships showed evidence of demographic differences from the overall CRCS sample that may have introduced selection effects, and the samples were less diverse, higher income, and more educated than Americans of the same generations in the general population . The analysis, and the ACEs literature overall, relies on a retrospectively reported measures rather than prospective reporting of abuse, neglect, and household dysfunction, which would have minimized the risk of recall bias. Reverse causality and unmeasured confounding are potential threats of these retrospectively reported ACEs, though the longitudinal nature of our dataset allowed us to examine correlates of childhood adversity, such as parental mental health, that correlated with retrospectively reported ACEs but were collected concurrently with the ACEs actually occurring (i.e. during childhood/childrearing). The timing of collection of our mediator variables may not have corresponded with the timing of ACE exposures in children, given that many ACEs are episodic in nature and may have occurered during isolated periods of increased stress or conflict that fell outside of mediator data collection periods. The limited sample also limits our ability to identify sensitive developmental windows

or time-varying risk factors that could have driven ACE counts or potentiated their impact on mental health, health behaviors, parenting, and intergenerational ACE transmission risk.

CONCLUSION

This study is the first to demonstrate clear correlations between elevations in overall parent ACEs and ACE counts in their children. Mother's ACEs appeared to be more strongly correlated with their children's ACE counts than fathers, but each parent ACE score showed an additive effect in increasing children's ACE risk. Parent mental health, aggravation in parenting, and parenting disagreement each partially mediated the intergenerational ACE score correlation, suggesting that they contribute to intergenerational ACE score associations between parents and their children. Early identification of these childhood ACE risks from parental history could provide opportunity for early intervention to reduce intergenerational transmission of ACEs by focusing on improved parental mental health, reducing parental aggravation over their parenting roles, and helping parents minimize disagreements and conflicts.

Tables and Figures

Table 3-1. Adverse Childhood Experiences (ACE) Category Descriptions, Proportion of Adult Sample with Each ACE, and Proportion of Sample by ACE Count in the Panel Study of Income Dynamics Childhood Retrospective Circumstances Study (CRCS Overall, 2014-2015, n = 7,223).

PSID CRCS	ACE Category	Description Based on ACE Survey Item	Weighted Percentage Positive
ACE Type	Emotional Abuse	The combination of the respondent rating their relationship as poor with their mother and/or father and indicating that the relationship involved the highest degree of emotional tension	3%
	Physical Abuse	Whether the mother and/or father sometimes or often slapped, threw things at, or otherwise physically harmed the respondent	23.1%
	Sexual Abuse	Whether the respondent reported being the victim of a crime classified as assault or rape in childhood	3.6%
	Intimate Partner Violence	Whether the respondent reported that his/her mother and father often, sometimes, or not very often pushed, threw things at, or were otherwise physically harmful toward one another	20.8%
	Household Substance Abuse	Whether the respondent reported his/her mother and/or father abused drugs or alcohol	19.5%
	Mental Illness in Household	Whether the respondent reported his/her mother and/or father had any mental health problems (panic attacks, depression)	21.4%
	Parental Separation or Divorce	Whether the respondent reported his/her parents were separated or divorced	27%
	Emotional Neglect	Whether the respondent reported that his/her mother or father displayed no affection or parenting effort	7.2%
	Deceased or Absent Parent	Whether the respondent reported that his/her mother or father was deceased or unknown to him/her at a time in the childhood of the respondent	5%
ACE Count	0 ACEs		36.4%
	1 ACE		27.5%
	2 ACEs		15.9%
	3 ACEs		9.7%
	4 ACEs		5.4%
	5 ACEs		3.4%
	6 ACEs		1.1%
	7 ACEs		0.5%
	8 ACEs		0.1%
	9 ACEs		0.0%

Table 3-2. Sample Characteristics – Adult Children in Parent-Child Dyads with Adverse Childhood Experience Information Collected Via the Panel Study of Income Dynamics Childhood Retrospective Circumstances Study

Characteristics	Weighted Percentage or Mean (SD) for Sample of Parent-Child Dyads with ACEs Data (n = 2,205)	Weighted Percentage or Mean (SD) for Parent-Child Dyads with ACEs Data and Mediation Variable Data (n = 660)	Weighted Percentage or Mean (SD) for Overall CDS-2014 Sample (n = 8,703)
Adult Child Characteristics			
Gender			
Female	52.1	55.2	53.2
Race			
Caucasian	85.8	81.6	83.7
African American	11.8	9.6	11.3
Asian/Pacific Islander	1.6	5.0	2.6
Other	0.9	3.9	2.4
Ethnicity			
Latino/Hispanic	4.0	15.7	6.0
Adult Child's Education			
Less Than High School	6.5	7.5	9.3
High School Graduate/GED	22.9	18.8	25.6
College/Vocational School/Graduate School	70.6	73.8	65.1
Adult Child's Age in Years	39.4 years (11.2)	25.1 years (2.3)	49.5 years (16.4)
Adult Child's Self-Rated Socioeconomic Level in Childhood			
Worse than Average	18.7	21.0	21.2
Average	48.3	39.7	49.8
Above Average	32.9	39.3	29.0
Number of Adverse Childhood Experiences in Adult Child			
0	36.9	39.4	36.4
1	28.5	22.8	27.5
2-3	24.1	29.5	25.6
4 or more	10.5	8.3	10.6
Parent Characteristics			

Characteristics	Weighted Percentage or Mean (SD) for Sample of Parent-Child Dyads with ACEs Data (n = 2,205)	Weighted Percentage or Mean (SD) for Parent-Child Dyads with ACEs Data and Mediation Variable Data (n = 660)	Weighted Percentage or Mean (SD) for Overall CDS-2014 Sample (n = 8,703)
Mother's Education			
Less Than High School	11.6	4.0	--
High School Graduate/GED	28.2	16.9	--
College/Vocational School/Graduate School	60.2	79.1	--
Father's Education			
Less Than High School	10.6	5.3	--
High School Graduate/GED	24.2	18.5	--
College/Vocational School/Graduate School	65.3	76.2	--
Father's Kessler-6 Emotional Distress Score	1.82 (2.7)	2.01 (3.0)	--
Mother's Kessler-6 Emotional Distress Score	2.60 (3.6)	2.53 (3.9)	--
Higher of Either Parent's Kessler-6 Emotional Distress Score	2.56 (3.6)	2.70 (3.9)	--
Number of Adverse Childhood Experiences of Mother			
0	40.0	46.9	--
1	29.5	19.8	--
2-3	21.1	25.5	--
4 or more	9.4	7.8	--
Number of Adverse Childhood Experiences of Father			
0	41.7	35.9	--
1	29.4	36.0	--
2-3	22.4	24.6	--
4 or more	6.5	3.5	--
Number of Adverse Childhood Experiences in Parent with Highest Count			
0	30.3	26.6	--
1	32.3	32.0	--
2-3	26.6	33.3	--
4 or more	10.8	8.1	--

Table 3-3. Absolute Risk of Child ACE Count Category by Highest of Either Parent's Adverse Childhood Experience Count

Estimates of Absolute Risk (95% CI) of Child ACE Counts by Parent ACE Counts (Column Totals Sum to One Hundred Percent)	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 or More ACEs
Probability of 0 Child ACEs	43.8% (38.7, 48.9)	41.2% (36.4, 46.0)	31.6% (27.1, 36.2)	28.0% (20.8, 35.2)
Probability of 1 Child ACE	25.3% (20.6, 29.9)	30.3% (25.5, 35.1)	29.6% (24.5, 34.7)	25.8% (18.1, 33.6)
Probability of 2-3 Child ACEs	23.8% (19.3, 28.3)	22.7% (18.5, 26.9)	24.1% (19.6, 28.6)	23.0% (16.2, 30.0)
Probability of 4+ Child ACEs	7.1% (4.4, 9.8)	5.8% (3.5, 8.2)	14.6% (10.5, 18.7)	23.1% (15.9, 30.4)

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Table 3-4. Differences in Adjusted Relative Risk of Child Adverse Childhood Experiences Count by Mothers' or Fathers' Individual Adverse Childhood Experience Counts

Child ACE Count Outcome Adjusted Absolute Probabilities (95% CI) n=1, 610	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
	Mothers' ACE Count			
0 ACEs	42.6 (38.4, 46.7)	37.8 (32.4, 46.7)	30.4 (24.7, 36.1)	25.1 (16.2, 34.0)
1 ACE	25.8 (21.9, 29.6)	29.7 (23.9, 35.5)	28.4 (22.2, 34.7)	23.2 (14.1, 32.2)
2-3 ACEs	25.8 (21.9, 29.7)	21.5 (16.3,26.7)	21.3 (15.7, 26.8)	23.8 (15.6, 32.0)
4 or More ACEs	5.8 (4.0, 7.7)	11.0 (6.3, 15.6)	19.9 (13.7, 26.1)	27.9 (18.9, 36.9)
	Fathers' ACE Count			
0 ACEs	39.2 (35.7, 42.7)	39.4 (32.1, 46.7)	31.8 (25.2, 38.5)	32.4 (18.5, 46.2)
1 ACE	27.5 (24.1, 30.9)	27.1 (19.3, 34.9)	25.8 (17.9, 33.8)	26.5 (11.0, 42.1)
2-3 ACEs	22.5 (19.3, 25.6)	28.4 (20.4, 36.3)	30.5 (22.1, 38.8)	19.8 (5.7, 33.9)
4 or More ACEs	10.9 (8.5, 13.2)	5.1 (1.6, 8.7)	11.9 (5.4, 18.3)	21.3 (5.6, 37.1)

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Table 3-5. Associations Between Parents' Adverse Childhood Experiences Reported in the Childhood Retrospective Circumstances Study and Mental Health (Kessler-6 Emotional Distress Score), Aggravation in Parenting Scale, and Parent Disagreement Scale Scores from the Same Parents Reported in the 2014 Child Development Supplement

Parent Psychological Distress & Attitudes Mediators (Coefficients Represent the Linear Change in Mediator Scale Score for Each Parent ACE Count Increase)	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Higher of Either Parent's ACE Score (n = 2,558)				
Kessler-6 Emotional Distress Scale	Ref	**0.48 (0.1, 0.9)***	**1.03 (0.6, 1.4)*****	**1.51 (1.0, 2.06)*****
Aggravation in Parenting Scale	Ref	-0.001 (-0.1, 0.1)	**0.14 (0.04, 0.2)****	**0.13 (0.01, 0.24)***
Parent Disagreement Scale	Ref	**0.13 (0.04, 0.2)****	0.07 (-0.02, 0.2)	**0.14 (0.04, 0.2)****
Mother's ACE Score (n=2,296)				
Kessler-6 Emotional Distress Scale	Ref	-0.005 (-0.4, 0.4)	**1.10 (0.7, 1.5)*****	**1.34 (0.7, 2.0)*****
Aggravation in Parenting Scale	Ref	**-0.15 (-0.2, -0.1)****	**0.15 (0.1, 0.3)****	**0.15 (0.04, 0.3)***
Parent Disagreement Scale	Ref	**0.14 (0.1, 0.2)****	**0.12 (0.04, 0.2)****	**0.17 (0.1, 0.3)*****
Father's ACE Score (n=1,583)				
Kessler-6 Emotional Distress Scale	Ref	**0.88 (0.5, 1.3)*****	**0.58 (0.1, 1.1)***	**1.44 (0.9, 2.0)*****
Aggravation in Parenting Scale	Ref	**0.15 (0.04, 0.26)****	**0.12 (0.00, 0.23)***	-0.02 (-0.2, 0.1)
Parent Disagreement Scale	Ref	0.09 (-0.01, 0.2)	0.07 (-0.03, 0.2)	007 (-0.1, 0.2)

* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold

Figure 3-1. Intergenerational Relationships Between Parents' Adverse Childhood Experiences and Their Own Children's Behavioral Health: A Conceptual Model

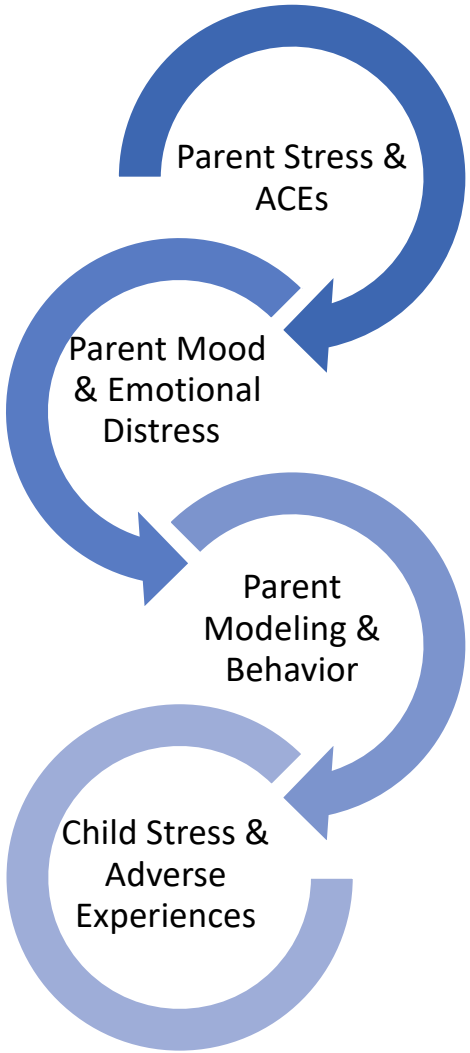


Figure 3-2. Visual Representation of the Analytic Sample in Dissertation Study Two

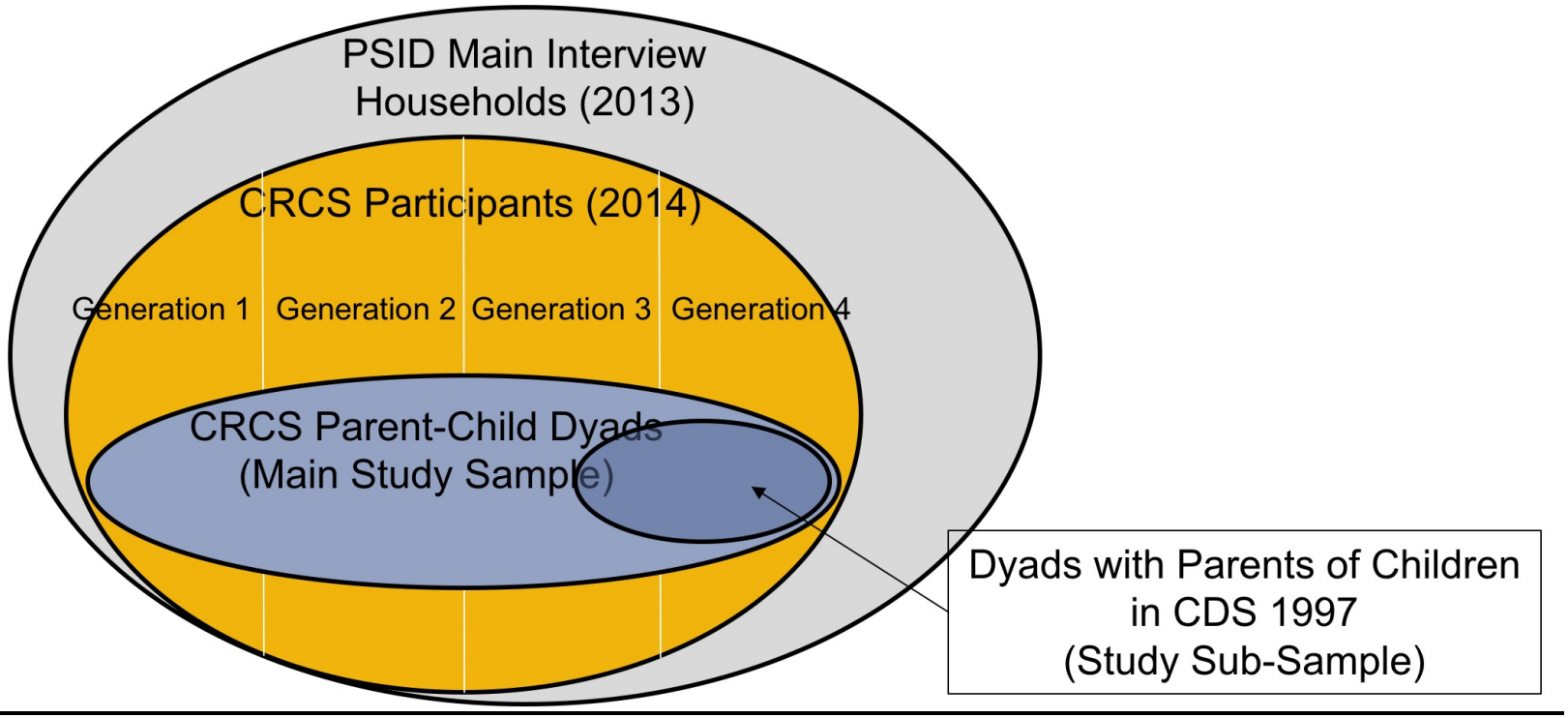
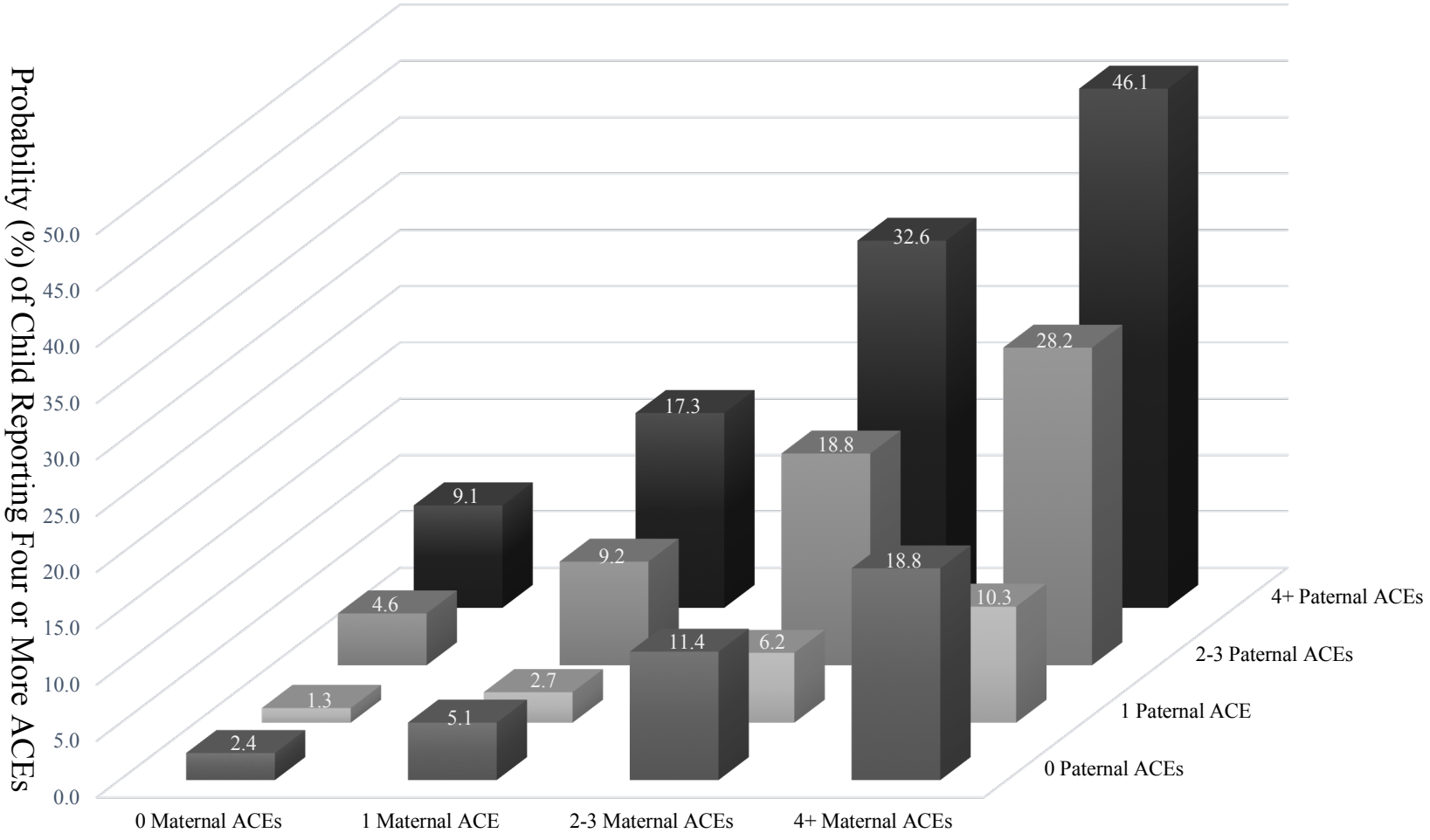


Figure 3-3. Risk of Four or More Child ACEs by Paternal and Maternal ACE Complement



Appendix 3-A. Full Text of Scales Used in Mediation Analyses

Table 3-A-1. The Kessler-6 Scale of Emotional Distress

During the past 30 days, about how often did you feel…	None of the time	A little of the time	Some of the time	Most of the time	All of the time
a. …nervous?	5	4	3	2	1
b. …hopeless?	5	4	3	2	1
c. …restless or fidgety?	5	4	3	2	1
d. …so depressed that nothing could cheer you up?	5	4	3	2	1
e. …that everything was an effort?	5	4	3	2	1
f. …worthless?	5	4	3	2	1

Table 3-A-2. The Aggravation in Parenting Scale

Please indicate on a scale from 1 to 5, where 1 means not at all true and 5 means completely true, the number that best describes how true each statement is	Completely True				Not At All True
Being a parent is harder than I thought it would be	5	4	3	2	1
I feel trapped by my responsibilities as a parent	5	4	3	2	1
I find that taking care of my child(ren) is much more work than pleasure	5	4	3	2	1
I often feel tired, worn out, or exhausted from raising a family	5	4	3	2	1
There are some things that my child(ren) does (do) that really bother me a lot	5	4	3	2	1
I find myself giving up more of my life to meet my child(ren)'s needs than I ever expected	5	4	3	2	1
I often feel angry with my child(ren)	5	4	3	2	1

Table 3-A-3. Parental Disagreement Scale

In most families there are disagreements or arguments. How often do you and [your spouse/partner] disagree about…	Never	Hardly Ever	Sometimes	Often	
How your child(ren) are raised?	1	2	3	4	-
How you spend money on your child(ren)?	1	2	3	4	-
The amount of time [your spouse/partner] spends with your child(ren)?	1	2	3	4	-
The friends [your spouse/partner] spends time with?	1	2	3	4	-
[Your spouse/partner's] use of alcohol or drugs?	1	2	3	4	-
To what extent do you and [your spouse/partner] agree or disagree about…	**Completely Disagree**	**Disagree**	**Neither Agree Nor Disagree**	**Agree**	**Completely Agree**
Your job or career plans?	1	2	3	4	5
[Your spouse/partner's] job or career plans?	1	2	3	4	5
Spending leisure time?	1	2	3	4	5
Next are some statement about how families get along and settle arguments. Tell me how much you agree or disagree with each statement.	**Completely Disagree**	**Disagree**	**Neither Agree Nor Disagree**	**Agree**	**Completely Agree**
We fight a lot in our family	1	2	3	4	5
Family members sometimes get so angry they throw things	1	2	3	4	5
Family members always calmly discuss problems	1	2	3	4	5
Family members often criticize each other	1	2	3	4	5
Family members sometimes hit each other	1	2	3	4	5

Appendix 3-B. Supplemental Tables

Table 3-B-1. Differences in Adjusted Relative Risk Ratio of Adult Child ACE Count Category by Highest of Either Parent's Adverse Childhood Experience Count – Results of the Multinomial Model Results Used to Estimate Predicted Probabilities in Table 3-3 Above

Child Adverse Childhood Experience Count	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 or More ACEs
Multinomial Logistic Model Results – Relative Risk Ratios				
0 ACEs	Base Outcome			
1 ACE	Ref	1.28 (0.9, 1.9)	**1.75 (1.2, 2.6)****	**1.80 (1.0, 3.2)***
2-3 ACEs	Ref	1.01 (0.7,1.5)	**1.57 (1.0, 2.4)***	**1.82 (1.0, 3.3)***
4 or More ACEs	Ref	0.88 (0.4, 1.7)	**3.4 (1.8, 6.3)*****	**6.6 (3.2, 13.6)*****

* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold

Table 3-B-2. Differences in Adjusted Relative Risk Ratios of Child Adverse Childhood Experiences Count by Mothers' or Fathers' Individual Adverse Childhood Experience Counts

Child ACE Count Outcome (n = 1,610)	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Mothers' ACEs (Adjusted Relative Risk Ratio)				
0 ACEs	Base Outcome			
1 ACE	Ref	1.34(0.9, 2.0)	**1.71 (1.1, 2.7)***	1.80 (0.9, 3.7)
2-3 ACEs	Ref	0.98 (0.6,1.6)	1.34 (0.8, 2.2)	**2.00 (1.0, 4.0)***
4 or More ACEs	Ref	**2.31 (1.1, 4.9)***	**6.26 (3.0, 13.0)*****	**12.43 (5.3, 29.3)*****
Fathers' ACEs (Adjusted Relative Risk Ratio)				
0 ACEs	Base Outcome			
1 ACE	Ref	0.97 (0.6, 1.6)	1.23 (0.7, 2.1)	1.26 (0.5, 3.1)
2-3 ACEs	Ref	1.23 (0.7, 2.2)	**1.84 (1.1, 3.2)***	1.19 (0.4, 3.5)
4 or More ACEs	Ref	0.44 (0.2, 1.1)	1.52 (0.7, 3.5)	2.9 (0.8, 10.8)

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Chapter Four

Parents' Adverse Childhood Experiences and Their Children's Behavioral Health Problems

Adverse childhood experiences (ACEs) include abuse, neglect, and household dysfunction experienced before age eighteen, and ACEs have well-established downstream health consequences over the lifecourse. Higher ACE scores predict behavioral health problems in childhood and adulthood, worse mental health, adverse health related behaviors, chronic disease burden, and premature mortality.[174] [175] [176] Little published evidence, however, exists regarding intergenerational associations between ACE scores in parents and behavioral health in their children.

Although specific parental adverse experiences, such as abuse in childhood, have been associated with children's socio-emotional problems and risk of maltreatment,[177] [178] [179] [180] [181] intergenerational associations between more global parent ACE counts and children's behavioral health problems remain largely unexamined. If, as is commonly hypothesized, various types of childhood adversity cause harm through a common set of stress pathways, then parent ACE count might reflect the total "dose" across types of adversity better than any specific ACE. Moreover, intergenerational effects of ACEs might be transmitted through common pathways such as parent mental health and unfavorable parenting practices.[182] [183] [184] Maternal ACEs

predict infant and early childhood developmental outcomes in a single domestic study,[185] and two Canadian studies have shown that maternal total ACEs predict mothers' perceptions of infants' emotional problems and, separately development,[186] [187] but no studies have examined such relationships throughout childhood.

The ACE count bundles multiple risk factors in the domains of abuse, neglect, and household dysfunction together and may serve as a more comprehensive index of parental adversity experienced during their childhood. Estimates of the intergenerational behavioral health risk to children of their parents' ACE counts could provide insight into how childhood adversity and adult health hazards are transmitted in families and help clinicians more accurately anticipate and decrease the risk of child behavioral health problems.

This study examines differences in indices of children's behavior problems and risk of behavioral health conditions – attention deficit hyperactivity disorder and any mental health disturbance – associated with their parents' retrospective ACE counts in a national sample of families. I explore separate parent-specific associations between the mothers' and fathers' ACE counts and children's behavioral problems, as well as potential mediators of these associations including parental mental health and parenting aggravation.

PARTICIPANTS AND METHODS

Design and Participants

I used data from the 2013 wave of the Panel Study of Income Dynamics (PSID), a panel survey with a genealogic design that collects household economic, health, and sociologic information by telephone from a nationally representative sample of U.S. adults, spouses or partners, and their

children. Child behavioral outcomes and parents' ACE data were obtained from two 2014 PSID supplements: the Child Development Supplement (CDS-2014) and the Childhood Retrospective Circumstances Study (CRCS). All 5,636 children aged 0-17 in PSID households were eligible for CDS-2014, which collected information via telephone and in-person on children's behavior, psychological and social well-being, family environment, education, and caregiver characteristics between the fall of 2014 and the spring of 2015. Of the eligible children, 4,333 (77%) contributed any data after families of 881 children could not be reached within the data collection period, 391 refused or had language barriers, and 31 were excluded for other reasons. Of children whose behavioral outcomes were collected, those with any parent reporting information on all ACEs assessed by CRCS were included in our study. The CRCS retrospectively assessed nine ACEs for English-speaking adults and their spouses or partners from the PSID 2013 main interview. Eight thousand and seventy-two individuals completed the CRCS via web-based or mailed survey between May, 2014, and January, 2015, for an unweighted response rate of 62% (weighted response rate 67%) that was similar to web-based supplements in other national panel studies.[188] Among the 4,333 CDS-2014 children, 67% had either a mother or a father who participated in CRCS, yielding 2,903 children eligible for this study. The main study group thus comprised children participating in CDS-2014 with one or more parents reporting complete ACE data in CRCS, which I analyzed to answer the primary study question: what is the association between parents' ACEs and their children's behavioral health problems? A visual representation of the analytic sample is provided in Figure 4-1.

Construction of Adverse Childhood Experience Predictor

Parents participating in CRCS reported any experiences prior to age 18 of physical abuse, emotional abuse, sexual abuse or assault, emotional neglect, witnessing intimate partner violence

at home, witnessing household substance use, having a parent with mental illness, any parental separation or divorce, and/or having a deceased or estranged parent. Table 4-1 displays the proportion with each type of ACE and the distribution of participant ACE counts. Consistent with prior literature, ACE counts were binned into four categories: 0, 1, 2-3, and 4+.[189] [190] [191]

For our main analysis, the parent ACE predictor variable was specified as the higher of either parent's ACE count category, allowing for inclusion of children with only one parent who participated in CRCS. For analyses examining the relationship between each parent's ACE count and child behavioral outcomes, we included the ACE count of each parent (if present) in the model along with an indicator variable for the presence of each parent. Analyses examining specific parent ACE predictors one-by-one counted them positive if either parent had experienced the specific ACE.

Given this is the first published use of ACEs from the PSID, I confirmed retrospective ACEs were associated with current health outcomes, measures of childhood stress, and home environment (Appendix I).

Outcomes

Outcomes included the Behavior Problems Index (BPI), a 30-item battery used to assess the incidence and severity of child behavior problems.[192] [193] The BPI was administered to the primary caregivers of children aged 3-17 in CDS-2014. Response options for all BPI items included "never", "sometimes", and "often"; which were dichotomized to "never" (0) or "sometimes/often" (1) and summed for a total BPI score for each child. Primary validation of the BPI from the 1981 National Health Interview Survey Child Health Supplement found high

internal reliability with an alpha of 0.91. That validation study reported a mean of 6.4 points and standard deviation of 5.7. To benchmark the index, it also reported children who had previously needed psychiatric treatment having BPI scores roughly one standard deviation above population average.[194] Internalizing and externalizing behavior BPI subscales were provided from the PSID (Appendix 4-A, Table 4-A-1).[195]

The 10-item CDS-2014 Positive Behavior Scale (PBS) measured positive behaviors such as self-control, persistence, self-esteem, social competence, and compliance in children aged 6-11.[196] The PBS score is the average of its 10 component items (shortened for the CDS from the usual 25 items), which ask primary caregivers to respond on a five-point scale from "Not at all like your child" (0) to "Totally like your child" (5) (Appendix 4-A, Table 4-A-2). The PBS has an adequate internal consistency (alpha 0.79), moderate stability over time, and high construct validity with inverse correlations between the PBS and behavior problems index between -0.48 (parent-rated) and -0.8 (teacher-rated) in prior CDS waves.

Two clinical outcomes included primary caregiver report of the child ever having been told by a clinician that they had attention deficit hyperactivity disorder (ADHD) or any mental health or emotional disturbance.

Covariates

The PSID main interview and CDS-2014 collected data from which I included the following covariates in our analyses: an education variable for each parent (less than high school, high school graduate/GED, some college, completed college, and graduate degree); child age in years; child race (White, African American, Asian/Pacific Islander, and Multiracial/Other); an indicator

for child Latino/Hispanic ethnicity; household income (<100%, 100-199%, 200-299%, 300-399%, and ≥400% of the Federal Poverty Line); count variables for the number of household members and children, and indicators of the presence of each parent. Results were nearly identical including a covariate for reasons single-parent households had less than two parents (i.e. divorce, parent death, etc.), so it was omitted.

I examined demographic differences between the sub-sample of children with complete data and the overall CDS-2014 sample. After performing multiple imputation to recover some missing observations due to missing parental ACE predictor data and finding that the results were substantially similar to unimputed analyses (Appendix II), I chose not to use multiple imputation to address data missingness and instead excluded observations with incomplete data. The primary cause of the remaining missingness that could not be imputed using the approach described in Appendix II – parents not participating in the web-based CRCS – was unlikely to be random and, if anything, would likely bias our findings toward the null.

In supplemental analyses to ensure that our main regression findings were adequately free from selection bias, we used treatment effects models with inverse probability of treatment weighting and regression adjustment.[197] I estimated the probability of treatment (parent ACE count category) using data reported by the parents in the sample on their own parents' (i.e. their children's grandparents) education levels, their self-rated socioeconomic status in childhood, their race and ethnicity, and family structure. The covariates used in the main regression analyses were also used in these doubly robust treatment effects models as regression adjustment covariates, given that there was limited choice of variables available to construct the treatment

probability weights and the variance ratios for certain variables showed imperfect balance between the groups at each parent ACE treatment level.

Statistical Analyses

I regressed children's behavioral outcomes on their parents' ACE counts using multvariate linear and logistic regression models, adjusted for covariates with survey-robust standard errors. Models were weighted to accommodate the complex survey design, achieve population representation, and adjust for nonresponse.

I performed secondary analyses to assess whether relationships between parent ACE counts and behavioral health outcomes were mediated by parents' mental illness (using the Kessler-6 scale of emotional distress) or aggravation (using the Aggravation in Parenting Scale, APS). Both scales have strong psychometric properties and are well-validated. [198] [199] I performed formal Sobel-Goodman tests – a well-validated approach to determine the degree of reduction in the coefficient on continuous outcome variables after accounting for a mediator -- to estimate the proportion of the ACE count effect on BPI and PBS scores mediated by aggravation parents experienced in their parenting roles or their anxiety and depression symptoms.[200] In additional secondary analyses, I ran separate linear regression analyses for each of the nine parent ACEs coded as binary predictor variables against child behavioral outcomes.

I also examined parent-rated overall child health status and odds of obesity using the parent ACE count predictor to determine whether adversity tracked with other aspects of children's health. The null results (Appendix 4-B, Table 4-B-1) of these analyses confirmed children's behavioral health outcomes were distinctly associated with parent childhood adversity.

All analyses were carried out in Stata, version 14 (StataCorp). The UCLA Institutional Review Board approved this study, which used restricted data from University of Michigan's Institute for Social Research.

RESULTS

Of the 2,903 CDS-2014 children whose parents participated in the CRCS, our sample included 2,529 children with complete data. One-fifth of children had a parent who reported experiencing four or more ACEs during their own childhood. Over twenty percent of our sample was non-White, one eighth was Latino, one quarter had parents with a high school education or less, one eighth lived below the Federal Poverty Line, and the average age was 9 years. The average scores on the BPI and PBS were 6.8 (SD 5.8) and 4.1 (SD 0.5), respectively. Attention deficit hyperactivity disorder was reported for eight percent of children, and just under four percent of children were reported to have been given a diagnosis of emotional disturbance (Table 4-2).

Children who had a parent with a history of four or more ACEs had worse scores on the BPI and PBS, as well as on the internalizing and externalizing behavior subscales of the BPI, compared to children whose parents reported no ACEs during their childhood (Table 4-3). Higher odds of hyperactivity and emotional disturbance were also observed for children of parents with the highest ACE burden.

When I included the ACE count of each responding parent in our model, I found that high ACE counts for mothers were strongly associated with child behavior outcomes (Table 4-4). For children with mothers whose ACE counts were four or more, the adjusted odds ratios for

hyperactivity and emotional disturbance were 3.1 (95% CI 1.5, 6.1) and 5.4 (95% CI 1.9, 15.1) compared to no maternal ACEs, while for children of fathers with four or more ACEs the adjusted odds ratios were 1.3 (95% CI 0.6, 2.9) and 2.3 (95% CI 0.7, 7.7) compared to no paternal ACEs. Likewise, BPI scores were 2.3 (95% CI 1.4, 3.3) and 2.8 (95% CI 1.6, 3.9) points higher for children whose mothers reported, respectively, two to three and four or more ACEs compared to no maternal ACEs, while BPI scores were 1.1 (95% CI 0.6, 2.2) points higher for children of fathers with two to three more ACEs compared to no paternal ACEs.

When examining which component ACEs for parents were associated with increases in children's BPI scores, each ACE except neglect, exposure to intimate partner violence, and death or estrangement of a parent showed a statistically significant positive association (Table 4-5).

Sobel-Goodman mediation analyses showed that 27.0% of the association between child BPI total score and parents' ACE count category was mediated by primary parent caregivers' Kessler-6 emotional distress scores, while 19.0% of the association was mediated by primary caregivers' scores on the Aggravation in Parenting Scale. Accordingly, these parent mediators attenuated the associations between the higher of either parent's ACE count and children's behavioral outcomes when included in our primary regression models (Appendix 4-C, Table 4-C-1).

Analyses using inverse probability of treatment weighting with regression adjustment were consistent with our primary analyses' findings, suggesting minimal selection bias if the observables included in the model are correlated with any unmeasured sources of selection bias (Appendix 4-C, Tables 4-C-2 and 4-C-3).

DISCUSSION

In this study of a national sample of families, I find associations between parents' ACE counts and their children's behavioral health problems. Higher parent ACE counts – particularly mothers' ACE counts – were associated with higher scores on validated measures of both internalizing and externalizing behavior problems (BPI); lower measures of positive behaviors (PBS), and increased odds of attention deficit hyperactivity disorder and emotional disturbance. Six of the nine individual parent ACEs examined in our study were associated with statistically significant increases in BPI scores.

This is the first report showing a relationship between overall parental ACE count and children's behavioral health diagnoses, indicating that the impacts of elevated ACEs on emotional well-being may extend across generations. These intergenerational correlations are partially mediated by parents' emotional distress and aggravation with parenting. The findings extend to ACEs more generally the results of existing studies linking specific ACEs experienced by parents (e.g., physical abuse) and behavioral outcomes in their children.

I found mothers' ACE counts exerted a stronger influence on child behavioral outcomes than fathers' ACE counts. Mothers were predominantly the primary caregivers for children in the sample, which may explain the greater influence of their experience of adversity through more time spent with the child. There is also evidence from the child and adolescent development literature that mothers' and fathers' parenting tends to differ on standard dimensions of parenting style (authoritative, authoritarian, and permissive),[201] and that the differences in parenting styles

correlate with differential emotional adjustment in teens.[202] This raises the possibility that parent ACEs may influence children's behavior through parenting styles more common among mothers. In-utero maternal influences might be another mechanism through which maternal adversity in particular could affect child outcomes.[203] These mechanisms deserve further study.

The study's results show that parent ACE scores could help clinicians identify, very early on, children at higher risk for behavioral health problems and provide an opportunity to prevent downstream consequences associated with childhood behavioral health problems, such as higher risk of academic underachievement,[204] involvement in the justice system,[205] mental illness,[206] substance use,[207] and poorer attainment.[208] If these hazards to lifelong success can be traced back, even just in part, to parent ACEs, this could help target preventive interventions early in an at-risk child's life, perhaps by equipping parents with skills to promote their child's healthy emotional development before they are even born. Given the relative ease of collecting parent ACE information, I suggest exploring how parent ACEs might be collected for behavioral risk stratification in prenatal and early childhood clinical settings or for better understanding underlying familial risks after behavior problems are identified. Additional research is needed to evaluate prospectively the impact of screening for parents' ACEs and intervening to mitigate child behavioral health risk.

These results lend further evidence that early childhood stresses have long-lasting downstream consequences across generations. Given that childhood behavior problems are linked to later life mental health, and intervention during the perinatal period has been suggested as a method to reduce adult mental illness burden,[209] the study's findings further support a growing literature on family-based, two-generation approaches to mental illness treatment. Clinically validated and

implemented approaches to preventing child maltreatment and exposure to violence may represent strategies to not only minimize short-term harms to the child but also prevent behavior problems in future generations.[210]

Limitations

As in most studies measuring the long-term consequences of ACEs, this study is limited by relying on retrospective reports of ACEs. Reverse causality is a potential threat if behavior problems in children prompted parents to examine their upbringings through a lens of greater frustration, although it seems unlikely that parents would report ACEs that simply did not occur. Unmeasured confounding biological or behavioral factors in parents and children, ways parents relate to their children, or the interaction of these factors, could play a role in linking the ACE predictors and child outcomes in our study. Resilience factors and childhood adversity not measured by the ACE measure were not addressed in this study and this limits our ability to gauge the full dynamic effect of how adversity is experienced and responded to. Furthermore, sensitivity analyses using inverse probability of treatment weighting found substantially similar results. Selection into the sample of children whose parents reponded to CRCS may have disproportionately included or excluded children whose parents had a history of ACEs or other factors. Though this study could not, future studies should examine whether children's behavior problems related to their parents' ACEs predispose them to adult mental illness, risky behaviors, and lower achievement.

CONCLUSION

I found child behavioral health problems are linked to higher ACE counts experienced by those children's parents, particularly their mothers. This is the first study of American families to

report that overall parent ACE count correlates with behavioral health problems in their children. Parent mental health and aggravation with parenting partially mediated the association between parent ACEs and child behavior. Efforts to reduce child behavior problems should consider risk stratification on parents' ACEs and upstream approaches to reducing ACEs or interrupting their intergenerational impacts.

Tables and Figure

Table 4-1. Adverse Childhood Experiences (ACE) Category Descriptions, Proportion of Adult Sample with Each ACE, and Proportion of Sample by ACE Count in the Panel Study of Income Dynamics Childhood Retrospective Circumstances Study (CRCS Overall, 2014-2015, n = 7,223).

PSID CRCS	ACE Category	Description Based on ACE Survey Item	Weighted Percentage Positive
ACE Type	Emotional Abuse	The combination of the respondent rating their relationship as poor with their mother and/or father and indicating that the relationship involved the highest degree of emotional tension	3%
	Physical Abuse	Whether the mother and/or father sometimes or often slapped, threw things at, or otherwise physically harmed the respondent	23.1%
	Sexual Abuse	Whether the respondent reported being the victim of a crime classified as assault or rape in childhood	3.6%
	Intimate Partner Violence	Whether the respondent reported that his/her mother and father often, sometimes, or not very often pushed, threw things at, or were otherwise physically harmful toward one another	20.8%
	Household Substance Abuse	Whether the respondent reported his/her mother and/or father abused drugs or alcohol	19.5%
	Mental Illness in Household	Whether the respondent reported his/her mother and/or father had any mental health problems (panic attacks, depression)	21.4%
	Parental Separation or Divorce	Whether the respondent reported his/her parents were separated or divorced	27%
	Emotional Neglect	Whether the respondent reported that his/her mother or father displayed no affection or parenting effort	7.2%
	Deceased or Absent Parent	Whether the respondent reported that his/her mother or father was deceased or unknown to him/her at a time in the childhood of the respondent	5%
ACE Count	0 ACEs		36.4%
	1 ACE		27.5%
	2 ACEs		15.9%
	3 ACEs		9.7%
	4 ACEs		5.4%
	5 ACEs		3.4%
	6 ACEs		1.1%
	7 ACEs		0.5%
	8 ACEs		0.1%
	9 ACEs		0.0%

Table 4-2. Sample Characteristics – Children in 2014 Panel Study of Income Dynamics Child Development Supplement with One or More Parent Having an Adverse Childhood Experience Score from the 2014 Childhood Retrospective Circumstances Study

Characteristics	Weighted Percentage or Mean (SD) for Final Sample (n = 2,529)	Weighted Percentage or Mean (SD) for Overall CDS-2014 Sample (n = 4,203)
Child Race		
Caucasian	78.03	72.13
African American	12.14	14.46
Asian/Pacific Islander	3.00	3.45
Other	6.83	9.97
Child Ethnicity		
Latino/Hispanic	13.63	20.50
Household Health Insurance		
Insured	88.89	82.17
Primary Caregiver's Education		
Less Than High School	7.14	13.38
High School Graduate/GED	17.39	20.86
Any College/Vocational	27.02	28.29
College Graduate	27.26	21.01
Graduate School	21.18	16.39
Child Age in Year	9.33 years (SD 4.43)	9.26 years (SD 4.57)
Household Income Level		
>400% FPL	39.64	32.20
300-400% FPL	13.84	12.61
200-299% FPL	19.04	20.07
100-199% FPL	15.83	20.06
<100% FPL	11.65	15.05
Number of Adverse Childhood Experiences in Parent with Highest Count		
0	20.73	--
1	30.05	--
2-3	31.92	--
4 or more	17.31	--

Characteristics	Weighted Percentage or Mean (SD) for Final Sample (n = 2,529)	Weighted Percentage or Mean (SD) for Overall CDS-2014 Sample (n = 4,203)
Hyperactivity Diagnosis	8.36	8.66
Emotional Disturbance Diagnosis	3.60	3.69
Behavior Problems Index – Total Score	6.83 (SD 5.82)	6.91 (SD 5.93)
Behavior Problems - Externalizing Score	4.93 (SD 4.10)	4.97 (SD 4.14)
Behavior Problems - Internalizing Score	2.49 (SD 2.92)	2.53 (SD 2.96)
Positive Behavior Scale Score	4.13 (SD 0.53)	4.15 (SD 0.54)

Table 4-3. Differences in Likelihood of Child Behavior Problems and Conditions by Higher of Either Parent's Adverse Childhood Experience Count

Child Behavioral Outcome Measure or Condition	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician (Adjusted Odds Ratios, n = 2,564)				
Hyperactivity	Ref	1.44 (0.8, 2.6)	1.42 (0.8, 2.5)	**2.07 (1.1, 3.8)***
Emotional or Mental Disturbance	Ref	1.56 (0.6, 4.1)	1.66 (0.6, 4.3)	**4.24 (1.7, 10.8)****
Behavior Scales (Adjusted Linear Regression Coefficients, n = 2,316)				
Behavior Problem Index – Total Score	Ref	0.22 (-0.6, 1.1)	**1.83 (1.0, 2.7)*****	**2.30 (1.3, 3.2)*****
Behavior Problem Index – Externalizing Behaviors Score	Ref	0.40 (-0.2,1.0)	**1.26 (0.6, 1.9)*****	**1.46 (0.8, 2.1)*****
Behavior Problem Index – Internalizing Behaviors Score	Ref	0.30 (-0.1, 0.7)	**0.95 (0.5, 1.4)*****	**1.4 (0.8, 1.9)*****
Positive Behaviors Scale	Ref	-.09 (-0.2, 0.03)	**-0.17 (-0.3, -0.05)****	**-0.26 (-0.4, -0.1)*****

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Table 4-4. Differences in Likelihood of Child Behavior Problems and Conditions by Mothers' or Fathers' Individual Adverse Childhood Experience Counts

Child Behavioral Outcome Measure or Condition **(n = 1,979 Children With Data Available on All Parents' ACE Scores)**	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Mothers' ACEs and Children's Behavioral Outcomes (Adjusted Odds Ratio or Adjusted Linear Coefficient)				
Hyperactivity (aOR)	Ref	1.85 (0.9, 3.6)	1.62 (0.9, 3.0)	**3.10 (1.5, 6.2)****
Emotional or Mental Disturbance (aOR)	Ref	1.93 (0.7, 5.4)	2.04 (0.8, 5.5)	**5.66 (2.0, 15.9)****
Behavior Problem Index - Total Score (Adjusted Linear Coefficient)	Ref	0.50 (-0.4, 1.4)	**2.36 (1.4, 3.3)*****	**2.77 (1.7, 3.9)*****
Fathers' ACEs and Children's Behavioral Outcomes (Adjusted Odds Ratio or Adjusted Linear Coefficient)				
Hyperactivity (aOR)	Ref	0.99 (0.5, 1.9)	0.97 (0.5, 2.0)	1.29 (0.6, 2.9)
Emotional or Mental Disturbance (aOR)	Ref	1.71 (0.5, 5.7)	0.89 (0.2, 3.2)	2.43 (0.7, 8.1)
Behavior Problem Index - Total Score (Adjusted Linear Coefficient)	Ref	0.58 (-0.3, 1.5)	**1.09 (0.04, 2.15)***	1.09 (-0.4, 2.6)

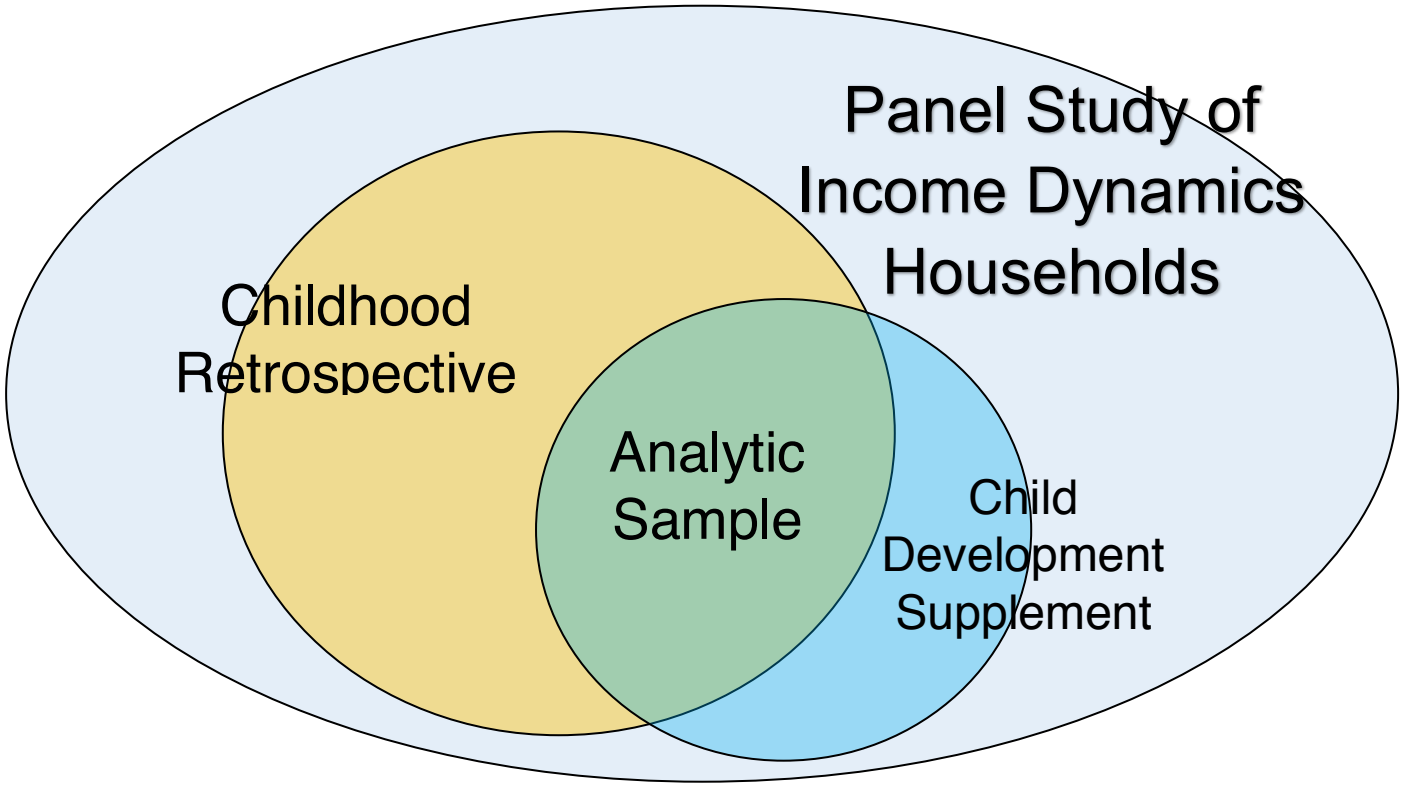
* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Table 4-5. Associations Between Parents' Specific Adverse Childhood Experiences and Children's Behavior Problem Index Scores

History of Specific Adverse Childhood Experience in Either Parent (n = 2,397)	Average Increase in Total Behavior Problems Index Score When ACE Present in Either Parent (95% CI)	Average Increase in Behavior Problems Index Externalizing Sub-Scale Score When ACE Present in Either Parent (95% CI)	Average Increase in Behavior Problems Index Internalizing Sub-Scale Score When ACE Present in Either Parent (95% CI)
Divorce	**1.06 Points (0.40, 1.73)*** **	**0.73 Points (0.18, 1.28)** **	**0.76 (0.36, 1.16)*** **
Emotional Abuse	**1.49 Points (0.80, 2.18)** **	**0.81 Points (0.26, 1.35)** **	**0.68 Points (0.26, 1.11)** **
Physical Abuse	**1.10 Points (0.45, 1.74)***	**0.61 Points (0.09, 1.13)***	0.31 Points (-0.08, 0.70)
Sexual Abuse	**1.77 Points (0.49, 3.05)*** **	0.55 Points (-0.43, 1.53)	**1.07 Points (0.29, 1.85)** **
Neglect	0.54 Points (-0.46, 1.53)	0.06 Points (-0.64, 0.77)	0.20 Points (-0.37, 0.76)
Exposure to Mental Illness in Household	**1.39 Points (0.74, 2.04)*** **	**1.05 Points (0.54, 1.55)*** **	**0.89 Points (0.51, 1.27)*** **
Exposure to Illicit Substance Use in Household	**1.28 Points (0.59, 1.96)** **	**0.76 Points (0.20, 1.31)** **	**0.65 Points (0.23, 1.06)** **
Exposure to Intimate Partner Violence in Household	0.53 Points (-0.14, 1.19)	**0.80 Points (0.26, 1.31)** **	0.34 Points (-0.06, 0.73)
Death or Estrangement of Caregiver(s)	1.11 Points (-0.14, 236)	0.87 Points (-0.17, 1.92)	0.66 Points (-0.09, 1.41)

* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold.

Figure 4-1. Visual Representation of The Analytic Sample in Dissertation Study Three



APPENDIX 4-A: Behavior Problems Index and Positive Behavior Scale

Table 4-A-1: The Behavior Problems Index

For the next set of statements, decide whether they are not true, sometimes true, or often true, of your child's behavior. He/She…	Externalizing Behavior Subscale	Internalizing Behavior Subscale
1 ...has sudden changes in mood or feeling.	X	
2 ...feels or complains that no one loves him/her.		X
3 ...is rather high strung, tense and nervous.	X	X
4 ...cheats or tells lies.	X	
5 ...is too fearful or anxious.		X
6 ...argues too much.	X	
7 ...has difficulty concentrating, cannot pay attention for long.	X	
8 ...is easily confused, seems to be in a fog.		X
9 ...bullies or is cruel or mean to others.	X	
10 ...is disobedient.	X	
11 ...does not seem to feel sorry after misbehaves.	X	
12 ...has trouble getting along with other people (his/her) age.	X	X
13 ...is impulsive, or acts without thinking.	X	
14 ...feels worthless or inferior.		X
15 ...is not liked by other people (his/her) age		X
16 ...has a lot of difficulty getting (his/her) mind off certain thoughts.		X
17 ...is restless or overly active, cannot sit still.	X	
18 ...is stubborn, sullen, or irritable.	X	
19 ...has a very strong temper and loses it easily.	X	
20 ...is unhappy, sad or depressed.		X
21 ...is withdrawn, does not get involved with others.		X
22 ...breaks things on purpose or deliberately destroys (his/her) own or another's things.	X	
23 ...clings to adults.		X
24. ...cries too much.		X
25 ...demands a lot of attention.	X	
26 ...is too dependent on others.		X
27 ...feels others are out to get (him/her).		X
28 ...hangs around with kids who get into trouble.		

29 ...is secretive, keeps things to (himself/herself).		
30 ...worries too much.		X
31 ...is disobedient at school.	X	
32 ...has trouble getting along with teachers.	X	
Number of Items	**17**	**14**
Cronbach's Alpha	**0.88**	**0.84**

Table 4-A-2: The Positive Behavior Scale

Thinking about your child, please tell me how much each statement applies to him/her on a scale from 1 to 5, where 1 means not at all like your child and 5 means totally like your child. He/She…
1 ...is cheerful and happy.
2 ...waits his/her turn in games and other activities.
3 ...does neat, careful work.
4 ...is curious and exploring, likes new experiences.
5 ...thinks before he/she acts, is not impulsive.
6 ...gets along well with other children.
7 ...usually does what you tell him/her to do.
8 ...can get over being upset quickly.
9 ...is admired and well-liked by other children.
10 ...tries to do thing for himself/herself, is self-reliant.

APPENDIX 4-B: Analyses of Associations Between Parent Adverse Childhood Experience Scores & Child Health Status and Obesity

Table 4-B-1. Non-Associations Between Parent Adverse Childhood Experiences, Childhood Obesity, and Childhood Overall Health Status

Child Health Outcome Measure or Condition	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
(Adjusted Odds Ratios, n = 2,564)				
Obesity	Ref	0.84 (0.5, 1.5)	0.85 (0.5, 1.5)	1.23 (0.7, 2.2)
(Adjusted Linear Regression Coefficients, n = 2,316)				
Overall Child Health (Parent-Rated)	Ref	-0.07 (-0.2, 0.3)	0.07 (-0.03, 0.2)	-0.03 (-0.1, 0.1)

APPENDIX 4-C: Supplemental Analyses and Tables

Table 4-C-1. Mediation Regression Analyses: Effect of Including Primary Caregiver Mental Health Scale (Kessler-6 Emotional Distress Score) and Aggravation in Parenting Scale as Mediators of Parents' Adverse Childhood Experiences' Impact on Children's Behavioral Outcomes.

Child Behavioral Outcome Measure or Condition (n = 1,979 Children With Data Available on All Parents' ACE Scores)	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Original Model Without Mediator Variables Adjusted Odds Ratio or Adjusted Linear Coefficient (95% CI)				
Hyperactivity (aOR)	Ref	1.39 (0.8, 2.6)	1.37 (0.8, 2.4)	**2.02 (1.1, 3.7)***
Emotional or Mental Disturbance (aOR)	Ref	1.51 (0.6, 4.0)	1.52 (0.6, 4.0)	**4.02 (1.6, 10.4)****
Behavior Problem Index - Total Score (Adjusted Linear Coefficient)	Ref	0.25 (-0.6, 1.1)	**1.89 (1.0, 2.7)*****	**2.37 (1.4, 3.3)*****
Original Model Plus Primary Caregiver Kessler-6 Emotional Distress Scale Score Adjusted Odds Ratio or Adjusted Linear Coefficient (95% CI)				
Hyperactivity (aOR)	Ref	1.33 (0.7, 2.4)	1.28 (0.7, 2.2)	1.77 (0.97, 3.2)
Emotional or Mental Disturbance (aOR)	Ref	1.39 (0.5, 3.7)	1.31 (0.5, 3.4)	**2.92 (1.1, 7.5)***
Behavior Problem Index - Total Score (Adjusted Linear Coefficient)	Ref	-0.1 (-0.9, 0.7)	**1.29 (0.5, 2.1)****	**1.45 (0.6, 2.4)****
Original Model Plus Primary Caregiver Aggravation in Parenting Score Adjusted Odds Ratio or Adjusted Linear Coefficient (95%C CI)				
Hyperactivity (aOR)	Ref	1.41 (0.8, 2.6)	1.28 (0.7, 2.2)	**1.85 (1.0, 3.4)***
Emotional or Mental Disturbance (aOR)	Ref	1.51 (0.6, 4.1)	1.44 (0.6, 3.7)	**3.91 (1.5, 10.4)****
Behavior Problem Index - Total Score (Adjusted Linear Coefficient)	Ref	0.20 (-0.6, 1.0)	**1.49 (0.7, 2.3)*****	**1.96 (1.1, 2.8)*****

* indicates statistically significant result at alpha < 0.05 threshold, ** indicated statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold.

Table 4-C-2. Differences in Child Behavioral Health Problems and Conditions by Parent's Adverse Childhood Experience Count, Doubly Robust Treatment Effects Models (n = 2,005)

	Mother's Adverse Childhood Experience Count Mean Risk or Score for Referent and Average Treatment Effects (95% CI)			
Child Behavioral Outcome Measure or Condition	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician (Mean Rate for Referent and Average Change in Rate (95% CI))				
Hyperactivity	Referent Group Rate 0.08 (0.05, 0.10)	0.01 (-0.03, 0.04)	-0.01 (-0.04, 0.03)	**0.06 (0.01, 0.11)***
Emotional or Mental Disturbance	Referent Group Rate 0.02 (0.01, 0.03)	0.004 (-0.01, 0.02)	0.01 (-0.01, 0.03)	**0.04 (0.005, 0.07)***
Behavior Scales (Mean Score for Referent and Average Change in Score (95% CI))				
Behavior Problem Index – Total Score	Referent Group Mean 5.66 (5.2, 6.1)	0.41 (-0.2, 1.1)	**2.15 (1.5, 2.8)*****	**2.95 (2.0, 3.9)*****
Behavior Problem Index – Externalizing Behaviors Score	Referent Group Mean 4.20 (3.9, 4.5)	0.25 (-0.2, 0.8)	**1.37 (0.9, 1.9)*****	**1.95 (1.3, 2.6)*****
Behavior Problem Index – Internalizing Behaviors Score	Referent Group Mean 1.89 (1.6, 2.1)	0.20 (-0.1, 0.5)	**0.84 (0.5, 1.2)*****	**1.38 (0.9, 1.9)*****
Positive Behaviors Scale	Referent Group Mean 4.27 (4.2, 4.3)	-.07 (-0.2, -0.04)	**-0.14 (-0.2, -0.04)****	**-0.17 (-0.3, -0.04)****
	Father's Adverse Childhood Experience Count Mean Risk or Score for Referent and Average Treatment Effects (95% CI)			
Child Behavioral Outcome Measure or Condition	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician (Mean Rate for Referent and Average Change in Rate (95% CI))				
Hyperactivity	Referent Group Rate 0.05 (0.03, 0.07)	0.02 (-0.02, 0.05)	0.01 (-0.03, 0.04)	0.05 (-0.01, 0.10)
Emotional or Mental Disturbance	Referent Group Rate 0.01 (0.003, 0.02)	0.02 (-0.003, 0.03)	0.01 (-0.01, 0.03)	**0.05 (0.01, 0.09)***
Behavior Scales (Mean Score for Referent and Average Change in Score (95% CI))				
Behavior Problem Index – Total Score	Referent Group Mean 5.97 (5.5, 6.4)	**0.87 (0.1, 1.6)***	**1.16 (0.3, 2.0)****	0.62 (-0.5, 1.8)

Behavior Problem Index – Externalizing Behaviors Score	Referent Group Mean 4.40 (4.1, 4.8)	**0.64 (0.1, 1.2)***	**0.75 (0.2, 1.3)***	0.61 (-0.2, 1.4)
Behavior Problem Index – Internalizing Behaviors Score	Referent Group Mean 1.94 (1.7, 2.2)	0.28 (-0.1, 0.7)	**0.66 (0.2, 1.1)****	**0.68 (0.8, 1.3)***

* indicates significant indicates difference from referent group with p-value <0.05, ** indicates significant indicates difference from referent group with p-value <0.01, *** indicates significant indicates difference from referent group with p-value <0.001.

Table 4-C-3. Covariate Balance Over Treatment Levels for Doubly Robust Treatment Effects Model Results Presented in Table 4-D-2 for the Outcome of Behavioral Problems Index.

	Weighted Variance Ratios Treatment Variable: Mother's Adverse Childhood Experience Count			
Propensity Model Covariates	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Maternal Grandmother's Education Level	Referent Group	0.66	0.73	0.60
Maternal Grandfather's Education Level	Referent Group	0.71	0.66	0.58
Mother's Childhood Socioeconomic Status	Referent Group	1.12	1.27	1.23
Mother's Race	Referent Group	0.46	0.56	0.59
Mother's Ethnicity	Referent Group	1.02	2.93	0.96
Mother's Number of Brothers	Referent Group	0.67	0.65	0.65
Mother's Number of Sisters	Referent Group	1.32	1.47	1.07
	Treatment Variable: Father's Adverse Childhood Experience Count			
Propensity Model Covariates	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Paternal Grandmother's Education Level	Referent Group	0.97	0.74	0.68
Paternal Grandfather's Education Level	Referent Group	0.98	0.72	0.77
Father's Childhood Socioeconomic Status	Referent Group	1.39	1.32	1.57
Fathers' Race	Referent Group	0.80	0.62	0.89
Father's Ethnicity	Referent Group	1.02	1.03	1.15
Father's Number of Brothers	Referent Group	1.52	0.78	1.64
Father's Number of Sisters	Referent Group	1.28	1.64	0.69

Chapter Five

Conclusion: Future Directions and Implications

In this dissertation, I explored novel relationships between adverse childhood experiences (ACEs) and later expenses from health care, behavioral health problems in subsequent generations, and the transmission of risk for ACEs from parents to children through a new application of a well-established dataset detailing the lives of four generations of American families. This dissertation presented new evidence on the relationship between adversity in childhood and 1) greater economic headwinds due to medical expenses by adulthood, 2) higher likelihood of maltreatment experienced by the next generation, and 3) greater behavioral health problems across generations. While each of these hazards related to childhood adversity from ACEs can be measured separately, the picture that emerges when considering the weight of evidence from the ACEs literature plus the study findings here is one of multifaceted (economic, social, behavioral, medical, etc.) hardship that ACEs appear to predict and/or perpetuate. In other words, ACEs appear to put individuals at risk for broad, deep, and long-lasting financial, social, behavioral, and health harms for them and their children. The findings of the three dissertation studies align with and build on what is already known about ACEs in the literature, and they have important implications for practice and policy in the interest of children, their families, and their communities. In addition, the work that has led to these findings has informed my understanding of the advantages and shortcomings of the field of ACE research, with implications for the future of this very active field of investigation. In this final chapter, I will

interpret and discuss the findings of three studies in the context of existing ACEs literature; explore their implications for practice and policy; and explore future directions for my research, ACEs research using the PSID, and research on ACEs more broadly.

THE FINDINGS IN THE BROADER CONTEXT OF ACES RESEARCH

At the outset of the dissertation research, it was not clear that any of the PSID ACEs studies proposed were viable. Initially, I thought perhaps the ACEs measures were too imprecise, too varied to be coherent when combined, or too different from previously published ACEs question items to capture the underlying constructs with fidelity. Effort was put into ensuring that the PSID would support studies on ACEs and into validating the ACE predictors as constructed from the CRCS (Appendix I), since the items from this questionnaire were not originally developed for an ACE score measure, per se. Remarkably, the ACE scale constructed from all CRCS items covering the typical ACE domains of abuse, neglect, and household dysfunction performed quite consistently as a measure of social, economic, and health risk and did not require significant adjustment to predict the outcomes in the three dissertation research studies. This basic finding, left underemphasized in the chapters above, is striking to me. To my mind, the ease of use and powerful prediction lends quite a bit of credence to the ACE score as a legitimate measure of adversity, and it helps explain why the diverse constructions of the ACE score available in the published literature all appear to yield similar conclusions about the lifelong consequences of adversity (see Table 1-1). Certainly, the ACE score is not a singular or an ideal measure of adversity, but it does stand out for its off-the-shelf ease of use, durability, and portability. Having seen and benefited from these properties of the ACE score first hand for this research, I suspect that they help explain, at least in part, the rapid growth of the ACE score as a standard measure

of childhood adversity, especially in fields like pediatrics where the relative lack of complexity of the measure is seen as an advantage for clinical implementation.

Well beyond simply confirming the durability of the ACE score, the findings of the three ACE studies here have built upon the ACEs literature and extended the boundaries of what is known about the ACEs in new and important dimensions. Before this work began, there was a large gap in the literature on the relationships between ACEs and their health-related economic consequences. While it was well-recognized that individuals with lower income were more likely to experience ACEs and recent work had found that ACEs predicted income declines over the lifecourse,[211] no published research had explored whether the ACE score exerted an economic effect through worse health outcomes. The first dissertation chapter takes this approach and suggests an economic argument for addressing adversity due to elevated ACE scores. Before the dissertation research began, no studies in the ACEs literature had published on intergenerational associations between parents' ACEs and their children's health or development, despite this link being explored for specific types of abuse and maltreatment in the child abuse literature and it being a natural next step in the progression of ACEs research. Since these dissertation studies began, at least four studies have been published on intergenerational health risks related to parents' ACE scores, as well as mediators of these relationships.[212] [213] [214] [215] Three of these studies emerged in the last three months, suggesting an acceleration in interest and awareness of intergenerational ACEs research. Our intergenerational studies remain the only ones to report elevated risk of children's behavioral health conditions across the full age range of childhood and to report associations between ACE scores across adult intergenerational dyads. So, while the dissertation study research was well-grounded in prior evidence and is consistent with prior literature on the nature of the impact of ACEs over time, the dissertation adds important new

information to the conversation around ACEs and illuminates their potential for broad and lasting health and economic effects.

A theme running through the results of all three dissertation studies was that ACEs among women and mothers exerted a stronger influence on costs and children's outcomes than ACEs among men and fathers. While a sizable portion of this difference in effect might be attributable to the fact that women in the PSID experience and report more ACEs than men, on average, and this creates more variance in ACE scores among women and may account for larger detected outcome effect sizes in regression models, the conspicuous number of studies in the ACE literature that report the influence of mothers' ACEs (but not fathers') on child outcomes suggests that our finding is not isolated. If this finding is replicable in other datasets, it bears further exploration in its own right. As has been discussed in the concluding paragraphs of the chapters above, there are a number of possible explanations – from differences in parenting practices to disparate social strategies to differences in biological roles during gestation/childbirth/childhood.

The dissertation studies confirm that a large proportion of what mediates intergenerational ACE effects or relationships is psychological distress, mental illness, and parenting behaviors and attitudes, such as aggravation with the child. Mental illness symptoms also appear to partially mediate ACEs' downstream toll in medical expenses, as do chronic health conditions, entirely consistent with the bulk of ACEs literature showing that ACEs predict adult chronic disease risk. This has important implications clinical care and suggests that leveraging mental health services for individuals after they have experienced ACEs may help interrupt lifelong and intergenerational harms of ACEs. However, it is important to recognize that the vast majority of

the ACE relationships that were detected in the studies were mediated by factors other than what could be detected in common anxiety and depression screening tools. There is much more that remains to be understood about how ACEs exert their influence on behavioral, mental, and physical health over the long-term.

IMPLICATIONS FOR HEALTH CARE PRACTICE

While the relevance of ACEs and the types of adversity they measure to health outcomes is increasingly apparent to researchers and clinical practitioners alike, there is an active conversation in progress in the literature regarding exactly how the relationships between ACEs and health should be addressed over the lifecourse.[216] [217] [218] [219] A growing chorus of calls for screening for ACEs in pediatric clinical settings has raised awareness of this potential avenue to identify those at greater health risk from ACEs. At the opposite end of the age spectrum in adult clinics, especially those in the medical safety net, the mantra of trauma-informed care is repeated often and has been defined in terms of clinicians understanding and recognizing extreme adversity or trauma, though how best to respond to this adversity in the trauma-informed framework is not clearly defined. Nevertheless, these movements in clinical medicine toward incorporating and understanding patient histories of adversity as important elements for clinical data gathering, conceptions of health risk, and, potentially, improved medical management offer fertile ground for applying insights from the three studies in this dissertation to health care practice. Implications of the studies in terms of health care for children, health care for adults and families, and population and community health are explored below.

Health Care for Children

The literature in pediatrics (and other fields concerned with the medical and behavioral health of children) has avidly adopted research on ACEs and fostered considerable momentum toward clinical consideration of ACEs.[220] [221] [222] Prominent pediatricians have successfully established the non-diagnostic term "toxic stress" and made headway toward pathologizing adversity associated with child poverty, paving the way for considerable interest in the mechanistic pathways that link adversity and poor child health as well as adversity "targets" for intervention. Adverse childhood experiences offer a set of such targets for intervention in the ACEs themselves by virtue of being, perhaps, the most prominent measure of risk for "toxic stress" discussed in the literature. This dynamic, in which the three studies of this dissertation should be contextualized, leaves the field of pediatrics with the question of how to respond to the mounting evidence that ACEs affect the behavioral, mental, physical, and financial health of patients and the adults they will become.

In particular, the research studies in this dissertation raise the possibility that clinicians could make use of parent ACE information to risk stratify and identify children for closer monitoring for behavioral health problems or for ACEs themselves, if not early intervention for those with elevated behavioral problem and adversity risk. This may be welcome to many pediatricians who have understood intuitively that parental history of ACEs is independently predictive of child abuse, maltreatment, and household dysfunction experienced by those parents' children, as well as being predictive of behavioral health problems, but did not have evidence describing the average effect size for these relationships. The question now becomes how best to practically apply the empirical information provided by the growing evidence on ACEs in the clinical setting. The crux of this question is how the information conveyed by parental ACE risk should change practice. To my mind, there are a number of practical applications of this knowledge that could change practice.

First, in families whose children display behavioral health problems, clinical assessment of ACEs among parents could be implemented and the consequences of any identified ACEs to parent mental health and parent behavior could be addressed as an adjunctive intervention. Tools to address the downstream mental health consequences of parent ACEs are available widely through family mental health services. For adverse parent attitudes and behaviors associated with personal histories of ACEs, parent coaching and support programs are emerging interventions.[223] [224] [225] Home visitation programs are increasingly common and thought to exert protective effects for at-risk children whose parents are often ACE-exposed, likely by partnering with parents in a trauma-informed fashion and offering resources that make parenting more manageable.[226] [227] [228]

Second, even when practices are not equipped with the resources to address ACE consequences for parents, parent ACE assessment could still help clinicians avoid misdiagnosis or mistreatment of children's behavioral problems or emotional disturbance. Childhood anxiety and depression, which can be linked to ACEs, are well-recognized as common clinical comorbidities travelling with attention problems,[229] but it can sometimes be challenging for clinicians to know what family stressors to explore in order to identify and disentangle these comorbid behavioral and mental health conditions. With parent ACEs now associated with attention deficit hyperactivity disorder and childhood emotional disturbance, ACEs offer clinicians a set of risk factors to explore that, if identified, would suggest that a child in their office could be at higher risk for experiencing comorbid behavioral and mental health problems. Further, it is possible that many of the behavior problem diagnoses among children in our study were misdiagnosed and that, in fact, the behaviors observed were normal manifestations of family stress associated with

ACEs alone. Assessment of parent ACEs could help avoid such misdiagnoses if routinely implemented for children with behavioral health diagnoses.

Third, while screening for parent ACEs in the general population of families may offer some additional information for risk-stratification of a few children who would not otherwise be identified, issues of cost-efficiency and time tradeoffs in the already-compressed pediatric preventive care encounter likely preclude this population-wide screening approach.[230] But screening for parent ACEs in at-risk populations (families in low-income settings where ACEs are more prevalent, for example) could be much more cost-effective. Given that clinicians in these settings may unwittingly find themselves treating the behavioral consequences of intergenerational adversity, knowing up front whether a child's family history puts them at higher risk for experiences ACEs, behavioral health problems, or mental illness could very readily save clinician time and effort while helping patients connect to appropriate services sooner.

Fourth, when clinicians find themselves caring for a child who has experienced ACEs, all three studies in this dissertation suggest that they have an opportunity to actively address long-term risks to that individual financially and as a future parent. In addition to helping the ACE-exposed child avoid further adversity, either by child protective services involvement and separation from the parents (in severe instances of abuse or neglect) or by repairing relationships between the child and the parents without separating them, clinicians should bear in mind that the child might benefit from exposure to healthier models of attachment and parenting to inform them as future parents, perhaps through involvement in family counseling or event just through the encouragement from the clinician to pursue a range of group social activities in their

communities. This could help them avoid falling into similar patterns of parenting to what they experienced themselves. Exposure to healthier attachment models and examples of supportive relationships may also help avoid unwanted behavioral health outcomes from emerging, or even help children find alternative outlets for medical care-seeking that might drive future elevated health care costs, though these ideas are speculative and beyond the limits of the research in this dissertation to determine.

In my own role as a pediatrician working with socially marginalized families, sorting out the complex links between a parent's ACEs in the past and how I should manage a child's inattention today still feels somewhat obtuse to me. But reframing how I conceptualize the long-term fallout after a child experiences abuse, neglect, or household dysfunction to include thinking about the parent they will become and how best to help prepare him/her despite an ACE history seems somewhat more feasible. One can imagine a host of sensible steps to take after a child experiences an ACE to help her/him raise his/her future child differently, such as offering parenting coaching to every teen who was ever a ward of the foster system, or perhaps even to any child whose parents have divorced. Ultimately, the success of such efforts will be determined by whether the child health and welfare systems, along with families and communities, can ensure that resources are available to help children repair the damage done by ACEs long after the initial adversity has passed.

Health Care for Adults and Families

The research presented in this dissertation makes clear that the health impact of ACEs in families is deep, pervasive, long-lasting, and self-perpetuating. So, any implications for child health care,

such as those outlined above, should be considered in the context of health care for the entire family. Beginning with healthcare for mothers, the second and third studies showed that the mental health of mothers is an especially important predictor of likelihood of transmission of ACEs and children's behavior problems. Parental, and particularly maternal, mental health is a well-recognized determinant of child health risk in infancy and beyond,[231] but up to now there has been little consideration in the literature of the antecedents to maternal mental health that may make it such a potent influence on children's health. If a considerable number of women experience worse mental health linked to their own histories of ACEs, and that mental illness puts their children at risk, it is therefore important for clinicians treating depressed or anxious mothers to recognize that a root cause of their emotional distress could relate to their own fractured childhood attachments and, perhaps, feeling ill-equipped to provide emotionally supportive attachments to their own childen for lack of appropriate models. This reframes maternal mental illness related to ACEs not as just a medical issue but as an opportunity to help mothers develop social and parenting skills that will help them avoid dysfunctional family relationship dynamics that may have sparked their initial ACEs, thereby equipping them to feel more capable as caregivers and to be less likely to maltreat their own children and perpetuate intergenerational ACE cycles. Mental health services focused on repairing family functioning and replacing dysfunctional relationship dynamics could be especially effective when clinicians suspect that maternal depression is related to a history of ACEs.

Beyond the implications for parents' mental health, the first dissertation study has broader implications indicating that the health care system is instrumental, at least in part, in the perpetuation of cycles of poverty, adversity, and poor health by exerting a disproportionate burden of health care costs upon those who have experienced ACEs. While the added cost

burden in any given year on households associated with adults' previously experiencing numerous ACEs was not enormous, it appeared to be sufficient to considerably increase the likelihood that the household would carry medical debt or have medical expenses beyond its means to overcome. Given that nearly half of Americans report that they would not be able to cover an unexpected $400 expense,[232] the hundreds of dollars in additional out-of-pocket medical costs per year may indeed be sufficient to plunge a sizable minority of households into debt. The important message for the health care system here is that we (i.e. clinicians) may be responding to the medical complications of adversity with care whose costs exacerbate a lifelong cascade of financial hardship, further adversity, and worse health. Any potential solution to this problem should balance the benefits of appropriate medical care against the harms of the financial hardship it may impose. This type of calculus -- weighing the health benefits of medical care against the harms to health and well-being of the economic costs of that care -- would be a significant departure from business as usual in medicine but could be a promising new frontier of value-based health care. Such an approach could be considered an extension of social determinants of health concepts into medical cost-effectiveness analyses. Until we develop the first "trauma-informed incremental cost effectiveness ratio", however, steps should first be taken to make needed health care more affordable so that families do not experience economic strain that can precipitate family conflict and dysfunction, and potentially even ACEs.

Population and Community Health

At the population level, the prevalence of ACEs coupled with their intergenerational behavioral health effects and associated household health care expenses and indicates that ACEs are a threat to public health with a large public price tag. Childhood adversity and its ripple effects are infrequently framed as a public health issue, but the evidence suggests that they are epidemic and

transmissible within families. Taking a public health approach to reducing ACEs and childhood adversity would represent a very different tactic compared to those typically used, which are often limited to reactive (rather than proactive) steps through the child welfare system that is tailored to respond to relatively infrequent types of adversity (i.e. severe abuse and neglect). Given the medical cost to families and communities associated with ACEs, taking a proactive public health approach to reducing childhood adversity could theoretically be cost-effective to society, depending on the size and scope of the campaign. Extending the analogy of traditional public health issues (such as infectious diseases) to ACEs leads this author to wonder how best to inoculate the public against their harms. Does an analogous "vaccine" against ACEs and their downstream health consequences exist, perhaps in the form of community resilience factors that could be scaled to respond to the ACEs epidemic? The answer to that question is likely years of research away and will require first scaling existing programs that attempt to offer such protection, such as parent coaching programs, community-based mental health services, home visitation, and others that have begun to emerge in the literature. The population-wide prevalence of ACEs suggests that their upstream drivers (i.e. social and economic inequality, lack of community, dearth of social supports and cohesion) need to be addressed at the level of public policy, rather than relying on the health care system to scale and deliver programs that focus primarily on ACEs' downstream consequences.

IMPLICATIONS FOR HEALTH AND SOCIAL POLICY & SYSTEMS

A policy response to ACEs and their broad, deep, and long-lasting impacts in families has been called for in various forms.[233] [234] [235] [236] While adopted public health and policy frameworks like Healthy People 2020 have included the call for elements of these proposals (such as cross-sector coordination and attention to health drivers over the lifespan), and the resources to fully

implement the approaches proposed to address the upstream drivers of ACEs appear unlikely to materialize in the near term. Short of policies that directly minimize economic inequality, discrimination, and disruption of communities, proposals for trauma-informed systems that touch on the lives of children and families (i.e. the child welfare, education, and first responder systems) have been offered up.[237] In light of the preponderance of existing adversity-health evidence and the new information found through the research in this dissertation detailing the far-reaching and long-lasting economic, behavioral, social, and health consequences of ACEs, these proposals take on even greater import.

ACEs and Child and Family Social Policy & Systems

The three studies in this dissertation center about the family as the crucible of long-term economic, behavioral, social, and health outcomes, so there are important implications for systems and policies serving children and families stemming from this work. A cross-cutting set of recommendations for trauma-informed awareness and action was set forth for child- and family-facing systems by the National Center for Child Traumatic Stress in 2008 that continues to resonate a decade later in light of the present work.[238] The most robust system improvement recommendations proposed to date apply to the child welfare system but could be applied to child-facing systems or sectors such as health care, education, juvenile justice, or first responders. These recommendations for trauma-informed child welfare systems included creating environments and interactions with families that maximize children's capacity for reducing overwhelming emotions associated with adversity, helping them make new meaning of their experiences of adversity, addressing the consequences of adversity for their socialization and development, utilize their history of adversity to anticipate future needs, promote positive relationships in children's lives, and coordinate services with other agencies to do the same.[239]

Importantly, the recommendations spend equal emphasis on managing prior adversity and preparing the child to better avoid and cope with adversity in the future. In other words, much of the emphasis is on building resilience. This strikes me as important as we consider how best to address ACEs from a systematic and policy standpoint. Children who have family histories of ACEs and adversity are more likely to participate in ongoing cycles of maltreatment and adversity, suggesting an accelerant effect of ACEs. To counteract this spark of adversity related to ACEs, social programs would likely need to invest greater resources in extinguishing the effects of ACEs through building resilience, rather than just presuming that removal of children from circumstances of maltreatment is sufficient to reduce their risk for harm.

An important policy question regarding how best to reduce and address the consequences of ACEs is what systems or sectors are best positioned to quarterback the type of coordination that would be required to identify, manage, repair, and/or prevent ACEs and their downstream harms. While the child welfare system currently has the most experience managing the consequences of ACEs, it is not well-positioned or well-funded to surveil communities of children for ACEs and, in fact, it depends on mandated reporters in a host of other fields to perform this function (and only when the most dangerous ACEs are surfaced). But the mandated reporters in these other fields currently do little to systematically identify children who have been exposed to ACEs (of any type, least of all those that do not require reporting to child protection). Health care and education systems reach most all children at some point during their childhood and seem like better candidates for sectors that could systematically identify children exposed to ACEs or parents who are suffering from the long-term consequences of ACEs. However, these systems are currently ill-equipped to respond to ACEs or adversity if there is not a clear diagnosable ailment or academic impairment that appears at the same time as the ACEs. At current levels of

funding and resources, the public education and health systems are already stretched thin and seem unlikely to be able to absorb this new role that would focus almost exclusively on coordination of services across sectors and prevention of health and academic consequences that could take decades (perhaps even generations, as suggested by two studies in this dissertation) to materialize. This is not so say that health care, public health, education, and other systems could not be reorganized to meet the population health challenges of ACEs, but this transformation would likely require a radical redistribution of resources in these systems, meaning that health care services (as they are currently constructed to address downstream consequences of ACEs) could be left short-changed. Alternatively, an influx of additional resources would be needed to deliver on the new ACE surveillance, response, and prevention roles that would be required. To my mind, this suggests that the best chance of addressing ACEs systematically is instead through holistic community development to coordinate and support existing systems, as well as and policies promoting family and community economic and social resilience.

Cross-Sector Collaboration, Community Development, and Policy

A loosely coherent set of initiatives has emerged in the last decade focused on community development and coordination of services across sectors to promote population health, similar to what would be required to systematically identify, address, and prevent the impacts of ACEs. One of the most prominent has been the Robert Wood Johnson Foundation's Culture of Health initiative, but others have also sought to connect resources across sectors, empower local communities to improve their own health and resilience, and address economic and social factors that are linked to systematic experiences of adversity at the community level and likely drive ACEs within families and households as well.[240] [241] [242] While measures and frameworks for these initiatives have been proposed and local pilots embodying their aims have been enacted, the

siloed sectors, policies, and resources that they remain cobbled upon currently hamstring opportunities for reaching widespread adoption and scale. Fundamentally, in order to move from our current systems that heavily invest in treating the downstream health and social consequences of ACEs, rather than their prevention or mitigation after early detection, policies will be needed to shift incentives away from taking action only after the damage of adversity is done and toward reducing the risk of adversity and ACEs in the first place. This would represent a dramatic policy shift and require considerably more resources to be invested in early childhood and family well-being. Without substantially greater evidence for how best to shift resources to invest in children and families to prevent ACEs and the harms of adversity more broadly, it will be challenging to shift public views, the will of policymakers, and the status quo.

IMPLICATIONS FOR RESEARCH ON ADVERSE CHILDHOOD EXPERIENCES

The methods and findings of the studies presented in this dissertation surfaced a number of future directions for research on ACEs. These future directions can be grouped into a few major categories, including further research to 1) understand the mechanistic roles of ACEs as in an adversity-health-wealth downward spiral over lifetimes and generations; 2) exploring how the timing, severity, and buffers against ACEs factor into their impact; 3) reconsidering the scope of ACEs empirically; and 4) evaluating effective interventions to blunt or prevent ACEs' impacts. After reviewing these future research directions for the field of research on ACEs, I will describe a path forward for my own research in this field.

Evolving Understanding of ACEs in the Adversity-Health Cascade

In addition to identifying a dose-response pattern linking ACE severity, the novel outcomes in these studies, other new patterns emerged in the relationships between ACEs and the observed

outcomes that have yet to be described in the ACE literature but might be important for the ACEs field as a whole. These patterns raise new questions about the mechanisms and pathways through which ACEs exert their effects, time horizons of ACE effects, how to understand the matrilineal patterns of ACE associations, the influence of ACEs on social relationship success, and also about how best to conceptualize ACEs as latent or enmeshed measures of adversity versus punctuated, discrete events distinguishable in their effects from a child's adversity milieu.

Latent Versus Punctuated Adversity

Determining whether ACEs themselves are the causative agent in initiating or accelerating the cycle of lifecourse and intergenerational hazards, rather than serving as measures of intensity of the latent rumble of adversity that produces them, was not the intent of the studies herein and may not be of practical importance for clinicians, unless the ACE score measure itself is too crude to capture meaningful differences in risk or it omits important dimensions of adversity or resilience that should be factored in. Given the scope of this dissertation was deliberately bounded by the conventional constructions of the ACE score, this first series of studies does not offer an answer but rather a foundation upon which to build future studies exploring how the conventional ACE score might be augmented to better measure the manifold risks conveyed by background childhood adversity. Distinguishing the effects of the background noise of latent adversity from the punctuated events captured in the ACE score could begin by cataloguing a wide variety of background adversity measures at various levels in relation to the family (i.e. economic, health, and social risks/stressors and supports at the household, neighborhood, policy levels) and determining the extent of collinearity of effect (on health or financial well-being) between these various adversity measures and ACEs. This process could go a long way toward confirming that ACE events themselves are valid risk factors for poor financial, physical and

mental health, as opposed to simply correlates of background stressors driving these outcomes. If the various adversity measures instead are largely collinear with ACEs, then this would suggest an alternate interpretation. The Panel Study of Income Dynamics offers wealth of information on family adversity at various levels and could support this important exploratory work.

Longer Horizons of ACE Impacts

The three studies in this dissertation emphasize that the time horizon for fully measuring the impact of ACEs does not end with the lifetime of the child who experienced the ACEs, which is the maximum length of time most of the ACEs literature tends to focus on. Just as the child abuse and mental illness literatures (beyond the ACEs field) have increasingly studied intergenerational cycles of narrow categories of maltreatment or emotional disturbance and proposed two-generation solutions, our findings argue that ACEs research should adopt intergenerational study methodologies and interventions as well. While the behavioral, mental, physical and financial health consequences of ACEs are substantial enough over the course of a single lifetime, to put the true scale of the harms in context ACEs research should evolve to determine how detrimental these consequences are over multiple generations. Therefore, intergenerational studies also offer a promising route for demonstrating the impact of interventions to blunt the long-term impact of ACEs. While the studies in this dissertation have consistently shown that mental health and parenting attitudes are at least partly implicated as links between ACEs in one generation and harms in the next, their incomplete mediation effects mean it is not clear whether interventions addressing parenting and mental health are enough to interrupt intergenerational cycles of adversity on their own.

Differential ACE-Related Health Costs by Household Structure

In the first study in this dissertation, I found that the associations between medical out-of-pocket costs and ACEs differed in strength by household structure, with single-adult households showing greater costs than two-adult households at elevated ACE score categories, adjusted for covariates. This suggests that there may be protective effects of pair-bonding relationships against downstream ACE impacts or that those who are more afflicted with worse ACEs and greater health expenses are less likely to be in partnered relationships. This speaks to an impact of ACEs on social connectedness and relationship success that was not measured as an outcome in the study but might be considered a spillover effect. The social disruption effect of ACEs might be yet another way that adversity fragments families and communities, effectively reducing their resilience and capacity to handle subsequent stressors. Future studies should examine whether the downstream mental health and behavioral effects of ACEs disrupt relationships prospectively, and what impacts this has on health and health costs, if any.

Matrilineal Impacts

A differential strength of association by gender between ACEs and many of the outcomes in my three dissertation studies was observed. Women's and mothers' ACEs were stronger predictors of household medical expenses and children's behavioral health risks, respectively, and mothers' ACEs were better predictors of their sons' and daughters' ACEs. While the research literature on the lifecourse effects of abuse more often tends to study cohorts of women, the ACEs research literature has not consistently stratified its analyses by gender or considered gender-specific risks of ACEs. Our findings suggest that this may be warranted.

The findings of these three studies raise important questions about why these differential gender effects might be observed, how they might be operating, and what can be done to address them

specifically. While we found in our sample that women more often reported ACEs, the size of this difference in reporting doesn't fully explain why the impact per ACE on outcomes was larger for women, nor why there was a larger effect size seen for women's ACEs even when their categorical ACE scores fell in the middle categories (i.e. 1 ACE or 2-3 ACEs). Differences in relational dynamics of mothers and fathers with their children are beyond the scope of this dissertation, but future work to understand such differences may help illuminate the matrilineal ACE effects observed in this work. Other possible mechanisms, such as epigenetic changes established in utero, should also be considered as evidence continues to emerge showing direct links between maternal stress and infant brain architecture.[243] [244] Even more importantly, understanding the gender-specific influences of ACEs could inform our ability to identify how the effects of ACEs could be interrupted and repaired. It may also help us recognize whether societal changes that have forced modern mothers to evolve into dynamics and roles very different from those found throughout much of human evolution could be protective or harmful in terms of the stresses placed on families.

Consideration of Mechanisms by Which Adversity from ACEs Takes Effect

Each of the studies in this dissertation explored potential mechanisms through which ACEs may influence downstream mental, physical, and economic outcomes, though the studies were limited in terms of the types of mediators that were available to explore the mechanisms of these adversity cascades. The consistent findings that mental health and parental attitudes partially mediated intergenerational ACE effects confirmed much of what is already known about such mechanisms but raised even deeper questions about what links adversity, relationships, and mental health within families. While behavioral factors, such as parenting aggravation, may be correlated with parent and child ACEs and was observable in the second and third dissertation

studies, deeper behavioral explanations may actually be driving the observed intergenerational adversity dynamics. For instance, if parents were deprived of functional social relationship models in childhood due to ACEs that disrupted attachment and positive interactions with their closest family members, this could lead to lack of understanding (or at least lack of comfort) around how to build those relationships with their own children and perpetuate adversity. This lack of social repertoire could manifest as a host of behavioral problems consequent to ACEs and crossing generations.[245] [246]

From the demographer's perspective, the early life disruptions due to ACEs may yield various threats to social capital and connectedness, with implications for the quality and quantity of social bonds available throughout the life course. This has implications for family structure, likelihood of family stresses, and resilience of relationships formed by those with ACE histories. For instance, early experience with relationship disruption may make individuals either averse to future pair bonding or adapted to feel less reliant on social bonds for support, leading to higher likelihood of forgoing marriage and lower likelihood of forming a two-parent household.[247] Mothers who have experienced ACEs have also been shown to have children at younger ages,[248] which might thrust them into parenthood at a stage of life where they are less prepared to cope with the challenges of raising a family and predispose them to adopt negative attitudes from frustration in their parenting roles. There may also be differences in behavioral health and adversity risk to the child raised in households that are more socially isolated because the parents (one or both) are accustomed to greater social disruption.[249] Beyond these observable behavioral mechanisms through which ACEs may lead to downstream lifecourse and intergenerational harms, interference from ACEs (either in a parent or directly) to normal attachment processes

and social relationships early in a child's life likely has neuroendocrine biological ramifications that could also play a role in conveying the harms of ACEs over time.[250] [251]

Indeed, a host of ways in which ACEs could result in the biological embedding of adversity within individuals and families have begun to be explored,[252] [253] [254] [255] and these mechanisms could be operating in parallel to or in concert with the behavioral mechanisms described above. These potential mechanisms through which various forms of adversity have been shown to influence physiology include neural networks, neuroendocrine dysregulation of the stress response pathway, chronic inflammation, epigenetic shifts, and gene-environment interactions.[256] [257]All of these mechanisms of biological embedding of stress could play a role in within-generation and cross-generational ACE effects, though I could not measure them directly in the dissertation studies.

Considering Timing, Severity, and Protective Factors

Returning to new directions for ACEs research using the PSID, the intentionally focused approach to creating conventional ACE scores that was used in the three studies comprising this dissertation leave open future opportunities for exploration of unconventional ACE score constructions. Areas that appear ripe for research exploration include exploring timing of exposure, severity adjustment of each individual ACE within the overall ACE count, and accounting for childhood resilience factors that buffer against adversity. The current studies, like most of the ACEs literature, did not consider timing of ACE exposure during childhood and treated all ACE exposures as equivalent. We know, however, that children's resilience and dependency in the face of stressors is not static over the duration of childhood, and that early

developmental periods and periods of social transition are especially vulnerable to ACEs or other social disruptions. Furthermore, accounting for timing of ACEs alone may not be sufficient if there is no thought put into the recursive nature of adversity that results when normal developmental processes that require secure attachment and relationship safety are derailed. Development does not stop after such events but must continue on into the next sequenced developmental phase, though the child may not be adequately prepared for that subsequent stage of development, putting him/her at risk for compounding challenges as the building blocks of development continue to be stacked upon a shaky or crumbling foundation.[258] While cumulative exposure to adversity has been shown to be a strong driver of various poor adult outcomes,[259] [260] this is not inconsistent with recent evidence that some of the long-term health consequences of early adversity are at least partially the result of adaptive processes that allow children to respond to stressors more robustly over the short and long term.[261] [262] This may be evolutionarily adaptive, allowing for cognitive and metabolic tradeoffs in the face of childhood trauma that through much of human history would have increased the likelihood of an individual's survival and reproduction, but now these adaptive mechanisms may predispose to metabolic syndrome, cardiovascular disease, and hypothalamic-pituitary burnout over the full modern lifecourse.[263] [264] [265] This suggests that timing and adaptation to childhood ACEs needs to be considered carefully and afforded more complexity than the current ACEs model that envisions adversity as a simple process of weathering due to stress, rather than a trigger for an entirely different developmental trajectory to kick in. These are ripe areas for further ACEs research.

Severity-adjustment could allow the ACE count to be weighted according to the frequency or intensity data accompanying most of the individual ACE items in the CRCS. For instance, the ACE count could register greater severity of ACE burden for an individual who lived through

two divorces as opposed to one, whose mother's depression was so severe she was hospitalized as opposed to never treated, or who was slapped frequently as opposed to occasionally. Accounting for resilience factors, perhaps by constructing a spectrum index measuring from one extreme (all ACEs without protective factors) to the other (no ACEs and many protective factors), could serve as a unifying approach that holistically includes pertinent risk and resilience variables that influence health risk outcomes of interest within and across generations. Choosing which potential resilience factors to include and test may prove to be the biggest conceptual challenge to this approach, given that no framework for organizing and accounting for household and individual exposures to resilience has been widely adopted. That leaves this area ripe for further research.

Sharpening and defining the concept of ACEs and How They Measure Adversity

The ACE score rose to prominence out of a need for measures that could encapsulate diverse types of adversity, but this amalgam may have produced too blunt a measure because it did not distinguish between the unique forms of adversity it subsumed. When examining the long-term risks of each of the individual ACEs (i.e. physical abuse, exposure to mental illness, divorce, etc.) there was no consistent pattern to suggest that one or more of the ACEs was expendable to the overall ACE score measure or was considerably more or less influential. Similarly, in the process of exploring patterns of missingness in the ACE data there was no ACE that respondents declined or omitted to report substantially more or less often than the others, suggesting that response bias around ACEs is more-or-less even, if present at all, in the PSID. In fact, none of the individual ACEs were missing in more than two percent of the CRCS sample, suggesting that those who completed the survey did not show substantial hesitance to reporting any of the ACEs. These two findings together – that each type of ACE appeared to convey risk but respondents did

not show substantially different rates of reporting them – lend empiric evidence suggesting that response (or non-response) bias does not plague conventional ACEs methodology, though the ACE literature has largely ignored this potential source of bias. I take this as evidence to suggest that no individual ACE is expendable to the ACE score, though further validation of the ACE score as an adversity index is warranted. Other authors using the PSID have undertaken such psychometric testing using a latent variable approach and found significantly improved prediction with the resulting indices.[266] Still further research is necessary to define the bounds of what measures of adversity should be included in the ACE score in order to arrive at a more efficient index for measuring childhood adversity. The currently used, conventional ACE score that was found almost through trial and error by Felitti, while it is a powerful predictor of poor health outcomes, could be conceptualized as a first-generation tool – similar in potency and refinement to the penicillium mold that was first discovered to have antibacterial properties by happenstance on an untidy lab bench and would require years of research to be developed and adapted into a vastly more powerful and efficient toolkit of antibiotic therapies. So is the potential for the ACE score to be refined and adapted to suit a host of predictive applications that promise to inform our understanding of adversity in childhood and its long-lasting effects.

Developing and Evaluating Interventions

The potential applications of further developing our understanding of ACEs, however, extend well beyond risk prediction and must venture into primary, secondary, and tertiary prevention of ACEs and their pervasive downstream social, behavioral, health, and economic risks. If we presume for a moment that we can develop clinical systems or cross-sector coordination for early identification of children whose families carry the burden of ACEs, the critical question is whether we have effective interventions to mitigate the risk of future ACEs or the consequences

of ACEs experienced already. The depth of existing literature covering interventions capable of preventing ACEs is shallow,[267] [268] [269] [270] and I am not familiar with any studies showing particular interventions that can mitigate the health or economic harms of a high ACE score once it has already been experienced. This presents an enormous opportunity to implement and evaluate interventions that target each level of prevention of ACEs (primary through tertiary) and to develop them from local pilots to scalable, population-wide initiatives.

The studies in this dissertation give a hint at the types of interventions that may be deployed and evaluated to reduce the occurrence and downstream consequences of ACEs. Specifically, timely access to mental health services focused on mitigating parents' (or future parents') emotional distress after experiencing ACEs could reduce the chances of those parents experiencing long-term increases in health expenses, if the therapies are capable of building resilience rather than further dependence upon the costly health care system. Similarly, appropriate mental health services for parents could help prevent parents' children from experiencing ACEs or behavioral problems, potentially interrupting the intergenerational cycle of adversity from ACEs. Additionally, the intergenerational studies in this dissertation found that parenting attitudes partially mediated the associations between parents' ACEs and their children's adverse outcomes. This suggests that parent coaching and other strategies to help parents become more capable of managing any aggravation or relationship conflict they feel in their parenting roles could also be utilized as effective ACE prevention interventions. A few studies have already begun to validate this intervention approach to reduce the likelihood of ACEs.[271] These are just the beginning of the many possible interventions that could be explored.

Moving beyond the findings of the dissertation studies, one can imagine a host of clinical, cross-sector, community-driven, and policy level interventions that could be employed to prevent and mitigate the effects of ACEs. One important direction that has appeared in the literature recently is the focus on resilience factors and the creation of resilient, protective social environments and communities as an intervention for families at risk of ACEs. Developing resilience, which can be conceived as a trait, process, or outcome and usually is defined as some variation on an individual's (or any dynamic system's) ability or capacity to cope in the face of stress,[272] has been proposed as the antidote to ACEs. The challenge becomes understanding what constitutes functional resilience in the face of ACEs and then delivering programs to generate such resilience for children and families as an intervention before or after ACEs occur. Answers that have been proposed in the pediatric literature have proposed fairly narrow household- and individual-level resilience-building interventions, such as parenting support and education.[273] Public health approaches to resilience-building, mainly conceived at community scale such as in the recovery from large-scale adversity such as natural disasters, also appropriately emphasize the importance of community social connectedness, social service accessibility, and community-wide coordination of services in the interest of traumatized individuals and families.[274] Rigorous evaluation of resilience interventions after ACEs are still needed to understand their potential to prevent ACEs from occurring or minimize their social, behavioral, health, and economic consequences.

Next Steps for The Present Research

Informed by the future directions for ACEs research described above, there are immediate next steps that the studies in this dissertation lead to involving the PSID. The PSID and CRCS offer exceptional opportunities to examine severity, timing, and context of ACEs to allow for the

development of more predictive severity-, development-, and resilience-adjusted indices. I will pursue these next steps, with attention to integrating not only sources of adversity/ACEs but also resilience factors and protective resources. As mentioned above, the CRCS contains a wealth of severity data for most all of the ACEs items it measures, allowing for severity-adjustment or weighting of the ACE score. Resilience factors captured in the PSID include a host of household, educational, community level, and, potentially, state and regional policy information. These will be explored to understand how they operate in concert with ACEs, what their relative influence is in preventing or counteracting ACEs' impacts on financial, mental, and physical health over the lifecourse, and whether any of them might be the basis for interventions that could be deployed to interrupt intergenerational cycles of adversity. In future studies to identify other targets for intervention, I plan to explore other possible intergenerational adversity mediators, such as the absence of social supports, community cohesion, and economic security. Understanding these links in the mechanistic chain from ACEs to worse health and economic outcomes in families will help the field move beyond the current focus on observational relationships involving ACEs toward a more robust, nuanced, and actionable science of ACEs and adversity. There are opportunities to examine how ACE effects operate across siblings in the same family or extended family relations, such as between grandparents and grandchildren. Finally, an important next step will also be understanding how neighborhood and community social forces, such as segregation, economic inequality, unemployment trends, and community cohesion, might influence ACE risks.

CONCLUSION

In conclusion, the three research studies comprising this dissertation extend what is known about ACEs and their lifecourse and intergenerational consequences, suggesting that the impacts of

ACEs are broad, deep, and long-lasting within families. The studies' findings strengthen the economic and health cases for investing early in preventing childhood adversity due to ACEs from propagating on across generations. Such prevention will require a sustained commitment to match the duration of the risks that elevated ACE convey. While the findings show that elevated ACE scores are clearly linked to a variety of hazards that accelerate social marginalization, future studies should examine not only how best to measure ACEs, their impacts, and the pathways that mediate their ripples of adversity through families but also focus on health system, public health, community development, and social policy interventions to prevent ACEs and mitigate their intergenerational harms.

Appendix I

Validation of The Adverse Childhood Experiences Score in the Panel Study of Income Dynamics

I approached validation of the adverse childhood experiences (ACEs) score within the Panel Study of Income Dynamics (PSID) in two distinct ways. First, I sought to confirm that ACEs reported through the PSID's Childhood Retrospective Circumstances Study (CRCS) behaved as they have in prior studies showing correlations between ACEs count and risk of certain adult health conditions. Second, I wanted to verify that retrospectively reported ACEs in the CRCS were not strongly affected by recall bias and were in fact representative of the level of adversity experienced by individual survey participants during childhood. Here I describe steps taken in both PSID ACEs validation approaches.

Based on the full CRCS sample of adults for whom I have complete ACEs information (all nine ACE items described in the methods section of the main manuscript), I used logistic regression models adjusted for covariates similar to those in the primary analyses (including total household income level, participant education, participant age, and participant race/ethnicity) to validate relationships between ACEs and individual chronic conditions that have been shown using other datasets and published in the literature, including statistically significant elevated risk of

diabetes, hypertension, heart disease, arthritis, and lung disease. I validated the linear association between ACE score and chronic condition count, with the average number of chronic conditions reported in the 2013 PSID main interview increasing from 0.94 (95% CI 0.89-0.99) among those with no reported ACEs in the sample to 1.28 (95% CI 1.2-1.36) among those with three or more ACEs. Similarly, I found through negative binomial regression models that the average number of nights hospitalized per year reported in the 2011 and 2013 PSID interview waves was 0.59 hospital nights higher in the group with three or more ACEs compared to those with zero reported ACEs (1.37 [95% CI 1.01-1.73] compared to 0.78 [95% CI 0.59-0.98]). These findings suggested that the PSID CRCS ACE score tracked with adult health outcomes similar to other ACE scores in the published literature.

The second validation I undertook was designed to address the possibility of recall bias due to the retrospective nature of ACE measurement. The longitudinal, genealogic nature of PSID allowed us to identify a sub-sample of 660 adult CRCS participants who had been child subjects in the 1997-2007 PSID Child Development Supplement (CDS), which assessed the Aggravation in Parenting Scale and Kessler-6 Emotional Distress Scale of these children's primary parental caregivers, as well as the Home Observation Measurement of the Environment (HOME) Scale measured by in-person interviewers. I compared the retrospectively reported ACE scores from CRCS to these contemporaneously reported measures from CDS of childhood stress and adversity, such as parent mental health issues, emotional distress, and aggravation, that would all increase the likelihood of child maltreatment and household dysfunction as captured in the CRCS ACE scores. I found statistically significant correlations between CRCS participants' retrospectively reported ACEs and their parents' concurrently-reported Aggravation in Parenting Scale, Kessler-6 scores, and HOME Scale in CDS (authors' unpublished data from manuscript in

preparation). This increased confidence that the PSID CRCS ACEs score I developed was able to reliably assess childhood adversity.

Appendix II

Sensitivity Analyses After Multiple Imputation of Missing Adverse Childhood Experience Data

In each of the three primary studies described in this dissertation, data on adverse childhood experiences (ACEs) of the adult participants and/or parents of child participants has included a non-trivial percentage of missing values. Roughly eleven percent of the 8,072 individuals who participated in the Childhood Retrospective Circumstances Study (CRCS) had incomplete information in variables that were used to construct the ACE predictors for the three studies, leading to missingness in the constructed ACE predictors (continuous counts and ordinal categorical scores). When examining the degree of missingness, the data was at least 98% complete for each of the nine component ACEs (i.e. indicators of having experienced physical abuse, sexual abuse, emotional abuse, neglect, death/estrangement of a parent, mental illness in a parent, substance use in a parent, parental divorce, or intimate partner violence between one's two parents) , but the 0%-to-2% of missing cases across each component ACE rolled up to the roughly 11% missingness of the overall ACE count and four-category ACE score due to the summative nature of their construction. When examining the pattern of missingness in the data, the rates of missing values in the 9 component ACEs corresponded generally with the number of variables that were taken into account to construct each component ACE. For instance, the component ACE measuring whether a respondent was exposed to parental mental health issues was created from multiple questions in the CRCS assessing respondents' parents' mental illnesses (both mother and father and including multiple mental illnesses) and, therefore, was more often missing than the component ACE measuring exposure to parental substance use

disorder, which was constructed from only a pair of variables – one assessing maternal substance use and one assessing paternal substance use. No other patterns of missingness were evident from the ACE data to suggest that the data was not missing at random from the nine component ACEs (and the twenty-nine variables that were used to construct them), and I had no compelling conceptual reason to believe that responses would be biased toward or away from disclosure of ACEs to the CRCS among those who had experienced ACEs. Therefore, the decision was made to explore multiple imputation of the primary ACE predictors in each of the three studies as sensitivity analyses to help ensure that the ACE predictor missingness did not obscure more accurate findings and improve power slightly.

Initial explorations of how to approach the imputation for each study made it evident that pursuing multiple imputation had the potential to introduce bias and influence results in the pursuit of more complete data. This was most clear from the need to combine pairs of the 29 individual CRCS items that were used to create the 9 component ACEs in order to avoid perfect prediction situations that otherwise precluded the imputation models from converging. Approaches that attempted to use all 29 items consistently failed because the imputation regressions for multiple imputed variables failed to merge. Given the likely bias toward the null introduced through this pair-wise combination of the 29 items into 15 items and the small impact the imputation had on the findings, the results from analyses reflecting these imputations appear here, rather than in the main text.

To avoid straying too far from the way in which the ACE predictors (continuous total ACE count and ordinal, categorical ACE score) were originally constructed for the primary analyses, I decided to impute the nine component ACEs as binary imputed variables and subsequently roll

them up into a count and categories/score. This worked well for two of the studies and nearly worked for the third, prompting an alternate approach (see below under section B-III). The specific approaches used for each of the three main studies are presented below.

B-I. Adverse Childhood Experiences and Adults' Household Out-of-Pocket Medical Costs

The approach to imputing adult household members' ACE scores as a secondary analysis for the study assessing the association between ACE scores and household out-of-pocket medical costs began with an attempt to impute the 9 component ACEs for each adult in the CRCS based on all 29 CRCS items that measured any of these 9 ACEs. Finding that the imputation models had multiple shortcomings leading to imputation failure, including perfect prediction of some component ACEs and inability of some of the logistic imputation models to converge, the 29 CRCS variables were combined pair-wise into 15 binary variables containing ACE information. The 15 variables were created with a value of "0" and then the values were replaced to "1" if either of the two ACEs represented by each of the 15 was positive based on the data from the original 29 CRCS proto-ACE items. The pair-wise combinations of proto-ACE items were chosen, in general, to pair items that fell into broadly similar domains (of abuse, neglect, and household dysfunction) of adversity so that adversity experienced in multiple domains would not be reduced to a single positive indicator. The combinations were as follows:

1. An emotional abuse item and a neglect item
2. Another emotional abuse item and a separate neglect item
3. The divorce item and three parent death/estrangement items (because each had so few positive responses)
4. A sexual abuse item and a parental death/estrangement items

5. Another sexual abuse item and two parental death/estrangement items (because each had so few positive responses)

6. A parent mental illness item and a parent substance use disorder item

7. Another parent mental illness item and a second parent substance use disorder item

8. Another parent mental illness item and a parent intimate partner violence item

9. Another parent mental illness item and a second intimate partner violence item

10. A physical abuse item and a parent intimate partner violence item

11. Another physical abuse item and a second parent intimate partner violence item

12. A third physical abuse item and a third parent intimate partner violence item

13. A fourth physical abuse item and a fourth parent intimate partner violence item

14. A fifth physical abuse item and the first parent intimate partner violence item

15. A sixth physical abuse item and the second parent intimate partner violence item

The nine component ACE measures were registered as imputed and then imputed based on the 15 paired ACE measures listed above using logistic models with ten rounds of imputation each. Pseudo-observations were needed to accommodate near-perfect prediction of one component ACE and these pseudo-observations were removed for subsequent analyses. The component ACEs were then used to construct an ACE count for each respondent and this count was then binned in a final predictor variable of the ordinal, categorical ACE score. The results of the main analyses evaluating the relationships between out-of-pocket costs and ACEs using the imputed data gained 418 observations (9%) in the sample overall and are presented in the Table B-1 below.

B-II. Intergenerational Associations Between Parents' ACEs and Their Children's ACEs

For the second study on the intergenerational associations between parents' ACEs and their children's ACEs, it was first important to consider which set of ACEs – the parents' or the adult children's – to impute. Wanting to gain the largest percentage of observations per imputed ACE score, imputation of the children's ACEs was most appealing and straightforward, since it did not involve imputing a set of ACEs for each parent and subsequently merging imputed datasets that may not have one-to-one correspondence of observations across master and merged data (due to siblings and parents potentially belonging to multiple parent-child dyads). While imputing the children's ACEs was an imputation of an outcome, which is typically to be avoided, for the purposes of this exercise examining the degree to which our study results are impacted by the missing values, imputing the children's ACEs remained the approach that would be most informative for this sensitivity analysis.

The imputation proceeded through steps similar to those described in section one of this appendix. I began with the pair-wise combination of the 29 CRCS variables relevant to the adult children's ACEs into 15 binary ACE variables to avoid encountering perfect prediction or model convergence failure when imputing their 9 component ACEs. The imputation of the 9 component ACEs was successful but required the use of pseudo-observations to minimize perfect prediction, and these pseudo-observations were again removed from the subsequent regression analyses. The 9 imputed component ACEs were summed to construct the children's ACE count variable, and this was binned into the ordinal ACE score with categories of 0 ACEs, 1 ACE, 2-3 ACEs, and 4 or more ACEs. All missing data in the children's ACE scores were imputed and the analyses involving these data yielded an approximately 6% larger sample (roughly 110 more observations) than the original study analyses. The results, presented in Table B-2 and the subsequent paragraph below, showed slightly moderated effect sizes after imputation

but substantially similar overall findings and levels of statistical significance. This slight moderation, which mirrors results found in imputed analyses from the other two studies above, might be due to the bias toward the null that would be expected due to the pair-wise creation of the 15 ACE measures from the original 29 ACE-related items in the CRCS. This reduction of the variance across 29 variables to half as many and the imposition of the constraint that different ACE categories be combined to reach these 15 (e.g. an indicator of experiencing physical abuse combined with an indicator of witnessing intimate partner violence) would be expected to reduce the effect size seen by yielding damped imputed children's ACE score values.

Linear models assessing the associations between each parent's ACE count and their child's ACE count showed similar findings after imputation of the children's ACE count variables (and an increase of 6.4% in sample size) compared to before this imputation. After imputation, the average increase in children's ACE counts was 0.23 ACEs (main effect, 95% CI 0.15, 0.31) for every increase of one ACE in their mother's ACE count and 0.16 ACEs (main effect, 95% CI 0.05, 0.27) for every increase of one ACE in their father's ACE count, compared to 0.25 (95% CI 0.17, 0.33) and 0.19 (95% CI 0.08, 0.30) respectively before imputation. The coefficient on the linear model's mother's-ACE-count-by-father's-ACE-count interaction term was -0.07 (95% CI -0.12, -0.03) after imputation compared to -0.09 (95% CI -0.14, -0.05) before.

B-III. Parents' ACEs and Their Children's Behavioral Health

The imputation approach for the study linking parents' ACE scores and their children's behavioral health began by proceeding through similar steps to those described above under section one for the first study, using the twenty-nine variables from the CRCS that encoded an ACE. Observations were excluded in cases where neither parent of a child participated in the

CRCS. For both mothers and fathers of children in this behavioral health study, the twenty-nine variables were used to create twenty-nine binary variables with values corresponding to the presence or absence of a response that would constitute an ACE. Similar to the imputation approach described for the first study above, these binary variables were found to perfectly predict many of the nine ACE measures used to construct the overall ACE count for mothers and fathers, leading the imputation models to fail. Therefore, the twenty-nine binary variables were combined pair-wise into fifteen binary variables whose values were one if either of the pair of original binary variables used to create each of them was one (positive for that particular ACE). When attempting to impute the nine ACE individual measures for mothers and fathers separately based on these fifteen binary variables, the imputation model again had many instances of perfect prediction and other failures to converge. The decision was made to attempt to impute the higher-of-either-parent's nine component ACE measures from the two sets of fifteen binary variables (one set from each parent) in the same imputation model. This came close to converging but failed because the higher-of-either-parent experiencing sexual abuse component ACE imputation model failed to converge, apparently due to a small number of parents who had experienced this ACE relative to the number of covariates in the model. An alternate approach was attempted, which I refer to as Approach 1: I imputed the higher-of-either-parent's four-category ACE score directly from the two sets of 15 paired, binary ACE variables. This led to a successful imputation. As a less-optimal alternative, I also undertook an imputation Approach 2: I omitted the variable encoding whether either parent had experienced sexual abuse from the list of the 9 component ACE measures to impute, leaving eight component ACE measures imputed from the two sets of 15 paired, binary ACEs. From the successfully imputed eight ACE measures, I constructed an ACE count totaling the sum of these binary eight ACE measures. I then constructed a four-category ACE score from this total count. I then used the four-category

ACE count yielded by each of these two imputation approaches as the predictor variable in the main analyses from the parents' ACEs and child behavior study. The resulting regressions included between 126 (5%) and 142 (6%) and more observations in the sample, depending on the outcome of interest. The findings based on either imputation approach were substantially similar to the original results of the analyses and are provided in Table B-3.

Conclusion

In all, imputation of ACE values across the three studies yielded findings that were entirely consistent with the findings of the original, pre-imputation data and main analyses. The slight moderation of the effect sizes as seen in the post-imputation analyses was likely due, at least in part, to the bias introduced through the process of creating the 15 auxillary variables from 29 original ACE-related CRCS items that pulled the results toward the null. These findings suggest that the missingness of ACE data (not due to selection) from the CRCS does not pose a major threat to validity of the results of our three studies' analyses, though the missingness might account for small differences in regression results between the main, un-imputed analyses and those that would be obtained from an idealized, complete set of CRCS ACE data. These small differences would not be expected to alter the conclusions of the studies, which show that high ACE scores are associated with greater burden of household out-of-pocket medical expenses in adulthood, greater risk of behavioral health problems for one's offspring, and greater risk of those children experiencing ACEs themselves.

Appendix II Tables

Table II-1. Coefficients on Annual Out-of-Pocket Medical Expenses for Households by Adverse Childhood Experience Count of Adult Respondents, Stratified by Number of Adults and Presence of Children in the Household

Regression Coefficients (95% CI)	Highest of Household Adult Respondent ACE Scores		
	0 ACEs (Ref)	1-2 ACEs	3 or More ACEs
All Households (n=5,202)			
Overall Household OOP Medical Costs	--	**0.15 (0.05, 0.25)****	**0.16 (0.04, 0.29)***
Inpatient Care OOP Costs	--	**0.26 (0.05, 0.46)***	**0.28 (0.02, 0.54)***
Ambulatory Care OOP Costs	--	**0.11 (0.01, 0.21)***	**0.15 (0.01, 0.28)***
Prescription/Other Services OOP Costs	--	**0.21 (0.02, 0.40)***	0.04 (-0.14, 0.22)
Single Member Households (n=792)			
Overall Household OOP Medical Costs	--	0.20 (-0.10, 0.50)	**0.58 (0.27, 0.89)*****
Inpatient Care OOP Costs	--	-0.37 (-0.97, 0.23)	**0.62 (-0.03, 1.26)†**
Ambulatory Care OOP Costs	--	0.28 (-0.11, 0.67)	**0.63 (0.25, 1.01)*****
Prescription/Other Services OOP Costs	--	**0.36 (0.01, 0.70)***	**0.44 (0.14, 0.74)****
Single Adult Households with Children (n=461)			
Overall Household OOP Medical Costs	--	0.20 (-0.20, 0.61)	**0.48 (0.06, 0.91)***
Inpatient Care OOP Costs	--	0.46 (-0.44, 1.36)	0.33 (-0.73 1.38)
Ambulatory Care OOP Costs	--	0.16 (-0.39, 0.71)	**0.54 (0.8, 0.99)***
Prescription/Other Services OOP Costs	--	0.01 (-0.53, 0.55)	0.38 (-0.17, 0.92)
Households with Two Adults and No Children (n=1,568)			
Overall Household OOP Medical Costs	--	**0.19 (0.05, 0.33)****	**0.21 (0.04, 0.39)***
Inpatient Care OOP Costs	--	**0.27 (-0.05, 0.58)†**	**0.42 (0.03, 0.81)***
Ambulatory Care OOP Costs	--	**0.15 (-0.001, 0.31)†**	**0.17 (-0.002, 0.35)***
Prescription/Other Services OOP Costs	--	**0.33 (0.06, 0.60)***	0.05 (-0.23, 0.31)
Households with Two Adults and Any Children (n=1,339)			
Overall Household OOP Medical Costs	--	0.04 (-0.13, 0.20)	0.06 (-0.17, 0.28)
Inpatient Care OOP Costs	--	**0.25 (-0.04, 0.53)†**	0.36 (-0.08, 0.81)
Ambulatory Care OOP Costs	--	-0.04 (-0.23, 0.15)	-0.09 (-0.34, 0.15)
Prescription/Other Services OOP Costs	--	-0.01 (-0.22, 0.21)	-0.18 (-0.43, 0.06)

* indicates statistically significant result at alpha < 0.05 threshold, ** indicates statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold. † indicates result at alpha <0.10 threshold.

Table II-2. Adjusted *Coefficients* of Adult Child ACE Count Category by Highest of Either Parent's Adverse Childhood Experience Count – Results of the Multinomial Model Results After and Before Imputation of Children's ACEs

Child Adverse Childhood Experience Count	Highest of Either Parent's Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 or More ACEs
Multinomial Logistic Model Results – Coefficients After Imputation (n=1,837)				
0 ACEs	Base Outcome			
1 ACE	Ref	0.25 (-0.1, 0.6)	**0.54 (0.1, 0.9)****	**0.54 (-0.02, 1.1)†**
2-3 ACEs	Ref	0.01 (-0.4, 0.4)	**0.38 (-0.04, 0.8)†**	**0.52 (-0.04, 1.1)†**
4 or More ACEs	Ref	-0.25 (-0.9, 0.4)	**1.0 (0.4, 1.6)*****	**1.7 (1.0, 2.4)*****
Multinomial Logistic Model Results – Coefficients Before Imputation (n=1,727)				
0 ACEs	Base Outcome			
1 ACE	Ref	0.25 (-0.1, 0.6)	**0.56 (0.2, 1.0)****	**0.59 (0.01, 1.2)***
2-3 ACEs	Ref	0.01 (-0.4,0.4)	**0.45 (0.02, 0.9)***	**0.60 (0.02, 1.2)***
4 or More ACEs	Ref	-0.13 (-0.8, 0.5)	**1.21 (0.6, 1.8)*****	**1.9 (1.2, 2.6)*****

* indicates statistically significant result at alpha < 0.05 threshold, ** indicates statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold. † indicates result at alpha <0.10 threshold.

Table II-3. Differences in Likelihood of Child Behavior Problems and Conditions by Higher of Either Parent's Adverse Childhood Experience Count

Child Behavioral Outcome Measure or Condition	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician After Imputation Approach 1 (Adjusted Odds Ratios, n = 2,706)				
Hyperactivity	Ref	1.22 (0.7, 2.2)	1.21 (0.7, 2.0)	**1.81 (1.01, 3.1)***
Emotional or Mental Disturbance	Ref	1.16 (0.5, 2.9)	1.21 (0.5, 2.9)	**3.22 (1.4, 7.7)****
Behavior Scales After Imputation Approach 1 (Adjusted Linear Regression Coefficients, n = 2,442)				
Behavior Problem Index – Total Score	Ref	0.11 (-0.7, 1.0)	**1.69 (0.8, 2.5)*****	**2.23 (1.3, 3.2)*****
Behavior Problem Index – Externalizing Behaviors Score	Ref	0.29 (-0.3, 0.9)	**1.14 (0.5, 1.7)*****	**1.40 (0.7, 2.1)*****
Behavior Problem Index – Internalizing Behaviors Score	Ref	0.26 (-0.2, 0.7)	**0.91 (0.5, 1.4)*****	**1.33 (0.8, 1.8)*****
Positive Behaviors Scale	Ref	-.09 (-0.2, 0.02)	**-0.16 (-0.3, -0.04)****	**-0.26 (-0.4, -0.1)*****
Imputation Approach 2				
Child Behavioral Outcome Measure or Condition	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician After Imputation Approach 2 (Adjusted Odds Ratios, n = 2,706)				
Hyperactivity	Ref	1.02 (0.6, 1.9)	1.26 (0.8, 2.1)	1.42 (0.8, 2.5)
Emotional or Mental Disturbance	Ref	0.85 (0.3, 2.2)	1.17 (0.5, 2.8)	**2.64 (1.1, 6.2)****
Behavior Scales After Imputation Approach 2 (Adjusted Linear Regression Coefficients, n = 2,442)				
Behavior Problem Index – Total Score	Ref	0.11 (-0.7, 1.0)	**2.02 (1.2, 2.9)*****	**2.02 (1.1, 2.9)*****
Behavior Problem Index – Externalizing Behaviors Score	Ref	0.30 (-0.3, 0.9)	**1.40 (0.8, 2.0)*****	**1.35 (0.7, 2.0)*****
Behavior Problem Index – Internalizing Behaviors Score	Ref	0.30 (-0.1, 0.7)	**1.06 (0.6, 1.5)*****	**1.19 (0.7, 1.7)*****
Positive Behaviors Scale	Ref	**-.10 (-0.2, 0.02)†**	**-0.16 (-0.3, -0.05)****	**-0.22 (-0.3, -0.1)*****
Original Findings Before Imputation				
Child Behavioral Outcome Measure or Condition	**Parent Adverse Childhood Experience Count**			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Behavioral Conditions Reported to Parents By a Clinician (Adjusted Odds Ratios, n = 2,564)				

Child Behavioral Outcome Measure or Condition	Parent Adverse Childhood Experience Count			
	0 ACEs	1 ACE	2-3 ACEs	4 Or More ACEs
Hyperactivity	Ref	1.44 (0.8, 2.6)	1.42 (0.8, 2.5)	**2.07 (1.1, 3.8)***
Emotional or Mental Disturbance	Ref	1.56 (0.6, 4.1)	1.66 (0.6, 4.3)	**4.24 (1.7, 10.8)****
Behavior Scales (Adjusted Linear Regression Coefficients, n = 2,316)				
Behavior Problem Index – Total Score	Ref	0.22 (-0.6, 1.1)	**1.83 (1.0, 2.7)*****	**2.30 (1.3, 3.2)*****
Behavior Problem Index – Externalizing Behaviors Score	Ref	0.40 (-0.2,1.0)	**1.26 (0.6, 1.9)*****	**1.46 (0.8, 2.1)*****
Behavior Problem Index – Internalizing Behaviors Score	Ref	0.30 (-0.1, 0.7)	**0.95 (0.5, 1.4)*****	**1.4 (0.8, 1.9)*****
Positive Behaviors Scale	Ref	-.09 (-0.2, 0.03)	**-0.17 (-0.3, -0.05)****	**-0.26 (-0.4, -0.1)*****

* indicates statistically significant result at alpha < 0.05 threshold, ** indicates statistically significant result at alpha <0.01 threshold, and *** indicates statistically significant result at alpha <0.001 threshold. † indicates result at alpha <0.10 threshold.

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