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The Role of Health Behaviors and Socioeconomic Status in Explaining the Relationship Between Child Abuse and Cancer

Author

Alcala, Hector Ernesto

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The Role of Health Behaviors and Socioeconomic Status in Explaining the Relationship Between Child Abuse and Cancer

A dissertation submitted in the partial fulfillment of the

requirements for the degree

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by

Hector E. Alcala

Fielding School of Public Health

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ABSTRACT OF THE DISSERTATION

The Role of Health Behaviors and Socioeconomic Status in Explaining the Relationship Between Child Abuse and Cancer

by

Hector E. Alcala

Doctor of Philosophy in Public Health

University of California, Los Angeles, 2015

Professor Marjorie Kagawa Singer, Chair

Recent research has linked experiences of child abuse to cancer later in life. However much of the available research has failed to look at the independent effects of child abuse types (i.e. physical, sexual and emotional abuse) and does not attempt to test potential reasons for this association. To address these shortcomings, the purpose of this study is to investigate the contribution of three health behaviors (i.e. smoking, overweight or obesity and alcohol drinking) and two measures of socioeconomic status (i.e. educational attainment and household income) that are hypothesized to mediate the association between abuse type experienced in childhood and cancer risk in adulthood. Overall, evidence exists supporting some of the connections. However, not all evidence examines all abuse types and not all evidence is consistent. Data from the 2011 Behavioral Risk Factor Surveillance Survey (BRFSS), a representative telephone

survey of adults 18 years of age and over living in the United States was used in this investigation.

The following four aims were examined: 1) Assess the representativeness of data from the BRFSS; 2) Determine if each abuse type was independently associated with cancer, after controlling for other abuse types, other adverse childhood experiences and sociodemographic characteristics; 3) Determine if the relationship between child abuse and cancer is mediated by health behaviors 4) Determine if the relationship between child abuse and cancer is mediated by socioeconomic status. Aim 1 was examined using 1 proportion z-tests, comparing BRFSS estimates by state to comparison data obtained from national sources. Aim 2 was examined using logistic regression. Aims 3 and 4 were examined using logistic regression, with Karlson, Holm and Breen's KHB method used to analyze mediating effects of health behaviors and socioeconomic status. Analyses were conducted using Stata 14.0 and using probability weights.

Results for Aim 1 revealed that data was not entirely representative. For Aim 2, models showed that physical, sexual and emotional abuse were each associated with increased odds of cancer. For Aim 3, mediation analyses revealed that smoking partially mediated the relationship between physical abuse and cancer and between sexual abuse and cancer. Smoking fully mediated the association between emotional abuse and cancer. For Aim 4, mediation analyses revealed that household income partially mediated the relationship between sexual abuse and cancer.

Overall, this study highlighted that abuse is different from other adverse childhood experiences when it comes to its association with cancer. Furthermore, abuse types have unique mediators, suggesting that there are unique causal pathways connecting each abuse type and cancer.

The dissertation of Hector E Alcala is approved.

Linda Bourque

Ondine von Ehrenstein

Ayako Janet Tomiyama

Marjorie Kagawa Singer, Committee Chair

University of California, Los Angeles

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Curriculum Vitae

EDUCATION

2015	University of California, Los Angeles, CA Ph.D(c), Public Health, Concentration: Community Health Sciences Minor: Health Psychology Dissertation Title: The Role of Health Behaviors and Socioeconomic Status In Explaining The Relationship Between Child Abuse And Cancer
2011	University of California, Los Angeles, CA Master of Public Health (MPH), Concentration: Community Health Sciences
2009	University of California, Los Angeles, CA B.A., Psychology and Political Science (Double Major) Minors: Public Health and Human Complex Systems

---

RESEARCH EXPERIENCE

Data Analyst, UCLA Department of Radiology, Feb 2015–present

Graduate Student Researcher, UCLA Center for Population Health and Health and Health Disparities, August 2014–August 2015

Graduate Student Researcher, Center for Health Policy Research, June 2013–Sept. 2013

Graduate Student Researcher, California Health Interview Survey, Jan 2011–Sept. 2013

Research Assistant, Operationalizing Culture for Health Behavior and Social Science Research (UCLA), April 2012–September 2013

Research Assistant/Lab Helper, UCLA Dept. of Integrative Biology and Physiology, Oct 2005–Jan 2011

Research Assistant, UCLA Dept. of Psychology, Sept 2007–June 2009

TEACHING EXPERIENCE

Special Reader for Foundations of Community Health Sciences (CHS 210), UCLA Dept. of Community Health Sciences, Fall 2012. Overall student rating: 4.7/5

Special Reader for Theory-Based Data Analysis (CHS 219), UCLA Dept. of Community Health Sciences, Fall 2013. Overall student rating: 4.4/5

OTHER WORK EXPERIENCE

Associate Program Coordinator, Minority Training Program in Cancer Control Research, Los Angeles, CA. April 2014-present

Consultant, MedIQ, Baltimore, MD. 2013-2015

Consultant, California Dept. of Public Health, Environmental Health Investigations Branch, Richmond, CA. 2014-2015

Intern, Southern California Coalition for Occupational Safety and Health, Los Angeles, CA. 2010.

DJ/Assistant Programing Manger, UCLARadio.com. 2005-2008.

PUBLICATIONS

Alcalá HE. "The Differential Mental Health Impact of Cancer Across Racial/Ethnic Groups: Findings from a Population Based study in California". BMC Public Health. 2014; 14(1):930.

Alcalá HE, Albert SL, Trabanino SK, Garcia R, Glik DC, Prelip M, Ortega AN. "Access to and Use of Healthcare Services among Latinos in East Los Angeles and Boyle Heights". Family and Community Health. 2016; (In Press)

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AWARDS

National Science Foundation Interdisciplinary Relationship Science Program Fellowship, UCLA, 2007-2008, $1,000

Health Resources and Services Administration Fellowship, UCLA, 2011-2012, $10,000

National Institute of General Medical Sciences Traineeship, UCLA, 2013-2014, $22,032 plus tuition

UCLA Graduate Division Tuition and Stipend Matching Funds, 2014, $4,181

Travel Award for Early Career Researchers in Latino Mental Health, American Psychiatric Association and The American Society of Hispanic Psychiatry, 2014, $1,000

Dr. Ursula Mandel Fellowship, UCLA, 2014-2015, $15,000

Samuel J. Tibbits Fellowship, UCLA, 2015-2016, $4,000

Iota Chapter of Delta Omega Poster Competition, UCLA and American Public Health Association, 2015, $700

PROFESSIONAL AFFILIATIONS

Member of the American Public Health Association (APHA)

Member of the California Public Health Association-North (CPHA-N)

PROFESSIONAL SERVICE

Student Representative, UCLA Dept. of Community Health Sciences Faculty Search Committee, 2014

Ad Hoc Reviewer, PLOSOne, 2014-2015

Ad Hoc Reviewer, American Journal of Public Health, 2015

Ad Hoc Reviewer, Journal of Health Care for the Poor and Underserved, 2015

CERTIFICATIONS

Certified Public Health (CPH), National Board of Public Health Examiners, License 8029.

1. Introduction

1A. Problem Statement

An emerging body of research has documented an association between experiencing child abuse and having cancer. A Canadian investigation has shown that adults who report physical abuse have 1.5 times the odds of also reporting a cancer, when compared to their peers who did not experience physical abuse.[1] Similarly, developing research has suggested child sexual abuse is associated with increased risk of cervical cancer. Specifically, women who had been sexually abused as children had two times the odds of cervical cancer, when compared to those who had not been abused.[2] In addition, smoking status moderated this relationship, with women who smoked and experienced sexual abuse at the highest risk. While this research highlights additional consequences of child abuse, little work has been done to understand these relationships. Specifically, we do not know which abuse types are related to cancer and what the potential mediators of this relationship are.

Impact of Child Abuse

Child abuse has a far-reaching impact on Americans. Nationally, the incidence of physical, sexual and emotional child abuse varies widely by state, with mean annual number of cases of 29.4, 15.1 and 11.7 respectively per 10,000.[3] Among adults, a third report having experienced physical abuse as children.[4] Relatedly, approximately 10% of adults report having experienced sexual abuse.[5] However, lifetime prevalence of abuse types vary widely by population studied, definition of abuse used by researchers and methodology used.[6,7] Finally, the financial impact of child maltreatment (i.e. child abuse and neglect) is also heavy, with new cases costing an estimated 124 billion dollars, over the life time of new cases occurring in a given year.[8]

While abuse impacts a sizable proportion of the U.S. population, not all groups are at equal risk of being abused or being abusers. First, some groups of children are more likely to be abused. For example, boys with hearing impairment, speech language disorders, learning disabilities, intellectual disabilities, emotional disorders, visual impairments and other disorders, experience rates of abuse higher than the general population.[9] Additionally, younger children are more likely to be abused than their older counterparts.[10] Second, some people are more likely to be abusers. For example, abuse is more common among parents of lower socio-economic status,[11] parents using drugs or alcohol,[11] parents suffering from depression,[11,12] in families with family-related stress[12] and non-biological parents.[13] Additionally, prevalence of types of child abuse varies by racial/ethnic groups, with Latinos and Blacks being more verbally abusive than non-Latino whites.[14] Also, holding certain values increase the acceptability of abuse. For example, across various denominations, using Christianity extrinsically[15] (i.e. finding religion useful in providing security, status, distraction etc.) is associated with higher rates of abuse. Similarly, endorsing male dominance (i.e. machismo) and eschewing familism, are related to higher rates of abuse, irrespective of racial group.[14]

Child abuse has been linked to a growing number of negative health consequences in both adults and children. Physical and sexual abuse are particularly problematic because they are linked to short-term outcomes such as bruising, bone fractures and death.[16] In addition to short-term consequences, physical and sexual abuse have been linked to mental illness, drug use, self-mutilation, poor-self esteem, obesity and other issues in adulthood.[17-19] Finally, abuse has also been linked to precursors of poor health, including substance abuse, risky sexual behaviors and criminality in both adults and children.[20] In all, available evidence has documented consistent

associations between child sexual and physical abuse to, primarily, physical consequences in the short-term and psychiatric consequences in the long-term.

More recently, a link between child abuse and cancer has emerged but is poorly understood. Existing empirical work has hypothesized four broad mechanisms. First, adoption of deleterious health behaviors as a result of abuse is thought to increase the risk of cancer.[1,2] Second, abuse is thought to lead to a cascade of biological changes, such as compromised immune activity, and increased susceptibility to viruses.[2] Third, child abuse may impact health long term because it frequently co-occurs with other childhood stressors, like parental divorce, that have been shown to impact health.[1] Fourth, child abuse may hinder socioeconomic advancement, putting abused individuals on track for lower socioeconomic status and poorer health.[1] While child abuse-specific frameworks are scarce, more generalized theoretical frameworks might be helpful in capturing the associations, and subsequently will be discussed in Chapter 3.

The current body of research investigating the connection between abuse and the development of chronic disease, however, suffers from many conceptual and methodological limitations. Namely, abuse is not clearly conceptualized as a concept, leaving its contents and boundaries ambiguous. Thus, the literature does not consistently distinguish between abuse sub-types and frequently subsumes abuse into larger categories. These decisions are driven by both the theoretical frameworks researchers use and limits of instruments that fail to capture different abuse types or advise that these distinctions be ignored altogether. Given the novel connection between abuse and cancer, and the current limitations of research exploring the connection between abuse and chronic disease, a more thorough investigation of the association between child abuse and the development of cancer is warranted to more clearly delineate the conceptual

issues of child abuse and identify the methodological limitations that appear to obfuscate the potential pathways between abuse and chronic disease. These issues are covered in greater detail in Chapter 2.

1B. Aims, Research Questions and Hypotheses

This study used the 2011 Behavioral Risk Factor Surveillance Survey (BRFSS) to expand on the limited research exploring the association between child abuse and cancer. Four overarching aims are articulated, each with subsequent research questions and hypotheses (stated in the alternative) in the following pages:

Aim 1: To assess the representativeness of the BRFSS 2011 sample. While the BRFSS attempts to be a nationally representative survey, this assumption should be tested.

Research Question:

1) Are demographic characteristics (i.e. age, sex, gender and race) and cancer rates from BRFSS comparable to published data from the 2010 Census and the National Cancer Institute's 2014 State Cancer Profiles?

   $H1_A$: BRFSS sample characteristics do not differ from those of national data sources.

Aim 2: To examine the association between three child abuse sub-types (i.e. physical, sexual or emotional) and cancer among adults. Specifically, the goal of this aim is to determine if physical, sexual and emotional abuse are each independently associated with cancer, and if these associations persist when accounting for other abuse types and other adverse childhood experiences (i.e. parental divorce, living with adults with mental illness etc.).

Research Questions:

2.1) Is child physical abuse associated with the development of cancer after controlling for other abuse types and other adverse childhood experiences?

$H2.1_A$: Child physical abuse is associated with increased odds of developing cancer, after controlling for other abuse types and other adverse childhood experiences.

2.2) Is child sexual abuse associated with the development of cancer after controlling for other abuse types and other adverse childhood experiences?

$H2.2_A$: Child sexual abuse is associated with increased odds of developing cancer, after controlling for other abuse types and other adverse childhood experiences.

2.3) Is child emotional abuse associated with the development of cancer after controlling for other abuse types and other adverse childhood experiences?

$H2.3_A$: Child emotional abuse is associated with increased odds of developing cancer, after controlling for other abuse types and other adverse childhood experiences.

Aim 3: To examine if the association between each child abuse sub-type (i.e. physical, sexual or emotional) and cancer is explained by risky health behaviors. Specifically, the goal of this aim is to determine if the relationship between abuse types and cancer is mediated by smoking cigarettes, drinking alcohol or overweight and obesity.

Research Questions:

3.1) Do cigarette smoking, alcohol drinking and/or being overweight or obese mediate the association between child physical abuse and cancer?

$H3.1_A$: The association between physical abuse and developing cancer is mediated by smoking, alcohol drinking and being overweight or obese.

3.2) Do cigarette smoking, alcohol drinking and/or being overweight or obese mediate the association between child sexual abuse and developing cancer?

$H3.2_A$: The association between sexual abuse and developing cancer is mediated by smoking, alcohol drinking and being overweight or obese.

3.3) Do cigarette smoking, alcohol drinking and/or being overweight or obese mediate the association between child emotional abuse and developing cancer?

$H3.3_A$: The association between emotional abuse and developing cancer is mediated by smoking, alcohol drinking and being overweight or obese.

Aim 4: To examine if the association between each child abuse sub-type (i.e. physical, sexual or emotional) and cancer is explained by socioeconomic status. Specifically, the goal of this aim is to determine if the relationship between abuse types and cancer is mediated by a respondent's household income and educational attainment in adulthood, two factors that have been identified as contextual risk factors for cancer incidence.

Research Questions:

4.1) Do household income and educational attainment mediate the association between child physical abuse and developing cancer?

$H4.1_A$: The association between physical abuse and developing cancer is mediated by household income and educational attainment.

4.2) Do household income and educational attainment mediate the association between child sexual abuse and developing cancer?

$H4.2_A$: The association between sexual abuse and developing cancer is mediated by household income and educational attainment.

4.3) Do household income and educational attainment mediate the association between child emotional abuse and developing cancer?

$H4.3_A$: The association between emotional abuse and developing cancer is mediated by household income and educational attainment.

2. Literature Review

2A. Current Limitations of the Research

The work linking child abuse and chronic disease more broadly, and, cancer specifically, suffers from two main shortcomings. The first is the issue of definitions, where no agreement exists upon definitions of child abuse. The second, which is partially a consequence of the first, is a methodological issue, where analytic strategies limit the types of conclusions that can be drawn. Each of these issues are discussed subsequently.

2B. Defining, Operationalizing and Measuring Abuse

In order to comprehend the phenomena of child abuse, one must first understand its relationship to other related phenomena. The most important related phenomena is that of child maltreatment, which is defined as "...acts of omission or commission by a parent or guardian that are judged by a mixture of community values and professional expertise to be inappropriate and damaging."[21] Child maltreatment is an umbrella term that encompasses both child abuse and child neglect. From this definition, we can derive the distinction between child abuse, and the related category of neglect. Namely, abuse entails acts of commission, while neglect entails acts of omission. However, this distinction is not made in many legal settings, which, instead, frequently collapse abuse and neglect into types (e.g. emotional abuse and emotional neglect are combined etc.),[22] thus ignoring the distinctions between acts of commission and acts of omission. Both abuse and neglect share two characteristics also highlighted in this definition. First, abuse and neglect are frequently limited to acts committed or omitted by parents or guardians against individuals who are legally children. Thus, abuse is defined by who perpetrators and victims are. Second, the definition emphasizes the context dependency of abuse and neglect. Namely, actions

are only defined as abuse or neglect if there is a larger societal norm supporting this classification.

Child abuse and child neglect can be subsumed into other broader terms or constructs. One such term is that of "risky families", which "are characterized by conflict and aggression and by relationships that are cold, unsupportive, and neglectful."[23] This can include cases of child abuse and neglect, but it largely focuses on more normative features of the family home environment.[24] Similarly, the construct of adverse childhood experiences (ACEs) which includes experiences of abuse and other measures of family dysfunction,[25] can also encompass child abuse.

Disentangling and Defining Types of Abuse

Child abuse, while frequently subsumed into larger categories, can be divided into its own categories. Specifically, three broad categories of child abuse exist: 1) child physical abuse; 2) child sexual abuse and 3) child emotional abuse. Understanding the distinctions between these categories is likely critical to understanding the impact of each abuse type on health.

Physical Abuse

Physical abuse, while frequently identifiable by the injury it leaves behind, is not easily defined. Broadly speaking, child physical abuse refers to intentional trauma or physical injury that results from harming a child. This can include activities such as biting, burning, kicking, punching or beating.[26] Here there is disagreement about specific disciplinary actions and whether or not they constitute abuse. Particularly, some attempt to differentiate between physical child abuse, corporal punishment and physical discipline, with the latter two defined by their legality and acceptance as normative parenting acts.[27] Also, despite being nearly synonymous with visible injury, it is unclear if visible trauma or injury needs to be immediately identifiable.[28] It is

unknown if legality or visible injury are important factors to consider when studying the development of chronic diseases.

Sexual Abuse

Sexual abuse is forced sexual contact with a child or unforced sexual contact that occurs in a relationship that is exploitative due to age differentials.[29] Contrary to other types of abuse, which, either explicitly or implicitly, have a limited view of abusers as caretakers or parents, child sexual abuse is often explicitly more inclusive and includes sexual contact with all adults under all conditions and peers under some conditions.[29] Some even broaden the category to include all sexual acts, including those committed by same or similar age peers and acts in which animals are forced to engage in sexual acts with children.[22] However, individual research studies may define child sexual abuse to include only acts perpetrated by caretakers, or include limitations on what actions constitute sexual abuse.[29] Using a more inclusive definition generally views all sexual contact involving children as harmful, while the more exclusive may view contact with peers as less harmful than contact with others and contact with family members as more harmful than contact with non-family members. Like physical abuse, it is unknown if these distinctions are important to consider when studying chronic disease development.

Emotional Abuse

Several activities are encompassed by the term emotional abuse.[30] First is the act of rejecting a child, which can involve failing to acknowledge the child's worth and needs. This manifests itself in adults defining the child as a failure, refusing to display affection to the child and refusing to acknowledge a child's accomplishments.[30] Second, emotional abuse involves actively isolating a child from social experiences. These include forbidding interactions with peers, excluding a child from family activities or physically keeping the child in an environment

in which he or she cannot contact others (i.e. a locked room, closet etc.).[30] In this way, the victimized child believes he or she is alone in the world. Thirdly, emotional abuse can include terrorizing where the adult bullies, scares or creates a climate of fear. The result of this terrorizing is that the child believes the world is a dangerous and unwelcoming place.

There is considerable ambiguity about the distinction between emotional abuse and the concepts of verbal and psychological abuse. If we treat verbal abuse, for example, as a type of emotional abuse, verbally abusive acts could involve rejection, isolation and terrorizing. Similarly, while many people use the terms emotional and psychological abuse interchangeably, there exist strong arguments against this. Briefly, emotional abuse can be defined as "a sustained, repetitive inappropriate emotional response to a child's experience of emotion and its accompanying expressive behavior."[31] This type of abuse inflicts emotional pain, inhibits expression of emotions, hinders development of emotion and contorts a child's understanding of emotion. Conversely, psychological abuse impairs mental processes in a child including intelligence, memory, perception and moral development.[31] This type of abuse can entail such activities as exploitation, lies or exposure to domestic violence. Using this frame we can see that psychological and emotional abuse share many characteristics, and likely co-occur within the same action or in two simultaneous actions, but they have somewhat distinct consequences. Finally, some have proposed that psychological abuse is dependent on the compromised psychological development of the child,[32] with the same act being abusive to some children at some time points. This claim could be applied to any type of abuse, making it unlikely that this is a distinguishing feature of psychological abuse.

Abuse Co-occurrence

Co-occurrence of abuse types is known as multi-type abuse.[33] Rates of co-occurrence of physical and sexual abuse have ranged from 2.4% to 17%, with men being less likely to be the victims of abuse co-occurrence than women.[34 35] When considering co-occurrence of child abuse and neglect, only 5% of child abuse occurs without other concurrent child abuse or neglect.[36 37] Given, the prevalence of multi-type abuse, one must determine the effects this has on definition, operationalization and measurement of abuse in research.

The first thing we must contend with in dealing with multi-type abuse is defining it. This becomes a near impossible task in the current landscape where definitions of abuse are not uniform and the boundaries between each abuse type cannot be delineated. Thus, researchers must first ask themselves if these phenomena are, in fact, distinct. If the distinction between abuse types is meaningless and artificial, then so to is the phenomena of multi-type abuse. One must also consider how much abuse types have in common. One point of view argues that all maltreatment (i.e. abuse and neglect) is destructive to children because, at their core, they all cause psychological harm.[38] From this viewpoint, differentiating abuse types by the specific action, intention or even perpetrator is counterproductive. Instead the focus should be on the psychological deficits that a child develops, which, after all, are what distinguishes between those who experience negative consequences from those who do not.[38] Alternatively, one could argue that child abuse is just part of some other underlying concept,[39] thus further diminishing the need to define abuse types discreetly. If multi-type abuse is thought to be a real occurrence, then a definition must outline the similarities and differences between this and any other single abuse type. Finally, if researchers are not interested in the multi-type abuse phenomena, their analytic strategies should account for co-occurrence.

Next, researchers have to operationalize and create measurements of abuse. This is currently very problematic with our existing instruments. If we accept that distinct abuse types exist, we must create measures that fully account for overlap and account for the type of overlap that a researcher wants. While many instruments allow for the measurement of multiple abuse types, they tend to measure these constructs in a way that forces discrete abusive actions into one abuse type. For example, in its measure of childhood sexual abuse, the Childhood Trauma Questionnaire asks respondents to indicate if they were hurt if they didn't do something sexual.[40] The use of "hurt" more than implies that physical or emotional abuse is also taking place when a respondent endorses the item. Yet in analyses, this nuance would not be captured. Similarly, if a child was verbally berated for refusing to perform a sexual act, would the average scale consider this multi-type abuse? The current measurement tools available fail to adequately capture circumstances in which abuse co-occurs and thus we are likely to underestimate the true rate of co-occurrence.

Overall, the methodological and conceptual issues surrounding co-occurrence become more regrettable when we realize the effect this type of abuse has on children. Multi-type abuse (i.e. reporting one or more abuse sub types) victims experience higher rates of psychopathology when compared to their peers who only experience one type.[41] Similarly, experiencing multi-type abuse is associated with experiencing greater abuse severity,[41] suggesting a quantitative difference in abuse for children in these situations. There is also evidence showing that particular combinations of child abuse and neglect are particularly damaging. Chiefly, the combination of physical neglect, physical abuse, emotional neglect and verbal abuse have the most detrimental impact on a child's positive perceptions for the future.[36] These results suggest that the experience of multi-type abuse is real and has grave consequences. However, our current ability to

understand this problem will remain inadequate until we first critically evaluate how we define each individual abuse type.

The inadequate and unclear definitions of abuse have meaningful impacts on the study of chronic disease. If all abuse is believed to be similar, then distinguishing between abuse types is unnecessary. Similarly, if abuse is thought to be part of a larger familial context, looking at abuse alone is not helpful. However neither of these positions have clearly demonstrated or argued. Conversely, if specific mechanisms between specific disease and abuse types are hypothesized, then one must consider the relationship of abuse types to each other and the relationship of abuse to larger categories. The tension between these stances is clear when reviewing the literature on child abuse and chronic disease, which is reviewed in the following section, which also underscores how abuse should be defined and conceptualized in the chronic disease context.

2C. Current Analytic Strategies

Three main approaches occur in the literature linking childhood abuse and chronic conditions. The most prominent type involves using scales that model a count of childhood adversities and either using it as a continuous predictor or transforming it into a dichotomous one (any vs. no adversities). That is, varying adverse childhood experiences such as parental drug use, poverty, domestic violence, sexual abuse, physical abuse, emotional abuse and neglect are lumped together and treated as interchangeable. That is, the hypothesis of interest is whether or not childhood adversity, in general, is associated with disease. This paradigm has found greater number of adverse childhood experiences increased risk of ischemic heart disease,[25] stroke,[25] chronic bronchitis or emphysema,[25] mental illness and substance use, [25,42,43] lung cancer incidence and mortality,[25,44] severe obesity,[43] overall cancer incidence,[45] adult metabolic functioning, [46] and cardio vascular disease.[47] However, because many different experiences are

collapsed together, it is impossible to know if all of these experiences are equally important in conferring risk for disease.

A second approach involves the disaggregation of established scales of childhood adversity, thus testing whether or not specific childhood adversities are associated with specific disease outcomes. For example, when a seven point measure of risky family environment that included an item for physical abuse was disaggregated, no individual item was predictive of cardiovascular disease (CVD) when all covariates were controlled for, even though the scale as a whole predicted CVD.[48] Similarly, a 16 item scale of additive childhood misfortune was associated with higher cancer odds for men, but not women.[49] Finally, all but one item on the Adverse Childhood Experiences (ACEs) questionnaire was found to be associated with increased risk of ischemic heart disease.[50] When summed into a scale, ischemic heart disease risk was higher for those experiencing at least 3 adverse child experiences, when compared to those experiencing none. Overall, disaggregation of umbrella constructs suggests that not all adverse experiences in childhood confer the same risk. However, these scales rarely include measures of all abuse types.

The third and final approach has been to examine childhood abuse using abuse-specific scales or items, while sometimes attempting to rule out the effects of other childhood adversities. This approach more directly tests the hypothesis that abuse is related to disease. Using this approach, child sexual abuse has been associated with increased risk of cancer,[2,51] mental illness,[52] and lung and cardiac disease.[53] Physical abuse has been associated with increased risk of cancer,[1] chronic health conditions in general,[54] obesity,[55] peptic ulcer disease,[53,56] arthritis,[53,55] lung disease, neurological disorders and autoimmune diseases.[53] Emotional abuse has been shown to be associated with eating disorders, depression, suicide attempts and sexual problems.[57]

Additionally, each abuse type has been shown to not be associated with all chronic conditions[53] and uniquely associated with certain mediators.[58] This suggests that abuse types are not only distinct in their impacts, but also have independent effects when other adversities are accounted for.

In summary, when studying chronic disease it would be advantageous to have separate measures for all abuse types and other childhood adversities. This approach acknowledges that abuse types can have unique mechanisms that linking them to disease, while also acknowledging that some of these mechanisms are shared. Also, this approach allows for the identification of mechanisms to test or plan interventions around. Some frameworks relevant to examining the connection between child abuse and cancer are discussed in the Chapter 3.

3. Theoretical Framework and Conceptual Model

3A. Current Theoretical Frameworks

Key insight about the potential mechanisms linking child abuse and cancer can be gleaned from models, frameworks and hypotheses developed to study related phenomena. Some models, like the Risky Families Model, specifically link household dysfunction to health in adulthood. Other work, like that by Kendall-Tackett (2002), specifically focuses on child abuse as a predictor of poor health. Additionally, work by Kelley-Irving and colleagues (2012b) focuses on the biological mechanisms that link early adversities to cancer. Finally, other models and hypotheses make connections between specific abuse types and/or specific cancer types. These models are discussed in detail in the subsequent text.

Risky Families

One prominent model, the Risky Families Model, was developed by Repetti (2002) and colleagues, and describes more normative levels of dysfunction in the family. The model posits that a family social environment characterized by conflictual, aggressive, neglectful or unsupportive relationships is "risky" for children living in these environments. This places children at risk for a variety of physical and emotional health conditions in adolescence and adulthood. The effect of this risky family environment is indirect and occurs through several key pathways. First, risky families trigger persistent activation and eventual dysregulation of biological stress responses, including immune and inflammatory responses. Second, emotional processing is hindered, compromising a person's ability to cope with emotionally arousing situations. Thirdly, social competence (i.e. skills needed to adapt socially) is underdeveloped hindering one's ability to form supportive relationships outside of the family context, which could potentially compensate for the risky family context. Finally, to deal with the deficits

described or as a means of self-medicating, individuals may engage in risky health behaviors such as smoking or substance abuse. Some parts of this process begin in infancy (i.e. biological responses and emotional processing), while others start in adolescence (i.e. risky health behaviors). While pieces of the model have been tested,[24,46,60,61] the model in its entirety has not been examined.

The Risky Families Model also posits several complex relationships among mechanisms linking the family social environment and health. For example, emotional processing has bidirectional associations with both biological dysregulation and deficient social cognitive processing. Additionally, the family social environment influences risky health behaviors directly, as well as through emotional processing. In all, the model presents a cascade of deleterious changes throughout the life course, that eventually impact health in adolescence and adulthood.

Four Pathways Model

There are also less developed, but promising, models limiting their focus to child abuse as predictors of health later in life. Developed at the same time as the Risky Families Model, Kendall-Tackett's (2002) Four Pathways Model, hypothesizes four broad categories of mechanisms that specifically link child abuse to health. The first, the behavioral pathway, is similar to risky health behaviors in the Risky Families Model, but it specifically focuses on behaviors that are known consequences of child abuse: substance abuse, obesity, eating disorders, suicide, risky sexual practices, smoking and sleep difficulties. Second, child abuse can also impact disease risk by impacting social pathways. Particularly, abused individuals are more likely to have fewer social ties, have negative attachment styles, find themselves in relationships where they are re-victimized and isolated to the extent that they are homeless. This is similar to

the social deficits delineated in the Risky Families Model. Third, child abuse can alter cognitions and thus impact health. Specifically, abused children may grow up believing that the world is a dangerous place, be less inclined to trust others and promote perceptions of themselves as unhealthy. Fourth, abuse increases the risk of mental illness, such as depression and PTSD, which have been associated with mental and physical health. However, in the context of cancer, this connection is not consistently supported by the literature.[62-64] Overall, while the model did not attempt to link a specific abuse type to a specific mediator or a specific health outcome, many of the studies informing the model drew from the sexual abuse literature.

Embodiment of Adverse Childhood Experiences

While the Four Pathways and Risky Families Models provide mechanisms by which abuse and related experiences can impact health, these models do not specifically focus on cancer as a health outcome. A recent framework by Kelly-Irving and colleagues specifically aims to explain the biological changes that link adverse childhood experiences to cancer initiation and progression. Drawing from the broader work on stress, they contend that childhood adversities "get under the skin" via two pathways.[65] The first pathway functions indirectly and is comprised of risky health behavior as coping mechanisms (as previously discussed). The second pathway is direct and is comprised of a series of biological changes occurring over time. One change occurs through the chronic activation of the hypothalamic–pituitary–adrenal (HPA) axis and sympathetic–adrenal–medulla (SAM) system, which leads to altered levels of stress hormones. These hormones, they argue, lead to a cascade of harmful events, including suppressed immune function and exaggerated inflammatory responses, which compromise the body's ability to repair DNA or kill cancerous cells. Additionally, they argue that exposure to stressful environments could cause epigenetic changes that alter gene expression. These modifications, in turn, could

render one more biologically vulnerable to stress hormones and thus increase cancer risk. Also, epigenetic changes may promote the expression of cancer promoting genes and dampen the expression of tumor-suppressor genes. Finally, Kelley-Irving argues that biological systems are impacted by health behaviors. Overall, this framework is useful in its cancer specific orientation; however, it relies heavily on evidence from animal studies.

Other Abuse and Cancer-Specific Theories and Frameworks

Less developed theories that link specific abuse experiences to cancer. Fuller-Thomson and Brennenstuhl (2009) proposed that childhood physical abuse was indirectly linked to cancer via adult health behaviors and adult socio-economic status. The latter linkage is missing from the Risky Families Model and the Four Pathways Model, but it is important because childhood abuse is associated with lower educational attainment,[66] higher unemployment and lower earnings.[67] Lower adult socio-economic status, in turn, is associated with higher cancer risk.[68] Additionally, Fuller-Thomson and Brennenstuhl (2009) contend that childhood physical abuse may exist as part of a larger group of childhood adversities, similar to those that exist in the Risky Families Model. However, unlike the Risky Families Model, these other adversities are factors that must be controlled for in order to determine if physical abuse has an independent effect.

Additionally, models have attempted to explain the connection between childhood sexual abuse and adult cancer risk. Again, one common mechanism explaining the association is health behaviors. For example, when looking at cervical cancer specifically, childhood sexual abuse in girls is hypothesized to increase smoking and decrease barrier contraceptive use.[2] In the field of childhood sexual abuse, negative health behaviors have been framed as avoidant coping strategies to deal with abuse.[69] According to this framework, childhood sexual abuse increases the likelihood of using emotional avoidance (i.e. avoiding negative emotions arising from abuse).

Thus, problematic avoidant coping behavior, such as drinking, exists to evade a direct confrontation with the emotions stemming from abuse. Furthermore, the use of avoidant coping strategies is influenced by a variety of factors in the child's environment, such as the child's inability to leave or alter their abusive environment.

A second mechanism linking childhood sexual abuse to cancer is biological. Like more general models of childhood adversity, childhood sexual abuse can lead to over activation of stress response systems and decreased immunological function. This latter point is especially pertinent to sexual abuse since sexual contact can lead to exposure to the human papilloma virus (HPV), an established risk factor for cervical cancer.[2] Thus sexual abuse as a child can lead to very early exposure to HPV, persistent infection and thus elevated risk.

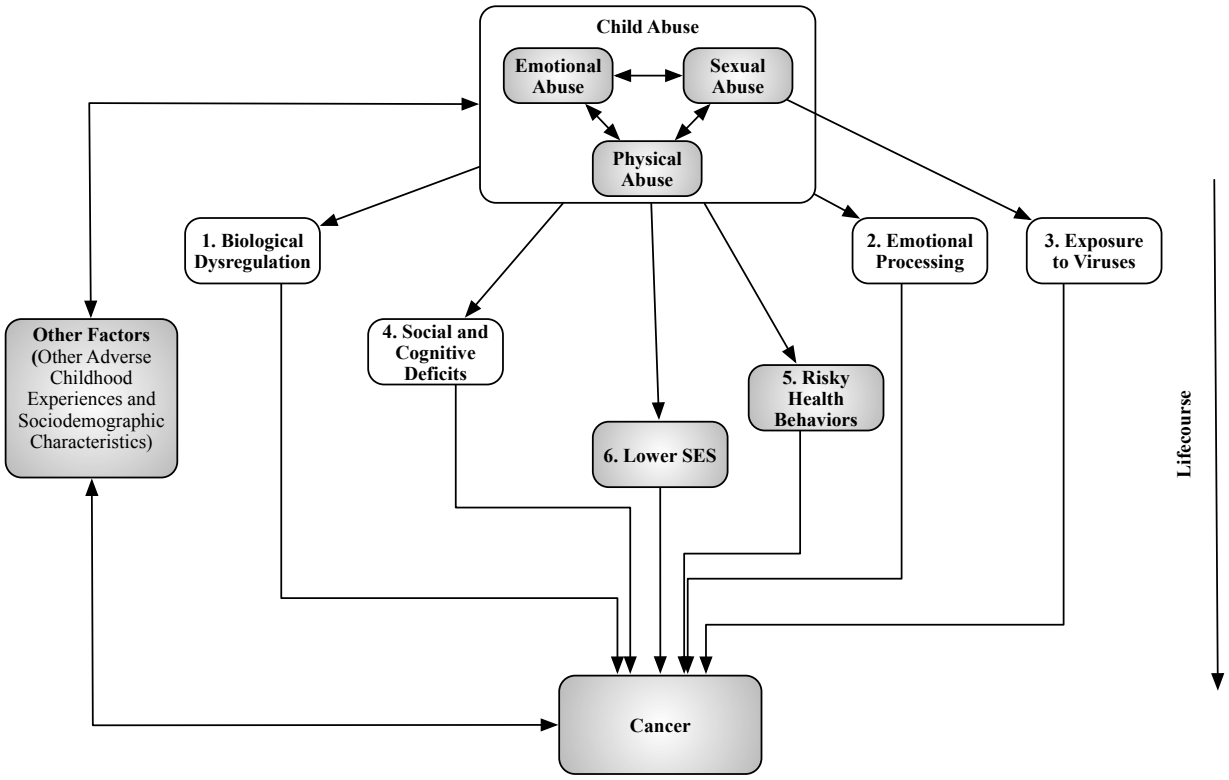
Considering the theoretical frameworks presented and the conceptual and measurement issues discussed earlier, a contextualized theoretical framework is needed. This is needed for multiple reasons. First, the theoretical framework that one adopts is crucial because, it largely informs what questions are asked, the assumptions that are made and the analytic strategy used. If we base our analyses on more general models of childhood social environments we may fall into the trap of treating all features of the environment as equivalent and interchangeable. Conversely, if we focus solely on child abuse, we may not be able to determine if child abuse experiences have any effects independent of the larger negative environment the child is exposed to. Second, choosing a framework that focuses solely on child abuse may still mean that researchers treat different abuse experiences as interchangeable (i.e. physical, sexual and emotional abuse). Third, using models that are not disease specific may lead researchers to focus on incorrect explanatory pathways. Consequently, a theoretical framework that integrates these considerations is warranted.

3B. General Integrated Theoretical Framework

Based on the previous reviewed theoretical and empirical work, Figure 3.2 shows an integrated framework linking child abuse and cancer, and includes factors outside of the scope of the present study, due to the limitations of the database selected. A description of the conceptual framework for the present study is included in the subsequent figure. Figure 3.2 largely builds on the foundation provided by the Risky Families and Four Pathways Models, but includes considerations specific to the context of the present study. To begin, this model treats each abuse type as different, but correlated phenomena. Consequently, it can adequately account for the co-occurrence of abuse types and also allows for abuse types to have unique pathways leading to cancer. Additionally, the model highlights other factors that could be associated with abuse and cancer. These include sociodemographic factors and other adverse childhood experiences. Thus, the framework requires that analytical strategies not treat abuse experiences as interchangeable with other childhood adversities.

Next, the model, as depicted in Figure 3.2, highlights six pathways by which abuse impacts cancer risk: 1-3) Beginning early in the life course, abuse can lead to biological dysregulation, emotional processing deficits and viral exposures. The latter mechanism is unique to sexual abuse. 4) Abuse leads to social and cognitive deficits. These occur later in development and are influenced by emotional deficits. 5) Abuse can lead to the adoption of risky health behaviors as a means of coping with abuse; and 6) Abuse sometimes attenuates socioeconomic status attainment in adulthood, which, in turn, increases risk of cancer. This model does not visually depict all of the relationships that can exist between the mediating pathways. Rather it is designed for simplicity, not because these connections do not exist.

Figure 3.2: Theoretical Framework

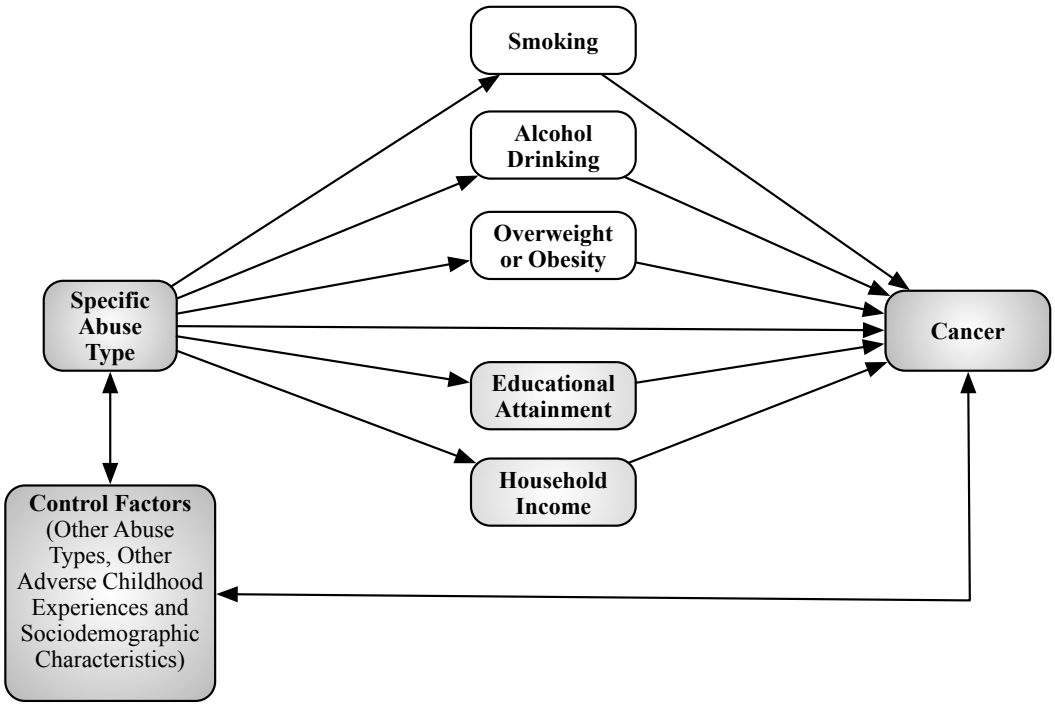


Note: Model does not depict all connections between pathways, or the directionality of these connections.

3C. Conceptual Framework

For the present study, a conceptual framework based on the theoretical framework described above will be utilized. This framework is presented in Figure 2 and is limited to the independent variables of interest (i.e. child sexual, physical and emotional abuse), the outcome of interest (i.e. cancer), cancer-related risky health behavior mediators (i.e. smoking, drinking and overweight or obesity) and socioeconomic status mediators (i.e. income and educational attainment). While both adult socioeconomic status and socioeconomic status of one's family of origin can impact health, this study focuses on adult socioeconomic status. Additionally, the framework includes important factors that influence both the outcome and predictors of interest (i.e. geography, age, gender and race/ethnicity). A brief review of research supporting connections between the proposed pathways is presented in the subsequent pages.

Figure 3.3: Conceptual Framework



Note: White boxes represent mediating effects of risky health behaviors and the light gray boxes represents the mediating effect of socioeconomic status.

Health Behaviors

The purpose of this study is to investigate the contribution of three health behaviors that are hypothesized to mediate the association between abuse type experienced in childhood and cancer risk in adulthood. For the present study these health behaviors are: 1) overweight or obesity; 2) alcohol drinking; and 3) smoking. Overall, evidence exists supporting each connection. However, not all evidence examines all abuse types and not all evidence is consistent.

Obesity or Overweight

While not a health behavior, overweight and obesity is the by-product of two forces that are conceptualized as health behaviors. Namely, excessive energy consumption (i.e. diet) and/or inadequate energy expenditure (i.e. exercise) can lead to overweight and obesity. This is

problematic because the causal evidence linking obesity to cancer of the breast, colon, endometrium, kidney and esophagus has been determined to be sufficient.[70] Additionally, obesity is the biggest preventable cause of cancer among non-smokers.[70] Similarly, overweight status has been linked to higher risk of cancer of the breast, colon, endometrium, kidney and gallbladder.[71]

Sexual, physical and emotional abuse are associated with higher weight, [72] and greater risk of being obese.[72-74] This connection may be mediated by changes in dietary behaviors among those experiencing abuse. For example, women and gay or bisexual men who experience sexual abuse have higher rates of binge eating and bulimia.[18,75-77] However, the available evidence for this pathway suggests that more abuse types are associated with higher rates of disordered eating among women than men,[18,78] and non-Latina white women than minority women.[18] Finally, this association may also be mediated by changes in physical activity among those experiencing child abuse, however, this relationship remains untested.

Alcohol use and abuse

Alcohol use has been causally linked to elevated risk for cancers of the pharynx, colon, larynx, esophagus, liver, rectum, breast, pancreas and lung,[79] with strong links to cancers of other sites.[80] Available evidence also suggests that light drinking (1 drink or less per day) is enough to confer an elevated cancer risk of colorectal cancer[81] and drinking 2.5 drinks or less a day increases risk for several different cancers.[80]

Experiences of child abuse are associated with engaging in alcohol use and abuse. This association has been documented earlier in life. For example, teenagers who have experienced physical abuse have higher odds of alcohol abuse when compared to their non-physically abused peers.[82] Meta-analyses reveal that sexual abuse, but not physical abuse is associated with increased risk of alcohol usage among teenagers.[83] Among adults, experiences of childhood

physical, emotional or sexual abuse are each associated with heavy drinking.[84-86] The discrepancy in findings among teenagers and adults may reflect the differing key periods for which drinking becomes an effective or accepted strategy to cope with different types of abuse.

Cigarette Smoking

Tobacco use is one of the most established cancer risk factors. Cigarette smoking is commonly studied as a risk factor for cancer. Smokers are at an elevated risk for lung, head and neck, urinary tract, pancreatic, and bladder cancer.[87] Other forms of tobacco consumption, including hookah and chewing tobacco have also been associated with elevated risk of certain cancers.[88,89]

The evidence for the link between child abuse and cigarette smoking among teenagers and adults is mixed. Overall, meta-analyses have documented no association between sexual abuse and use of nicotine among teenagers.[83] However, physical abuse is associated with an elevated risk of nicotine use.[83] Individual studies reveal an even more nuanced picture. For example, child physical or sexual abuse is not associated with odds of ever smoking among adolescents. However, experiencing child physical or sexual abuse is associated with increased adolescent smoking frequency in boys, but not girls,[90] suggesting a complex moderating effect of gender. Conversely, other studies have shown that being hit once was enough to increase risk of tobacco use among both teen boys and girls, with more frequently occurring hitting conferring an even greater risk.[82] This risk further increased among those who had experienced more than one abuse type. Overall, these mixed findings may reflect the different populations and sampling strategies that were used in individual studies. Among adults, a similarly inconsistent picture emerges, with some studies showing links between abuse and smoking and some studies not showing this association.[91,92]

Socio-economic Status

Socio-economic status (SES), or a person's social and economic position in society, is a robust predictor of health.[93] SES is frequently measured using income and educational attainment.[94] Both are thought to influence health because they influence access to material resources, while education is thought to influence health though knowledge, literacy, prestige, problem-solving ability and influence over others.[95]

Higher SES is associated with greater utilization of cancer screening procedures including PSA test,[96] mammogram,[97-99] colorectal cancer screening[100] and Pap smear.[99] Additionally, lower SES is associated with cancer related risk behaviors such as smoking,[101,102] alcohol drinking and dependence,[103] poorer diet, [104] and decreased physical activity.[104] However, the effect of SES on cancer risk is not so straight forward, with different measures of SES showing positive or negative associations with cancers of specific sites.[105,106]

Evidence from cross-section and longitudinal studies has suggested that child abuse impacts SES in a variety of different ways. Specifically, physical and sexual abuse have been associated with lower occupational classes,[57] lower IQ,[107] poorer reading ability,[107] hindered academic achievement,[108,109] lower educational attainment,[66] higher unemployment and lower earnings.[67] Child maltreatment, has been linked to poorer performance on standardized tests, lower grades, increased likelihood of repeating a grade, greater number of disciplinary referrals and greater number of suspensions.[110] Thus abuse appears to have a short-term impact on academic achievement, which can eventually translate to limited employment prospects, and eventual earnings.

Other Factors

Experience of abuse in the US varies across several demographic characteristics. First, men and women report similar rates of both physical and emotional abuse, but women report much higher rates of sexual abuse.[111] Across racial/ethnic groups, Blacks tend to report both physical and sexual abuse at rates that are lower than all other ethnic groups.[111] In terms of age, a curvilinear relationship with age and all abuse types exist, with those in young adulthood and those over age 55 having the highest rates of reporting.[111] Also, there is substantial variability in a prevalence of abuse types across different states.[111] Finally, other adverse childhood experiences that frequently co-occur with abuse are similarly related to demographic characteristics.[111]

Cancer risk also varies by demographic characteristics. First, when considering gender, males account for more than half of the incidents of cancer cases and deaths in the US.[112] Overall half of American men develop cancer, whereas only a third of American women do.[112] Second, the odds of developing cancer increase with age.[112] This is unsurprising considering the nature of oncogenesis with cell replication errors and aging. Third, when it comes to race/ethnicity stark disparities in cancer incidence and mortality exist. Across racial/ethnic groups Blacks have the highest incidence and mortality rates, while Asian Americans, in aggregate, have the lowest,[112] yet cancer is the number one cause of death in both Asian American men and women.[113] Some Pacific Islander sub-groups, like Samoans and Native Hawaiians have cancer mortality rates similar to those of Blacks.[114] Fourth, in terms of geography, cancer incidence and mortality is also highly variable by state. For example, cancer mortality among males is highest in

Mississippi and lowest in Utah.[112] Finally, as previously noted, non-abuse related adverse childhood experiences have been linked to cancer. [25,44,45]

4. Research Design and Methods

4A. Data Source

The 2011 Behavioral Risk Factor Surveillance System (BRFSS) survey was used to execute the four study aims. This random digit dial telephone survey is designed to be representative of non-institutionalized adults (ages 18 and over) living in all U.S. states, Guam, Washington D.C., Puerto Rico and the U.S. Virgin Islands. BRFSS utilizes a multi-stage design that makes use of stratification, clustering and differing selection probabilities.

The BRFSS is conducted annually, with data collected on the survey consisting of a core set of questions asked of all participants in all states and optional modules that can be asked of all or some participants in states electing to administer a given module. Each state could elect to administer its own combination of optional modules. Core surveys were collected using both landlines and cell phones in all states, while optional modules were collected with landline and/or cellphones.[115] In the 2011 BRFSS cycle, all states administered questions about cancer status, but only 10 states (California, Maine, Minnesota, Montana, Nebraska, Nevada, Oregon, Vermont, Washington and Wisconsin) administered a module of questions measuring childhood adversities, including child abuse.[116] The median weighted American Association for Public Opinion Research response rate (RR4) for these regions was 49.85%, which is better than many other telephone-based surveys in the United States.[117]

A total of 131,686 respondents participated in the 10 states that administered questions about child abuse and childhood adversities. However, the California administration of the BRFSS omitted the item asking respondents about living with an adult who had been jailed. Consequently, the California sample was not considered for analyses, leaving 120,586 cases for this study.

4B. Operationalization and Measurement of Constructs

Independent Variables

Child Abuse

The main independent variables for this study were physical, sexual and emotional abuse. The items used to measure these constructs come from the Adverse Childhood Experience (ACE) scale. This 11-item scale measures physical abuse, sexual abuse, psychological abuse as well as household dysfunction.[25] Five items in the scale asked whether or not the respondent had been exposed to specific adversity while they were underage 18. The remaining items allowed respondents to specify the frequency of occurrence of a specific adversity (i.e. never, once or more than once). For the purpose of analyses, all items were dichotomized to indicate if the experience had ever happened. This coding scheme is consistent with existing work, but refrains from summing these items into a scale, and is shown in Table 1 below.[51]

For this study, physical and emotional abuse were both measured using single items representing whether or not the respondent had reported ever experiencing the abuse types. It is important to note that the measure for physical abuse makes an attempt at excluding more normative parenting practices (i.e. spanking). Also, emotional abuse is limited to verbal abuse. Sexual abuse was derived by combining items measuring being sexually touched, being made to sexually touch someone and being forced to have sex. As long as respondents reported one of these experiences, even if values were missing for the other experiences, they were coded as having ever experienced sexual abuse.

Table 4.1: Adverse Childhood Experiences

Question	Domain	Type of Variable	Coding
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.	Physical Abuse	Independent	Ever/Never
How often did anyone at least 5 years older than you or an adult, ever touch you sexually?	Sexual Abuse	Independent	Ever/Never
How often did anyone at least 5 years older than you or an adult, try to make you touch them sexually?	Sexual Abuse	Independent	Ever/Never
How often did anyone at least 5 years older than you or an adult, force you to have sex?	Sexual Abuse	Independent	Ever/Never
How often did a parent or adult in your home ever swear at you, insult you, or put you down?	Psychological/Emotional Abuse	Independent	Ever/Never
Did you live with anyone who was depressed, mentally ill, or suicidal?	Household dysfunction (mental illness)	Control	Yes/No
Did you live with anyone who was a problem drinker or alcoholic?	Household dysfunction (substance abuse)	Control	Yes/No
Did you live with anyone who used illegal street drugs or who abused prescription medications?	Household dysfunction (substance abuse)	Control	Yes/No
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Household dysfunction (criminal behavior in household)	Control	Yes/No
Were your parents separated or divorced?	Household dysfunction (divorce)	Control	Yes/No
How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?	Household dysfunction (adults treated violently)	Control	Ever/Never

Dependent Variable

Cancer

The dependent variable of interest, lifetime cancer diagnosis, was assessed with a single item. This item indicated whether or not a doctor had ever told the respondent that they had

cancer. Because of the frequently benign nature of skin cancer, only non-skin cancer cases were coded as having the disease for Aims 1-4. Those without a cancer diagnosis served as the reference group in analyses. The BRFSS did not allow for disaggregation of cancer by site.

Mediating Variables

Smoking

To measure smoking, a single item measuring whether or not a person ever smoked one hundred cigarettes in their lifetimes was used. Individuals who responded affirmatively to this item were coded as "ever smokers." This measure was chosen over current smoking status because, in the cancer context, a diagnosis of cancer may lead individuals to stop smoking, thus biasing associations toward the null. Never smokers served as the reference group in analyses.

Alcohol Consumption

To measure alcohol consumption average number of alcoholic drinks in the past 30 days was used. A drink represented a 12-ounce beer, a 5-ounce glass of wine or a shot of liquor.

Overweight or Obesity

To measure overweight or obesity, a dichotomous variable indicating whether or not respondents were overweight or obese was used. Respondents were asked to report weight (in pounds) and height (in feet and inches). From this, body mass index (BMI) was derived by dividing weight (in kilograms) by height (in meters squared). Obese individuals are those with BMI scores greater than or equal to 30 and overweight individuals are those with BMI scores between 25 and 29.9. Individuals who were not overweight or obese served as the reference category in analyses. While separate categories for overweight and obese may provide additional information for analyses, a dichotomous or continuous variable is needed for mediation.

SES

Socioeconomic status will be measured by using household income and educational attainment. While relative measures of income (i.e. poverty level) or measures of amassed wealth (i.e. balance in savings accounts, stocks, etc.) may provide a more complete picture of the role of income, these were not ascertained in the BRFSS.

Household income

Respondents were asked if their annual household income, from all sources, fell into eight broad categories: under $10,000, $10,000 to $14,999, $15,000 to $19,999, $20,000 to $24,999, $25,000 to $34,999, $35,000 to $49,999, $50,000 to $74,999 and $75,000 or more. This variable was recoded into a continuous variable by first setting values to the midpoints of the first seven income categories, then recoding those in the final category as having incomes of $100,000 and finally dividing this value by 1,000. This new variable represents annual household income in thousands of dollars. This represents a more meaningful increase in income than a single dollar increase.

Educational Attainment

Educational attainment was recoded from its original categories (i.e. kindergarten or less, 1st through 8th grade, 9th through 11th grade, high school graduate, 1 to 3 years of college and 4 or more years of college) to continuous values that represented the midpoint of the category in terms of years of education, with the final category being coded as having 16 years of education.

Control Variables

Other Adverse Childhood Experiences

In order to determine if child abuse had an effect on cancer, above and beyond other correlated experiences, other childhood adversities were controlled for. These are depicted in the bottom half of Table 1 and include living with someone who was mentally ill, was a substance

user or abuser and was jailed or engaged in violence among other adult household members. Each adverse childhood experience was transformed into a dichotomous variable, indicating whether or not the respondent had reported the adversity. Not experiencing each adversity served as the reference group in analyses.

Sociodemographic characteristics

Sociodemographic characteristics were also included as controls. Age was included as a continuous variable. Gender was collected as a dichotomous variable and was included, as such. Neither gender made up the vast majority of respondents. Thus, males were selected as the reference category. Race/ethnicity was measured using a series of dummy variables representing the Office of Management and Budget's race and ethnicity category combinations (i.e. non-Latino white, non-Latino Black/African American, non-Latino Asian, non-Latino other race, and Latino). Because Non-Latino whites make up the vast majority of the sample, they served as the reference group. In cases where a respondent did not know his or her race/ethnicity or refused to provide a race/ethnicity BRFSS imputed race based on the most common race/ethnicity in the region of the state the respondent lived in. A total of 1,180 respondents did not provide race/ethnicity information, with the vast majority of them (1,113) being imputed as non-Latino white. State were measured using a series of dummy variables for each of the nine states represented in the sample, with Washington serving as the reference group, because it comprised the plurality of the sample.

4C. Missing Data and Imputation

To prepare data for analyses an examination of missing data was conducted. Table 4.2 shows the percent of cases missing for each variable. These reflect missing, "don't know" responses or response refusals. Overall, 27.10% of the sample was missing values on at least one

variable, with household income being the item with the greatest percent of missing values (12.71%). No participants had missing values for gender and state. Additionally, because race was imputed by the BRFSS, no values were missing for race. Given that "missingness" varied by characteristics observed in the study the data are not missing completely at random.

Table 4.2: Summary of Missing Values in BRFSS (N=120,586)

Variable	N Missing	% Missing
Control variables		
Age	1,090	0.90%
Gender	0	0.00%
Race	0	0.00%
State	0	0.00%
Lived w/ someone who was mentally ill	10,587	8.78%
Lived w/ problem drinker/alcoholic	10,224	8.48%
Lived w/ drug user/abuser	10,157	8.42%
Lived w/ someone who has been jailed	9,933	8.24%
Parents separated or divorced	10,679	8.86%
Adults in household treated each other violently	11,304	9.37%
Dependent variable		
Cancer Status	278	0.23%
Independent variables		
Physical abuse	10,603	8.79%
Sexual abuse	11,229	9.31%
Emotional abuse	11,461	9.50%
Mediating variables		
Ever smoke cigarettes	552	0.46%
Overweight or Obese	6,435	5.34%
Alcoholic drinks in past 30 days	7,372	6.11%
Household income	15,331	12.71%
Educational attainment	409	0.34%
Missing on at least one variable	32,673	27.10%

To examine if missing data was "ignorable", two-proportion z-tests and two-sample t-test comparing all variables across categories of missing (i.e. missing values on least one variable versus not missing any values) were conducted. As Table 4.3 shows, missing cases were more likely to be older, Latino, less educated, have fewer alcoholic drinks and have lower incomes,

when compared to complete cases. Missing cases were more likely to reside in Minnesota, Nevada, Oregon and Wisconsin. Additionally, missing cases were less likely to have ever smoked or be overweight or obese. No difference was found between the groups in terms of cancer status, physical abuse and sexual abuse. However, differences were observed between groups when it came to some of other childhood adversities.

Table 4.3: Means and Frequencies by Percent Missing on any Variable in BRFSS (N=120,586)

		Missing on any variable		
Variable	N	No %(n)	Yes %(n)	p-value
Control variables				
Female	120,586	57.15% (50,241)	65.98% (21,557)	<.0001
Race				
White	120,586	90.83% (79,849)	86.01% (28,102)	<.0001
Black	120,586	1.70% (1,493)	2.98% (974)	<.0001
Latiino	120,586	2.43% (2,132)	4.13% (1,350)	<.0001
Asian	120,586	1.03% (906)	1.30% (426)	<.0001
Other	120,586	4.02% (3,533)	5.57% (1,821)	<.0001
State				
Maine	120,586	3.39% (2,982)	3.11% (1,016)	0.015
Minnesota	120,586	20.62% (18,130)	23.22% (7,586)	<.0001
Montana	120,586	16.04% (14,104)	14.51% (4,740)	<.0001
Nebraska	120,586	9.04% (7,946)	7.18% (2,347)	<.0001
Nevada	120,586	3.34% (2,935)	4.77% (1,557)	<.0001
Oregon	120,586	3.87% (3,400)	4.61% (1,505)	<.0001
Vermont	120,586	11.56% (10,167)	10.60% (3,463)	<.0001
Washington	120,586	24.32% (21,378)	22.63% (7,394)	<.0001
Wisconsin	120,586	7.82% (6,871)	9.38% (3,065)	<.0001
Age	119,494	56.68% (87,913)	57.72% (31,583)	<.0001
Lived w/ someone who was mentally ill	109,999	16.01% (14,079)	15.16% (3,349)	0.002

Table 4.3: Means and Frequencies by Percent Missing on any Variable in BRFSS (N=120,586). (Continued)

		Missing on any variable		
Variable	N	No %(n)	Yes %(n)	p-value
Lived w/ problem drinker/alcoholic	110,362	24.54% (21,571)	24.25% (5,443)	0.366
Lived w/ drug user/abuser	110,429	7.46% (6,556)	6.75% (1,519)	<.0001
Lived w/ someone who has been jailed	110,653	4.03% (3,539)	5.01% (1,140)	<.0001
Parents separated or divorced	109,907	19.16% (16,847)	21.17% (4,657)	<.0001
Adults in household treated each other violently	109,282	14.94% (13,136)	14.47% (3,092)	0.081
Dependent variable				
Cancer Status	120,308	10.39% (9,138)	10.67% (3,455)	0.173
Independent variables				
Physical abuse	109,983	15.63% (13,739)	16.05% (3,542)	0.124
Sexual abuse	109,357	12.53% (11,015)	12.78% (2,740)	0.326
Emotional abuse	109,125	33.50% (29,449)	32.18% (6,826)	<.0001
Mediating variables				
Ever smoke cigarettes	120,034	47.51% (41,766)	46.74% (15,014)	0.019
Overweight or Obese	114,151	64.59% (56,781)	60.58% (56,781)	<.0001
Alcoholic drinks in past 30 days	113,214	1.24% (87,913)	1.01% (25,301)	<.0001
Household income	105,255	53.90% (87,913)	45.47% (17,342)	<.0001
Educational attainment	120,177	13.95% (87,913)	13.34% (32,264)	<.0001

Because income had the highest proportion of missing, variables were compared across categories of missing (i.e. missing values on income versus not missing on income) and statistical tests were conducted. As Table 4.4 shows, missing cases are more likely to be older,

black or Latino, less educated and have fewer alcoholic drinks, when compared to cases not missing on income. Missing cases were more likely to reside in Minnesota, Nevada, Oregon, Vermont and Washington. Additionally, missing cases are less likely to have ever smoked, have been diagnosed with cancer or be overweight or obese.

Cases missing on income differ on all childhood adversities except having lived with someone who has been jailed. Those missing on income had higher rates of living with someone that was mentally ill, living with a problem drinker/alcoholic, living with a drug user or abuser, having parents who were separated or divorced and living in households in which adults treated each other violently.

Table 4.4: Means and Frequencies by Percent Missing on Income Variable in BRFSS (N=120,586)

Variable	N	% Missing on income: No	% Missing on income: Yes	p-value
Control variables				
Female	120,586	58.16% (61,219)	69.00% (10,579)	<.0001
Race				
White	120,586	89.59% (94,298)	89.05% (13,653)	0.043
Black	120,586	2.07% (2,182)	1.86% (285)	0.08
Latino	120,586	2.84% (2,989)	3.22% (493)	0.009
Asian	120,586	1.08% (1,139)	1.26% (193)	0.050
Other	120,586	4.41% (4,647)	4.61% (707)	0.270
State				
Maine	120,586	3.37% (3,550)	2.92% (448)	0.004
Minnesota	120,586	21.18% (22,298)	22.29% (3,418)	0.002
Montana	120,586	16.04% (16,881)	12.80% (1,963)	<.0001
Nebraska	120,586	8.66% (9,119)	7.66% (1,174)	<.0001
Nevada	120,586	3.67% (3,860)	4.12% (632)	0.005
Oregon	120,586	4.00% (4,212)	4.52% (693)	0.002
Vermont	120,586	11.21% (11,796)	11.96% (1,834)	0.006
Washington	120,586	23.62% (24,859)	25.52% (3,913)	<.0001
Wisconsin	120,586	8.25% (8,680)	8.19% (1,256)	0.820
Age	119,496	56.44% (104,734)	60.63% (14,762)	<.0001

Table 4.4: Means and Frequencies by Percent Missing on Income Variable in BRFSS (N=120,586) (Continued)

Variable	N	% Missing on income: No	% Missing on income: Yes	p-value
Lived w/ someone who was mentally ill	109,999	16.37% (15,916)	11.82% (1,512)	<.0001
Lived w/ problem drinker/alcoholic	110,362	25.12% (24,496)	19.58% (2,518)	<.0001
Lived w/ drug user/abuser	110,429	7.63% (7,440)	4.93% (635)	<.0001
Lived w/ someone who has been jailed	110,653	4.70% (4,167)	3.96% (512)	0.100
Parents separated or divorced	109,907	19.83% (19,254)	17.55% (2,250)	<.0001
Adults in household treated each other violently	109,282	15.25% (14,736)	11.80% (1,492)	<.0001
Dependent variable				
Cancer Status	120,308	10.30% (10,814)	11.65% (1,779)	<.0001
Independent variables				
Physical abuse	109,983	16.19% (15,741)	12.07% (1,540)	<.0001
Sexual abuse	109,357	12.95% (12,518)	9.76% (1,237)	<.0001
Emotional abuse	109,125	34.07% (32,889)	26.89% (3,386)	<.0001
Mediating variables				
Ever smoke cigarettes	120,034	47.86% (50,185)	43.43% (6,595)	<.0001
Overweight or Obese	114,151	64.49% (65,241)	57.25% (7,435)	<.0001
Alcoholic drinks in past 30 days	113,214	1.22% (99,949)	0.96% (13,265)	<.0001
Educational attainment	120,177	13.86% (105,130)	13.24% (15,047)	<.0001

Given the sizable fraction of data with missing values, missing data were imputed. This was done using imputation by chained equations (ICE) in Stata. Briefly, this technique involves

using logistic, linear or ordinal regression models to estimate missing values and impute dichotomous, continuous and ordinal variables respectively. This technique does not assume that variables are multivariate normal, and thus allows for the imputation of categorical and dichotomous variables.[118] In the present study, imputation models included all variables listed in Table 4.2 (i.e. all study variables). Here a model had a particular variable with missing values treated as an dependent variable and all other variables were treated as independent variables.[119] This model was used to "fill in" missing data values with the values predicted by the model.[119] This process was repeated for each variable, with each subsequent variable taking advantage of the data imputed for previous variables.[119]

A single imputation of missing values was created. Multiple imputations are preferable, because having multiple imputations allows for the introduction of "noise" to capture the uncertainty inherent in estimating a missing value. In the present analyses the statistical program to analyze mediation with a dichotomous variable did not allow for the use of multiple imputations. As a result, a single imputation was used. Because the number of imputations has been shown to decrease standard errors,[120] using a single imputation will bias results to the null, when compared to using a greater number of imputations. For example, in simulated analyses, Graham and colleagues (2007) showed that increasing imputations from 3 to 5 resulted in a 0.5% decrease in standard errors.

After creating imputations, imputed values were examined to ensure that models yielded values within reasonable data ranges. Consequently 1,126 cases where income was imputed as a negative value were recoded to zero, nine cases where age was below 18 were recoded to 18 and 1,961 cases where alcohol consumption in the past 30 days was negative were recoded to zero. This yielded 120,586 complete cases after 100% of missing values were imputed.

In order to account for the use of imputations in analyses, a dummy variable indicating whether or not a specific observation had any data imputed was created. As such, the effect of imputation was controlled for. This variable was added into models in Aims 2-4.

To compare the performance of imputed and unimputed data, two logistic regression models predicting odds of cancer were run. The first used only complete cases, while the second used imputed data. As predictors, child abuse variables, adverse childhood experiences and control variables were included. Then, the percent change in standard errors between the unimputed and imputed models was calculated. As shown in Table 4.4, the use of imputed data led to decrease in the standard errors in all but one variable, when compared to the unimputed data. Percent change ranged from 1.31% and -22.69%. This latter change was seen in the standard error for Blacks, which fell by 22.69% in the imputed models. These findings suggest that use of imputed data will bias results to the alternative. Having lived with someone who was mentally ill and having lived with a drug user/abuser altered in significance between models, with the former becoming significant with imputed data and the latter becoming non-significant with imputed data. However, it is important to note, use of imputations did not alter the significance of the associations between abuse variables and cancer.

Table 4.4: Comparison of Standard Errors in Imputed and Unimpuuted Models Predicting Cancer

	Unimputed Data (N=87,913)		Imputed Data (N=120,586)		% Change in SE
Variable	AOR	SE	AOR	SE	
Physical Abuse	1.27	0.09	1.24	0.08	-11.46%
Sexual Abuse	1.40	0.08	1.37	0.08	-9.31%
Emotional Abuse	1.12	0.06	1.10	0.05	-10.71%
Lived w/ some one who was mentally ill	1.11	0.08	1.17	0.08	-4.13%
Lived w/ problem drinker	0.98	0.05	0.97	0.05	-8.45%
Lived w/ drug user	1.30	0.12	1.16	0.10	-17.78%
Lived w/ some one who was jailed	1.22	0.16	1.25	0.14	-11.13%
Parents divorced or separated	0.93	0.06	0.93	0.06	-12.18%
Adults in household treated each other violently	0.95	0.07	1.06	0.07	1.31%
Age	1.06	0.00	1.06	0.00	-11.97%
Female	1.38	0.06	1.38	0.06	-7.82%
Race					
Black	1.08	0.21	0.96	0.16	-22.69%
Latinos	0.91	0.15	0.98	0.14	-6.46%
Asian	0.42	0.09	0.41	0.08	-11.89%
Other	1.05	0.12	1.02	0.11	-14.88%

Notes: AOR= adjusted odds ratio; Model includes controls for state

4D. Analyses

All data analyses were conducted using Stata 14.0 and using the imputed data set. Analyses were run using probability weights to adjust for differential selection probability. BRFSS also produces adjustments for clustering and stratification. However, analyses for Aims 3 and 4 did not support the use of these adjustments, because the specific command (i.e. khb) was not written to support them. As such, adjustments for clustering and stratification were not made for any aims. Since adjusting for clustering increases standard errors, while adjusting for stratification decreases standard errors,[121] these standard errors may be biased.

To test the impact of ignoring stratification and clustering on standard errors, two logistic regression models predicting odds of cancer were run. The first only included adjustments for

differential selection probability (i.e. probability weights), while the second included probability weights and adjustments for stratification and clustering. As predictors, child abuse variables, adverse childhood experiences and control variables were included. As Table 4.5 shows, when standard errors were compared in both models standard errors were between 12.19% and 27.39% larger when all adjustments were made. Of note, emotional abuse was not a significant predictor in the model with all adjustments made. This suggested that ignoring stratification and clustering biased results towards the alternative hypotheses. Unsurprisingly, ignoring stratification and clustering had no impact on estimates of odds ratios.

Table 4.5: Comparison of Standard Errors in Models Predicting Cancer with Probability Weights Only and Using Full Adjustment for Complex Sample Design (N=120,586)

	Probability Weights Only		Fully Adjusted		% Change in SE
Variable	AOR	SE	AOR	SE	
Physical Abuse	1.24	0.08	1.24	0.10	25.73%
Sexual Abuse	1.37	0.08	1.37	0.10	24.78%
Emotional Abuse	1.10	0.05	1.10	0.07	23.64%
Lived w/ some one who was mentally ill	1.17	0.08	1.17	0.10	24.95%
Lived w/ problem drinker	0.97	0.05	0.97	0.06	26.09%
Lived w/ drug user	1.16	0.10	1.16	0.12	19.68%
Lived w/ some one who was jailed	1.25	0.14	1.25	0.17	18.59%
Parents divorced or separated	0.93	0.06	0.93	0.07	25.95%
Adults in household treated each other violently	1.06	0.07	1.06	0.08	20.35%
Age	1.06	0.00	1.06	0.00	25.00%
Female	1.38	0.06	1.38	0.07	25.59%
Race					
Black	0.96	0.16	0.96	0.18	12.19%
Latinos	0.98	0.14	0.98	0.16	16.46%
Asian	0.41	0.08	0.41	0.10	27.39%
Other	1.02	0.11	1.02	0.13	20.42%

Notes: AOR= adjusted odds ratio; Model includes controls for state

Univariate analyses (i.e. means and frequencies) for all variables were run with and without weights. This allowed for a side-by-side comparison of sample characteristics. Differences between weighted and unweighted statistics allow for a cursory examination of the effect of weights. To accomplish **Aim 1**, certain sample characteristics (i.e. proportion with lifetime cancer diagnoses, over age 65, female, non-Latino white, black, Asian and Latino) were compared to estimates available from the U.S. 2010 Census and the National Cancer Institute's 2014 State Cancer Profiles using one-proportion z-tests. The Cancer State profiles estimate cancer incidence using Surveillance, Epidemiology, and End Results (SEER) data and the MIAMOD (Mortality-Incidence Analysis MODEL).[122] The State Cancer Profiles report gender-specific cancer prevalence rates estimated using state-specific overall cancer incidence and mortality rates. Sample characteristics were compared by state.

For **Aim 2**, logistic regression models were fit in order to estimate the effect of abuse types on odds of having a lifetime diagnoses of cancer. This was conducted using a series of nested models outlined in Table 4.5 below. In Step 1, unadjusted models were fit with each abuse type predicting odds of cancer, yielding three separate models. In Step 2, to each of the three models in Step 1, other childhood adversities were entered as control variables. In Step 3, sociodemographic variables and a dummy variable for imputation was introduced into these models as controls. In Step 4, a model with all abuse types and all controls was fit. This last step allows for the assessment of independent effects of abuse types.

Table 4.5: Nested Models for Aim 2

Step	Outcome	Equation
1	Cancer	$B_{intercept} + B_{physical\ abuse}$
	Cancer	$B_{intercept} + B_{sexual\ abuse}$
	Cancer	$B_{intercept} + B_{emotional\ abuse}$
2	Cancer	$B_{intercept} + B_{physical\ abuse} + B_{other\ childhood\ adversities}$
	Cancer	$B_{intercept} + B_{sexual\ abuse} + B_{other\ childhood\ adversities}$
	Cancer	$B_{intercept} + B_{emotional\ abuse} + B_{other\ childhood\ adversities}$
3	Cancer	$B_{intercept} + B_{physical\ abuse} + B_{other\ childhood\ adversities} + B_{controls} + B_{imputation}$
	Cancer	$B_{intercept} + B_{sexual\ abuse} + B_{other\ childhood\ adversities} + B_{controls} + B_{imputation}$
	Cancer	$B_{intercept} + B_{emotional\ abuse} + B_{other\ childhood\ adversities} + B_{controls} + B_{imputation}$
4	Cancer	$B_{intercept} + B_{physical\ abuse} + B_{sexual\ abuse} + B_{emotional\ abuse} + B_{other\ childhood\ adversities} + B_{imputation} + B_{controls}$

For **Aims 3 and 4**, a series of steps were used to determine which abuse types could be tested for potential mediation. This was done using Baron and Kenny' s (1986) four criteria for establishing mediation.[123] These criteria are: 1) the independent and dependent variables are associated; 2) the mediator and the independent variable are associated; 3) the mediator is associated with the dependent variable, when the independent variable is also included in the model; 4) the direct effect of the independent variable becomes non-significant in this latter model. When all four criteria are met, the relationship between the independent and dependent variable is said to be fully mediated by the mediator in question.[124] If the fourth criterion is not met, but a significant proportion of the association between the independent and dependent is explained by the mediator, then partial mediation is said to occur.[124]

For **Aim 3**, the first criterion for mediation was met for abuse variables that were significant predictors of cancer in the final model in Aim 2. To evaluate the second criteria, the following models were run: 1) A logistic regression model predicting odds of ever smoking; 2) A logistic regression model predicting odds of being overweight/obese and 3) A linear regression model predicting number of alcoholic drinks consumed in the past 30 days. These models included all independent variables from Aim 2 (i.e. abuse types, adverse childhood experiences

and control variables). A mediator needed to be associated with specific child abuse types to be considered a potential mediator for that specific abuse type. To evaluate the third and fourth criteria, a logistic regression model predicting cancer with health behavior mediators, abuse types, adverse childhood experiences and control variables was run. All abuse types were included in the same model in order to determine the independent effects of abuse types. Significant health behaviors in this model could be examined for mediation, but only for abuse types for which they had an association with. The proportion mediated and the significance of mediated effects were calculated. Details of this modeling technique are described in the *Mediation in Logistic Regression* section. A summary of the models fit for Aim 3 are shown in Table 4.6.

Table 4.6: Models for Aim 3

Step	Outcome	Equation
1	Cancer	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}}$
2	Smoking	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}}$
	Overweight /Obesity	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}}$
	Alcohol	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}}$
3	Cancer	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}} + B_{\text{health behaviors}}$

For **Aim 4**, the first criterion for mediation was met for abuse variables that were significant predictors of cancer in the final model in Aim 3. Any abuse variable that was not significantly associated with cancer in this model was treated as a control variable in these analyses. To evaluate the second criteria, the following models were run: 1) A linear regression model predicting household income and 2) A linear regression model predicting years of educational attainment. These models included all independent variables from Aim 3 (i.e. abuse

types, adverse childhood experiences, health behaviors and control variables). A mediator needed to be associated with specific child abuse types to be considered a potential mediator for that specific abuse type. To evaluate the third and fourth criteria, a logistic regression model predicting cancer with socioeconomic status measures, health behaviors, abuse types, adverse childhood experiences and control variables was run. All abuse types were included in the same model in order to determine the independent effects of abuse types. Inclusion of health behaviors as controls tested the mediating effects of socioeconomic status, that was not already explained by health behaviors. Significant socioeconomic indicators in this model could be examined for mediation, but only for abuse types for which they were associated with. The proportion mediated and the significance of mediated effects were calculated. A summary of the models fit for Aim 4 are shown in Table 4.7.

Table 4.7: Models for Aim 4

Step	Outcome	Equation
1	Cancer	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}} + B_{\text{health behaviors}}$
2	Smoking	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}} + B_{\text{health behaviors}}$
	Alcohol	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}} + B_{\text{health behaviors}}$
3	Cancer	$B_{\text{intercept}} + B_{\text{physical abuse}} + B_{\text{sexual abuse}} + B_{\text{emotional abuse}} + B_{\text{other childhood adversities}} + B_{\text{imputation}} + B_{\text{controls}} + B_{\text{health behaviors}} + B_{\text{SES}}$

Mediation in Logistic Regression

In mediation analyses, one is interested in comparing the change in the coefficient of an independent variable in two models: 1) containing the independent and dependent variables (i.e. the focal relationship); and 2) containing the independent, dependent and mediating variables.[125] This type of comparison is not possible in logistic regression because change in regression coefficients in logistic regression comes from three sources: 1) the effect of the variable(s) added

into the model 2) the rescaling of the logistic regression equation that occurs when the variable(s) added to the equation contribute to the explanation of the dependent variable and 3) variables are not included in the model, but contribute to explaining variation in the outcome (i.e. unobserved heterogeneity). [121,125,126] In the case of mediation, the first captures the "real" mediating effect of the added variable, while the second represents a spurious effect of the added variable. The rescaling of logistic regression equations alters the scale variance and coefficients in a model, and makes it impossible to directly compare nested models,[121,125,126] which is needed in mediation analyses. Finally, omission of independent variables will impact the estimate of the focal relationship, even when the focal independent variable is not correlated with the other independent variables added into the model.[125]

In practical terms, in the logistic regression context a change in odds or log odds focal relationship can occur so long as the added variable(s) are associated with the outcome variable.[126] Variables do not need to be associated with the predictor variable to produce a change in the outcome. This is problematic for mediation because part of the change in coefficients in nested logistic regression models will occur independent of mediation and bias any test of mediation to falsely reject the null hypothesis (i.e. a Type 1 error). This is particularly of concern when examining the fourth criteria for mediation (i.e. full mediation) that requires a focal relationship to no longer be significant after the introduction of mediators. This can occur even when the variables do not contribute to the explanation of the focal relationship. As such, tests for mediation in logistic regression must be able to capture "real" mediated effects.

To address the issues inherent in mediation in non-linear models, Karlson, Holm and Breen created the KHB method of mediation. The KHB-method holds the scale of dependent variables fixed in order to allow comparison across models. To accomplish this, a full model

with independent, dependent, control and mediating variables is fit.[127] Then, a reduced model with independent, dependent, control and residuals of mediating variables is fit. These models can be compared because the scale of both models is identical.[127] Thus, the KHB-method allows for the calculation of direct and indirect effects in mediation. This method produces estimates of percent mediated that are comparable to those using Monte Carlo estimation.[127] While the KHB user-written command in Stata permits the use of probability weights, it does not permit for the adjustment of stratification or clustering. The KHB method was used to evaluate mediation in Aims 3 and 4, despite the limitations, because other available alternatives do not permit the use of any weights and they do not correctly account for the problem of rescaling in logistic regression.[125,126]

5. Results

5A. Sample Characteristics

Table 5.1 shows the weighted sample characteristics. Overall experiences of physical and sexual abuse were each reported by less than a fifth of the sample. Emotional abuse was more common and experienced by more than a third of the sample. No single childhood adversity was experienced more often than emotional abuse. The sample, on average, was majority female, white and approximately 50 years of age. The most common state of residence was Washington, with over a fourth of the sample residing in the state. In terms of mediating variables, almost half of the sample had ever been smokers and over a half was overweight or obese. Additionally, on average, the sample had low levels of drinking, made over 50,000 dollars a year in household income and had some college education.

Table 5.1 also shows the unweighted sample characteristics. When compared to weighted sample characteristics, cancer was more prevalent, physical and emotional abuse was less common, average age was older and more of the sample was non-Latino white.

Table 5.1: Weighted and Unweighted Sample Means and Frequencies in BRFSS, 2011 (N=120,586)

	Unweighted		Weighted
	N	% or Mean	% or Mean
Dependent Variable			
Cancer	12,627	10.47%	6.96%
Independent Variables			
Physical Abuse	19,049	15.80%	18.02%
Sexual Abuse	15,193	12.60%	12.20%
Emotional Abuse	40,038	33.20%	38.01%
Control Variables			
Lived w/ some one who was mentally ill	19,135	15.87%	17.81%
Lived w/ problem drinker	29,550	24.51%	25.83%
Lived w/ drug user	8,965	7.43%	11.03%
Lived w/ some one who was jailed	5,303	4.40%	7.54%
Parents divorced or separated	23,899	19.82%	25.86%
Adults in household treated each other violently	18,207	15.10%	17.61%
Age	120,586	56.96	46.9
Female	71,798	59.54%	50.63%
Race			
White	107,951	89.52%	82.93%
Black	2,467	2.05%	3.37%
Latino	3,482	2.89%	6.61%
Asian	1,332	1.10%	2.81%
Other	5,354	4.44%	4.26%
State			
Maine	3,998	3.32%	2.74%
Minnesota	25,716	21.33%	20.98%
Montana	18,844	15.63%	3.99%
Nebraska	10,293	8.54%	7.09%
Nevada	4,492	3.73%	5.27%
Oregon	4,905	4.07%	7.71%
Vermont	13,630	11.30%	2.59%
Washington	28,772	23.86%	26.88%
Wisconsin	9,936	8.24%	22.74%
Mediating Variables			
Ever smoke cigarettes	57,039	47.30%	45.41%
Overweight or Obese	76,550	63.48%	62.77%
Alcoholic drinks in past 30 days	120,586	1.21	1.49
Household income (in thousands)	120,586	52.18	52.73
Educational attainment (in years)	120,586	13.78	13.32

Table 5.2 shows the differences in sample characteristics by cancer status. Specifically, it shows the number and frequency of respondents for each variable by cancer status. A larger percentage of those with a lifetime cancer diagnosis experience physical (20.68% versus 17.82%) and sexual abuse (16.85% versus 11.85%) when compared to those without cancer. A smaller percentage of individuals with a lifetime cancer diagnosis experienced emotional abuse (35.55% versus 38.18%), when compared to those without cancer. In terms of other childhood adversities, there was no difference in experiencing most childhood adversities by cancer status, with two exceptions. Specifically, a smaller percentage of those with lifetime cancer diagnosis lived with a drug user (8.84% versus 11.19%) and had parents who were divorced or separated (19.86% versus 26.31%) when compared to those without cancer. Those with a lifetime cancer diagnosis were over 10 years older than those without cancer. Females made up a larger percentage of those who had cancer in their lifetimes. Whites made up a larger percentage of those with a lifetime cancer diagnosis, while Asians and Latinos made up a smaller percentage of those with a lifetime cancer diagnosis. A larger percentage of individuals with lifetime cancer diagnosis lived in Montana when compared to those without cancer. Those with a lifetime cancer diagnosis were more likely to be obese, more likely to have smoked, drank less, had lower incomes and fewer years of education.

Table 5.2: Weighted Sample Means and Frequencies by Cancer Status in BRFSS, 2011 (N=120,586)

	No Cancer (N=107,959)		Cancer (N=12,627)		P-Value
	N	% or mean	N	% or mean	
Independent Variables					
Physical Abuse	16,933	17.82%	2,116	20.68%	0.0041
Sexual Abuse	13,318	11.85%	1,875	16.85%	<.0001
Emotional Abuse	36,183	38.18%	3,855	35.55%	0.0263
Control Variables					
Lived w/ some one who was mentally ill	17,246	17.84%	1,889	17.43%	0.6861
Lived w/ problem drinker	26,497	25.81%	3,053	26.09%	0.7865
Lived w/ drug user	8,244	11.19%	721	8.84%	0.0052
Lived w/ some one who was jailed	4,873	7.63%	430	6.23%	0.0847
Parents divorced or separated	21,888	26.31%	2,011	19.86%	<.0001
Adults in household treated each other violently	16,378	17.55%	1,829	18.46%	0.3513
Age	107,959	45.73	12,627	62.56	<.0001
Female	63,489	49.82%	8,309	61.34%	<.0001
Race					
White	96,248	82.50%	11,703	88.79%	<.0001
Black	2,312	3.44%	155	2.52%	0.0795
Latinos	3,271	6.82%	211	3.83%	0.0002
Asian	1,277	2.97%	55	0.74%	<.0001
Other	4,851	4.27%	503	4.12%	0.7424
State					
Maine	3,567	2.74%	431	2.87%	0.4628
Minnesota	23,377	21.07%	2,339	19.80%	0.1243
Montana	16,765	3.95%	2,079	4.64%	0.0015
Nebraska	9,151	7.11%	1,142	6.82%	0.4369
Nevada	3,999	5.22%	493	6.01%	0.14
Oregon	4,305	7.65%	600	8.50%	0.1201
Vermont	12,297	2.59%	1,333	2.56%	0.8148
Washington	25,565	26.90%	3,207	26.55%	0.7059
Wisconsin	8,933	22.77%	1,003	22.25%	0.7119
Mediating Variables					
Ever smoke cigarettes	50,008	44.58%	7,031	56.50%	<.0001
Overweight or Obese	68,518	62.58%	8,032	65.20%	0.0161
Alcoholic drinks in past 30 days	107,959	1.53	12,627	1.04	<.0001
Household income (in thousands)	107,959	53.34	12,627	44.46	<.0001
Educational attainment (in years)	107,959	13.33	12,627	13.13	0.0026

Table 5.3 shows the correlations between all items pertaining to abuse and adverse childhood experiences. All correlations were significant and positive between all items. In terms of strength, many correlations were weak ($r<0.20$). The two strongest correlations were between physical and emotional abuse ($r=0.44$) and between physical abuse and living in a household where adults treated each other violently ($r=0.43$).

Table 5.3: Correlations Between Abuse Variables and ACEs in BRFSS, 2011 (N=120,586)

	Physical Abuse	Sexual Abuse	Emotional Abuse	Lived w/ someone who was mentally ill	Lived w/ problem drinker/alcoholic	Lived w/ drug user/abuser	Lived w/ someone who has been jailed	Parents separated or divorced	Adults in household treated each other violently
Physical Abuse	1.00								
Sexual Abuse	0.26	1.00							
Emotional Abuse	0.44	0.23	1.00						
Lived w/ someone who was mentally ill	0.28	0.24	0.30	1.00					
Lived w/ problem drinker/alcoholic	0.26	0.19	0.30	0.26	1.00				
Lived w/ drug user/abuser	0.20	0.18	0.21	0.29	0.28	1.00			
Lived w/ someone who has been jailed	0.17	0.14	0.16	0.17	0.22	0.36	1.00		
Parents separated or divorced	0.20	0.15	0.21	0.19	0.25	0.21	0.19	1.00	
Adults in household treated each other violently	0.43	0.22	0.35	0.25	0.36	0.21	0.20	0.28	1.00

Note: All correlations are significant ($p<.001$)

Table 5.4 shows the co-occurrence of child abuse types. Overall the majority of respondents reported experiencing no abuse types (55.33%). Almost a fifth of respondent reported experiencing only emotional abuse (19.97%). Experiencing only physical abuse was reported by 2.57% of respondents and experiencing only sexual abuse was experienced by 3.64% of respondents. The most common co-occurring abuse types where physical and emotional abuse, which were experienced by almost a tenth of the sample (9.93%). All three abuse types co-occurred in 5.07% of respondents.

Table 5.4: Co-Occurrence of Child Abuse Variables in BRFSS, 2011 (N=120,586)

	Unweighted		Weighted
	N	%	%
Any mention			
Physical Abuse	16,933	15.80%	17.82%
Sexual Abuse	13,318	12.60%	11.85%
Emotional Abuse	36,183	33.20%	38.18%
Unique mentions			
No Abuse	71,719	59.48%	55.33%
Physical Abuse Alone	2,989	2.48%	2.57%
Sexual Abuse Alone	5,246	4.35%	3.64%
Emotional Abuse Alone	20,836	17.28%	19.97%
Physical and Sexual Abuse Alone	594	0.49%	0.45%
Physical and Emotional Abuse Alone	9,849	8.17%	9.93%
Sexual and Emotional Abuse Alone	3,736	3.10%	3.04%
Physical, Sexual and Emotional Abuse	5,617	4.66%	5.07%

5B. Aim 1 Results: Assessing the Representativeness of the BRFSS

Table 5.5 summarizes the differences shown in table 5.6 through 5.14, which depict the results of Aim 1. All tables compare state-specific estimates of cancer incidence and demographic characteristics from national data sources to estimates produced from BRFSS 2011. Cancer incidence information was taken from the National Cancer Institute's 2014 State Cancer Profiles and all other information comes from the 2010 Census. Overall, results revealed that

female cancer prevalence, percent black and percent Asian were misestimated in all 9 states under examination.

Table 5.5: Summary Comparison of BRFSS Estimates with National Data Sources, by State

	State								
	ME	MN	MT	NE	NV	OR	VT	WA	WI
2014 Cancer Prevalence (Male)		↓	↓		↓	↓	↓	↓	↓
2014 Cancer Prevalence (Female)	↓	↓	↓	↓	↓	↓	↓	↓	↓
Age 65 and Over									
Female									
Non-Latino white	↑			↓			↑		
Black	↑	↑	↑	↑	↓	↑	↑	↑	↑
Asian	↑	↑	↑	↑	↑	↑	↑	↑	↑
Latino	↓			↑		↑		↓	↑

Note: ↑ denote instances where comparison values were significantly higher than the BRFSS and ↓ denote Instances where comparison values where significantly lower than the BRFSS.

Table 5.6 shows that Maine BRFSS estimates did not differ from comparison numbers in terms of male cancer prevalence, percent age 65 and over and percent female. However, the BRFSS did differ from national comparisons in terms of race, with the BRFSS having a smaller percent of non-Latino white (94.4% versus 95.6%), Black (0.85% versus 0.90%) and Asians (0.17% versus 0.90%) respondents than did the national comparisons. Latinos made up a larger percent of the Maine BRFSS sample than did the national comparisons (1.88% versus 1.00%).

Table 5.6: Comparison of BRFSS Estimates with National Data Sources, Maine

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	5.46%	0.59	4.86%	0.155
2014 Cancer Prevalence (Female)	9.18%	0.64	4.17%	<0.001
Age 65 and Over	20.40%	0.69	20.03%	0.296
Female	51.80%	1.19	51.70%	0.466
Non-Latino white	94.4%	0.64	95.6%	0.030
Black	0.85%	0.03	0.90%	0.048
Asian	0.17%	0.06	0.90%	<0.001
Latino	1.88%	0.43	1.00%	0.020

Table 5.7 shows that Minnesota BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female, percent non-Latino white and percent Latino. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (5.53% versus 4.57%), female cancer prevalence (7.58% versus 4.76%), percent Black (3.74% versus 4.30%) and percent Asian (2.70% versus 3.60%).

Table 5.7: Comparison of BRFSS Estimates with National Data Sources, Minnesota

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	5.53%	0.36	4.57%	0.004
2014 Cancer Prevalence (Female)	7.58%	0.27	4.76%	<0.001
Age 65 and Over	17.29%	0.39	16.99%	0.224
Female	50.66%	0.71	50.86%	0.391
Non-Latino white	86.76%	0.54	86.1%	0.111
Black	3.74%	0.28	4.30%	0.023
Asian	2.70%	0.27	3.60%	<0.001
Latino	4.08%	0.34	3.70%	0.132

Table 5.8 shows that Montana BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female, percent non-Latino white and percent Latino. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (6.37% versus 5.21%), female cancer prevalence (9.78% versus 5.16%), percent Black (0.11% versus 0.30%) and percent Asian (0.38% versus 0.60%).

Table 5.8: Comparison of BRFSS Estimates with National Data Sources, Montana

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	6.37%	0.45	5.21%	0.005
2014 Cancer Prevalence (Female)	9.78%	0.53	5.16%	<0.001
Age 65 and Over	19.48%	0.46	19.16%	0.244
Female	50.32%	0.80	50.15%	0.417
Non-Latino white	89.49%	0.51	90.00%	0.159
Black	0.11%	0.08	0.30%	0.009
Asian	0.38%	0.13	0.60%	0.045
Latino	2.40%	0.33	2.30%	0.381

Table 5.9 shows that Nebraska BRFSS estimates did not differ from comparison numbers in terms of male cancer prevalence, percent age 65 and over and percent female. However, the BRFSS did differ from national comparisons in terms of female cancer prevalence (8.18% versus 5.09%), percent non-Latino white (89.98% versus 85.40%), percent black (1.87% versus 4.00%), percent Asian (0.63% versus 1.70%) and percent Latino (5.56% versus 7.20%).

Table 5.9: Comparison of BRFSS Estimates with National Data Sources, Nebraska

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	5.16%	0.41	5.43%	0.255
2014 Cancer Prevalence (Female)	8.18%	0.51	5.09%	<0.001
Age 65 and Over	18.41%	0.46	18.04%	0.213
Female	50.92%	0.93	50.91%	0.495
Non-Latino white	89.98%	0.73	85.40%	<0.001
Black	1.87%	0.37	4.00%	<0.001
Asian	0.63%	0.19	1.70%	<0.001
Latino	5.56%	0.58	7.20%	0.002

Table 5.10 shows that Nevada BRFSS estimates did not differ from comparison numbers in terms of male cancer prevalence, percent age 65 and over and percent female. However, the BRFSS did differ from national comparisons in terms of female cancer prevalence (8.18% versus 5.09%), percent non-Latino white (89.98% versus 85.40%), percent Black (1.87% versus 4.00%), percent Asian (0.63% versus 1.70%) and percent Latino (5.56% versus 7.20%).

Table 5.10: Comparison of BRFSS Estimates with National Data Sources, Nevada

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	7.25%	1.09	3.68%	0.001
2014 Cancer Prevalence (Female)	8.65%	0.95	3.71%	<0.001
Age 65 and Over	16.30%	0.74	15.93%	0.311
Female	49.39%	1.51	49.74%	0.410
Non-Latino white	58.50%	1.58	58.90%	0.400
Black	11.03%	1.14	7.50%	0.001
Asian	5.10%	0.81	7.60%	0.001
Latino	22.15%	1.47	22.30%	0.459

Table 5.11 shows that Oregon BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female and percent non-Latino white. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (6.21% versus 4.50%), female cancer prevalence (9.09% versus 4.81%), percent Black (0.77% versus 1.60%), percent Asian (1.89% versus 3.70%) and percent Latino (6.99% versus 9.10%).

Table 5.11: Comparison of BRFSS Estimates with National Data Sources, Oregon

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	6.21%	0.78	4.50%	0.014
2014 Cancer Prevalence (Female)	9.09%	0.59	4.81%	<0.001
Age 65 and Over	18.58%	0.59	18.00%	0.161
Female	50.81%	1.21	51.02%	0.432
Non-Latino white	81.75%	1.17	82.10%	0.382
Black	0.77%	0.30	1.60%	0.003
Asian	1.89%	0.54	3.70%	<0.001
Latino	6.99%	0.22	9.10%	<0.001

Table 5.12 shows that Vermont BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female and percent Latino. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (5.66% versus 4.04%), female cancer prevalence (8.05% versus 4.83%), percent non-Latino white (95.00% versus 98.70%), percent Black (0.50% versus 0.80%) and percent Asian (1.28% versus 1.30%).

Table 5.12: Comparison of BRFSS Estimates with National Data Sources, Vermont

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	5.66%	0.45	4.04%	<0.001
2014 Cancer Prevalence (Female)	8.05%	0.45	4.83%	<0.001
Age 65 and Over	18.94%	0.46	18.34%	0.097
Female	51.30%	0.80	51.29%	0.494
Non-Latino White	95.00%	0.37	98.70%	<0.001
Black	0.50%	0.12	0.80%	0.006
Asian	0.72%	0.15	1.20%	0.001
Latino	1.28%	0.18	1.30%	0.456

Table 5.13 shows that Washington BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female and percent non-Latino white. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (5.35% versus 4.59%), female cancer prevalence (8.37% versus 5.01%), percent Black (2.56% versus 3.30%), percent Asian (5.47% versus 7.30%) and percent Latino (10.31% versus 8.90%).

Table 5.13: Comparison of BRFSS Estimates with National Data Sources, Washington

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	5.35%	0.32	4.59%	0.009
2014 Cancer Prevalence (Female)	8.37%	0.36	5.01%	<0.001
Age 65 and Over	16.50%	0.31	16.09%	0.094
Female	50.47%	0.62	50.62%	0.402
Non-Latino White	76.52%	0.59	76.10%	0.238
Black	2.56%	0.23	3.30%	0.001
Asian	5.47%	0.36	7.30%	<0.001
Latino	10.31%	0.43	8.90%	0.001

Table 5.14 shows that Wisconsin BRFSS estimates did not differ from comparison numbers in terms of percent age 65 and over, percent female, percent non-Latino white and percent Black. However, the BRFSS did differ from national comparisons in terms of male cancer prevalence (4.74% versus 4.59%), female cancer prevalence (8.83% versus 4.77%), percent Asian (1.22% versus 2.00%) and percent Latino (3.33% versus 4.60%).

Table 5.14: Comparison of BRFSS Estimates with National Data Sources, Wisconsin

	BRFSS		Comparison	P-Value
	%	SE	%	
2014 Cancer Prevalence (Male)	4.74%	0.06	4.59%	0.006
2014 Cancer Prevalence (Female)	8.83%	0.76	4.77%	<0.001
Age 65 and Over	18.16%	0.69	17.88%	0.342
Female	50.74%	1.16	50.85%	0.462
Non-Latino White	86.94%	0.87	86.30%	0.231
Black	4.77%	0.43	5.40%	0.071
Asian	1.22%	0.28	2.00%	0.003
Latino	3.33%	0.57	4.60%	0.013

Overall, based on the analyses conducted as part of Aim 1, the data were found to not be representative of the underlying state populations. While this is a major concern when it comes to estimating prevalence, it is less consequential when estimating associations. However, the overestimation of proportion of the population with cancer suggests that the study population may be less healthy than the population at large. Also, the misestimating of the proportion of the population that is Asian and black, means that the sample does not capture the racial diversity of the underlying population. As such, results of Aims 2-4 should be interpreted with these considerations in mind.

5C. Aim 2 Results: Association Between Abuse and Cancer

Tables 5.15 through 5.18 show the results of Aim 2. While coefficients are not displayed, models control for the respondent's state of residence, as noted. Table 5.15 shows nested models predicting cancer from physical abuse. As Model 1 shows, when only physical abuse was used to predict cancer, having experienced physical abuse was associated with 20% (OR: 1.20; 95 %CI: 1.09,1.33) higher odds of cancer. In Model 2, when adverse childhood experiences are controlled for, having experienced physical abuse was associated with 29% (AOR: 1.29; 95% CI:1.15,1.44) higher odds of cancer. In this model, living with a drug user (AOR: 0.78; 95% CI: 0.67,0.92) and having divorced or separated parents (AOR: 0.66; 95% CI: 0.59,0.74) were associated with lower odds of cancer. In Model 3, when adverse childhood experiences and sociodemographic characteristics are controlled for, having experienced physical abuse was associated with 34% (AOR: 1.34; 95% CI: 1.19,1.54) higher odds of cancer. In this model, living with someone who was mentally ill (AOR: 1.23; 95% CI: 1.07,1.41), living with a drug user (AOR: 1.19; 95% CI: 1.00,1.41), living with a parent who was jailed (AOR: 1.28; 95% CI: 1.02,1.61), being a year older (AOR: 1.06; 95% CI: 1.05,1.06) and being female (AOR: 1.43; 95% CI: 1.32,1.56) were

associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.40; 95% CI: 0.28,0.58). The flag for imputation was not associated with cancer (AOR: 0.98; 95% CI: 0.89-1.07). Across successive models, the strength of the association between physical abuse and cancer increases, indicating the relationship was being suppressed.

Table 5.16 shows nested models predicting cancer from sexual abuse. As Model 1 shows, when only sexual abuse is used to predict cancer, having experienced sexual abuse was associated with 51% (OR: 1.51; 95% CI: 1.37,1.66) higher odds of cancer. In Model 2, when adverse childhood experiences are controlled for, having experienced sexual abuse was associated with 67% (AOR: 1.67; 95% CI: 1.50,1.85) higher odds of cancer. In this model, living with a drug user (AOR: 0.77; 95% CI: 0.65,0.90) and having divorced or separated parents (AOR: 0.65; 95% CI: 0.58,0.73) were both associated with lower odds of cancer. In Model 3, when adverse childhood experiences and sociodemographic characteristics are controlled for, having experienced sexual abuse was associated with 44% (AOR: 1.44; 95% CI: 1.29,1.60) higher odds of cancer. In this model, living with someone who was mentally ill (AOR: 1.23; 95% CI: 1.07,1.41), living with someone who was jailed (AOR: 1.27; 95% CI: 1.01,1.59), living in a home where adults treated each other violently (AOR: 1.17; 95% CI: 1.03,1.32), being a year older (AOR: 1.06; 95% CI: 1.05,1.06) and being female (AOR: 1.37; 95% CI: 1.26,1.49) were associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.40; 95% CI: 0.28,0.58). The flag for imputation was not associated with cancer (AOR: 0.98; 95% CI: 0.90,1.07). Across successive models, the strength of the association between sexual abuse and cancer increases and then decreases indicating the relationship was being suppressed by other adverse childhood experiences and partially attributable to underlying differences in demographic characteristics.

Table 5.17 shows nested models predicting cancer from emotional abuse. As Model 1 shows, when only emotional abuse is used to predict cancer, having experienced emotional abuse was associated with 11% (OR: 0.89; 95% CI: 0.82,0.97) lower odds of cancer. In Model 2, when adverse childhood experiences are controlled for, having experienced emotional abuse was associated with 11% (AOR: 0.89; 95% CI: 0.81,0.97) lower odds of cancer. In this model, living with a drug user (AOR: 0.80; 95% CI: 0.68,0.94) and having divorced or separated parents (AOR: 0.67; 95% CI: 0.60,0.75) were associated with lower odds of cancer. In Model 3, when adverse childhood experiences and sociodemographic characteristics are controlled for, having experienced emotional abuse was associated with 20% (AOR: 1.20; 95% CI: 1.09,1.23) higher odds of cancer. In this model, living with someone who was mentally ill (AOR: 1.24; 95% CI: 1.09,1.42), living with a drug user (AOR: 1.20; 95% CI: 1.01,1.42), living with someone who was jailed (AOR: 1.30; 95% CI: 1.04,1.63), living in a home where adults treated each other violently (AOR: 1.15; 95% CI: 1.02,1.29), being a year older (AOR: 1.06; 95% CI: 1.05,1.06) and being female (AOR: 1.42; 95% CI: 1.31,1.54) were associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.40; 95% CI: 0.28,0.58). When follow-up analyses were conducted to investigate the change in directionality in the relationship between Mode1 2 and Model 3, it was revealed that introducing age into Model 2 produced this change. After controlling for other adverse childhood experiences, a year increase in age was associated with a 1.00% decrease in odds of reporting emotional abuse (AOR: 0.99; 95% CI: 0.99,0.99), indicating age suppressed the association between emotional abuse and cancer. The flag for imputation was not associated with cancer (AOR: 0.98; 95% CI: 0.89,1.07).

Table 5.18 shows a model predicting cancer from physical, sexual and emotional abuse and all other control variables. This model is the next successive step in the models presented in

Tables 5.15-5.17. In this model, having experienced physical abuse was associated with 23% (AOR: 1.23 95% CI: 1.09,1.40) higher odds of cancer. Similarly, having experienced sexual abuse was associated with 37% (AOR: 1.37 95% CI: 1.23,1.53) higher odds of cancer. Finally, having experienced emotional abuse was associated with 10% (AOR: 1.10 95% CI: 1.00,1.21) higher odds of cancer. Living with someone who was mentally ill (AOR: 1.17; 95% CI: 1.02,1.33), living with someone who was jailed (AOR: 1.25; 95% CI: 1.00,1.57), being a year older (AOR: 1.06; 95% CI: 1.05,1.06) and being female (AOR: 1.39; 95% CI: 1.28,1.50) were associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.41; 95% CI: 0.28,0.59). The flag for imputation was not associated with cancer (AOR: 0.97; 95%CI: 0.89,1.07).

Table 5.15: Logistic Regression Predicting Cancer from Physical Abuse in BRFSS 2011 (N=120,586)

	Model 1: Bivariate		Model 2: All ACEs			Model 3: All ACEs and Controls	
Variable	OR	95% CI	AOR	95% CI		AOR	95% CI
Physical abuse	1.20	(1.09,1.33)	1.29	(1.15,1.44)		1.34	(1.19,1.52)
Lived w/ some one who was mentally ill	--	--	1.02	(0.90,1.16)		1.23	(1.07,1.41)
Lived w/ problem drinker	--	--	1.10	(0.99,1.20)		1.00	(0.90,1.10)
Lived w/ drug user	--	--	0.78	(0.67,0.92)		1.19	(1.00,1.41)
Lived w/ some one who was jailed	--	--	0.91	(0.73,1.13)		1.28	(1.02,1.61)
Parents divorced or separated	--	--	0.66	(0.59,0.74)		0.95	(0.84,1.07)
Adults in household treated each other violently	--	--	1.11	(0.98,1.24)		1.10	(0.97,1.24)
Age	--	--	--	--	--	1.06	(1.05,1.06)
Female	--	--	--	--	--	1.43	(1.32,1.56)
Race							
Black	--	--	--	--	--	0.98	(0.70,1.36)
Latinos	--	--	--	--	--	0.96	(0.72,1.28)
Asian	--	--	--	--	--	0.40	(0.28,0.58)
Other	--	--	--	--	--	1.03	(0.84,1.27)
Imputation flag	--	--				0.98	(0.89,1.07)

Notes: AOR= adjusted odds ratio; UCL=upper confidence limit; LCL= lower confidence limit; Model 3 includes controls for state

Table 5.16: Logistic Regression Predicting Cancer from Sexual Abuse in BRFSS 2011 (N=120,586)

	Model 1: Bivariate			Model 2: All ACEs			Model 3: All ACEs and Controls	
Variable	OR	95% CI		AOR	95% CI		AOR	95% CI
Sexual Abuse	1.51	(1.37,1.66)		1.67	(1.50,1.85)		1.44	(1.29,1.60)
Lived w/ some one who was mentally ill	--	--	--	0.98	(0.86,1.12)		1.23	(1.07,1.41)
Lived w/ problem drinker	--	--	--	1.08	(0.98,1.19)		1.00	(0.90,1.10)
Lived w/ drug user	--	--	--	0.77	(0.65,0.90)		1.17	(0.99,1.39)
Lived w/ some one who was jailed	--	--	--	0.89	(0.71,1.11)		1.27	(1.01,1.59)
Parents divorced or separated	--	--	--	0.65	(0.58,0.73)		0.94	(0.84,1.06)
Adults in household treated each other violently				1.14	(1.02,1.29)		1.17	(1.03,1.32)
Age	--	--	--	--	--	--	1.06	(1.05,1.06)
Female	--	--	--	--	--	--	1.37	(1.26,1.49)
Race								
Black	--	--	--	--	--	--	0.95	(0.68,1.32)
Latinos	--	--	--	--	--	--	0.97	(0.74,1.29)
Asian	--	--	--	--	--	--	0.40	(0.28,0.58)
Other	--	--	--	--	--	--	1.03	(0.84,1.27)
Imputation flag							0.98	(0.90,1.07)

Notes: AOR= adjusted odds ratio; UCL=upper confidence limit; LCL= lower confidence limit; Model 3 includes controls for state

Table 5.17: Logistic Regression Predicting Cancer from Emotional Abuse in BRFSS 2011 (N=120,586)

	Model 1: Bivariate		Model 2: All ACEs		Model 3: All ACEs and Controls	
Variable	OR	95% CI	AOR	95% CI	AOR	95% CI
Emotional Abuse	0.89	(0.82,0.97)	0.89	(0.81,0.97)	1.20	(1.09,1.32)
Lived w/ some one who was mentally ill	--	-- --	1.09	(0.96,1.23)	1.24	(1.09,1.42)
Lived w/ problem drinker	--	-- --	1.12	(1.03,1.24)	0.99	(0.90,1.09)
Lived w/ drug user	--	-- --	0.80	(0.68,0.94)	1.20	(1.01,1.42)
Lived w/ some one who was jailed	--	-- --	0.93	(0.75,1.16)	1.30	(1.04,1.63)
Parents divorced or separated	--	-- --	0.67	(0.60,0.75)	0.95	(0.84,1.07)
Adults in household treated each other violently	--	-- --	1.26	(1.12,1.41)	1.15	(1.02,1.29)
Age	--	-- --	--	-- --	1.06	(1.05,1.06)
Female	--	-- --	--	-- --	1.42	(1.31,1.54)
Race						
Black	--	-- --	--	-- --	0.97	(0.69,1.35)
Latinos	--	-- --	--	-- --	0.98	(0.74,1.30)
Asian	--	-- --	--	-- --	0.40	(0.28,0.58)
Other	--	-- --	--	-- --	1.04	(0.85,1.28)
Imputation flag					0.98	(0.89,1.07)

Notes: AOR= adjusted odds ratio; UCL=upper confidence limit; LCL= lower confidence limit; Model 3 includes controls for state

Table 5.18: Logistic Regression Predicting Cancer from Abuse in BRFSS 2011 (N=120,586)

Variable	AOR	95% CI
Physical Abuse	1.23	(1.09,1.40)
Sexual Abuse	1.37	(1.23,1.53)
Emotional Abuse	1.10	(1.00,1.21)
Lived w/ some one who was mentally ill	1.17	(1.02,1.33)
Lived w/ problem drinker	0.97	(0.88,1.07)
Lived w/ drug user	1.16	(0.98,1.38)
Lived w/ some one who was jailed	1.25	(1.00,1.57)
Parents divorced or separated	0.93	(0.83,1.05)
Adults in household treated each other violently	1.06	(0.93,1.20)
Age	1.06	(1.05,1.06)
Female	1.39	(1.28,1.50)
Race		
Black	0.97	(0.69,1.34)
Latinos	0.98	(0.74,1.29)
Asian	0.41	(0.28,0.59)
Other	1.02	(0.83,1.25)
Imputation flag	0.97	(0.89,1.07)

Notes: AOR= adjusted odds ratio; Model includes controls for state

5D. Aim 3 Results: Mediating Effects of Health Behaviors

Given that all specific abuse types were independently associated with cancer in Aim 2, all abuse types can be mediated. Given that the goal of this work is to study the independent effects of each abuse type, net of all others, mediation for any abuse type was examined by controlling for the other two abuse types.

To determine which health behaviors could be mediators for specific abuse types, three different models were run: 1) A logistic regression model predicting odds of ever smoking; 2) A logistic regression model predicting odds of being overweight/obese and 3) A linear regression model predicting number of alcoholic drinks consumed in the past 30 days. These models included all independent variables from Aim 2 (i.e. abuse types, adverse childhood experiences and control variables). Mediators that were associated with specific child abuse types were

considered potential mediators for that specific abuse type. Potential mediators that did not meet the criteria for mediation were treated as control variables.

A logistic regression predicting cancer was fit with abuse types, adverse childhood experiences, control variables and health behaviors as predictors. Significant health behaviors in this model could be examined for mediation, but only for abuse types for which they had an association with. A mediation model was then fit, which showed the total mediated effect of all health behaviors, by abuse type. Effects were then decomposed, as appropriate. The results of these models are presented in the subsequent text. While coefficients were not displayed, all models control for the respondent's state of residence.

Evaluating Smoking as a Potential Mediator

Table 5.19 shows a logistic regression predicting ever smoking from abuse, while including all control variables in Aim 2. Having experienced physical abuse increased odds of ever smoking by 37% (AOR: 1.37; 95% CI: 1.26,1.48). Having experienced sexual abuse increased odds of ever smoking by 51% (AOR: 1.51; 95% CI: 1.39,1.64). Having experienced emotional abuse increased odds of ever smoking by 16% (AOR: 1.16; 95% CI: 1.10,1.24). Thus physical, sexual and emotional abuse can be mediated by ever smoking.

Table 5.19 also shows that some control variables were associated with ever smoking. Living with someone who was a problem drinker (AOR: 1.35; 95% CI: 1.26,1.43), living with a drug user (AOR: 1.43; 95% CI: 1.29,1.59), living with someone who was jailed (AOR: 1.54; 95% CI: 1.36,1.75), having parents who were divorced or separated (AOR: 1.56; 95% CI: 1.46,1.66), living in a home where adults treated each other violently (AOR: 1.14; 95% CI: 1.06,1.24) and being a year older (AOR: 1.02; 95% CI: 1.02,1.02) were associated with higher odds of ever smoking. Women had lower odds of ever smoking when compared to men (AOR:

0.61; 95% CI: 0.58,0.64). Asians had lower odds of ever smoking than did non-Latino whites (AOR: 0.48; 95% CI: 0.40,0.59). Additionally, the flag for imputation was associated with 6% lower odds of ever smoking (AOR: 0.94; 95% CI: 0.89,0.99), suggesting that individuals with missing data had more positive health behaviors.

Table 5.19: Logistic Regression Predicting Ever Smoking from Abuse in BRFSS 2011 (N=120,586)

Variable	AOR	95% CI
Physical Abuse	1.37	(1.26,1.48)
Sexual Abuse	1.51	(1.39,1.64)
Emotional Abuse	1.16	(1.10,1.24)
Lived w/ some one who was mentally ill	0.97	(0.90,1.04)
Lived w/ problem drinker	1.35	(1.26,1.43)
Lived w/ drug user	1.43	(1.29,1.59)
Lived w/ some one who was jailed	1.54	(1.36,1.75)
Parents divorced or separated	1.56	(1.46,1.66)
Adults in household treated each other violently	1.14	(1.06,1.24)
Age	1.02	(1.02,1.02)
Female	0.61	(0.58,0.64)
Race		
Black	0.82	(0.70,0.97)
Latinos	0.69	(0.60,0.80)
Asian	0.48	(0.40,0.59)
Other	1.48	(1.29,1.70)
Imputation flag	0.94	(0.89,0.99)

Notes: AOR= adjusted odds ratio; Model includes controls for state

Evaluating Overweight/Obesity as a Potential Mediator

Table 5.20 shows a logistic regression model predicting overweight and obesity from abuse, while including all control variables in Aim 2. Having experienced physical abuse was not associated with odds of being overweight or obese (AOR: 1.04; 95% CI: 0.96,1.13). Having experienced sexual abuse was associated with 37% (AOR: 1.37; 95% CI: 1.27,1.49) higher odds of being overweight or obese. Having experienced emotional abuse was associated 10% (AOR: 1.10; 95% CI: 1.03,1.17) higher odds of being overweight or obese. Thus only, sexual and emotional abuse can be mediated by being overweight or obese.

Table 5.20 also shows that some control variables were associated with being overweight or obese. Living with someone who was a mentally ill decreased odds of being over weight or obese (AOR: 0.91 95% CI: 0.84,0.99). Living in a household where adults treated each other violently (AOR: 1.08; 95% CI: 1.00,1.18) and being a year older (AOR: 1.02; 95% CI: 1.02,1.02) were associated with higher odds of being overweight or obese. Women had lower odds of being overweight or obese compared to men (AOR: 0.51; 95% CI: 0.48,0.54). Blacks (AOR: 1.44; 95% CI: 1.19,1.73), Latinos (AOR: 1.54; 95% CI: 1.34,1.77), and those identifying as some other race (AOR: 1.18; 95% CI: 1.02,1.38) had higher odds of being overweight or obese when compared to non-Latino whites. Asians had lower odds of being overweight or obese when compared to non-Latino whites (AOR: 0.46; 95% CI: 0.39,0.55). Additionally, the flag for imputation was associated with 9% lower odds of being overweight or obese (AOR: 0.91; 95% CI: 0.86,0.97), suggesting that individuals with missing data had more positive health behaviors.

Table 5.20: Logistic Regression Predicting Overweight or Obesity from Abuse in BRFSS 2011 (N=120,586)

Variable	AOR	95% CI
Physical Abuse	1.04	(0.96,1.13)
Sexual Abuse	1.37	(1.27,1.49)
Emotional Abuse	1.10	(1.03,1.17)
Lived w/ some one who was mentally ill	0.91	(0.84,0.99)
Lived w/ problem drinker	1.05	(0.99,1.12)
Lived w/ drug user	0.97	(0.87,1.08)
Lived w/ some one who was jailed	1.02	(0.90,1.17)
Parents divorced or separated	1.00	(0.93,1.07)
Adults in household treated each other violently	1.08	(1.00,1.18)
Age	1.02	(1.02,1.02)
Female	0.51	(0.48,0.54)
Race		
Black	1.44	(1.19,1.73)
Latinos	1.54	(1.34,1.77)
Asian	0.46	(0.39,0.55)
Other	1.18	(1.02,1.38)
Imputation flag	0.91	(0.86,0.97)

Notes: AOR= adjusted odds ratio; Model includes controls for state

Evaluating Alcohol Consumption as a Potential Mediator

Table 5.21 shows a linear regression model predicting number of alcoholic drinks consumed in the past 30 days, while including all control variables in Aim 2. Having experienced physical abuse was not associated with the number of alcoholic drinks consumed in the past 30 days (Beta: 0.02; 95% CI: -0.10,0.14). Having experienced sexual abuse was not associated with the number of alcoholic drinks consumed in the past 30 days (Beta: -0.02; 95% CI: -0.13,0.09). Having experienced emotional abuse was associated with the consumption of 0.14 more alcoholic drinks consumed in the past 30 days (Beta: 0.14; 95% CI: 0.06,0.22). Thus only emotional abuse can be mediated by alcohol consumption in the past 30 days.

Table 5.20 also shows that some control variables were associated with alcohol consumption. Living with a drug user (Beta: 0.19; 95% CI: 0.19,0.33), having parents who were divorced or separated (Beta: 0.13; 95% CI: 0.05,0.21) and living in a household where adults treated each

other violently (Beta: 0.15; 95% CI: 0.01,0.30) were associated with fewer drinks consumed in the past 30 days. Females consumed fewer drinks in the past 30 days, when compared to males (Beta: -0.71; 95% CI: -0.77,-0.64). Additionally, the flag for imputation was associated with consumption of 0.09 fewer alcoholic drinks in the past 30 days (Beta: -0.09; 95% CI: -0.16,-0.03), suggesting that individuals with missing data had more positive health behaviors.

Table 5.21: Linear Regression Predicting Number of Drinks in the Past 30 Days from Abuse in BRFSS 2011 (N=120,586)

Variable	Beta	95% CI
Physical Abuse	0.02	(-0.10,0.14)
Sexual Abuse	-0.02	(-0.13,0.09)
Emotional Abuse	0.14	(0.06,0.22)
Lived w/ some one who was mentally ill	-0.04	(-0.14,0.06)
Lived w/ problem drinker	-0.04	(-0.12,0.04)
Lived w/ drug user	0.19	(0.05,0.33)
Lived w/ some one who was jailed	0.18	(-0.03,0.39)
Parents divorced or separated	0.13	(0.05,0.21)
Adults in household treated each other violently	0.15	(0.01,0.30)
Age	-0.02	(-0.02,-0.02)
Female	-0.71	(-0.77,-0.64)
Race		
Black	-0.24	(-0.60,0.12)
Latinos	-0.13	(-0.30,0.04)
Asian	-0.54	(-0.68,-0.40)
Other	-0.02	(-0.21,0.17)
Imputation flag	-0.09	(-0.16,-0.03)

Model includes controls for state

Final Model for Aim 3

Table 5.22 shows a logistic regression model predicting cancer from physical, sexual and emotional abuse and all other control variables and health behaviors. In this model, having experienced physical abuse was associated with 21% (AOR: 1.21 95% CI: 1.07,1.38) higher odds of cancer. Similarly, having experienced sexual abuse was associated with 33% (AOR: 1.33 95% CI: 1.20,1.49) higher odds of cancer. In this model, having experienced emotional abuse was not associated with cancer (AOR: 1.09 95% CI: 0.99,1.20). Consequently, the relationship

between emotional abuse and cancer could not be mediated further, leaving this variable to function as a control in Aim 4. All associations between abuse types and cancer are weaker than the associations seen in the final model in Aim 2.

Table 5.22 also shows that several control variables are associated with cancer. Living with someone who was mentally ill (AOR: 1.17; 95% CI: 1.02,1.33), being a year older (AOR: 1.06; 95% CI: 1.05,1.06) and being female (AOR: 1.43; 95% CI: 1.31,1.56) were associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.43; 95% CI: 0.30,0.62). The flag for imputation was not associated with cancer (AOR: 0.99; 95% CI: 0.90,1.08), suggesting that individuals with missing data did not differ in their odds of cancer.

Also, in Table 5.22 the associations between health behaviors (i.e. smoking cigarettes, overweight or obesity and number of alcoholic drinks consumed in the last 30 days) and cancer are shown. In this model, ever smoking cigarettes was associated with 37% (AOR: 1.37 95% CI: 1.07,1.38) higher odds of cancer. Number of alcoholic drinks in the past 30 days was associated with decreased odds of cancer (AOR: 0.96 95% CI: 0.94,0.99), making it an implausible "cause" of cancer in this sample. This association is also, however, inconsistent with previously highlighted research showing drinking increases risk of cancer. Thus, drinking was not considered as a potential mediator. Overweight or obesity (AOR: 1.02 95% CI: 0.94,1.11) was not associated with odds of cancer, leaving it unable to serve as a mediator.

Table 5.22: Logistic Regression Predicting Cancer from Abuse with Mediators in BRFSS 2011 (N=120,586)

Variable	AOR	95% CI
Physical abuse	1.21	(1.07,1.38)
Sexual abuse	1.33	(1.20,1.49)
Emotional abuse	1.09	(0.99,1.20)
Lived w/ some one who was mentally ill	1.17	(1.02,1.33)
Lived w/ problem drinker	0.95	(0.86,1.05)
Lived w/ drug user	1.15	(0.97,1.36)
Lived w/ some one who was jailed	1.23	(0.98,1.54)
Parents divorced or separated	0.91	(0.81,1.02)
Adults in household treated each other violently	1.05	(0.92,1.19)
Age	1.06	(1.05,1.06)
Female	1.43	(1.31,1.56)
Race		
Black	0.96	(0.69,1.34)
Latinos	1.01	(0.77,1.34)
Asian	0.43	(0.30,0.62)
Other	1.00	(0.81,1.23)
Imputation flag	0.99	(0.90,1.08)
Mediators		
Ever smoke cigarettes	1.37	(1.26,1.48)
Overweight or Obese	1.02	(0.94,1.11)
Alcoholic drinks in past 30 days	0.96	(0.94,0.99)

Notes: AOR= adjusted odds ratio; Model includes controls for state

Mediation Analyses for Aim 3

Table 5.23 shows the results of mediation analyses on the association between physical abuse and cancer, while accounting for sexual and emotional abuse. The only health behavior that met criteria for mediation was smoking. In total, 10.19% ((0.02/0.21)*100) of the total association between physical abuse and cancer was mediated by ever smoking cigarettes (Beta: 0.02 p=0.001). Both the direct (Beta: 0.19 p=0.003) and indirect effect (Beta: 0.02 p<0.001) were significant. Because there was only one mediator, decomposition analyses were not appropriate.

Table 5.23: Mediating Effect of Health Behaviors on the Relationship Between Physical Abuse and Cancer in BRFSS 2011 (N=120,586)

Mediators Considered		
Ever smoke cigarettes		
Summary of Mediation	Beta	p-value
Total effect	0.21	0.001
Direct effect	0.19	0.003
Indirect effect	0.02	<0.001
Decomposition of Mediation	z	p-value
Ever smoke cigarettes	N/A	N/A
Overweight or obese	N/A	N/A
Alcoholic drinks in past 30 days	N/A	N/A

Table 5.24 shows the results of mediation analyses of the association between sexual abuse and cancer, while accounting for physical and emotional abuse. Among health behaviors, smoking met criteria for mediation. In total, 9.54% ((0.03/0.32)*100) of the total association between physical abuse and cancer was mediated by ever smoking cigarettes (Beta: 0.03 $p<0.001$). Both the direct (Beta: 0.29 $p<0.001$) and indirect effect (Beta: 0.03 $p<0.001$) were significant. Because there was only one mediator, decomposition analyses were not appropriate.

Table 5.24: Mediating Effect of Health Behaviors on the Relationship Between Sexual Abuse and Cancer in BRFSS 2011 (N=120,586)

Mediators Considered		
Ever smoke cigarettes		
Summary of Mediation	Beta	p-value
Total effect	0.32	<0.001
Direct effect	0.29	<0.001
Indirect effect	0.03	<0.001
Decomposition of Mediation	z	p-value
Ever smoke cigarettes	N/A	N/A
Overweight or obese	N/A	N/A
Alcoholic drinks in past 30 days	N/A	N/A

Table 5.25 shows the results of mediation analyses of the association between emotional abuse and cancer, while accounting for physical and sexual abuse. Among health behaviors smoking, met criteria for mediation. In total, 10.00% ((0.01/0.10)*100) of the total association

between emotional abuse and cancer was mediated by ever smoking cigarettes (Beta: 0.01 p<0.001). The indirect effect (Beta: 0.01 p<0.001) and not the direct effect (Beta: 0.09 p=0.07) were significant, suggesting full mediation. Because there was only one mediator, decomposition analyses were not appropriate.

Table 5.25: Mediating Effect of Health Behaviors on the Relationship Between Emotional Abuse and Cancer in BRFSS 2011 (N=120,586)

Mediators Considered		
Ever smoke cigarettes		
Overweight or obese		
Alcoholic drinks in past 30 days		
Summary of Mediation	Coefficient	p-value
Total effect	0.10	0.044
Direct effect	0.09	0.070
Indirect effect	0.01	<0.001
Decomposition of Mediation	z	p-value
Ever smoke cigarettes	N/A	N/A
Overweight or obese	N/A	N/A
Alcoholic drinks in past 30 days	N/A	N/A

5E. Aim 4 Results: Mediating Effect of Socioeconomic Status

Given that physical and sexual abuse were independently associated with cancer in the final model in Aim 3, only these abuse types could be mediated. Because emotional abuse was no longer associated with cancer, it was treated as a control variable for analyses in Aim 4. Additionally, because the goal of this work is to study the independent effects of each abuse type, net of all others, mediation for any abuse type was examined by controlling for the other two abuse types.

To determine which socioeconomic status measures could be mediators for specific abuse types, two different models were run: 1) A linear regression model predicting household income and 2) A linear regression model predicting educational attainment. These models included all independent variables from Aim 3 (i.e. abuse types, adverse childhood experiences, control

variables and health behaviors). Mediators that were associated with specific child abuse types were considered potential mediators for that specific abuse type. Potential mediators that did not meet the criteria for mediation were treated as control variables.

A logistic regression predicting cancer was fit with abuse types, adverse childhood experiences, control variables, health behaviors and socioeconomic status as predictors. Significant measures of socioeconomic status in this model could be examined for mediation, but only for abuse types for which they had an association with. A mediation model was then fit, which showed the total mediated effect of all socioeconomic status measures, by abuse type. Effects were then decomposed, as appropriate. The results of these models are presented in the subsequent text. While coefficients are not displayed, all models control for the respondent's state of residence.

Evaluating Years of Educational Attainment as a Potential Mediator

Table 5.26 shows a logistic regression model predicting years of educational attainment from abuse, while including all variables in Aim 3. Having experienced physical abuse was associated with .21 fewer years of educational attainment (Beta: -0.21; 95% CI: -0.31,-0.11). Having experienced sexual abuse was not associated with educational attainment. Having experienced emotional abuse was associated with 0.25 more years of educational attainment (Beta: 0.25; 95% CI: 0.18,0.31). Thus only, physical and emotional abuse can be mediated by educational attainment. However, because emotional abuse was no longer associated with cancer in Aim 3, it cannot be evaluated for mediation.

Table 5.24 also shows that some control variables are associated with educational attainment. Living with someone who was mentally ill (Beta: 0.34; 95% CI: 0.26,0.42), having one additional alcoholic drink in the past 30 days (Beta: 0.05; 95% CI: 0.04,0.07) and being

female (Beta: 0.14; 95% CI: 0.07,0.20) were associated with more years of educational attainment. Living with someone who was jailed (Beta: -0.80; 95% CI: -0.97,-0.63), having parents that were divorced or separated (Beta: -0.29; 95% CI: -0.36,-0.21), living in a household in which adults treated each other violently (Beta: -0.23; 95% CI: -0.33,-0.13), ever smoking cigarettes (Beta: -0.58; 95% CI: -0.64,-0.52) and being overweight or obese (Beta: -0.09; 95% CI: -0.15,-0.02) were associated with fewer years of educational attainment. Blacks (Beta: -0.37; 95% CI: -0.53,-0.21), Latinos (Beta: -2.64; 95% CI: -2.87,-2.40) and those identifying with other racial/ethnic groups (Beta: -0.40; 95% CI: -0.55,-0.25), had fewer years of education attainment than non-Latino whites. Asians (Beta: 0.64; 95% CI: 0.47,0.81) had more years of education attainment than non-Latino whites. Additionally, the flag for imputation was associated with 0.63 fewer years of educational attainment (Beta: -0.63; 95% CI: -0.70,-0.56), suggesting that those with missing data were of lower socioeconomic status.

Table 5.26: Linear Regression Predicting Years of Educational Attainment from Abuse in BRFSS 2011 (N=120,586)

Variable	Beta	95% CI
Physical abuse	-0.21	(-0.30,-0.11)
Sexual abuse	-0.04	(-0.14,0.15)
Emotional abuse	0.25	(0.18,0.31)
Lived w/ some one who was mentally ill	0.34	(0.26,0.42)
Lived w/ problem drinker	0.00	(-0.08,0.08)
Lived w/ drug user	0.06	(-0.05,0.18)
Lived w/ some one who was jailed	-0.80	(-0.97,-0.63)
Parents divorced or separated	-0.29	(-0.36,-0.21)
Adults in household treated each other violently	-0.23	(-0.33,-0.13)
Age	-0.01	(-0.01,0.00)
Female	0.14	(0.07,0.20)
Race		
Black	-0.37	(-0.53,-0.21)
Latinos	-2.64	(-2.87,-2.40)
Asian	0.64	(0.47,0.81)
Other	-0.40	(-0.55,-0.25)
Imputation flag	-0.63	(-0.70,-0.56)
Health behavior mediators		
Ever smoke cigarettes	-0.58	(-0.64,-0.52)
Overweight or Obese	-0.09	(-0.15,-0.02)
Alcoholic drinks in past 30 days	0.05	(0.04,0.07)

Model includes controls for state

Evaluating Annual Household Income as a Potential Mediator

Table 5.27 shows a logistic regression model predicting annual household income (in thousands of dollars), while including all variables in Aim 3. Having experienced physical abuse was associated with 2,470 fewer dollars in annual household income (Beta: -2.47; 95% CI: -3.60,-1.33). Having experienced sexual abuse was associated with 2,230 fewer dollars in annual household income (Beta: -2.23; 95% CI: -3.37,-1.10). Having experienced emotional abuse was associated with 1,380 more dollars in annual household income (Beta: 1.38; 95% CI: 0.46,2.30). Thus, physical and sexual abuse can be mediated by household income.

Table 5.27 also shows that some control variables are associated with annual household income. Living with someone who was mentally ill (Beta: -0.90; 95% CI: -2.02,-0.21), living

with someone who was jailed (Beta: -6.77; 95% CI: -8.57,-4.96), having parents who were divorced or separated (Beta: -4.13; 95% CI: -5.11,-3.15), living in a household in which adults treated each other violently (Beta: -2.47; 95% CI: -3.64,-1.30), being a year older (Beta: -0.19; 95% CI: -0.22,-0.17), being female (Beta: -4.71; 95% CI: -5.48,-3.94) and ever smoking cigarettes (Beta: -9.50; 95% CI: -10.24,-8.75) were associated with lower household income. Blacks (Beta: -16.40; 95% CI: -18.36,-14.45) and Latinos (Beta: -19.44; 95% CI: -21.24,-17.64) had lower household income than non-Latino whites. Each additional alcoholic drink consumed in the past 30 days was associated with higher household income (Beta: 0.69; 95% CI: 0.50,0.89). Additionally, the flag for imputation was associated with 5,290 fewer dollars in household income (Beta: -5.29; 95% CI: -6.10,-4.47), suggesting that those with missing data were of lower socioeconomic status.

Table 5.27: Linear Regression Predicting Annual Household Income (in thousands) from Abuse in BRFSS 2011 (N=120,586)

Variable	Beta	95% CI
Physical abuse	-2.47	(-3.60,-1.33)
Sexual abuse	-2.23	(-3.37,-1.10)
Emotional abuse	1.38	(0.46,2.30)
Lived w/ some one who was mentally ill	-0.90	(-2.02,0.21)
Lived w/ problem drinker	0.48	(-0.47,1.43)
Lived w/ drug user	-1.01	(-2.50,0.49)
Lived w/ some one who was jailed	-6.77	(-8.57,-4.96)
Parents divorced or separated	-4.13	(-5.11,-3.15)
Adults in household treated each other violently	-2.47	(-3.64,-1.30)
Age	-0.19	(-0.22,-0.17)
Female	-4.71	(-5.48,-3.94)
Race		
Black	-16.40	(-18.36,-14.45)
Latinos	-19.44	(-21.24,-17.64)
Asian	1.16	(-1.72,4.04)
Other	-10.85	(-12.72,-8.98)
Imputation flag	-5.29	(-6.10,-4.47)
Health behavior mediators		
Ever smoke cigarettes	-9.50	(-10.24,-8.75)
Overweight or Obese	-0.77	(-1.55,0.02)
Alcoholic drinks in past 30 days	0.69	(0.50,0.89)

Model includes controls for state

Final Model for Aim 4

Table 5.28 shows a logistic regression model predicting cancer from physical, sexual and emotional abuse and all other control variables, health behaviors and measures of socioeconomic status. In this model, having experienced physical abuse was associated with 21% (AOR: 1.21 95% CI: 1.06,1.37) higher odds of cancer. Similarly, having experienced sexual abuse was associated with 33% (AOR: 1.33 95% CI: 1.19,1.48) higher odds of cancer. Having experienced emotional abuse was not associated with cancer (AOR: 1.09 95% CI: 0.99,1.20). All associations between abuse types and cancer are similar in strength to those seen in the final model in Aim 3.

Table 5.26 also shows that several control variables are associated with cancer. Living with someone who was mentally ill (AOR: 1.16 95% CI: 1.01,1.32), being a year older in age

(AOR: 1.05 95% CI: 1.05,1.06), being female (AOR: 1.40 95% CI: 1.28,1.53) and ever smoking cigarettes (AOR: 1.35 95% CI: 1.24,1.46) were associated with higher odds of cancer. Asians had lower odds of cancer than did non-Latino whites (AOR: 0.43; 95% CI: 0.29,0.61). The flag for imputation was not associated with cancer (AOR: 0.99; 95% CI: 0.90,1.08), suggesting that individuals with missing data did not differ in their odds of cancer.

Also, in Table 5.26 the associations between socioeconomic status (i.e. annual household income and years of educational attainment) and cancer are shown. In this model, each year of educational attainment was associated with 2% (AOR: 1.02 95% CI: 1.01,1.04) higher odds of cancer. Also, in this model, a thousand dollar increase in annual household income was associated with .1% increase (AOR: 1.00 95% CI: 1.00,1.00) in odds of cancer. Thus both annual household income and years of educational attainment can serve as mediators.

Table 5.28: Logistic Regression Predicting Cancer from Abuse with Mediators in BRFSS 2011 (N=120,586)

Variable	AOR	95% CI
Physical abuse	1.21	(1.06,1.37)
Sexual abuse	1.33	(1.19,1.48)
Emotional abuse	1.09	(0.99,1.20)
Lived w/ some one who was mentally ill	1.16	(1.01,1.32)
Lived w/ problem drinker	0.95	(0.86,1.05)
Lived w/ drug user	1.14	(0.96,1.35)
Lived w/ some one who was jailed	1.22	(0.97,1.54)
Parents divorced or separated	0.91	(0.81,1.02)
Adults in household treated each other violently	1.05	(0.92,1.02)
Age	1.05	(1.05,1.06)
Female	1.40	(1.28,1.53)
Race		
Black	0.93	(0.66,1.30)
Latinos	1.03	(0.77,1.37)
Asian	0.43	(0.29,0.61)
Other	0.98	(0.80,1.20)
Imputation flag	0.99	(0.90,1.08)
Ever smoke cigarettes	1.35	(1.24,1.46)
Overweight or Obese	1.02	(0.94,1.11)
Alcoholic drinks in past 30 days	0.97	(0.94,1.00)
Mediators		
Household income (in thousands)	1.00	(1.00,1.00)
Educational attainment (in years)	1.02	(1.01,1.04)

Notes: AOR= adjusted odds ratio; Model includes controls for state;
Odds for educational attainment have been rounded up and are significant;

Mediation Analyses for Aim 4

Table 5.29 shows the results of mediation analyses on the association between physical abuse and cancer. Both household income and educational attainment met criteria for mediation. In total, 1.57% ((0.003/0.191)*100) of the total association between physical abuse and cancer was mediated by household income and educational attainment (Beta: 0.00 p=0.321). The direct effect (Beta: 0.19 p=0.004) was significant, while the indirect effect (Beta: 0.00 p=0.321) was not, indicating no mediation. Because there was no mediation, decomposition analyses were not appropriate.

Table 5.29: Mediating Effect of Socioeconomic Status on the Relationship Between Physical Abuse and Cancer in BRFSS 2011 (N=120,586)

Mediators Considered		
Household income (in thousands)		
Educational attainment (in years)		
Summary of Mediation	Coefficient	p-value
Total effect	0.191	0.003
Direct effect	0.188	0.004
Indirect effect	0.003	0.321
Decomposition of Mediation	z	p-value
Household income (in thousands)	N/A	N/A
Educational attainment (in years)	N/A	N/A

Table 5.30 shows the results of mediation analyses on the association between sexual abuse and cancer. Household income and met criteria for mediation. In total, 2.08% ((0.006/0.289)*100) of the total association between sexual abuse and cancer was mediated by household income (Beta: 0.006 p=0.005). The direct effect (Beta: 0.283 p<0.001) and indirect effect (Beta: 0.006 p=0.005) were both significant. Because there was only one mediator, decomposition analyses were not appropriate.

Table 5.30: Mediating Effect of Socioeconomic Status on the Relationship Between Sexual Abuse and Cancer in BRFSS 2011 (N=120,586)

Mediators Considered		
Household income (in thousands)		
Summary of Mediation	Coefficient	p-value
Total effect	0.290	<0.001
Direct effect	0.283	<0.001
Indirect effect	0.006	0.005
Decomposition of Mediation	z	p-value
Household income (in thousands)	N/A	N/A
Educational attainment (in years)	N/A	N/A

6. Discussion

6A. Discussion

Summary of Findings

Results from Aim 1 revealed that the data was not consistently representative of the underlying population and thus failed to support the hypothesis for Aim 1. Cancer prevalence was the most problematic and was overestimated in most of the states in the study. This is not entirely surprising since positive predictive value of self-reported cancer when compared to cancer registry confirmed cases is 0.75,[128] suggesting that misreporting cancer diagnoses is commonplace. Additionally, the BRFSS was found not to be representative with respect to some sociodemographic characteristics in some states. Particularly, the proportion of the population that was non-Latino white was frequently overestimated, calling into question the demographic representativeness of the BRFSS. While probability weights should have addressed this concern, previous BRFSS data has been shown to differ from Census parameters, even after weighing data.[129] Thus, prevalence estimates from the BRFSS should be interpreted with caution.

It is also important to consider that differences between BRFSS and comparison values could be attributable to data imputation. That is, imputed data may be less accurate than real data, thus causing bias in prevalence estimates. However, none of the variables assessed as part of Aim 1 had significant portions of data imputed.

Results from Aim 2 showed that all abuse types were associated with increased odds of having cancer. For physical and sexual abuse this association persisted even after controlling for other childhood adversities and sociodemographic characteristics. For emotional abuse, this association is only apparent when controlling for sociodemographic characteristics. Specifically, before controlling for sociodemographic characteristics, emotional abuse actually reduced odds

of having cancer. Once sociodemographic characteristics were controlled for, emotional abuse increased odds of having cancer. Follow-up analyses revealed that the change in the direction of association was due to the introduction of age as a control variable, indicating that age functioned as a suppressor of this relationship (i.e. older individuals are more likely to report cancer and are less likely to report emotional abuse) and suggesting a degree of response bias. In these analyses, a ten-year increase in age, would correspond to a 10% decrease in odds of reporting emotional abuse. Overall, Aim 2 results show that each abuse type increases risk of cancer, above and beyond other childhood adversities and other abuse experiences. When all abuse types were entered into a model at the same time, the independent impact of each abuse type varied. Particularly, emotional abuse conferred the smallest increase in odds of developing cancer, followed by physical abuse and then sexual abuse.

The results of Aim 3 showed that some abuse types were associated with some health behaviors. Physical abuse was only associated with increased odds of ever smoking cigarettes. This association between physical abuse and smoking has been previously reported.[130,131] However, previous research has shown associations between physical abuse and alcohol consumption[86] and obesity,[18] albeit using different study samples and different measurements. Sexual abuse was associated with increased odds of ever smoking cigarettes and increased odds of being overweight or obese. The association between sexual abuse and smoking[130] and sexual abuse and obesity have been previously reported.[18] However, previous research has shown associations between sexual abuse and alcohol consumption,[86] albeit using different study samples and different measurements. Emotional abuse was associated with increased number of drinks consumed in the past 30 days, increased odds of ever smoking cigarettes and increased odds of being overweight or obese. All three associations have been previously reported.[131]

Emotional abuse was associated with the greatest number of negative health behaviors, despite previous research showing all three abuse types are associated with all three health behaviors. These discrepancies may be due to differences in measurement and study populations used in previous studies.

Results of Aim 3 also showed that ever smoking was associated with increased odds of cancer. This is consistent with previous work showing smoking elevates risk for many cancers.[87] Next, Aim 3 showed that overweight and obesity was not associated with cancer, despite existing research showing an association between adiposity and cancer of specific sites.[70,71] Finally, Aim 3 also showed that alcohol consumption in the past 30 days was negatively associated with cancer. This is contrary to previous work showing that even low levels of drinking are enough to elevate cancer risk.[80,81] This discrepancy is likely due to the fact that the measure of drinking in the present study captures current drinking patterns. As such, individuals with cancer may have motivation to reduce their consumption of alcohol, and thus lead to the apparent benefit of alcohol consumption. For these reasons, alcohol consumption was not analyzed as a mediator despite meeting the criteria to be considered one.

Results of Aim 3 also showed that smoking may mediate the relationship between specific abuse types and cancer. In terms of physical and sexual abuse, smoking partially mediated the association between physical abuse and cancer. Specifically, physical and sexual abuse were both associated with increased odds of ever-smoking cigarettes and, consequently, increased odds of cancer. That is, ever smoking partially explained the association between physical or sexual abuse and cancer. Overweight and obesity and alcohol consumption were not considered mediators of the association between physical or sexual abuse and cancer.

The final model in Aim 3 showed that emotional abuse was no longer associated with cancer. Per Baron and Kenny's (1986) criteria for mediation, this would suggest that smoking fully mediated the association between emotional abuse and cancer. This was confirmed, by the test of mediation that fully accounted for the problems inherent in logistic regression. Overweight and obesity and alcohol consumption were not considered as potential mediators of the association between emotional abuse and cancer.

The results of Aim 4 showed that abuse types had associations with socioeconomic status measures. Physical abuse was associated with fewer years of educational attainment and decreased household income. Sexual abuse was associated with decreased household income. Emotional abuse was associated with more years of educational attainment and increased household income. This last finding is surprising since it suggest emotional abuse can have positive impacts on socioeconomic status. However, this association is poorly studied in the literature and may or may not represent an anomaly. Finally, because income is greatly shaped by educational attainment, including both as moderators may diminish the strength of association between any one measure and child abuse types.

Aim 4 also showed the both measures of socioeconomic status increased odds of cancer. Previous research has shown both positive and negative associations with socioeconomic status and cancers of specific sites.[105,106] This positive relationship may occur because individuals with more financial resources may make greater use of cancer screenings, [96-100] and thus be more likely to be diagnosed with cancer. Also, lower socioeconomic status increases cancer-promoting health behaviors.[101-104] Because some of these health behaviors are controlled for in the current study, part of the association between socioeconomic status and cancer has already been accounted for.

Results of Aim 4 also showed that socioeconomic status may partially mediate the relationship between specific abuse types and cancer. Results showed that the association between sexual abuse and cancer was partially mediated by household income. Specifically, sexual abuse was associated with decreased household earnings, which, in turn, were associated with increased odds of cancer. The association between both physical and emotional abuse and cancer were not mediated by socioeconomic status measures currently under examination in this study.

Additionally, the results for Aims 2-4 showed that imputations were not associated with odds of cancer. However, for Aim 3, individuals with imputed data had better health behaviors than individuals without imputed data. Also, for Aim 4, individuals with imputed data had lower socioeconomic status than those without imputed data. This suggests that inclusion of imputed data for mediation analyses pushed results to the null in Aim 3 and to the alternative in Aim 4.

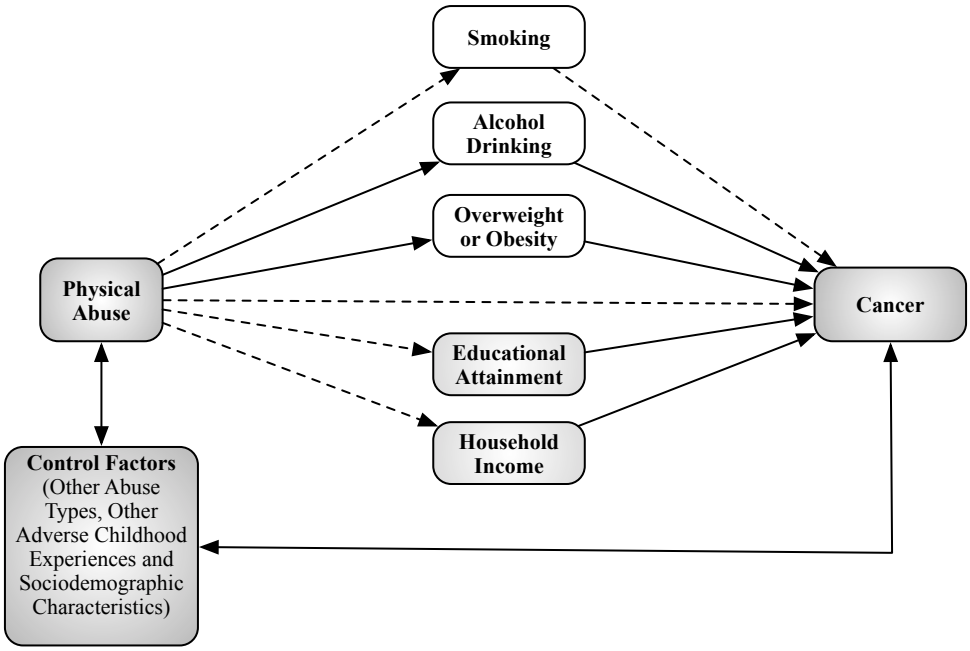
Revised Conceptual Frameworks and Hypotheses Revisited

Based on the findings from Aims 2-4, some revisions have been made to the original conceptual frameworks proposed. Overall, these revisions underscore that each child abuse type is connected to cancer via different mechanisms. Figure 6.1 shows that physical abuse is directly associated with cancer, and shares an indirect association to cancer through smoking. Figure 2 shows that sexual abuse, is also directly associated with cancer and is mediated by smoking and household income. Meanwhile, Figure 3 shows that the relationship between emotional abuse and cancer is fully mediated by smoking, leaving no direct relationship between emotional abuse and cancer.

These frameworks indicate that only some of the original study hypotheses have been supported. All of the hypotheses for Aim 2 are supported, since all abuse types are directly associated with cancer, even after controlling for other childhood adversities and other child

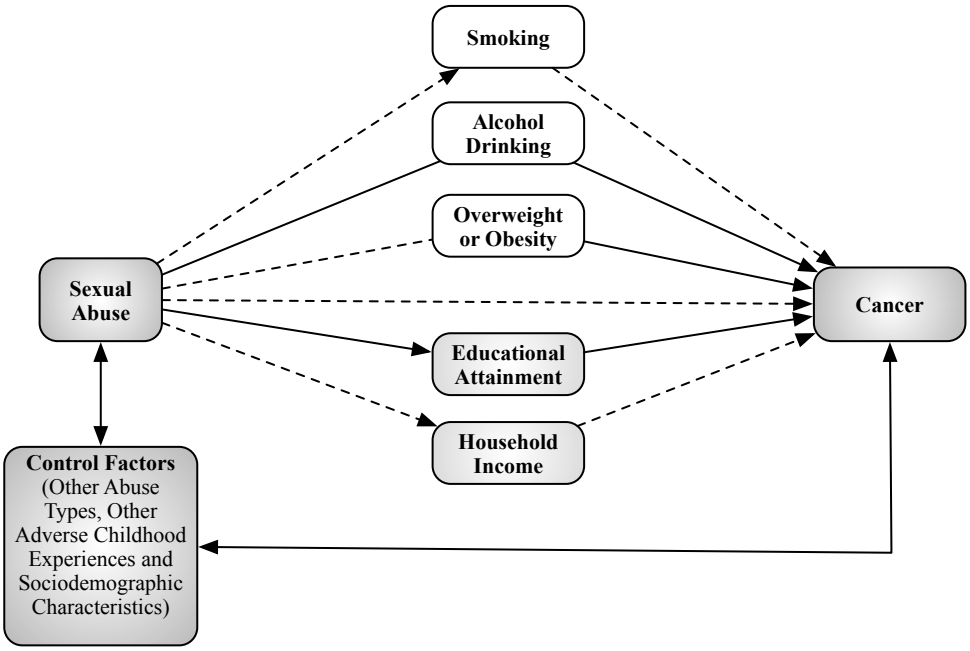
abuse types. However, Aims 3 and 4 are only partially supported because no abuse type was mediated by all five mediators under examination.

Figure 6.1: Revised Conceptual Framework - Physical Abuse



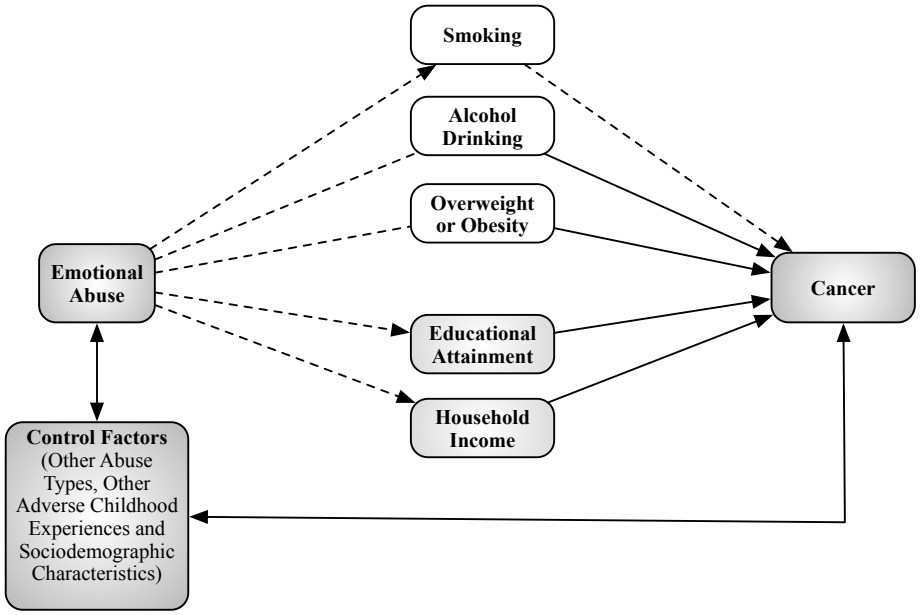
Note: White boxes represent mediating effects of risky health behaviors and the light gray boxes represents the mediating effect of socioeconomic status. Dashed lines represent mediating relationships supported by the current study.

Figure 6.2: Revised Conceptual Framework - Sexual Abuse



Note: White boxes represent mediating effects of risky health behaviors and the light gray boxes represents the mediating effect of socioeconomic status. Dashed lines represent mediating relationships supported by the current study.

Figure 6.3: Revised Conceptual Framework - Emotional Abuse



Note: White boxes represent mediating effects of risky health behaviors and the light gray boxes represents the mediating effect of socioeconomic status. Dashed lines represent mediating relationships supported by the current study.

These revised conceptual frameworks and results suggest that there is a relative rank of abuse types when it comes to conferring cancer risk: 1) sexual abuse; 2) physical abuse; 3) emotional abuse. This is unsurprising given the previously reviewed theoretical framework and the strength of empirical research. Sexual abuse is likely to impact cancer risk directly through exposure to viruses, which have been linked to cancer, while still leading to biological dysregulation, deficits in emotional processing, social and cognitive deficits, risky health behaviors and lower socio economic status. For physical and emotional abuse the risk of viral exposure is reduced or entirely absent. For emotional abuse, a paucity of empirical research had specifically examined its role in impacting health behaviors. This may be because the relationship is weaker, and thus not observed or reported when using smaller data sets.

Additionally, the relative detriment conferred by each abuse type is supported by the relative traumatic impact and social acceptability of these types. First, sexual abuse leads to more traumatic symptomatology,[132] when compared to physical abuse. As a result, victims of sexual abuse have a greater burden of traumatic symptoms, which may trigger more of the pathways leading to disease and overwhelm the social, emotional and financial resources available to cope with these pathways. Next, and irrespective of the objective harm caused by abuse, social norms around what constitutes abuse vary by abuse type. The greatest consensus around what specific actions are categorized as abusive emerges around sexually abusive actions, followed by physically abusive actions and, distantly, by emotionally abusive actions.[133] These norms around specific abusive actions suggest that physical and emotional abuse are much more normative and socially acceptable than sexual abuse. Consequently, because they are more normative, they may be less harmful to children, since their experiences will be more likely to be shared and less

likely to be stigmatized. Nevertheless, it is important to underscore that the present study still suggests that all abuse types are harmful.

It is important to highlight that much of the association between physical or sexual abuse and cancer remains unexplained. While mediators were found for each, the revised conceptual frameworks depicted here could be logically expanded by including additional measures of health behaviors and socioeconomic status or by including measures of other pathways linking abuse to health (i.e. viral exposures, biological deregulation, social deficits etc.). Conversely, the finding that the association between emotional abuse and cancer was fully mediated by smoking, suggests that unexamined pathways may not be important when examining the relationship between emotional abuse and cancer.

6B. Implications for Research, Policy and Public Health Practice

The present work has several implications for current methods and theory used in studying the connection between childhood adversity and chronic disease. First, the study adds to the growing literature linking child abuse and chronic somatic illnesses in adulthood. This is especially important when looking at child abuse and cancer, where only a handful of publications exist on the topic. The addition of more evidence supporting the connection between child abuse and cancer will, hopefully, help further legitimize these types of research inquiries. Second, this study provides evidence suggesting that adverse childhood experiences are not interchangeable in their health impacts. Experiences of child abuse appear to confer an increased risk of cancer that other childhood adversities do not. As such, future research should refrain from treating these experiences as interchangeable, even if the scales measuring these experiences advise just that. Similarly, theories should acknowledge that all childhood adversities are not created equal. Third, because the strength of association between each abuse

type and cancer dropped when all other abuse types were controlled for, co-occurrence of abuse types is an important theoretical and methodological consideration. Fourth, because the present study found that child abuse types have unique mediators that help explain their associations to cancer, future research must consider the type of abuse under investigation when hypothesizing explanations for observed associations. Finally, the study also suggests that child abuse types have independent consequences on cancer and thus should be treated as separate experiences. While abuse types co-occur and are defined in ambiguous ways, future research interested in examining the health impacts of these experiences should treat them as separate experiences.

The present study also has important policy implications. Presently, states in the U.S. have different definitions of what constitutes abuse. Some do not legally define emotional abuse and many have inconsistent definitions of specific actions that constitute physical abuse.[22] Additionally, states differ in the minimum and maximum age a child can be in order to be considered a victim of a specific abuse type and they differ in their definition of age of perpetrators of abuse types. The present research demonstrates that these experiences are problematic because they are harmful to health in the long term. As such, policy makers should consider the unique harm of independent abuse types when deciding which types are worth defining. Also, because legal definitions of constructs tend to shape how they are measured in research and practice, policy makers can help legitimize the concept of emotional abuse by legally acknowledging it across all states. Finally, because this study demonstrated that the harm of abuse may linger later into life, policy makers should consider uniformly criminalizing abusive actions across U.S. states, improving screening and reporting for child abuse and increasing resources to agencies responsible for removing children from abusive environments.

From a public health perspective, the present study highlights several potential means of curbing the harm of child abuse. In the ideal case, efforts should be made to prevent child abuse from happening in the first place. While this task is seemingly impossible because causes of child abuse include longstanding social problems like substance abuse, poverty and violence, the current study does provide new information that can be disseminated to the public in order to discourage abuse. Specifically, because the association between child abuse and cancer has been reported only in a handful of studies, media campaigns can seize on the growing evidence to link abuse to a new salient outcome in hopes of discouraging abuse and increasing the number of people who are willing to report it because they perceive it as harmful. Alternatively, if abuse cannot be prevented victims of abuse can be targeted for interventions to prevent smoking initiation. Similarly, existing smoking cessation interventions maybe tailored to victims of sexual and physical abuse so that the underlying trauma triggering the smoking response is dealt with. Finally, because sexual abuse was associated with cancer risk via decreased household earnings, interventions should consider providing survivors of sexual abuse with direct financial assistance or opportunities to increase their earning potential.

6C. Limitations

Because this study is cross-sectional in nature, several limitations are inherent. Most importantly, because independent, dependent and mediating variables are assessed at the same time point, it is impossible to determine temporal sequencing of events.[134] While it is unlikely that cancer, a disease of older age, will precede child abuse among most people, it is possible that having cancer may lead to subsequent changes in mediators. For example, an individual who has been diagnosed with cancer may quit smoking cigarettes or drinking alcohol in an attempt to improve his or her health. This is a particular concern for the alcohol drinking measure used in

the current study, which is limited to consumption in the past 30 days. Future studies can ameliorate these concerns by utilizing measures that capture lifetime patterns or by utilizing longitudinal study designs.

Several other concerns arise from the use of cross-sectional data. For example, some of the risk factors under investigation (both mediators and independent variables) may lead to death. Consequently, these risk factors maybe underrepresented among those with the disease.[134] While this is a concern, it is likely to bias results towards the null. Finally, because the study relies on retrospective recall of events, recall bias is a concern. This concern does not necessarily influence all variables equally. Specifically, when it comes to reporting maltreatment, recall bias accounts for less than 1% in variation in reporting.[135] However, one cannot rule out that current disease status may impact recall of disease factors in an effort to attribute causes to the disease.

Additionally, while this study aims to inform the creation of abuse and disease specific models and analyses, data limitations do not allow the full pursuit of this aim. In particular, no site-specific analyses of cancer can be undertaken, outside of skin-cancer. As such, all non-skin cancer conditions are treated as identical and interchangeable. This is certainly not the case. Cancer is a very heterogeneous disease,[136] that has a variety of causes, courses and treatment options. In the case of the present study, specific cancers may have specific mediating pathways between abuse, or show no relationship. Because of this, this study should be repeated with a data set that allows for the examination of a specific cancer, and includes important characteristics of the disease such as stage, age at diagnosis, recurrence and treatment course. Taking all of this into account, the present study aims to examine a wide swath of mediating pathways in an attempt to capture a wide array of site-specific cancers. However, this goal is limited by the fact that the BRFSS only asks participants about certain mediators.

Use of pre-existing data also limits the types of variables that can be examined and the research questions that can be answered. As previously mentioned, the BRFSS does not provide the richest details about the dependent variable, limiting the ability to draw conclusions about specific cancers. Measurement of mediators was similarly limiting since most ask about current health behaviors and socioeconomic status, which may change due to disease status. Similarly, the measures of abuse and childhood adversity used in the BRFSS are limited. For example, the measures for both physical and emotional abuse only included one item apiece, and only capture a fraction of their respective constructs. Relatedly, the BRFSS does not include information about the context in which the abuse exists (i.e. relation to the abuser, duration of abuse, intensity of abuse, age at which abuse started, the abuse victim's current evaluation of the abuse etc.). Furthermore, while the ACE module does include questions on abuse and household dysfunction, it does not have items that capture facets of child neglect. Consequently, the current study could not determine if child abuse has an impact of cancer risk, independent of child neglect. Taken all together, limitations underscore the need for future work in which the questions asked of respondents are designed specifically to answer the present research question.

Finally, there maybe some concern about the generalizability of results. As Aim 1 showed, the BRFSS sample used in this study does not represent the underlying population and thus may not be generalizable to this population. However, given that large-scale surveys like the BRFSS embody the most representative study designs, it is unclear how this problem can be effectively addressed. However, there are certain population groups that this study may not generalize to, which can be addressed by future research that specifically targets these groups for inclusion. First, because the analyses are limited to geographic regions that are primarily non-Latino white, it is unclear if findings will generalize to more racially diverse contexts. This is of

concern because research has indicated that rates of abuse differ by race, as well as attitudes of what constitutes maltreatment.[14] Because non-white racial/ethnic groups are too small in the current sample, subgroup analyses are not possible. Second, because no southern states are represented in the sample, it is impossible to know if broad regional differences are captured in the current study. Thirdly, because the BRFSS is limited to interviews of adults currently residing in households, it excludes those who are currently incarcerated or homeless. Because both of these populations report experiencing child abuse at high rates,[137-139] their exclusion may decrease the power of the present study.

6D. Future Directions

Given the paucity of work examining child abuse and cancer, many opportunities for future investigations exist. The best course of action would be to invest in longitudinal studies (i.e. prospective cohort studies) that follow newborns throughout their lives. This eliminates many of the limitations of the current study, but requires a lifetime before results can be produced. In place of this, retrospective cohort studies may be conducted. For example, child protective services records of abuse cases can be merged with cancer registry information in order to provide quicker insight into the abuse cancer connection (i.e. retrospective cohort study). Or similarly, existing studies of cancer or child abuse can be linked to either abuse records or cancer registries.[140] However, both retrospective and prospective studies raise serious concerns since they would require either tracking of abuse cases as they happen or having access to the sensitive information contained in reports of abuse after they happen.

In the short term, much can be done to improve cross-sectional studies of abuse and cancer. As previously mentioned, the measures of cancer, abuse and mediators can and should be made more detailed to make stronger arguments for directionality and to allow for the

examination of specific cancer types. Additionally, because of the subjective nature of abuse and abuse types, cross-sectional research may be able to disentangle the objective from the subjective. This may be done by asking respondents: 1) to report instances of abuse that resulted in intervention from Child Protective Services or the courts; 2) to report on abuse based on both the typical research definitions and the legally codified definitions of abuse in their jurisdiction; 3) to report on the harm or consequences of abuse types in order to examine if the distinctions between abuse types is meaningful. Also, cross-sectional studies may help us understand which population subgroups are differentially exposed to and/or vulnerable to child abuse.

7. References

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