TOXIC STRESS IN CANADIAN CHILDREN: THE INTERSECTIONALITY OF RACE, SOCIOECONOMIC STATUS & HEALTH INEQUITY

by

Ruth Elizabeth Lue

Bachelor of Nursing (University of New Brunswick, 2016)

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

Master of Nursing

in the Graduate Academic Unit of Nursing

Supervisors: Kelly Scott-Storey, RN, PhD, Faculty of Nursing
Lucia Tramonte, PhD, Department of Sociology

Examining Board: Sue O'Donnell, RN, PhD, Faculty of Nursing, Chair
Tracey Rickards, RN, PhD, Faculty of Nursing
Heather Sears, PhD, Department of Psychology

This thesis is accepted by the
Dean of Graduate Studies

THE UNIVERSITY OF NEW BRUNSWICK

December, 2022

ABSTRACT

Exposure to adverse childhood experiences (ACEs) can have deleterious and long-term effects. Known as *toxic stress*, unmediated exposure to ACEs often results in physiological, psychological, and epigenetic changes, leading to poor physical and mental health outcomes along the life span. The paucity of literature on the effects of toxic stress in racialized Canadian children highlights the importance of this study, as racism is a unique stressor experienced by racial groups. Data from the National Longitudinal Survey of Children and Youth and the Canadian Community Health Survey were analyzed to describe the effects of toxic stress on Canadian youth. Multivariate regressions modeled associations between ACEs and the presence of disease, and the experiences of stress among racialized youth and poor health outcomes. Results indicated that ACEs were positively associated with the presence of chronic conditions in childhood ($\chi 2=867.41$, $p < .001$). Results further demonstrated that in the context of high levels of daily stress, racialized youth had increased odds of having asthma (OR:1.10, 95% CI: 1.09-1.12), diabetes (OR: 1.43, 95% CI: 1.37-1.49), and heart disease (OR:1.73, 95% CI: 1.65-1.80), and had decreased odds of having anxiety disorders (OR: 0.61, 95% CI: 0.60-0.62) and mood disorders (OR: 0.56, 95% CI: 0.54-0.56). Results suggest that both ACEs and race play a significant role in vulnerability to disease.

Keywords: toxic stress, adverse childhood experiences, Adverse Childhood Experiences (ACEs), racial disparities, health outcomes

DEDICATION

To my Everlasting Father, the Lover of my soul, Who buffered me on every side

And

My son and mother for their insurmountable belief in me.

ACKNOWLEDGEMENTS

I would like to acknowledge my wonderful thesis committee, Dr. Kelly Scott-Storey and Dr. Lucia Tramonte. I am grateful and humbled to have been supported by such graceful and esteemed women. And to those who loved and encouraged me along the way – thank you.

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List of Symbols, Nomenclature or Abbreviations

ACE……...……. Adverse Childhood Experience

CCHS ……...……. Canadian Community Health Survey

HIE ……..……... Healthy Immigrant Effect

HPA ……. Hypothalamic-pituitary-adrenocortical

HUI ……...……Health Utility Index

NLSCY ……...……. National Longitudinal Survey of Children and Youth

PMK ……...…… Person Most Knowledgeable

PUD ...……..……..……. Public Use Data

SES ……..…..……..……..…….…… Socioeconomic Status

Chapter 1: Introduction

Stress is a dynamic interaction between the mind and body in response to intrinsic and/or extrinsic forces, otherwise known as *stressors* (McEwen, 2000; Tsigos et al., 2020). Stressors can be emotional, physical, or environmental (Franke, 2014). Stress affects all individuals across the lifespan, acting with variable frequency and severity within and between people (McEwen, 2000).

Stress can be a positive state. The concept of *eustress* is defined as stress resulting from "challenging but attainable and enjoyable or worthwhile tasks" (American Psychological Association, 2020a). The most common idea of stress, however, is the notion of *distress*, which is an undesirable state "that results from being overwhelmed by demands, losses, or perceived threats" (American Psychological Association, 2020b).

Considering the latter and more common connotation, when the body encounters stress, physiological processes are activated to enable the body to adapt to environmental challenges and achieve stability, which is necessary for survival (McEwen & McEwen, 2017). What then happens if the body experiences stress that is too severe, too frequent, or prolonged – thus never achieving stability? Further, what does this mean for stress-vulnerable populations? This phenomenon of unmediated prolonged, severe, or recurrent exposure to stressors is known as *allostatic load* (Bucci et al., 2017; McEwen, 2007). Coined by McEwen and Stellar (1993), allostatic load refers to the cumulative burden of chronic stress, when negative environmental challenges exceed the individual ability to cope. Allostatic load has been attributed to increased vulnerability to chronic illnesses,

such as cardiovascular disease, asthma, diabetes, and more (Jacob et al., 2019). In children, however, allostatic load can have lifelong consequences on brain development and body systems, negatively impacting behaviour, cognitive performance, and mental and physical health well into adulthood (Shonkoff et al., 2021). The concept of allostatic load occurring in the early years of life, in the absence of an effective buffer (primarily a nurturing adult), is known as *toxic stress* (McEwen & McEwen, 2017).

Much of the research on childhood adversity had the tendency to focus on Adverse Childhood Experiences (ACEs) such as abuse, neglect, and other challenges within the home, for example maternal depression and divorce (Franke, 2014; McEwen & McEwen, 2017; Shonkoff, 2012). More recently, however, researchers have tried to study racism as a chronic stressor and its impact on human biology and disease development, as racism in all forms presents a unique stressor experienced by visible racial groups (Shonkoff et al., 2021). Not only is the experience of racism a stressor and a threat to allostasis, the perception of threat and sustained hypervigilance results in a higher allostatic load (Berger & Sarnyai, 2015).

Systemic or institutional racism creates challenging environments, negatively impacting the way in which people of colour navigate through the world and can have devastating impacts on individuals, families, and communities. For example, Owusu-Bempah and Wortley (2014) noted that Black Canadians were significantly overrepresented in federal correctional institutions. The federal correctional system houses offenders with a sentence of two years or greater, in contrast to the provincial

correctional system, which houses offenders with a sentence of less than two years and those awaiting trial (Owusu-Bempah & Wortley, 2014). It is important to note that the provincial segment does not release statistics on the racial composition of its correctional population, but instead, use the data for intelligence purposes (Owusu-Bempah & Wortley, 2014). Data were analyzed from 2011 federal statistics and 2006 Canadian census, which revealed that while Blacks represented only 2.5% of the Canadian population, they represented 8.4% of all federally supervised offenders. Similarly, Aboriginal populations were also over-represented in the federal justice system, representing 18.5% of offenders, while only representing 3.8% of the Canadian population. This is in contrast to Whites, who represent 80% of the Canadian population and represent 60% of the correctional population. The authors note that aside from Hispanics and West Asians, whose population representation is equal to their representation in corrections, all other racial minority groups were significantly underrepresented in the federal corrections system. However, Black and Aboriginals were grossly overrepresented, highlighting the prevalence of anti-Black and anti-Aboriginal racism within the justice system. They further highlighted the discrimination that exists within the operation of the Canadian police, criminal courts, and correctional institutions. Institutional racism, such as that observed within the criminal justice system, is a direct cause of trauma, resulting in stressful environments that promote disproportionate health disparities among racial and ethnic groups (Shonkoff et al., 2021).

The impact of systemic racism is also apparent within educational institutions. A review of the Peel District School Board (PDSB) in Ontario was completed in response to concerns of systemic and anti-Black racism. The reviewers found that Black secondary students were overrepresented in school suspensions. While Black students only represented 10.2% of the secondary school population, they represented over 22.5% of student suspensions; no data disaggregated by race was available at the elementary level. Qualitative data from the PDSB review revealed that teachers and principals were more likely to unnecessarily escalate minor issues resulting in suspensions or police involvement leading to arrests and the censure of Black children at an early age. The review also revealed that Black students were more likely to be streamed into non-academic programs, noting that only 7.7% of Black secondary school students were enrolled in academic courses, while 21.7% were enrolled in applied courses, and 25.4% were enrolled in the locally developed credit course stream. The various streams impact whether the child can attend university. For example, the academic stream supports entrance requirement for university admission (Chadha et al., 2020), the applied stream supports entry requirements of college or diploma-level programs, and the locally developed pathway does not support college or university entrance, but rather entry into the workplace (Chadha et al., 2020; James & Turner, 2017).

Likewise, a report by James and Turner (2017) demonstrated systemic racism within the Toronto District School Board (TDSB). Researchers analyzed the data of high school students, 5,679 of whom self-identified as Black, 27,211 who identified as another

racialized group (e.g., South Asian, Chinese, Latin American, etc.), and 17,921 who identified as White. In the Academic stream, 53% of Black students were enrolled, compared to, 81% of White, and 80% of other racialized students. Black students were more than two times as likely to be enrolled in the Applied stream (39%), in comparison to Whites and other racialized students (16% and 18% respectively) and three times as likely to be enrolled in the Locally Developed stream than White and other racialized students (9% compared to 3% of White and 3% of other racialized students).

Additionally, data from both the PDSB and TDSB reviews demonstrated that those in Academic programs were more likely to graduate high school (approximately 90%) than those in the Applied stream (approximately 34%). The TDSB review further found that university offer of admission was closely related to educational stream, with 59% of Grade 12 students who took most of their courses at the academic level having confirmed an offer to an Ontario university. In contrast, there were no university confirmations for students who were in non-academic streams. Recent research has demonstrated that income is positively correlated with education level, in that those with a bachelor's degree, on average, earn more than those with a college diploma or with no post-secondary education (Frenette, 2019). Frenette (2019) further noted that a university education is more strongly associated with higher earnings for youth from lower-income backgrounds, when compared to those from medium and top income backgrounds. The findings of the PDSB and TDSB have significant implications for Black Canadian children, as most Black Canadians live in the Greater Toronto Area, with 442,015 living

in Toronto (Statistics Canada, 2017a) and 131,060 living in Peel Region (Statistics Canada, 2017b), making up approximately 47% of Canada's Black population according to 2016 census data.

Studies have demonstrated a link between the experiences of racial discrimination and chronic disease and poor health outcomes, as such, researchers have suggested that the definition of ACEs should be expanded to include exposure to racism and discrimination (Loe et al., 2019; Shonkoff et al., 2021). Racial minorities have an increased risk of developing several diseases that are associated with the experience of toxic stress, such as cardiovascular disease, diabetes, and cancer (Landrine & Corral, 2009). Epidemiological research has often attributed these racial disparities to genetic variations, an increased tendency to engage in health-damaging lifestyle choices, and challenges associated with a low socioeconomic status (Kneipp & Drevdahl, 2003). However, newer research has demonstrated that the impact of systemic racism on social and physical environments have a greater role in the development of illness in adulthood (Shonkoff et al., 2021). For example, several U.S. based studies have described the increased vulnerability in the experience of ACEs among racialized groups and the association between ACEs and chronic illness in adulthood (Duru et al., 2012; Morsy & Rothstein, 2019; Slopen et al., 2016; Sofer; 2019). A Canadian study conducted by Siddiqi et al. (2017) showed that adults who experienced discrimination were at an increased risk for chronic disease. Although the researchers did not specifically study the effects of racism in children, their findings were additive in that adverse experiences

increased the chances of developing chronic disease and that Black people were more likely to experience discrimination when compared to other races.

Other Canadian studies have found associations between the experience of early adversity and mental and physical health conditions in adults (Patten et al., 2015; Patten et al., 2016), but very few research studies have explored the relationship between ACEs and health conditions in visible minorities, especially including racism in the definition of ACEs. The lack of literature on the experiences of adversity and its lifetime impact on the health and well-being of racialized Canadians creates the appearance that socioeconomic inequities and racial disparities are marginal. Rodney and Copeland (2009) maintain that most view Canada as a more egalitarian society when compared to the U.S. As such, globally, there has been a tendency to erroneously assume that there are fewer socioeconomic inequities and health disparities than our American counterparts. This is often attributed to population health indicators such as life expectancy and infant mortality rate, which has Canada ranked among the highest developed nations (Organisation for Economic Co-operation and Development [OECD], 2022a; OECD, 2022b; Statistics Canada, 2018). However, notably, the limited amount of research on health and socioeconomic disparities within the context of race and ethnicity in Canada and Statistics Canada's use of broad categories such as 'visible minorities' as surrogates for race and ethnicity potentially conceal underlying social and health inequities between groups (Rodney & Copeland, 2009).

The extended body of research on the psychological and physiological impact of toxic stress needs additional studies that focus on racialized Canadian children who experience systemic racism as an additional traumatic experience (Morsy & Rothstein, 2019; Shonkoff et al., 2021). This study will focus on the experiences of toxic stress in children and its effect on social and health outcomes; the study will also address the effect of stress on racialized children and youth. Further, this study will describe the social mechanisms and processes that increase vulnerability to toxic stress among children. Lastly, this thesis will discuss ways in which nurses and other allied heath care professionals can help prevent or mitigate the negative effects of toxic stress among children. The practice of nursing is diverse and ubiquitous, reaching stress-vulnerable populations. As such, nurses have the capacity to create and promote adequate screening and interventions on personal, organizational, and systemic levels to ameliorate the impacts of toxic stress.

Chapter 2: A Review of the Literature

This literature review is based on a systematic search of databases for research articles that were published between January 2000 and January 2022. Keywords searched included 'allostatic load in children', 'allostatic load in Black children,' 'toxic stress in children,' and 'toxic stress in Black children' within the following databases: CINAHL, PUBMED, Medline, and Google Scholar. The scientific literature was initially screened for relevance by reviewing titles and abstracts. Inclusion criteria were articles that provided an operational definition of the term toxic stress and discussed socioeconomic factors surrounding toxic stress or allostatic load in children. Literature was excluded if the article discussed toxic stress resulting from hospital procedures (n=4), war/conflict (n=2), was presenting proposed studies (n=2), or if it centred around the impacts of COVID-19 (n=2). A total of 42 publications were included in this literature review.

An Overview of Toxic Stress in Children

Experiences of adversity during the early years of life have a significant impact on physical and mental health outcomes across the lifespan. These experiences of adversity act as stressors, evoking a physiological response within the body. A ground-breaking study conducted by Felitti et al. (1998) examined the relationship of disease in adulthood to the breadth of exposure to abuse and household dysfunction during childhood. The study included 13, 494 adults, and researchers analyzed seven categories of adverse childhood experiences (ACEs): psychological, physical, or sexual abuse; violence against mother; or living with household members who were substance abusers,

mentally ill or suicidal, or ever imprisoned. After adjusting for effects of demographic factors on the association between the cumulative number of categories of childhood exposures, the researchers found that those who had experienced four or more categories of childhood exposure to adverse experiences, compared to those who had experienced none, had a 4- to 12-fold increased risk for alcoholism, problematic substance use, depression, and suicide attempts; a 2- to 4-fold increase risk of smoking, poor self-rated health, having more than 50 sexual intercourse partners, and sexually transmitted diseases; and 1.4- to 1.6-fold increase risk for physical inactivity and severe obesity. The findings also suggested that childhood ACEs were positively correlated with the presence of adult diseases including ischemic heart disease, cancer, chronic lung disease, skeletal fractures, and liver disease. Overall, findings concluded that there was a strong relationship between exposure to abuse or household dysfunction during childhood and multiple risk factors for several leading causes of mortality and morbidity in adulthood. While the ACEs in the study incompletely represented the breadth of childhood adversities (Finkelhor et al., 2013; Shonkoff et al, 2012), it was the first study to demonstrate a relationship between childhood adversity and morbidity and mortality in adulthood and to demonstrate that the effects of adversity appears to be dose dependent (Felitti et al., 1998), meaning that the greater the number of traumatic events experienced over time, the worse the effect (Felitti et al., 1998). Research has consistently demonstrated that more cumulative adversity is associated with disproportionately poorer mental and physical health (Hughes et al., 2017; Jia et al., 2020; Scott-Storey, 2011).

Strides have been made to better understand the psychological and physiological impacts of childhood adversity (McEwen & McEwen, 2017). The exact etiology of how adversity in the early years impacts the developing brain and body is not completely understood, however, evidence suggests that the dysregulation of the physiologic stress response has a significant role in the development of poorer health outcomes (Bucci et al., 2016; McEwen & McEwen, 2017). Exposure to stressors (defined as he experience of physical, emotional, or environmental stress) triggers the activation of the brain's amygdala, which is responsible for detecting and signaling environmental threats to the hypothalamus in order to promote survival (Harvard Health, 2020). Function of the amygdala is regulated by the hippocampus, which is responsible for learning and memory; the prefrontal cortex, which is responsible for cognition and executive functions; and the locus coeruleus, which mediates the autonomic response during the stress response (Bucci et al., 2016). Once the signal is received by the hypothalamus, the hypothalamus communicates with the rest of the body through the autonomic nervous system (ANS), activating the hypothalamic-pituitary-adrenocortical (HPA) axis, thereby triggering the stress response (Harvard Health, 2020; Joos et al., 2019).

The ANS is responsible for regulating involuntary body functions such as breathing, heart rate, blood pressure, and the dilation or constriction of blood vessels as well as the bronchioles in the lungs (Harvard Health, 2020). The ANS is comprised of two components, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) (Harvard Health, 2020). The SNS is responsible for the stress response,

also known as the ‘fight-or-flight’ response resulting in a sudden increase of energy and elevated levels of stress hormones such as adrenaline, cortisol, and norepinephrine (Bucci et al., 2016; McEwen & McEwen, 2017; Shonkoff et al., 2012). When released, these hormones affect multiple organs, including the brain. Collectively, this stress response is normally healthy and protective occurring when a danger or a threat to survival is perceived by an individual (McCarty, 2016; McEwen, 2000). This activation diverts blood flow from areas of the body associated with resting (e.g., the digestive system) to areas that enable the individual to emergently mobilize to avoid harm, such as the brain, heart, lungs, and major muscles (Bucci et al., 2016; McEwen & McEwen, 2017; Shonkoff et al., 2012). Activation of the fight-or-flight response results in physiological changes leading to an increased heart rate, respiratory rate, blood pressure, and enhanced oxygenation of the brain and other tissues to improve alertness, vision, and hearing (Bucci et al., 2016; McEwen & McEwen, 2017; Shonkoff et al., 2012).

From an evolutionary perspective, the fight-or-flight response is an adaptive instinct that developed in response to predators or environmental stimuli that threatened human survival (Harvard Health, 2020). This ‘fight-or-flight’ activation is a protective response to stressors, that continues to aid in survival today (such as defending oneself or fleeing from harmful situations) (Bucci et al., 2016). Once the perceived threat has passed, the fight-or-flight response is deactivated by the parasympathetic system. Parasympathetic neurons balance the activation of the sympathetic system, thereby inducing a ‘rest and digest’ state in the body (Bucci et al., 2016; Jiang et al., 2019;

McEwen, 2000). The PNS functions to conserve energy, relax the body, and return physiological functions back to normal, thus achieving *allostasis* (McEwen & McEwen, 2017; Shonkoff et al., 2012). In other words, allostasis refers to the processes the body undergoes to adapt to stressful environmental challenges to achieve balance (McEwen, 2000).

Allostasis differs from homeostasis, in that, homeostasis refers to processes responsible for maintaining body systems within strict parameters optimal for survival and functioning (such as blood pH or body temperature), whereas allostasis refers to maintaining stability through altering physiologic parameters specifically to counteract challenges (Ramsay & Woods, 2014). Allostatic systems are adaptive and have a broader range of operating levels; they aim to produce the optimal level of various physiological parameters to respond to a perceived threat (McEwen, 2000; Ramsay & Woods, 2014). To achieve allostasis, the ANS, the immune system, the HPA axis and cardiovascular systems are all mobilized (McEwen, 2000; Ramsay & Woods, 2014;). Further, the body activates processes necessary for successful adaptation and to prevent a hyper-response to stressors (Bucci et al., 2016; Jiang et al., 2019). Negative feedback is triggered by the release of cortisol, at the level of the hypothalamus to stop the activation of the HPA axis, preventing consequential deleterious health effects, such as chronic or prolonged elevation of blood pressure or heart rate (Bucci et al., 2016; Jiang et al., 2019; McEwen, 2000; McEwen & McEwen, 2017). This complex physiological response to stressors

promotes survival, but when exposure to stressors is prolonged or unrelenting, problems can arise.

Stress

Positive Stress

Positive stress is ephemeral, infrequent, and mild to moderate in magnitude, characterized by brief increases in heart rate and mild elevations in hormone levels (Franke, 2014; Shonkoff et al., 2012). Examples include the first day of school, taking a test, or learning a new task (Shonkoff, 2010). Positive stress is crucial for healthy growth and development in children, as the child then learns to engage in healthy responses to adapt to adverse experiences that are part of life (Bucci et al., 2016; Franke, 2014; McEwen & McEwen, 2017; Shonkoff et al., 2012). Among children, the support of a caring adult or a nurturing environment buffers the potential negative impact of the stressor, and supports the child in being able to cope, thereby allowing the neurohormonal response to return to baseline (Franke, 2014; Shonkoff et al., 2012).

Tolerable Stress

In contrast to positive stress, tolerable stress results in an even greater activation of the stress response as a result of more severe, recurrent, or prolonged experiences of challenges, such as the death of a loved one or divorce (Bucci et al., 2016; Franke, 2014; Shonkoff et al., 2012). The neurohormonal response activated during times of tolerable stress has the potential to cause physiologic harm and negatively affect brain architecture (McEwen & McEwen, 2012). However, if the activation of the stress response is time-

limited and buffered by positive relationships with adults to help the child adapt, the brain and other organs recover from what might otherwise be damaging effects (Center on the Developing Child, 2021; Franke, 2014; Shonkoff et al., 2012). Integral to the idea of mitigating or minimizing the negative effects of both positive stress and tolerable stress in children is the presence of a caring and responsive adult who helps the child cope with the stressor, thereby buffering the impact of the stressor, which facilitates the return of stress response systems back to baseline (Center on the Developing Child, 2021; McEwen & McEwen, 2017; Shonkoff et al., 2012). Positive and tolerable stress builds motivation and resiliency (Garner, 2013).

Toxic Stress

Toxic stress, a type of chronic stress, can occur when a child experiences severe, frequent, and/or prolonged adversity, such as abuse (sexual, physical, emotional), exposure to violence, chronic neglect, caregiver substance abuse or mental illness, and/or the accumulated burdens of family economic hardship (Franke, 2014; McEwen & McEwen, 2017; Shonkoff et al., 2012). A defining difference between tolerable stress and toxic stress is the presence or absence of sufficient social-emotional buffering (Garner, 2013). If the experience of stress is not buffered, for example, by supportive caregiving and effective coping mechanisms, the body may fail to regulate the stress response, resulting in toxic stress (Bucci et al., 2016; Center on the Developing Child, 2021; McEwen & McEwen, 2017; Shonkoff et al., 2012). This dysregulation can lead to a prolonged activation of the HPA axis and a dysregulation of the release of the stress

hormones (Bucci et al., 2016; Center on the Developing Child, 2021; McEwen & McEwen, 2017; Shonkoff et al., 2012). Resultantly, the circulating stress-induced hormones, overtime, may become chronically excessive or chronically deficient (Bucci et al., 2016; Joos et al., 2019; Shonkoff et al., 2012). Over time, these stressors come at a price known as 'allostatic load' (Katz et al., 2012; McEwen, 2012), which is the cumulative "wear and tear" on the body as a result of exposure to chronic or recurrent stressors (McEwen, 2012; McEwen & McEwen, 2017).

Allostatic load is the result of longstanding failed adaptation or allostasis, resulting in pathology and leading to chronic illness (McEwen, 2000). In children, it is known that without mediation, for example from strong social and emotional supports or the presence of a caring adult, chronic or severe stress during the early years can encumber the body's ability to maintain allostasis, results in allostatic load causing an unbalanced physiological state (McEwen, 2012; McEwen & McEwen, 2017; Shonkoff et al., 2012). This prolonged activation of the stress response systems can disrupt the development of brain architecture and other organ systems and increase the risk for stress-related disease and cognitive impairment, well into the adult years (Franke, 2014; Katz et al., 2012; McEwen & McEwen, 2017; Shonkoff et al., 2012).

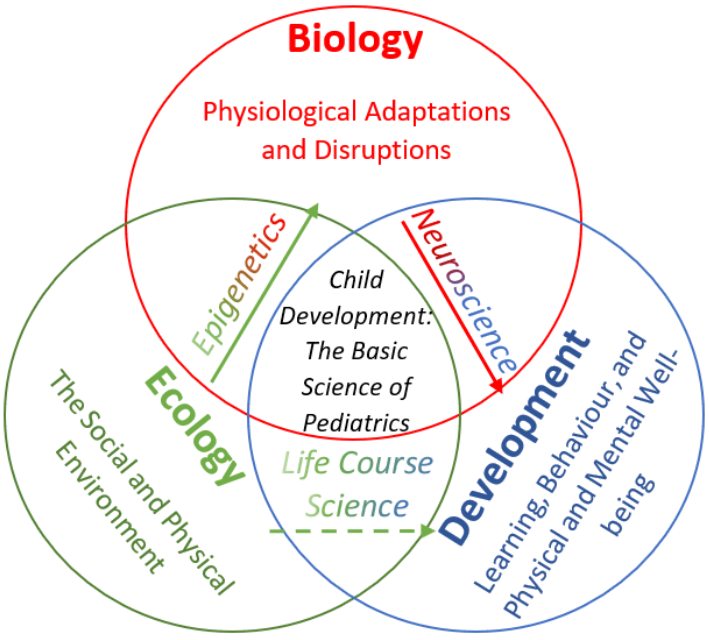
Conceptual Framework

The impact of ACEs on childhood development is best when understood in the context of the Ecobiodevelopmental (EBD) framework. Shonkoff's (2010, 2012) EBD framework was created to describe causal pathways responsible for overexposure to

ACEs and disparities in health. The EDB model is an appropriate framework as its purpose is to facilitate understanding of the complex relationships between ACEs, toxic stress, and brain architecture, and the impact of ACEs on physical and mental health in adulthood (Shonkoff, 2010). Moreover, it was created as a tool to foster the development and implementation of science-based strategies to address and reduce toxic stress in the early years, by improving social conditions that are often associated with disparities in learning, behaviour, and health (Shonkoff, 2010, 2012).

Figure 1

Ecobiodevelopmental Model



Note. Adapted from "The Lifelong Effects of Early Childhood Adversity and Toxic Stress" by J. Shonkoff, A. Garner, and The Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption,

and Dependent Care, and Section on Developmental and Behavioral Pediatrics, 2012, *American Academy of Pediatrics*, *129*(1), e232–e246. Copyright 2012 by the American Academy of Pediatrics.

The EBD model maintains that the processes involved in childhood development include both biological and ecological (social environment) mechanisms (Garner & Yogan, 2021). Rather than the idea of "nature versus nurture," the EBD model proposes that child development is "nature dancing with nurture over time" (Shonkoff et al., 2012, p. e234). Shonkoff et al. (2012) assert that the interaction of the child's biology and the social environment in the early years has a major influence on health and development across the lifespan.

The purpose of the model was to facilitate the understanding of the interplay of childhood experiences and the origins of disease and wellness (Garner & Yogman, 2021; Shonkoff et al., 2012). Drawing from the evidence, the EBD model explains that the "dance" between biology and ecology results in changes at the molecular, cellular, and behavioural level (Shonkoff et al., 2012). These changes have a significant impact on cognition, behaviour, and the development of disease. As such, our current understanding of health and wellness needs to be shifted toward enhancing the life of children and preventing major adversities in childhood (Garner & Yogman, 2021; Shonkoff et al., 2012). Additionally, the model suggests a focus on stable, nurturing relationships between children and parents and/or other engaged adults to both buffer adversity and promote resilience at all levels (family, community, societal) (Garner & Yogman, 2021).

The goal of the model is to provide an understanding of the childhood origins of adult-manifested diseases and to provide a framework to inform clinical practice and public policy to improve the health and well-being of individuals, families, and communities (Garner & Yogman, 2021; Shonkoff et al., 2012).

Impact of Toxic Stress on Biological Systems

The relationship between toxic stress and its impact on biological systems has been well established. It is known that the consequences of toxic stress are profound, often resulting in persistent inflammation, acceleration of the aging process, modification of brain architecture, and epigenetic changes (McEwen, 2013; McEwen & McEwen, 2017), leading to long term negative changes in multiple biological systems which increases the risk of developing behavioural, cognitive, mental, and physical health challenges (McEwen & McEwen, 2017; Shonkoff et al., 2012). In fact, the impact of the experience of chronic or severe adversity in childhood extends far beyond the early years. Animal and human studies have demonstrated that adversity occurring as early as the prenatal period produces a brain and body that have increased vulnerability to physiological and psychosocial stressors that may arise in later years (Bale, 2014; McEwen & Akil, 2020; Peña et al., 2017; Shonkoff et al., 2021).

More specifically, long-term exposure to psychosocial stressors results in structural and functional abnormalities in the prefrontal cortex, the amygdala and the hippocampus (McEwen & Gianaros, 2011). The development of foundational neural circuits occurs during mid to late fetal, infant, and toddler periods (Shonkoff et al., 2021).

It is during these periods that the brain is exceptionally plastic and sensitive to neural and immune feedback, systemic hormones, and endogenous neurochemicals on its circuitry and how it responds to stimuli (Shonkoff et al, 2012; Shonkoff et al., 2021). A systematic review of the impact of allostatic load in childhood conducted by Danese and McEwen (2012) found that children exposed to adversity had a smaller prefrontal cortex volume, greater activation of the HPA axis, and elevated systemic inflammatory markers when compared to children who did not experience adversity. This finding was also consistent in adults who had a history of childhood maltreatment when compared to adults who did not have a history of maltreatment in childhood (Danese & McEwen, 2012). Further, childhood maltreatment has also been associated with elevated inflammatory biomarkers in adults, including C-reactive protein, interleukin-6, and tumour necrosis factor (Shonkoff et al., 2021). Persistent inflammation suppresses the immune system, putting the individual at risk for developing a variety of chronic health conditions (Bucci et al., 2016; Forkey, 2018). Evidence also suggests that adults who experienced childhood adversity are more likely to experience physical illness and poorer health outcomes compared to adults without such adverse experiences in childhood (Franke, 2014). Lifelong consequences include greater risk for asthma (Barnthouse & Jones, 2019), autoimmune diseases, cardiovascular diseases, diabetes (Center on the Developing Child, n.d.), cancer (Franke, 2014), obesity, depression (Center on the Developing Child, n.d.), anxiety, post traumatic stress disorder, substance use disorders, suicide, and premature

death in adulthood (Bucci et al., 2016; Franke, 2014; McEwen & McEwen, 2017; Merill et al., 2021; Peña et al., 2017; Shonkoff et al., 2012).

The effects of toxic stress can also cause alterations in the structure and function of the developing brain (McEwen & McEwen, 2017). Regions of the brain responsible for learning, memory, executive functioning (prefrontal cortex, hippocampus, and amygdala) are especially sensitive to the impacts of prolonged stress, due to the abundance of glucocorticoid receptors on those structures (Chen & Baram, 2016). Excessive exposure to high levels of stress hormones such as cortisol (a glucocorticoid) suppresses neurogenesis in the hippocampus (Bucci et al., 2016; Chen & Baram, 2016; McEwen & McEwen, 2017). As a result, the child is at greater risk for learning and behavioural problems (Bucci et al., 2016; Jiang et al., 2019; McEwen & McEwen, 2017).

The impact of ACEs not only shapes biology in terms of its direct effects on the HPA axis and bodily functions, but also epigenetically (Bucci et al., 2019; Jiang et al., 2019). Epigenetics involves heritable changes in the activity and expression of genes without alterations in DNA sequence (Bucci et al, 2016, CDC, 2020a; Jiang et al., 2019). Environmental conditions (including social environment) can alter gene expression by various processes, such as DNA methylation, histone modification, and non-coding RNA (CDC, 2020a; Jiang et al., 2019). While the pathways vary, essentially, environmental signals and conditions can modify the ways in which proteins interact with or bind to DNA, thus affecting the information that RNA messenger molecules take from the DNA, switching genes “on” and/or “off” (CDC, 2020a). These chemical processes that switch

on and off various parts of the genome are characterized as epigenetic (Bucci et al., 2016; Jiang et al., 2019). Researchers note that epigenetic processes are extremely sensitive to early childhood adversity, when organ systems are still developing, resulting in long-term deleterious mental and physical health outcomes (Bucci et al., 2016; Jiang et al., 2019; McEwen & McEwen, 2017). As such, epigenetic regulation caused by a chronically dysregulated stress response (toxic stress) can affect how organ systems respond to stress in adulthood, potentially resulting in an increased risk of chronic disease (Bucci et al., 2016). Supportive environments, however, can generate positive epigenetic changes, even after negative epigenetic modifications have occurred, demonstrating the possibility of the reversal or restoration of physiological functioning through positive relationships, such as that with a supportive adult caregiver (Bucci et al., 2016, McEwen & McEwen, 2017).

Factors Increasing Vulnerability in Children

Race and Ethnicity

People of colour are more likely to experience adverse childhood experiences than their White counterparts (Duru et al., 2012; Morsy & Rothstein, 2019; Sofer; 2019). Further, McCune and colleagues (2021) examined sources of toxic stress of 78 families in Maywood, Illinois, a community noted by the authors to have high rates of poverty, violence, and significant barriers to accessing healthcare. Researchers found that Black respondents were 11.5 times more likely than non-Black respondents to report that their child was exposed to violence in the community – even after controlling for concern

about their child's behavior which served as a surrogate measure of the child's exposure to toxic stress ($p = 0.001$). Despite being underpowered, the findings of the study are in alignment with Slopen et al.'s study (2016) examining the interaction of race/ethnicity and socioeconomic status on the risk for exposure to ACEs. After analyzing the data of 84,837 children from the National Survey of Child Health in the United States, researchers found, among children of American-born parents, exposure to ACEs was more common among Black and Hispanic children compared to White children. Among participants who experienced two or more ACEs, almost 33% were Black, 31% were non-Black Hispanic, and 22% were White ($p < 0.05$*).* Further, they found significant findings for Black immigrant families in which almost 21% of children experienced two or more ACEs ($p < 0.05$*)* compared to 14% of White and 17% of Hispanic children ($p < 0.05$). Likewise, Maquire-Jack et al. (2020) found that the experience of ACEs was positively associated with child race/ethnicity. After analyzing the data of 50,212 children from the 2016 National Study of Child Health, researchers found that 59% of White children, 49% of Latinx children, and 36% of Black children had no ACE exposure ($\chi^2 = 197.5$, $p < .001$). They further noted approximately 34% of Black children in the sample experienced two or more ACEs, compared to 22% of Latinx children and 14% of White children.

Even before birth, it has been found that prenatal exposure to stress and adversity has implications on the health and well being of children. For example, researchers conducted a longitudinal study of predominantly young urban socioeconomically

disadvantaged Black and Latina women (N = 704, mean age = 18.53 years), and assessed the impact of discrimination during pregnancy on infant development at six months and one year (Rosenthal et al., 2018). The researchers found that women's reports of everyday discrimination during pregnancy prospectively predicted greater inhibition (i.e., intense anxiety of the unknown) and separation problems ($p < .001$ at six months; $p < .001$ at one year) and negative emotionality (NE), referring to the propensity to experience and express more negative emotions, such as fear, anger, or irritability, in their six-month and one-year old infants ($p < .001$ at six months; $p < .001$ at one year), while controlling for intervention condition, age, race/ethnicity, nativity, education level, employment status, food insecurity, relationship status, parity, infant preterm or low birth weight, and any neonatal intensive care unit stay (Rosenthal et al., 2018). A study conducted by Condon and colleagues (2019) examined the association between maternal experiences of discrimination and child biomarkers of toxic stress in a multiethnic, urban sample of Black and Hispanic mother-child dyads (N=54) living in low-income neighborhoods. The researchers found that maternal discrimination was associated with significantly increased salivary interleukin-6 levels, a known biomarker of toxic stress, in children aged four to nine years old ($\beta=0.15$, $p=.02$). Although the study was underpowered and needs to be replicated, it was the first to associate biomarkers of stress with maternal experiences of discrimination.

Additionally, the impact of systemic racism has profound effects on the socioeconomic environments in which Black people must function (Feagin, 2006).

Systemic racism is a form of racism that is entrenched in the laws, policies, and practices of established institutions, resulting in the oppression of designated groups (Alberta Civil Liberties Centre, 2021). Systemic oppression manifests as discrimination in areas such as criminal justice, employment, housing, health care, education, and political representation (Alberta Civil Liberties Centre, 2021). It differs from individual or overt discrimination, in that, no individual intent is necessary (Alberta Civil Liberties Centre, 2021). Systemic racism produces unhealthy environments, resulting in communities with institutions and systems that are oppressive, slow-responding and under-resourced, and disproportionately affect people of colour (Williams Shanks & Robinson, 2013).

Additionally, racial and ethnic bias is likely responsible for differences in medical care, living conditions, education and employment (Shonkoff et al., 2021). Blacks are more likely to live in poor neighbourhoods that are under resourced, have suboptimal living and working conditions, with education systems that lack quality teachers and resources (Shonkoff et al., 2021; Williams Shanks & Robinson, 2013). Several studies have documented the disparities between racial groups, noting that Whites are significantly more likely than Blacks and Hispanics to attain a bachelor's degree, earn a higher income, and own assets (Williams Shanks & Robinson, 2013). Racialized groups are more likely to be impoverished than their White counterparts (Block et al., 2019) and as such, they are more likely to have adverse experiences in childhood (e.g., hunger, violence, discrimination, property loss), which in turn increases their vulnerability to toxic stress (Williams Shanks & Robinson, 2013). To further add to this, those who are

impoverished are often less resourced to access supports to manage the feelings and experiences of stress, which in turn increases their vulnerability to toxic stress and its negative health impacts (Francis et al., 2018).

The impact of systemic racism results in the creation of environments, institutions and social systems that increase susceptibility to stress in Black children (Shonkoff et al., 2021). A report by Morsy and Rothstein (2019) found that Black children were 45% more likely than White children to be exposed to frightening or threatening experiences, such as physical abuse, sexual abuse, psychological abuse, neglect, living with someone with substance abuse problems or mental illness, seeing their caregiver treated violently, or having a parent incarcerated. Reasons for this can be attributed to chronic stress experienced by caregivers, living in unsafe and under resourced neighbourhoods, and the direct impact of experiencing racism and discrimination on both individual and systemic levels (Morsy & Rothstein, 2019).

Locating Canadian research that explored the experience of ACEs and the increased vulnerability to disease development, while scarce were present (see Jacob et al., 2019). However, Canadian studies that specifically looked at ACEs in the context of race was more difficult. For example, a study conducted by Patten et al. (2015) linked data from the Canada's National Longitudinal Survey of Children and Youth (NLSCY) to data from the National Population Health Survey and found that the cumulative experiences of ACEs were associated with depression, alcohol use and painful conditions

in Canadian adults. While the study did not explore racial associations, its findings elucidate the childhood origin of illness in adulthood.

Socioeconomic Status and Poverty

Socioeconomic status (SES) is a strong predictor of vulnerability to toxic stress (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). SES is defined as the social standing or class of an individual or group, which is often measured as a combination of education, income, and occupation (American Psychological Association, 2020c). People with lower SES face barriers accessing health services, good quality education, and social supports (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). Qualitative studies have demonstrated that food insecurity (Chilton & Rabinowich, 2012; Knowles et al., 2015) and parental experiences of stress related to poverty (Knowles et al., 2015) may lead to experiences of stress for the child. Knowles and colleagues (2015) found that among families reporting food insecurity, participants expressed that they had difficulties protecting their children from stress and depression. Healthy child development is strongly associated with greater income, wealth, family assets, stable professions, and living in well-resourced neighbourhoods (Williams Shanks & Robinson, 2013).

The effects of poverty on health and education are severe because poverty reduces the types and number of resources available to children and their families (Williams Shanks & Robinson, 2013). Consequently, poverty and scarce resources increase the number of environmental stressors that children and their families are exposed to. The

relationship between the experience of toxic stress and socioeconomic status, and especially poverty, has greater impact for people of colour. Selvaraj and colleagues (2019) screened 2569 families and children for risk factors for toxic stress. Risk factors were defined as unmet social needs within the family, such as lacking parental education, parental employment, childcare, food security, housing and bill security, and in need of legal aid. Selvaraj and colleagues (2019) found higher rates of risk factors for toxic stress were associated with being African American and Hispanic compared to those who were White. The combined effects of poverty and racism resulted in an increased vulnerability to toxic stress and to its consequences for people of colour.

Poverty coexists with several environmental stressors such as inadequate housing, housing insecurity, food insecurity, neighbourhood violence, and parental unemployment (Cox et al., 2018; McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). The adversity and stress that accompanies long term poverty results in biological changes that alter brain architecture and function (Blair & Raver, 2016; Williams Shanks & Robinson, 2013); such alterations can manifest in the form of struggles with school readiness and learning (McEwen & McEwen, 2017; McGruder, 2019; Williams Shanks & Robinson, 2013). Jackson et al. (2021) utilized data from the National Survey of Children's Health to assess the health and well-being of 15,402 preschool-aged (three to five years old) children. They measured school readiness using four indicators: early learning skills, self-regulation, social-emotional development, and physical health and motor development. The researchers found that among children who were exposed to three or more ACEs,

only one in five were on track across all domains in comparison to one in two children who were not exposed to ACEs. The findings suggest that the effect of early childhood adversity has a negative impact on school readiness in preschool-aged children.

Toxic stress in childhood affects complex life course processes, often leading to intergenerational poverty. Evidence of this relationship is provided in the review by McEwen and McEwen (2017), who pointed to the cumulative toxic stressors in the social environment during early childhood (such as the conditions created by household and neighborhood poverty) and to the evidence of its lasting effects on the development of the brain's frontal lobes, amygdala, and hippocampus. McEwen and McEwen (2017) reviewed selective studies from varied areas of biology (epigenetics, neuroscience, and child development) and sociology (mental health, poverty, education, family, neighborhood, and life course development). They found that in the absence of strong protective factors, biological systems that normally produce adaptation often become dysregulated in response to toxic stress. The toll of toxic stress had a pervasive and potent influence on self-regulation and on how effectively individuals used their cognitive skills to engage with their environments (see also Bucci et al., 2016). With weaker self-regulation and poorer executive function, young children experience increased difficulty in paying attention, organizing and sequencing tasks, resisting impulses and immediate gratification, controlling anger and aggression, and engaging in proactive planning (McEwen & McEwen, 2017). These in turn manifest in poor school readiness and eventually school achievement, with long-term implications on the attainment of post-

secondary education, job status, and asset ownership, resulting in intergenerational poverty and intergenerational toxic stress (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013).

Family Context

Financial Stress

Socioeconomic status is strongly linked to family structure and dynamics, which influences child development (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). Families with scarce resources and multiple children or dependents have increased difficulty providing for their members (Williams Shanks & Robinson, 2013). Stressors associated with poverty affect interpersonal relationships and can increase the risk for marital conflict and lack of maternal warmth (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). Maternal warmth is a strong buffer against the effects of toxic stress in children (Frank, 2014).

Parental Separation/Divorce

Researchers ascertain that parental separation/divorce is linked to an increased vulnerability to toxic stress (Bucci et al, 2016; Garner, 2013). Parental separation alters the family dynamic in several ways. A systematic review analyzing the impact of socioeconomic class and toxic stress in children noted that children of mothers who cohabit with the biological father often fare better than children of single mothers (Williams Shanks & Robinson, 2013). Researchers reported that single-mother households have an increased likelihood of experiencing poverty than dual parent

households. Economic stress on families weakens the capacity of families to protect their children from the disruptive effects of toxic stress (McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). Moreover, divorce or separation can result in exposure to conflict which may be stressful for the developing child (Shonkoff et al., 2021).

Caregiver Mental Illness

Adult mental illness in the household, particularly caregiver mental illness, has been identified as an ACE in several publications (see Center on the Developing Child; Felitti et al., 1998; McEwen & McEwen, 2017; Williams Shanks & Robinson, 2013). While none specifically identify why caregiver mental illness can be a toxic stressor, researchers maintain that the presence of supportive caregiver is a powerful buffer against toxic stress and that the absence of such greatly increases vulnerability to it (Bucci et al., 2016; Center on the Developing Child, 2021; McEwen & McEwen, 2017; Shonkoff et al., 201.

Exposure to Violence/Abuse

The original ACE study (Felitti et al., 1998), along with several more recent publications (see Center on the Developing Child, 2021; Jiang et al., 2019; McEwen & McEwen, 2017) have been associated with an increased stress response, leading to epigenetic changes and poor physical and mental health outcomes. It is of importance to note that the literature does not limit exposure to violence and abuse within the household, as it can also occur outside the home (e.g., within the neighbourhoods in

which children live, in the school setting, and various other areas in which children may find themselves) (Franke, 2014; McEwen & McEwen, 2017; Shonkoff et al., 2012).

Individual Variations

The magnitude of the response to stressors varies between children, even when in similar circumstances (Franke, 2014; McEwen & McEwen, 2017). In some children, genetic factors may play a role in their ability to effectively cope with stressors (Franke, 2014; McEwen & McEwen, 2017). While natural and social environments play a crucial role in the experience of toxic stress and the resultant health related outcomes, genetics also shapes the experience and response to stress (McEwen, 2007). McEwen (2007) highlighted that some individuals are genetically more vulnerable to respond to stressful experiences by developing depressive disorders, alcoholism, anxiety, and mood disorders. Moreover, epigenetics determines vulnerability to toxic stress (Jiang et al., 2019). As discussed earlier, epigenetics involves the alteration of gene expression, through chemical processes that switch genes on or off, and the heritability of those characteristics (Jiang et al., 2019). As such, children's vulnerability to adverse stress responses (e.g., depressive symptoms, temperament, etc.) may result from their parents' exposure to toxic stress (Reiss et al., 2013). Theories of stress sensitivity suggest that genes may cause some individuals to have either an environmental or a biological sensitivity to stressors (McEwen & McEwen, 2017; Reiss et al., 2013). Those who are environmentally sensitive respond "disproportionately well to positive, supportive environments but disproportionately negatively to adversity" (McEwen & McEwen,

2017, p. 461). In comparison, those who are biologically sensitive respond poorly to family conflicts and parental mental illness but can respond more positively when experiencing parental warmth (McEwen & McEwen, 2017). Research studies further suggest that social environments also have the capacity to make genetic traits more pronounced or suppressed. For example, the genetic influence on a positive trait may increase in response to an adverse environment, suggesting that children may have an inherited capacity to offset social challenges (Reiss et al., 2013).

Conversely, a study conducted by Dich et al (2017) suggested that in highly stressful environments, children with low negative emotionality (NE) were more likely to have a higher allostatic load than children with high NE in the same setting. NE refers to the propensity to experience and express more negative emotions, such as fear, anger, or irritability (Dich et al., 2017). Specifically, the study assessed the combined effects of NE and cumulative risk, such as the confluence of multiple risk factors related to poverty, on a sample of 239 children's internalizing and externalizing symptoms and allostatic load. Internalizing and externalizing behaviors were measured at four- and eight-year follow-ups. Allostatic load was measured at baseline and both follow-up time points using neuroendocrine, cardiovascular, and metabolic parameters. Researchers found that high cumulative risk for allostatic load and low NE were associated with higher levels of allostatic load. Conversely, at high levels of cumulative risk for allostatic load, high NE was associated with lower levels of allostatic load, suggestive of protective effects of NE.

The study concluded that high NE appeared to be protective against the effects of high cumulative risk exposure on allostatic load in children.

Conclusion

The effects of toxic stress in childhood are damaging and long-term, with negative health impacts that extend across the life span (Shonkoff, 2012; McEwen & McEwen, 2017). The EBD model provided a framework to understand the complex and dynamic relationship between the childhood environment and genetics and the development of adulthood disease. The interaction SES, race, and individual variables during the early years shapes ecology, which then becomes embedded biologically – thus impacting gene expression and brain development. As such, the consequences of ACEs and toxic stress have severe and long-term sequelae.

While some evidence exists to suggest that racialized children have an increased vulnerability in the experiences of childhood adversity and racism, there currently is a lack of research examining the effects of early adversity in the development of chronic illness, and even more scarce, the impact of ACEs and toxic stress in racialized Canadian children. This literature review highlights important gaps in what is currently known about the intersectionality of race, socioeconomic status and health inequity and the experience of toxic stress in Canadian children and suggests important direction for research.

Chapter 3: Research Methods and Methodology

Data Sources

This study consisted of two sets of multivariate statistical analysis of secondary cross-sectional data on a sample of children; one on children ages 0 to13 years old, followed by the Canadian National Longitudinal Survey of Children and Youth (NLSCY), Cycle 2 (1996-1997), and one on children ages 12 to 17 surveyed by the Canadian Community Health Survey (CCHS) (2018). The two sets of analyses contributed to a more complete understanding of the factors related to the experience of ACEs compared to analysis using a single data set.

The NLSCY is a longitudinal study conducted by Statistics Canada on Canadian children (Statistics Canada, 2010). The study began in 1994 with a sample of 0- to 11-year-olds, who were followed and interviewed every two years, for 16 years. At every assessment, additional samples increased the number of children in the early years, age 0 to 5, and jump started shorter, longitudinal studies lasting for 6 years (Statistics Canada, 2007).

The purpose of the NLSCY was to follow the development and well-being of children from birth to early adulthood. The study was designed to explore the interplay of factors influencing children's social, emotional and behavioural development and to monitor their impact on children's development over time (Statistics Canada, 2007, para 1). A further objective of the NLSCY was to provide information to aid in the development of effective policies and strategies to help children and youth live healthy

and rewarding lives (Statistics Canada, 1999). The NLSCY provides a detailed collection of information on the health and well-being of over 20,000 children and youth across Canada (Statistics Canada, 1999), offering an adequate sample for my study. Although dated, Cycle 2 of the NLSCY was elicited as it was available through the Data Liberation Initiative at the University of New Brunswick Harriet Irving Library. This cycle had a more robust dataset than the other available cohorts, likely due to increasing attrition with subsequent cycles (Baribeau et al., 2007). It is important to mention the accessibility and usefulness of public use data and to encourage its utilization among researchers.

Several variables and indexes in the NLSCY that are known ACEs and factors increasing vulnerability were identified. The selection of these variables and indexes is consistent with the approach of several studies and existing scientific literature that have identified ACEs responsible for toxic stress (Garner, 2013; McEwen & McEwen, 2017; Shonkoff et al., 2012). The list of variables and indexes from the NLSCY is not exhaustive of all known ACEs and factors increasing vulnerability, but it is sufficient as it addressed various categories of ACEs such as abuse, neglect, chronic state of fear, other traumas (i.e., natural disasters, accidents and illness, exposure to violence/war, disabilities/chronic disease); and parental and family stressors such as parental dysfunction (i.e., substance abuse, domestic violence, mental illness), divorce, single-parenting, and poverty (Garner, 2013). In sum, data from the NLSCY offered an in depth understanding of the factors most likely responsible for toxic stress among children.

One of the main shortcomings of public use NLSCY data is the absence of variables indicating children or parents' race or ethnicity. Consequently, I decided to replicate this study, utilizing public data on youth aged 12- to 17-year-old from the 2018 annual component of the Canadian Community Health Survey, which is inclusive of a rough indicator of race (White/non-White). Again, the CCHS offered a different testing dataset, to enhance our understanding of ACEs and to observe, even if grossly, if there is indeed a relationship between race and vulnerability to toxic stress. The CCHS collects cross-sectional information about the health, health behaviours and health care use of the non-institutionalized household population aged 12 or older, operating on a two-year collection cycle, with approximately 10,000 youth (ages 12 to 17 years old) covered in the 2018 cycle. While the CCHS does not capture ACEs to the extent of the NLSCY, its data are more recent, providing a more accurate picture of the current socioeconomic, political environment, and are disaggregated by racialized status – White and non-White. Through the utilization of the two data sets, a Canadian perspective of the vulnerability to ACEs and the development of disease in the context of race can be introduced in a mostly-and-only American empirical research's literature. For clarity, details on the sample, measures, analytical approach, and results for this study will be presented as two studies – one for the NLSCY and one for the CCHS.

Research Questions

This study will attempt to answer the following two questions:

1) Is there a relationship between ACEs and physical and mental health outcomes for Canadian children and adolescents?
2) Is there a relationship between ACE and physical and mental health outcomes among Canadian adolescents and does it vary by racialized status?

Ethical Considerations

Data from the NLSCY and CCHS were obtained by Statistics Canada through the Data Liberation Initiative (DLI) stipulated by the University of New Brunswick Harriet Irving Library[1]. As such, consent for the original research covers secondary data analysis. The data used is public use microdata; the data are completely anonymized and would not lead to the identification of the individuals involved. It is also for this reason that a research and ethics board (REB) approval was not sought, as it was determined that this study does not require approval for secondary data analysis of this nature, as noted by D. Coleman, Chair of REB at the University of New Brunswick (personal communication, December 7, 2021).

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[1] Numeric and spatial data collections relevant to curriculum are acquired through consortial arrangements with Statistics Canada (DLI), the Interuniversity Consortium of Political and Social Research, DMTI, and Service New Brunswick.

Chapter 4: Study 1

ACEs and Their Impact on Health Outcomes in Canadian Children

Sample

The first collection of data (cycle 1) of the NLSCY occurred during the winter and spring of 1994/1995 and continued until 2007/2008 (cycle 8), with data collection occurring at two-year intervals (Statistics Canada, 2010). The collection period of cycle 2 occurred between 1996 and 1997. The sample was comprised of children aged 0 to 13 years, living in a Canadian province (those living in territories were not included). Much of the information in the NLSCY was collected from parents (primarily the mother) on behalf of their children by means of a household interview. Children aged 10-13 years old completed a separate self-completed questionnaire. The design and sampling for the NLSCY was done in such a way to produce both cross-sectional and longitudinal estimates.

The Labour Force Survey (LFS) of Statistics Canada was utilized to identify households with children (Statistics Canada, 1999). Monthly, the LFS collected basic demographic information about all household members of a representative sample of Canadian households as well as labour market information about the adults living in these households. For the NLSCY, households that were in the LFS sample were examined to determine which households had children in the desired age groups (Statistics Canada, 1999). The LFS excludes certain populations since they are not part of the LFS sample frame, specifically individuals living in the Yukon and Northwest Territories (Nunavut was not established at this time), individuals living in institutions,

and individuals living on First Nations Reserves. Contact was established with households using the address and telephone number provided during cycle 1 or by the LFS. Once the person most knowledgeable (PMK) was identified, that person became the primary respondent for the household. In most cases, the PMK was the mother of the child (Statistics Canada, 1999).

Measures

Physical Health Conditions

Much of the information and related variables on children and parents' ailments in the NLSCY were suppressed when the datasets were prepared for public use outside of the dedicated Research Data Centres hosing the original NLSCY microdata. Public use data (PUD) available through the DLI only provided information on whether the child currently had a chronic condition that was diagnosed by a health care professional and was expected to last for at least six months. Variables available in NLSCY PUD included information on whether the child had a current diagnosis of a chronic condition diagnosed by a medical professional. In this study, such information was treated as a binary coded dichotomous variable, indicating with 1 and 0 the child having or not having the condition. Chronic conditions included allergies, chronic bronchitis, heart conditions, epilepsy, cerebral palsy, kidney disease, developmental delay, learning disabilities, emotional problems, or any other condition. Separate from this list, the NLSCY also included a variable as to whether a healthcare professional diagnosed the child as having asthma.

The NLSCY applied the Health Utilities Index Mark III (HUI) to measure health in children 4- to 13-years-old. Developed by McMaster University's Centre for Health Economics and Policy Analysis, the HUI is described as a generic health status index that synthesizes quantitative and qualitative aspects of one's health to provide a description of overall functional health (Horseman et al., 2003). Items are based on eight attributes: vision, hearing, speech, mobility, dexterity (use of hands and fingers), cognition, emotion, and pain and discomfort. Overall scores range from zero to one, with one representing high overall function and zero representing death. The scale was reversed in this analysis to match the direction of the other covariates.

Physical Aggression and Anxiety

The NLSCY data included two scales representing respectively children's emotional disorder-anxiety and physical aggression, with higher scores indicating the greater presence of the respective conditions. Scale items for emotional disorders (anxiety and physical aggression) were taken from the validated Ontario Child Health Survey (Boyle et al., 1993; Statistics Canada, 1999). The emotional disorder-anxiety scale presented to parents of children 4- to 11-years old. The scale was inclusive of the following items: (1) Seems to be unhappy, sad or depressed? (2) Is rather solitary? (3) Miserable, unhappy, tearful, distressed? (4) Is too fearful or anxious? (5) Is worried? (6) Cries a lot? Answers were provided on a Likert-type scale, with the available responses: 'Never or not true', 'sometimes or somewhat true', and 'often or very true'. Reliability of the scale was acceptable, with a Cronbach's alpha of 0.79 (Statistics Canada, 1999).

Four behaviour items were used to assess physical aggression in 4- to 11-year-olds: (1) Gets into many fights? (2) Reacts with anger and fighting? (3) Physically attacks people? and (4) Kicks, bites, hits other children? Each behavior item was rated by the Person Most Knowledgeable (PMK) about the child, using a three-point Likert scale: 'never or not true' (1), 'sometimes or somewhat true' (2), and 'often or very true' (3). The reliability was established with an acceptable internal consistency with a Cronbach's alpha of 0.77 (Statistics Canada, 1999).

Major Adverse Events

The NLSCY included variables reporting responses to questions on 14 adversities, defined as events that occurred over the life course of the child that resulted in a great deal of worry or unhappiness caused by the following: (1) death of a parent, (2) death of a family member, (3) divorce/separation of parents, (4) moving, (5) stay in hospital, (6) stay in a foster home, (7) separation from parents, (8) personal illness or injury, (9) illness or injury of a family member, (10) abuse, (11) change in household members, (12) alcoholism or mental health issues in a family member, (13) conflict between parents, and (14) other trauma.

As an original contribution of this study, I created a new ACEs scale inclusive of these 14 adversities; this new ACEs' indicator was conceived to test the cumulative impact of adverse events. Each of the 14 adversities were coded as either 1, indicating that there was a great deal of worry or unhappiness related to the associated event, or 0 if there was not. Items were then summed to create the scale. Values ranged from 0 to 14,

with greater scores indicating greater cumulative experiences of adversity. It is important to note that the original questions about adverse events were only asked for children aged four to eleven. Therefore, the ACEs indicator in my study is only applicable to children of this age group, hence determining the age range of the forthcoming analyses on NLSCY data.

Sociodemographic Characteristics and Family Environment

Single Parent Status.

The NLSCY established single parent status if the child lived with only one parent, whether biological or adopted. Foster children or those living with relatives were excluded from this group (coded 1=single parent household, 0=dual parent household).

Sex.

The NLSCY provided data on the sex of the children and youth included in the survey. The sex of the child is defined as the sex assigned at birth and is dichotomous (coded 1=male, 0 female).

PMK Depression.

The NLSCY data included PMK depression scores, which were derived from the modified version of the Center for Epidemiological Studies Depression (CESD) scale. This scale was reduced from 20 questions to 12 questions by the Chedoke-McMaster Hospital of McMaster University (Statistics Canada, 1999). Responses to questions were on a 4-point Likert-type scale, with scores ranging from 0 to 36. Higher scores indicated a greater presence of depressive symptoms. The abbreviated 12-item version of the scale

has been well validated (Lewisohn et al., 1997; Poulin et al., 2005), with an acceptable internal consistency, with a Cronbach's alpha coefficient of 0.82 (Statistics Canada, 1999).

Poverty/Income.

Food insecurity in Canada is strongly linked to poverty (Tarasuk & Mitchell, 2020). Recent data from Statistics Canada (2022) has demonstrated that those in the lowest income quintile in Canada had the highest food insecurity rates (26.7% in 2018, and 22.4% in 2019). As such, from the NLSCY, I utilized data that indicated if the child experienced hunger because the family did not have enough money within the last six months as a marker of poverty for this study (coded as 1=experienced hunger in the last six months, 0=did not experience hunger in the last six months).

Table 1 below displays information on the original variables, recoding approach adopted in this study, and final functional form of all the measures (variables or indicators) created from the NLSCY data.

Exposure to Violence

Data presented in the NLSCY asked the PMK how often the child see "adults or teenagers in your house physically fighting, hitting or otherwise trying to hurt others?" Questions were asked on a Likert-type scale, with the following responses: often, sometimes, seldom, or never. PMKs who responded that the child was exposed to violence often, sometimes, and seldom were coded as 1, and those who had responded with never were coded as 0.

Table 1

Variables and Indicators Constructed Using NLSCY Data and Applied in this Study for Descriptive and Inferential Analyses

Variables	Variable Name	Recoding Approach	Type	Values	Sample Description
Outcome	Chronic Illness	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% children with chronic illness
	Asthma	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% children with asthma
	Physical Aggression	Cumulative sum of questions asked with a response of no/yes	Quantitative	0 to 12, with 1 unit increment. 0 indicates no report of indicators of physical aggression; 12 indicating PMK reported that child had all indicators of physical aggression.	Median in sample
	Anxiety	Cumulative sum of questions asked with a response of no/yes	Quantitative	0 to 16, with 1 unit increment. 0 indicates no report of indicators of anxiety; 12 indicating PMK reported that child had all indicators of anxiety.	Median in the sample
	Health Utility Index -Mark III Score	Questions include detailed sets of algorithms presented in	Quantitative	0 to 1, with 0.1 unit increment	Median in the sample

Variables	Variable Name	Recoding Approach	Type	Values	Sample Description
		HUI questionnaire coding manual to derive and calculate utility scores			
Predictors	Major Adverse Events, Cumulative	Cumulative events causing significant worry/unhappiness	Quantitative	0 to 14, with 1 unit increment	Median in the sample
	Experience of Hunger Due to Poverty	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	%
	Presence of Depression in PMK	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	%
	Exposure to Violence	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	%
	Single Parent	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	%
	Sex	Female/Male	Qualitative, dichotomous, binary coded	0=Female; 1=Male	%

Analytical Approach

In this study I conducted a series of multivariate statistical analyses using secondary data from the NLSCY and CCHS. The analyses were conducted separately on each set of data. Interpreted separately and then, in the discussion section, together, they produced inference on the presence and distribution of toxic stress in children from different social and ethnic background, accounting for protective and risk factors associated with stress and health outcomes. See Chapter 5 for the analytical approach for the CCHS data.

To answer the research question– Is there a relationship between ACEs on physical and mental health outcomes during childhood and adolescence among Canadian children? – I selected multivariate linear regression and multivariate logistic regression as the appropriate statistical analytical tools to represent an outcome, in this study specifically children's health and mental health outcomes, as linear combination of a set of predictors.

Specifically, a multivariate linear regression models a quantitative outcome, while the multivariate logistic regression models a binary coded outcome where the two categories indicate occurrence or lack of occurrence of an event (Hatcher, 2013). Both multivariate logistic regression and multivariate linear regression can predict the probability of the occurrence of an event or values of a quantitative outcome as a function of a mix of qualitative and quantitative predictors (Hatcher, 2013).

Multivariate linear regression is expressed as:

$Y=a+bX1+cX2+cX3+….+e$

Multivariate logistic regression is expressed as:

Logit(Y)=a+bX1+cX2+cX3+….+e

All covariate variables were selected *a priori* based on a review of the literature on known ACEs. As previously noted, with the NLSCY, some of the measures of adversity were only asked to specific age groups. In such cases, models were restricted to the specified age group of four- to eleven-year-olds.

Logistic regression modelling was used to model the odds of binary outcomes such as the presence or absence of physical chronic conditions, mood disorders, and anxiety disorders, which were expressed as odds ratios (OR). Relationships between adversity and the overall health of Canadian children were assessed by analyzing the Health Utility Index Mark III (HUI), using multivariate linear regression. For each of the logistic regression analyses, the omnibus Chi-squared test and the significance level for each model are presented to demonstrate overall model fit. Regression modelling was preceded by regression diagnostics, including assessment of binary associations between outcomes and single predictors, as well as multicollinearity analysis between the predictors in the model (Hatcher, 2013).

Descriptive and inferential statistical analyses weighted the results by the appropriate survey weights; in this study, I adopted weight's normalization to maintain the number of weighted cases within the range of the sample size. All models incorporated appropriate survey weights, as suggested by Statistics Canada. The NLSCY contains both longitudinal and cross-sectional weights. Weights rebalance the sample composition to be representative of the population from where it was drawn. In the case

of longitudinal weights, they account for attrition and allow for the rebalancing of the representativeness of the running sample to the population representativeness from where the sample was drawn originally. This study used the cross-sectional weights of the NLSCY, so that the sample analyzed can be considered representative of children in the age group 4-13 years in Canada from 1996-1997, and the findings can be generalizable to this age group at that time.

Cross-sectional weights for this dataset were normalized: The use of normalized weights (also called standardized weights) allows researchers to make adjustments to the sample structure and to make it representative of the original population while still using a regular software package and maintaining the standard errors in the same order of magnitude as the sample (University of Toronto, 2008). As a software package associates the sum of the weights with the number of observations as it chooses, normalization of weights prevents the software from overestimating statistical power (University of Toronto, 2008). All statistical analyses were conducted using the statistical software SPSS 2022.

Results

Descriptives

Data from the NLSCY included 20,025 children between the ages of 0 to 13 years old. The proportion of males to females was near equal. Most of the children belonged to a two-parent home, with 13.4% belonging to a single parent home, and less than 1% who did not live with either parent. Almost 40% of PMKs had a college or university degree, with 28.4% having some education beyond high school, 19% with a

high school diploma, and 13.1% with an education below secondary school. Nearly a quarter of all respondents had a family income below the poverty line. Lastly, approximately one-fifth of the children included in the sample had a medically diagnosed chronic illness (see Table 2).

Table 2

Weighted Descriptive Characteristics of Children in the NLSCY (1996-1997), N=20,025

Characteristics of Children	**%**
Age of children (Range 0-13) M=5.52	SD=4.07
Sex	
Female	49.2
Male	50.8
Family Income	
Below Poverty Line (LICO ratio <1)	24.5
At or Above Poverty Line (LICO ratio ≥1)	75.5
Parental Status	
Two parents	86.3
One parent	13.4
Does not live with a parent	0.3
PMK Education	
Less than secondary	13.1
Secondary school graduation	19.0
Beyond high school	28.4
College or university degree	39.5
Presence of Chronic Condition	20.9

Table 3 describes the frequency of ACEs among children aged 4 to 13 years of age. As described in greater detail in the previous chapter, elements of ACE were only assessed for children aged 4 to13, hence the final score was calculated for this specific age group. NLSCY data demonstrates that two-thirds of PMKs reported that their children had no experiences of worry or unhappiness resulting from major adverse events, while almost 30% had only one, and a little over four percent experienced two or more major adverse events.

Table 3

Weighted Frequency of ACEs in Children 4-13 Years Old, N=11,959

Number of ACEs	%
0	66.5
1	29.2
2	3.1
3	0.7
4 or more	0.5

Physical Health Conditions

A logistic regression was performed to ascertain the effects of single parenthood, major adverse events, experiencing hunger related to poverty, higher depression scores in the PMK, exposure of violence, and sex on the presence of asthma and other chronic health conditions. Results for the models are presented as odds ratios. An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure (Szumilas, 2010). The

logistic regression model for asthma (χ^2= 4455.64, p < .001) was statistically significant, demonstrating an association between the predictors and the presence of asthma.

The children from lone-parent households had an increased odds of 1.33 (95% CI: 1.31-1.34) times of having asthma when compared to those from two parent households. Further exposure to violence increased the odds of the presence of asthma by 1.05 times (95% CI: 1.04-1.06) and more than doubled (OR: 2.21, 95% CI: 2.17 - 2.26) when the child experienced hunger resulting from poverty. Additionally, the results showed that the odds of suffering from asthma for males were 1.74 (95% CI: 1.72-1.75) times the odds of females. The presence of depression in the PMK, however, was not a statistically significant predictor for the presence of asthma among children.

For chronic conditions, the overall logistic regression model was statistically significant (χ2=867.41, p < .001), suggesting an association between childhood adversity (ACEs) and the diagnosis of a chronic condition. The model demonstrated that children from lone-parent households had odds of 1.23 (95% CI: 1.22-1.23) times of having a chronic illness diagnosis (p<0.05) than children from two parent households. The experience of major adverse events was associated with odds of 1.5 (95% CI: 1.53-1.54) for the presence of a chronic illness. Exposure to violence was associated with an increased odds of the presence of a chronic disease by 1.2 times (95% CI: 1.19-1.21) and more than 1.2 times when the child experienced hunger resulting from poverty (OR: 1.23, 95% CI: 1.20-1.25). Additionally, the model demonstrated that males had greater odds of having a chronic condition when compared to females (OR:1.36, 95% CI: 1.35-

1.37). Moreover, the odds of having of a chronic condition more than doubled when the PMK had depression (OR: 2.40, 95% CI: 2.35-2.43).

Table 4

Weighted Odds Ratios (OR) Expressing Weighted Logistic Regression Coefficients of ACEs on Chronic Condition

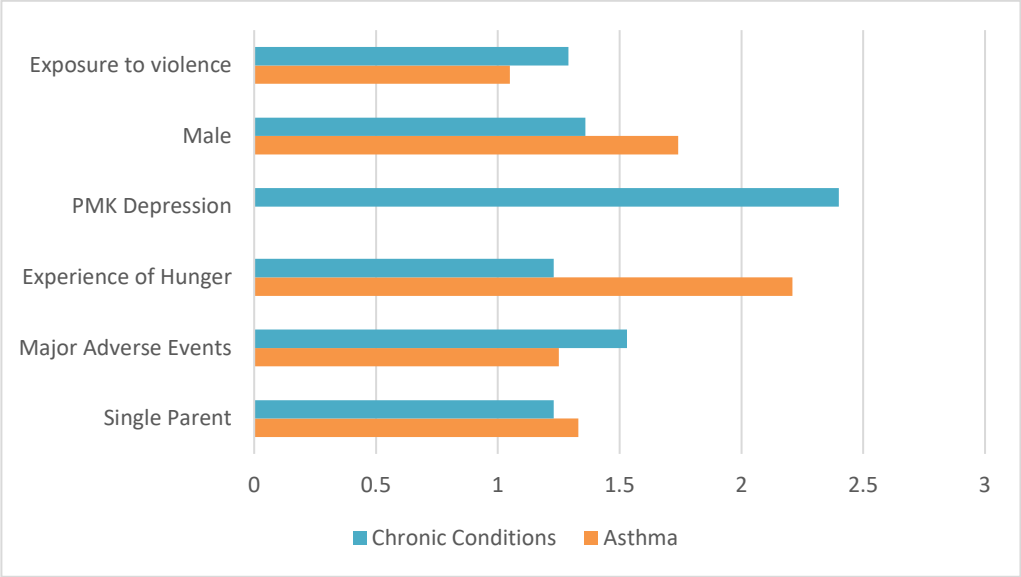
	Health Conditions			
	Asthma		Chronic Conditions	
Predictors	**OR**	**CI (95%)**	**OR**	**CI (95%)**
Reference point[1]	0.11		0.11	
Adverse Experiences				
Single Parent	1.33	1.31-1.34	1.23	1.22-1.23
Major Adverse Events	1.25	1.25-1.26	1.53	1.53-1.54
Experience of Hunger	2.21	2.17-2.26	1.23	1.20-1.25
Depression in PMK	1.00[2]	2.17-2.56[2]	2.40	2.35-2.43
Exposure to violence	1.05	1.04-1.06	1.20	1.19-1.21
Male	1.74	1.72-1.75	1.36	1.35-1.37

Note. Age of group 4-13 years old
[1]female, with absence of adverse experiences listed in the table
[2]not statistically significant, $p = 0.92$

Figure 2 below offers a visual comparison of the size of OR between the two logistic regression models, one for asthma and one for chronic conditions.

Figure 2

Odds Ratios for Chronic Conditions and Asthma, NLSCY



Note. Odds ratio for PMK depression in the prediction of asthma was not statistically significant. *Reference group female with no adversities, OR = 0.11

The overall health of Canadian children was assessed by analyzing HUI scores. Associations between HUI scores and ACEs were analyzed using multiple linear regression analysis. As previously mentioned, HUI scales were reversed to match the direction of the data. As can be seen in Table 6, factors such as lone-parent household, cumulative experiences of major adverse events, hunger, PMK depression, and exposure to violence were all associated with lower HUI scores ($F=99.19$, $p < 0.001$), thus indicating, that cumulative adversities result in poorer health in children. Males also had greater odds of having lower HUI scores in the context of adversity when compared to females.

Table 5

Weighted Multiple Linear Regression of Childhood Exposure to ACEs on HUI Scores

Predictors	Beta Coefficient	t	95% CI	SE
Intercept	0.17	18.62	0.15 – 0.18	.01
			p <0.001	
Single Parent	0.09	6.04	0.06 – 0.12	.02
			p <0.001	
Exposure to Violence	0.08	4.15	0.04 – 0.12	.08
			p <0.001	
Major Adverse Events	0.11	12.97	0.09 – 0.12	.11
			p <0.001	
Experience of Hunger	0.27	6.44	0.18 – 0.35	.04
			p <0.001	
PMK Depression	0.04	9.74	0.03 – 0.04	.01
			p <0.001	
Male	0.50	5.14	0.03 – 0.07	.01
			p <0.001	

Note. Ages of children 4-13 years old

Mental Health Conditions

Multiple linear regression was used to determine if there was a relationship between early childhood adversity and the presence of mental health conditions in

children 4- to 11-years-old. This age group was selected as the scales pertaining to mental unwellness only covered this age group.

Table 6 focuses on mental health conditions. Results were statistically significant, suggesting that a greater number of ACEs were associated with higher physical aggression scores (F= 142.21, $p < 0.001$) and higher anxiety scores (F= 268.14, $p < 0.001$). Additionally, in the context of adversity, males had higher scores on physical aggression scales (B=0.37, $p < 0.001$) and anxiety scales (B=0.50, $p < 0.001$) related to the experience of ACEs than females.

Results from the NLSCY suggest that children who experience early childhood adversity are at an increased risk for poor physical and mental health outcomes. Additionally, in comparison to females, male children who experienced adversity in the early years had an increased risk of poor mental and physical health.

Table 6

Weighted Multiple Linear Regression of Exposure to ACEs on Physical Aggression & Anxiety Scores

	Emotional Disorder					
	Physical Aggression			Anxiety		
Covariates	**Beta Coefficient**	**t**	**CI (95%)**	**Beta Coefficient**	**t**	**CI (95%)**
Reference point[1]	1.76	82.62	1.72 - 1.81	0.83	40.39	0.79- 0.87
Predictors						
Single Parent	0.06	1.66	0.00 - 0.13	0.02*	0.51*	0.05-0.08*
Major Adverse Events	0.23	11.41	0.19 - 0.27	0.46	23.48	0.42-0.50
Experience of Hunger	0.52	5.29	0.33 - 0.71	0.54	5.65	0.35-0.72
PMK Depression	0.12	14.04	0.10 - 0.14	0.20	23.80	0.18-0.21
Exposure to Violence	0.42	9.37	0.34 - 0.51	0.27	6.19	0.19-0.36
Male	0.37	14.99	0.32 - 0.42	0.05	2.13	0.00-0.09

Note. Ages of children 4-11 years old

[1]female, with absence of adverse experiences listed in the table

*Not statistically significant, $p = .61$

Chapter 5: Study 2

The Impact of ACEs on Health Outcomes in Canadian Youth

Sample

The CCHS (2018) surveyed individuals who were 12 years of age and older living in Canada. Those excluded from the sample were persons living on Reserves and other Aboriginal settlements; full-time members of the Canadian Forces; youth aged 12 to 17 living in foster homes; institutionalized populations; and persons living in the Quebec health regions of Nunavik and Terres-Cries-de-la-Baie-James (Statistics Canada, 2019). Statistics Canada (2019) notes that the abovementioned exclusions represent less than 3% of the target population.

Interviewers obtained verbal permission from parents/guardians to interview youths between the ages of 12 to 17-years-old who were selected for interviews. Statistics Canada (2019) notes that several procedures were followed by interviewers to minimize potential parental concerns to obtain a completed interview. If a parent/guardian requested to see the survey questions, interviewers notified the regional office to send a copy of the questionnaire. If privacy could not be obtained to interview the selected youth over the phone (another person listening in) the interview was coded as a refusal. At the end of the survey, information pertaining to insurance coverage, food security, and income was provided by the PMK.

Measures

Physical Health Conditions

The CCHS data referred to children aged 12- to 17-years old. The dataset extracted for this study included variables on chronic conditions that were diagnosed by a health care professional and were expected to last or have already lasted six months or more. Chronic conditions recoded in the CCHS included asthma, chronic bronchitis, emphysema, chronic obstructive pulmonary disease or COPD, arthritis, hypertension, hyperlipidemia, heart disease, stroke, cancer, Alzheimer's/dementia, Crohn's Disease, ulcerative colitis, and irritable bowel syndrome. However, some of these conditions were not asked to the 12- to 17-year-old population or did not have sufficient responses for testing. Conditions included in this study that were available and asked of Canadian youth included a current diagnosis of asthma, heart disease, and diabetes (type 1 and type 2) that had been diagnosed by a medical professional. As for the NLSCY, information was treated as a binary coded dichotomous variable, indicating with 1 and 0 the child having or not having such condition.

Mood and Anxiety Disorders

The CCHS asked children aged 12 to 17 in the sample if they had been diagnosed by a health care professional with an anxiety disorder, such as a phobia, obsessive-compulsive disorder, or panic disorder. It further asked if the children included were diagnosed with a mood disorder, such as depression, bipolar, mania, or dysthymia. The responses for both anxiety and mood disorders were treated as binary

coded dichotomous variables, indicating with 1 as the child having such a condition, and 0 for not having such condition.

Self Perception of Daily Stress

I have tried to replicate the construction of a similar ACEs indicator using the CCHS data. In the CCHS, 12- to 17-year-olds were asked about the amount of stress in their lives and were asked how they would describe the amount of stress they experienced. The response to the questions were on a Likert-type scale with the following responses: 'not at all stressful', 'not very stressful', 'a bit stressful', 'quite a bit stressful', and 'extremely stressful'. Those who responded with quite a bit stressful and extremely stressful were deemed to have high levels of daily stress and were coded as having high levels of daily stress (coded as 1). Those who answered with the following responses – 'not stressful at all', 'not very stressful', and 'a bit stressful' were coded as not having high levels of daily stress (coded as 0).

Sociodemographic Characteristics

Sex.

The CCHS both provided data on the sex of the children and youth included in the surveys. The sex of the child is defined as the assigned as the sex assigned at birth and is coded as 1 for male, and 0 for female.

Race.

Given the nature of the topic and the research question – 'is there a relationship between race and the occurrence of ACEs among Canadian children', a variable describing participant race was essential. Although the NLSCY collected data on both

child and parent racial/cultural identity, this information was not made available in the public use data (PUD). As such, the CCHS, a survey on the health of Canadians, inclusive of youth 12- to 17-years old was utilized to determine whether race was an important covariate in the development of illness or disease among racialized groups. While the racial/cultural identity was made available in CCHS data, the PUD only offered amalgamated data pertaining to ethnic or racial background, transforming them into two dichotomous variables – White (coded as 0) and non-White (visible minority and Aboriginal combined) (coded as 1). Those classified as non-White were those who belonged to the following racial or cultural groups: South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean, Japanese, and other.

Poverty/Income.

The CCHS also provided information on food insecurity due to poverty. However, due to lack of data completeness/availability in PUD, this data was not utilized, as such, income was assessed. Questions about total household income were not directed to the youth, but to the PMK, which was usually the mother. Income provided by PUD was available in the following intervals: less than $20,000/year, $20,000 to $39,999/year, $40,000 to $59,999/year, $60,000 to $79,999/year, and greater than $80,000/year. Household income less than or equal to $40,000/year was coded as 1 and household income over $40,000/year was coded as 0.

Immigrant Status.

Respondents were asked their country of birth. CCHS PUD data grouped variables together to create a dichotomous variable, to provide to categories – Canada and Other. Those who were grouped as born in Canada were considered non-immigrant (coded as 0), and those who were born in another country were considered immigrants (coded as 1). The CCHS did collect and provide data on whether a participant was currently or ever a landed immigrant, however, as this question would have likely excluded immigrants who have never been landed, the former question was selected.

Table 7 provides details of original variables, recoding approach adopted, and final functional form of all the measures (variables or indicators) created from the CCHS data.

Table 7

Variables and Indicators Constructed Using CCHS Data and Applied in this Study for Descriptive and Inferential Analyses

Variables	Variable Name	Recoding approach	Type	Values	Sample Description
Outcome	Asthma	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% youth with asthma
	Heart Disease	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% youth with heart disease
	Diabetes	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% youth with diabetes
	Anxiety Disorder	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0=Never; 1=Yes	% youth anxiety disorder
	Mood Disorder	Not diagnosed/currently diagnosed	Qualitative, dichotomous, binary coded	0 to 1, with 0.1 unit increment. 0 indicating death and 1 indicating absence of health conditions and normal development	% youth mood disorder
Predictors	Family Income	< $40,000 / ≥ $40,000	Qualitative, dichotomous, binary coded	0=$40,000; 1= ≥ $40,000	%

Variables	Variable Name	Recoding approach	Type	Values	Sample Description
Predictors	Racialized Status	White/Non-White	Qualitative, dichotomous, binary coded	0=White; 1=Non-White	%
	High levels daily stress	Questions asked on a 5-point Likert-scale, Scale dichotomized	Qualitative, dichotomous, binary coded	0=Not stressed at all + not very stressful + a bit stressful; 1= Quite a bit stressful + extremely stressful	%
	Immigrant	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	% Immigrant youth
	Racialized Immigrant	White Immigrant/Non-White Immigrant	Qualitative, dichotomous, binary coded	0=White immigrant; 1=Non-White immigrant	% Racialized immigrant youth
	Male	No/Yes	Qualitative, dichotomous, binary coded	0=No; 1=Yes	%

Analytical Approach

This study consists of two smaller studies, one from the NLSCY, and subsequently the CCHS. The CCHS was utilized to bridge generalizations from the findings from the NLSCY (1997) data with more recent data, that was also applicable to older children. However, it was chiefly used to include characteristics of race and ethnicity, which were absent in the NLSCY PUD. Further, for generalizability, variables and indexes selected in the CCHS were those that mirrored the NLSCY's constructs, as best as possible, given that the CCHS and NLSCY are two different surveys, with data collected for differing purposes.

As with the study conducted in the previous chapter, which utilized data from the NLSCY, this study conducted a series of multivariate statistical analyses of secondary data from the CCHS. The CCHS was employed primarily to answer the second question of this study – is there a relationship between ACEs and physical and mental health outcomes among Canadian adolescents and does it vary by racialized status? To answer this question, multivariate logistic regression was selected as the statistical analytical tool to represent an outcome, in this study specifically health and mental health outcomes for youth 12- to 17-years of age. Multivariate logistic regression models a binary coded outcome, in which the two outcomes indicated the occurrence or non-occurrence of the event (Hatcher, 2013). Multivariate logistic regression is used to predict the probability of the occurrence of an event, and is expressed as the following:

$$Logit(Y)=a+bX1+cX2+cX3+….+e$$

Indexes in the CCHS were evaluated on completeness, response rate, and validity. Validity was assessed by comparing the age-group's Cronbach's alpha with the alpha of the reference group as indicated in the surveys' manuals.

To gain an in-depth understanding of the impact of ACEs on health outcomes in racialized youth, three models were run. The first model looked at the relationship between ACEs and illness in the context of only racialized status (White and non-White). The second model analyzed the relationship between ACEs and health outcomes among racialized youth race, controlling for immigrant status. While data on immigrant status was suppressed in the NLSCY, it was made available in the CCHS. Immigrant status was controlled for, due to the healthy immigrant effect (HIE) (Lu & Ng, 2019; Ng, 2015). The HIE refers to the health of new immigrants, which is generally better than that of the Canadian-born (Ng, 2015). Ng (2015) asserts that, generally, the health of immigrants is inversely related to the length of years in Canada, meaning their health declines as their years in Canada increases. Finally, for the third model, the association of being a member of a racialized youth and immigrant in the context of experiencing ACEs and the presence of disease was analyzed.

Regression models for outcomes such the presence or absence of asthma, heart disease, diabetes, anxiety disorders, and mood disorders are expressed as odds ratios. To demonstrate goodness of fit, the omnibus Chi-squared test and the significance level are displayed (Hatcher, 2013). Regression diagnostics were performed prior to regression modelling. Such methods included analyzing for multicollinearity between predictors in the models and the assessment of binary associations between outcomes and single predictors (Hatcher, 2013).

The CCHS is a cross-sectional survey, and similarly, this study used the population cross-sectional weights in all the analyses presented in this document. Again, the cross-sectional weights ensure that the findings from the sample can be applicable to a population of 12- to 17-year-olds across Canada in 2018. Statistical weights as suggested by Statistics Canada were applied to both descriptive and inferential statistical models (Statistics Canada, 2019). As with the study in the previous chapter, to maintain the number of weighted cases within the range of the sample size, weight's normalization was adopted.

Cross-sectional weights were normalized, which allowed for adjustments to be made to the sample structure to make it representative of the original population. This is done to address issue with sample size sensitivity associated with using statistical software, to ensure that the standard error estimates are not overestimated (University of Toronto, 2008). All statistical analyses were conducted using the statistical software SPSS 2022.

Results

Descriptives

The ages of the youth included in the CCHS were 12-17 years old. There were slightly more males (51.2 %) included in the survey than females (48.8 %). Those with a before-tax family income of more than $80,000 or more made up 64.5% of respondents. Those with a before-tax family-income of less than $40,000 made up 13% of respondents. As noted above, the racial composition of respondents was made into a dichotomous variable in the PUD (i.e., White/non-White). Whites made up 78.8% of the

sample, and non-Whites were 21.2%. Immigrants comprised 9.5% of the sample, whereas Canadian-born respondents made up 90.5% (see Table 8).

Table 8

Weighted Descriptive Characteristics of Youth in the CCHS (2018) (N=8654)

Characteristics of Youth	**%**
Age of Youth (Range 12-17)	*
Sex	
Female	48.8
Male	51.2
Family Income	
≤ $20,000	4.4
$20,000 - $39,999	8.6
$40,000 - $59,999	10.4
$60,000 - $79,999	11.3
≥ $80,000	65.3
Health Condition	
Asthma	10.2
Diabetes (Type 1 and 2)	0.6
Heart Disease	0.7
Mood Disorder	4.8
Anxiety Disorder	9.4
Race	
White	78.8
Non-White (including Aboriginal)	21.2
Immigrant Status	
Landed immigrant /non-permanent resident	9.5
Non-Immigrant (Canadian born)	90.5

Note. *Categorical data, no M or SD available

Model 1

Logistic regression was used in the first model, to analyze the relationship between high levels of daily stress, income, sex and race and the presence of mental and physical illness in youth 12- to 17-years-old. Logistic regression for asthma was statistically significant (X^2= 7806.15, $p < .001$), and demonstrated that racialized youth had a reduced odds (OR:0.89, 95% CI: 0.88-0.90) of having asthma when compared to White youth when exposed to adversity. The logistic regression model for heart disease was also statistically significant (X^2= 2118.42, $p < .001$), suggesting that racialized youth had increased odds of having heart disease when compared to White youth (OR:1.15, 95% CI:1.11-1.19). There was no statistically significant relationship between race and the presence of diabetes in this model.

Logistic regression models for mental health conditions demonstrated that racialized youth, when compared to White youth, had lower odds of having mood disorders (X^2= 3987.58, $p < .001$, OR: 0.45, 95% CI:0.44-0.46) and anxiety disorders (X^2= 6482.77, $p < .001$, OR: 0.50, 95% CI:0.44-0.46) (see Table 9).

Table 9

Weighted Odds Ratios (OR) Expressing Weighted Logistic Regression Coefficients for Physical and Mental Health Conditions Among Racialized Youth

Health Condition	OR	CI (95%)
Asthma	0.89	0.88-0.90
Diabetes*	0.96*	0.92 -1.00*
Heart Disease	1.15	1.11-1.19
Mood Disorders	0.45	0.44-0.46
Anxiety Disorders	0.50	0.49- 0.51

*not statistically significant, p= .06.

Model 2

Physical Health Conditions.

Logistic regression was used to determine if there was a relationship between the experience of high levels of daily stress, income, racial status, immigrant status and sex and the presence of physical ailments among 12– to 17-year-olds. Logistic regression model for the presence of asthma was statistically significant (X^2= 793.98, p < .001). A family income of less than $40,000/year was associated with an increased odds of having asthma (OR: 1.23, 95% CI: 1.21-1.24) when compared to children whose family income was $40,000 or more. Also, exposure to high levels of daily stress (OR: 1.58, 95% CI: 1.57-1.60) and being male (OR:1.43, 95% CI: 1.41-1.44) were associated with increased odds of asthma. Those who were immigrants had a reduced odds of having

asthma. Canadian children of racialized status (where immigrant status was controlled for), had higher odds of having asthma (OR: 1.10, 95% CI: 1.09-1.12).

The findings regarding the association between heart disease and ACEs were significant (X^2=4669.81, $p < .001$). Factors such as exposure to high levels of stress daily (OR: 1.73, 95% CI: 1.65-1.80), being non-White (OR: 1.73, 95% CI: 1.67-1.79) and male were all associated with increased odds of having heart disease. Being an immigrant was a protective factor for the presence of heart disease (OR: 0.10, 95% CI: 0.87-0.11). Lastly, an income of less than $40,000/year was associated with reduced odds of having heart disease (OR: 0.83, 95% CI: 0.79-0.87).

Associations between the presence of diabetes and ACEs were analyzed. Results demonstrated statistical significance (X^2= 1274.80, $p < .001$), suggesting that racialized groups (OR:1.43, 95% CI: 1.37-1.49), males (OR:1.96, 95% CI: 1.88-2.04), and those who experienced high levels of stress daily (OR:1.84, 95% CI: 1.77-1.91) had greater odds of having diabetes. Immigrants (OR: 0.04, 95% CI: 0.03-0.05) and those with an income of less than $40,000 had reduced odds of having diabetes (OR: 0.27, 95% CI: 0.25-0.30).

Table 10

Weighted Odds Ratios (OR) Expressing Weighted Logistic Regression Coefficients of ACEs and Physical Health Conditions

	Physical Health Condition								
	Asthma			Diabetes			Heart Disease		
Covariates	**OR**	**Wald**	**CI (95%)**	**OR**	**Wald**	**CI (95%)**	**OR**	**Wald**	**CI (95%)**
Reference point[1]	0.07	2547736.90		0.01	63844.28		0.01	118622.23	
Family Income <$40,000	1.23	940.83	1.21-1.24	0.27	767.24	0.25-0.30	0.83	56.25	0.79-0.87
Non-White	1.10	282.45	1.09-1.12	1.43	276.10	1.37-1.49	1.73	983.05	1.67-1.79
High levels daily stress	1.58	8232.30	1.57-1.60	1.84	1.84	1.77-1.91	1.73	688.22	1.65-1.80
Immigrant	0.49	6005.44	0.48-0.50	0.04	0.04	0.03-0.04	0.10	1699.64	0.09-0.11
Male	1.43	5036.61	1.41-1.44	1.96	1.96	1.88-2.04	1.29	234.55	1.29-1.33

Note. Reference group female, with absence of adverse experiences listed in the table

Mental Health Conditions.

When considering mental illnesses, logistic regression models for mood disorders (X^2= 3088.57, $p < .001$) and anxiety disorders were statistically significant (X^2=489.47, $p < .001$). A family income of less than $40,000/year (OR: 1.23, 95% CI: 1.21-1.25) and daily exposure to levels of stress (OR: 5.81, 95% CI: 5.73-5.90) were associated with an increased odds of the presence of mood disorders (i.e., depression, bipolar, mania, dysthymia). On the other hand, racialized groups (OR: 0.56, 95% CI: 0.54-0.56), males (OR:0.62, 95% CI: 0.61-0.63), and immigrants (OR: 0.69, 95% CI: 0.68-0.71) had a reduced odds of the development of mood disorders.

High levels of daily stress were strongly associated with anxiety disorders (OR: 5.98, 95% CI: 5.90-6.06). However, no statistically significant association was found between family income of less than $40,000/year and anxiety disorders. Immigrants (OR: 0.55, 95% CI: 0.54-0.56) and males (OR:0.60, 95% CI: 0.59-0.60) had reduced odds of having anxiety comparted to non-immigrants and females respectively. Moreover, identifying as non-White was negatively associated with anxiety disorders in youth (OR: 0.56, 95% CI: 0.54-0.56) (See Table 11).

Table 11

Weighted Odds Ratios (OR) Expressing Weighted Logistic Regression Coefficients of ACEs and Mental Health Disorders

	Mental Health Condition					
	Anxiety Disorders			Mood Disorders		
Covariates	**OR**	**Wald**	**CI (95%)**	**OR**	**Wald**	**CI (95%)**
Reference point[1]	0.43	200259.37		0.04	280426.13	
Family Income <$40,000*	1.01*	2364.942*	1.29-1.31*	1.23	452.28	1.21-1.25
Non-White	0.61	196.782	0.60-0.62	0.56	3639.55	0.54-0.56
High Levels Daily Stress	5.98	8139.735	5.90-6.06	5.81	58776.03	5.73-5.90
Immigrant	0.55	6100.394	0.54-0.56	0.69	686.77	0.67-0.71
Male	0.60	26942.06	0.59-0.60	0.62	4217.82	0.61-0.63

Note. Reference group female, with absence of adverse experiences listed in the table

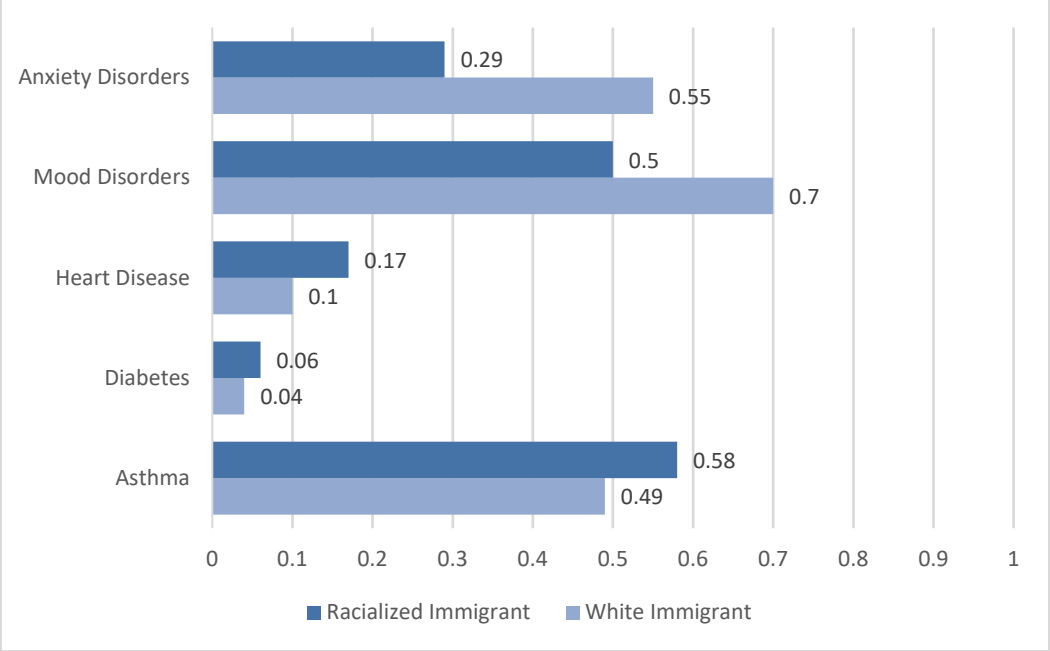
*Not statistically significant, $p = .92$

Model 3

Lastly, when analyzing models comparing all immigrants and racialized immigrants, of note is that while all immigrants had decreased odds of having physical and mental conditions when compared to non-immigrants, the odds differed for racialized immigrants. With odds ratios, when it is less than 1, increasing values of the variable correspond to decreasing odds of the event's occurrence (Szumilas, 2010). Figure 3 demonstrates that for asthma, diabetes, and heart disease, racialized immigrants had odds ratios, while less than 1 (suggesting it's protective), were greater than the non-racialized immigrant group, suggesting that immigrant status for racialized groups was less protective against physical conditions when compared to non-racialized immigrants. However, for mood and anxiety disorders, odds ratios for the overall immigrant group, while also less than 1, were greater than that of racialized immigrants suggesting that immigrant status for racialized groups was more protective against mental health conditions for immigrant groups in general than for racialized immigrants.

Figure 3

Illness OR Comparison for All Immigrants Compared to Racialized Immigrants



Chapter 6: Discussion

Nature of ACEs and Chronic Illness

This study sought to determine if there was a relationship between ACEs on physical and mental health outcomes among Canadian children and youth. The results of this study are congruent with the current body of literature suggesting that early adversity is associated with poorer physical and mental health outcomes. Analysis of NLSCY data demonstrated that factors such as poverty, living in a single parenthood household, and experiencing a major adverse event (e.g., divorce, death of a family member) were all associated with increased odds of having chronic illnesses (in general due to aggregation of illnesses in the data set) among children. Further, data from the CCHS were disaggregated, allowing for analysis of specific physical conditions such as asthma, diabetes, and heart disease among Canadian youth. Factors such as experiencing high levels of daily stress, being non-White, and being male were all associated with increased odds of having a chronic physical illness. Further, results indicate that more or cumulative adversities have an increased negative effect on both physical and mental health outcomes for both children and youth, demonstrating a dose-dependence relationship; this is consistent with existing literature which has demonstrated poor outcomes in adulthood (see Felitti et al., 1998; Merrick et al., 2017). The cumulative or dose-dependent relationship suggests that the impact of adversities on health outcomes are both cumulative and powerful even during childhood years, which underscores the need for interventions that both prevent and mediate the effect of toxic stress and its sequalae.

Surprisingly, youth who were from a family with low-income (household income less than $40,000/year) had 73% lower odds of having diabetes. This may possibly be explained by a few factors. First, some studies have noted that Type 1 diabetes is associated with higher socioeconomic status (Borchers et al., 2009; Liese et al., 2012). Second, Type 1 diabetes is significantly more prevalent in the 12- to 17-year-old age group than Type 2 (Mobasseri et al., 2020). As Type 1 and Type 2 diabetes, were grouped together in this study, and those with Type 1 account for most cases of diabetes in general, this would suggest that the majority of those with diabetes in this sample had Type 1 diabetes, which is more closely associated with a higher income. This is in contrast to Type 2 diabetes, which is more closely related to low SES (Bird et al., 2015), presenting in adulthood (Ittoop et al., 2020), which may explain why the results demonstrated that youth of lower-income status were less likely to have diabetes.

Additionally, an income of less than $40,000 was associated with a 17% reduced odds of heart disease in this study. Associations between low-income/socioeconomic status and vulnerability to heart disease is generally well-understood in adults (Rosengren et al., 2019), but is ill-defined in childhood (Best et al., 2019). However, studies have linked low-SES in childhood to risk for cardiovascular disease in adulthood (Lee et al., 2017), so while income in this study may be associated with lower odds of having a cardiac condition in childhood, manifestations might possibly occur in adulthood, with heart diseases that are more prevalent in adulthood, such as coronary artery disease (WHO, 2021). This suggests that although risk for CVD appears relatively low among those with lower SES in childhood, it is still an important point of intervention to mitigate

known risk later in life. Also, more research is needed to determine sociological and environmental factors associated with cardiovascular disease in children. For example, many childhood heart conditions are congenital (Chen et al., 2018), therefore maternal exposure to traumatic events should be explored to determine if an association exists.

Sex also played a significant role in the presence of illness within the different age groups. Analyses from the NLSCY (inclusive of children aged 4-13 years) demonstrated that males exposed to adversity had 36% increased odds of having a chronic physical illness when compared to females. Moreover, results demonstrated that male children had higher physical aggression and anxiety scores when compared to female children when exposed to adversity, which is consistent with the literature, in that, studies exploring the presence of physical aggression in young males found that, in general, they tended to be more physically aggressive than females (Lansford et al., 2012; Lorber et al., 2019). Conversely, analyses from the CCHS – the adolescent population - suggests that male youth (12-17 years old) exposed to adversity had 40% lower odds of having an anxiety disorder, and 38% lower odds of having a mood disorder when compared to female youth. Differences in the presence of physical aggression, mood and anxiety disorders between sexes could possibly be associated with the expectation of cis-gender males to adhere to masculine gender norms that encourage stoicism and discourage the demonstration of emotion or fear (Keohane & Richardson, 2018). Gender-normative ideologies are often influenced by parents and peers, and often start early, which can have negative consequences on mental and physical health (Weber et al., 2019). Further, males within societies with more distinct gender roles have a greater propensity to conform to

competitive stereotypes, resulting to more physical aggression, in contrast to stereotypes of gentleness and compliance associated with females (Nivette et al., 2018). Much of the research on mental health utilize the terms ‘gender’ and ‘sex’ interchangeably (Ristvedt, 2014), complicating generalizability. Additional research is needed to determine generalizability of findings between genders and sexes. Understanding gender and sex-related differences can provide insight into the experiences that cause increase vulnerability to illness. While the topic of race goes into greater depth in the following section, it is important to consider that the intersectionality of race, gender, and sex in the context of toxic stress and early adversity further complicates a rather complex issue for racialized groups. For example, the victimization of Black males in America has been reported to increase vulnerability to exposure of racism and traumatic events, which has resulted in premature death (Jones-Eversley, 2020). Unpacking and understanding the implications of the intersectionality of illness for racialized individuals in Canada requires further research.

Moreover, of importance to note is the age of the respondents for the CCHS data. It has been well demonstrated that the impact of ACEs has long lasting impacts on the mental and physical health of individuals well into adulthood (Shonkoff et al., 2012). Given the respondents are adolescents and are already demonstrating significant mental and physical health outcomes, findings underscore the importance of early intervention to limit the impact of early adversity to ameliorate or mitigate negative health outcomes later in life. For example, it has been suggested that by preventing adverse experiences in childhood the number of adults with depression in the United States could be reduced by

approximately 44%, chronic lung diseases by 27% and asthma by 24%, and up to 1.9 million cases of heart disease, and 2.5 million cases of overweight/obesity (CDC, 2010).

Lastly, while not tested in this study due to limited sample size of the subsets of certain groups, further research should explore if certain ACEs have greater impact than others in determining vulnerability to illness. While several studies, including this one, demonstrated dose dependence relationship (Felitti et al., 1998; Merrick et al., 2017), further studies are required to determine if the type of stressor plays a role in the presence or development of certain diseases. Some studies suggest that the type of stressor adds another dynamic in the predictability of illness in adults (see Conrad et al., 2017; Dembro et al., 2019). For example, in assessing the likelihood of developing PTSD in adults, Conrad and colleagues (2017) suggested that statistical methods such as random forests using conditional interference (RFCI) allowed for the ranking of traumatic events in the prediction of PTSD. RFCI further allows for the analysis of the severity of the stressor and potential confounding factors, while considering multicollinearity between predictor variables (Herzog et al., 2020). Other studies examining the associations between traumatic events and adverse health outcomes maintain that latent class analysis (LCA) is the preferred method to examine the effects of the complex constellation of traumatic events on health outcomes (Dembo et al., 2019; Zibrowski et al., 2020). Due to the heterogeneity of individual experiences of maltreatment, the LCA model is preferred as it seeks to find homogenous groups or latent classes within a sample (Dembo et al., 2019; Scott-Storey, 2011). With the various analytical approaches available, Scott-Storey (2011) cautions that researchers must assess the meaningfulness and utility of analytic

techniques through the application of theoretical rationale. Further research is necessary to determine if the type of ACE or severity of the ACE plays a role in the development of certain illnesses across the lifespan.

Race, ACEs, and Vulnerability

In addition to exploring associations between childhood adversity and illness, this study sought to determine if racialized adolescents had increased vulnerability to chronic illnesses, specifically asthma, heart disease, diabetes, and mood disorders, in the context of adversity. Findings suggest that racialized groups (where immigrant status was controlled for) were at 43% higher odds of having asthma compared to their White counterparts. While no comparative Canadian statistics are available, data from the Centers for Disease Control and Prevention (CDC) in the United States demonstrated that Black children were more likely than any other group to have, and to die from asthma (CDC, 2022). What was initially attributed to genetics, scholars are now suggesting that the disparity in the presence and severity of asthma can be partially attributed to the segregation of Blacks in disadvantaged neighbourhoods, with poorer air quality (Alexander & Currie, 2017). This is supported by Merkin and colleagues (2009) who found that Black individuals living in disadvantaged neighbourhoods had an increased allostatic load, evidenced by increased biological risk factors such as serum levels of C-reactive protein, albumin, glycated hemoglobin, HDL cholesterol, waist-to-hip ratio, blood pressure, and resting heart rate. It was hypothesized that the increased allostatic load associated with living in a disadvantaged neighbourhood, resulted in poorer health outcomes.

In the general population, the incidence of Type 1 diabetes is higher among Whites compared to all other racial groups (American Diabetes Association, n.d.). However, this study showed that, when compared to White youth, exposure to high levels of daily stress among racialized youth resulted in 43% higher odds for the presence of diabetes. This highlights the potential impact and the strength of ACEs in the vulnerability to diabetes in racialized youth. These results are consistent with the research conducted by Willie et al. (2015), who studied racial disparities in the management and outcomes among children under 18 years with Type 1 diabetes and found that Black children and youth were more likely to have a higher mean A1C level and experience more ketoacidosis and hypoglycemic events when compared to Whites and Hispanics, even after controlling for socioeconomic status. While this highlights an important opportunity for intervention in early childhood for racialized adolescents experiencing ACEs, further research would benefit from the exploration of associations between childhood adversity and epigenetic factors in the development of Type 1 diabetes among racialized groups.

A further finding from this study was that racialized youth had 39% lower odds of having an anxiety disorder and 44% lower odds of having a mood disorder when exposed to adversity in comparison to White youth. In part, this may be a result of the stigma surrounding mental health being greater among racial minorities (Eylem et al., 2020) and that racial minorities, particularly Blacks, are less likely to report symptoms of mental illness or seek help (Eylem et al., 2020; Gary, 2005). Additionally, it has been reported that Black youth face disproportionate challenges in accessing mental healthcare

compared to White youth (Fante-Coleman & Jackson-Best, 2020). The CCHS survey data drew from a question that specifically asked if the youth had been 'medically diagnosed', as such, in the context of limited access to appropriate mental healthcare, racialized youth may not have a professional diagnosis, even in the presence of mental illness or significant symptomatology.

Interestingly, differences in health outcomes specifically for immigrant youth demonstrated health disparities between Whites and racial groups. The healthy immigrant effect (HIE) asserts that immigrants in Canada have better health than their Canadian born counterparts, although their health begins to decline as their years in Canada increase (Elshahat et al., 2021). Although not well researched in adolescents, a population study utilizing CCHS data by Kwak (2016) has demonstrated that the HIE phenomena is also present among Canadian adolescents. Immigrant Canadians tend to be healthier due to immigration policies that favour those in good health, resulting in better overall health of newcomers (Kwak, 2016). This study presented interesting findings, in that, while immigrant status in general was a protective factor for health outcomes, it was less protective for racialized youth for the presence of asthma, diabetes, and heart disease than for White youth. This suggests that racialized immigrants are more vulnerable to physical diseases than White immigrants. Reasons for this are not fully clear, however, researchers suggest that racial inequities play a role in health outcomes among racialized immigrants (Hamilton & Hagos, 2020).

Conversely, this study demonstrated that immigrant status was more protective against mood and anxiety disorders for racialized youth when compared to White youth.

Reasons for this are unclear as research on HIE tends to focus on physical health, giving little attention to mental health (Elshahat et al., 2021). However, as noted previously, racialized youth are noted to be less likely to disclose symptoms of mental health, which may explain why being racialized, as opposed to White, was less protective against mental illness. More research is needed to ascertain the impact of the HIE on mental health among racialized Canadian youth.

Drawing from the Shonkoff's ecobiodevelopmental (EBD) framework (2010, 2012), the differences in health between racialized and White youth can likely, in part, be attributed to exposure to discrimination and racism among racialized youth. Shonkoff et al. (2021) notes that racism creates environments that overexpose people of colour to adverse experiences resulting in toxic stress. Others note that racism itself, is an ACE (Cronholm et al., 2015; Lowe et al., 2021). Through this lens, race is a social construct, rather than a biological category, that often highlights social disparities between racial groups and their subsequent negative impact on health outcomes (Atumah et al., 2021; Yudell, 2016). Race, however, is often misrepresented as a biological causal mechanism for disease, rather than a less than perfect proxy for predisposition to disease, often resulting from social factors that increase vulnerability to disease (Atumah et al, 2021; Shonkoff et al., 2021). This focus on race as a biological risk factor for disease, averts attention away from social mechanisms and structures, like systemic racism and discrimination, that play a large role in health disparities faced by racialized groups (Trent et al., 2019). For example, the data available for public use in this study aggregated all racialized groups into one and created one binary variable – White and

non-White. Siddiqui et al. (2017) maintains that this approach underestimates the effect of discrimination for Blacks and overestimates the experiences of racism for other groups such as Hispanics and Asians. The authors further recommend that Statistics Canada provide surveys and survey data that better reflect current racial groups in Canada (Siddiqui et al., 2017).

Further, national and provincial efforts and investments need to be targeted at fulsomely understanding health, well-being, and development of children and youth and their families within the context of race and ethnicity, in order to adequately identify inequities, inform healthy public policy, and track the effectiveness of policies and interventions over time. In fact, the paucity of race and ethnicity variables in public use data (PUD) in this study demonstrate the necessity of the collection and distribution of race related variables in the context of health. This study, nevertheless, attempted to bridge an understanding with what is currently known about ACEs and how this impacts various racial groups, which is an important contribution to the Canadian literature.

Strategies to address disparities experienced by varying racial groups should be specific, rather than uniform, to meet the complex challenges resulting from institutional and systemic racism. In order for these issues to be addressed, they must first be identified. This thesis, therefore, calls for a release of race-related variables in PUD and should be set as a priority for government agencies. PUD is easier to access as one does not need to be associated with provincial and territorial statistical agencies, or other agencies granted special access by Statistics Canada (Government of Canada, 1985), providing an opportunity for community groups and citizens to collaborate with

governments to develop strategies to improve the ecological conditions that contribute to the health and well being of all groups, and to evaluate effectiveness of interventions.

Next steps for research include examining differences between racial groups, as it has been noted previously, that some groups, such as Black children, experience significant disparities in health outcomes when compared to White or Asian children, even when controlling for SES.

Limitations

Age of Data

A notable limitation of this study is the dated data from the NLSCY Cycle 2, which was from 1996-1997. With the data being over 20 years old, it is likely that the current sociological climate that is responsible for the disparities that Black or other racialized children are experiencing today were not adequately captured. In an attempt to address this limitation, data from the CCHS (2018) was used to bridge generalizations to children and youth that was more current and reflected the experiences of racialized adolescents in Canada. While the CCHS data did not have the variables to the extent of the NLSCY data, crude models were still able to demonstrate the impact of race in the experience of toxic stress which provided greater insights into the understanding of the childhood origins of disease development in later years.

Respondent Bias

With the analysis of data from the NLSCY, an important consideration is that the responses are based on the report of the person most knowledgeable (PMKs) and may not accurately reflect the experiences of adversity from the child's perspective. For example,

approximately 33% of PMKs in the National Longitudinal Survey of Children and Youth (NLSCY) reported that their children had experienced at least one major adverse experience that caused them a great deal of worry or unhappiness. However, this may be an underrepresentation as parents may be unwilling to report that their children were exposed to such adverse experiences, particularly as these surveys are not completely anonymous (while de-identified in PUD, it is still possible to link a respondent's information through the Social Data Record Linkage Environment) (Statistics Canada, 2019). As a comparator, 61% of adults have retrospectively reported at least one adverse childhood experience (CDC, 2021). As such, the number of ACEs experienced by children in the NLSCY is likely underestimated.

Absence of Key Variables

Secondary analysis entails an analysis of data collected for the purposes of another study's research or to address research questions not identified in the primary purpose (Bryman & Bell, 2019). As such, not all desired variables are available for analysis. For example, in the NLSCY, variables pertaining to chronic conditions were suppressed – as such, this study does not provide an analysis of more common childhood conditions in children such as allergies, eczema, seizure disorders, learning disabilities, etc. Additionally, data from the CCHS does not include the breadth of variables representing known ACEs like the NLSCY data set, for example, the effect of the experience of certain adverse events like physical abuse or parental substance use cannot be analyzed.

Despite these limitations, the findings suggest that associations exist between race, the experience of ACEs, the presence of disease among Canadian children and youth. This study presents insights into the social mechanisms responsible for the experience of toxic stress and resultant disease development not only in Canadian youth, but also racialized Canadian youth. The experience of racism, whether personally mediated, structural, or internalized, presents a challenge exclusive to people of colour (Shonkoff, 2021). Structural racism experienced within the healthcare system, schools, financial institutions, and the judicial system results in oppressive and stressful environments that can disrupt allostasis, increasing vulnerability to toxic stress for racialized groups (Berger & Sarnyai, 2015). Findings warrant the need for the collection of data that includes ACEs and associated factors, that is also available for public use.

Promoting Resilience

Promoting resilience in children is an important intervention to ameliorate the impacts of toxic stress (McEwen & McEwen, 2017). Shonkoff's Ecobiodevelopmental (EBD) model (2010; 2012) not only provides a mechanism for understanding the dance between biology and ecology that shape physiological systems increasing vulnerability to illness and disease, but the model also identifies opportunities for bolstering resilience to buffer against toxic stress (Shonkoff, 2010; Shonkoff et al., 2012). In children, the presence of a supportive caregiver, positive social support networks and community supports can prevent, mitigate, or facilitate overcoming toxic stress, effectively reducing or potentially reversing the harmful effects of toxic stress on neurologic and physiologic systems (McEwen & McEwen, 2017; Perkins, 2019; Williams Shank & Robinson, 2013).

Strong, nurturing relationships with caregivers are known powerful mediators against the effects of toxic stress (Bucci et al., 2016; Center on the Developing Child, 2021; McEwen & McEwen, 2017; Shonkoff et al., 2012). As such, providing support to parents of children experiencing adversity, will better enable them to support their children physically and emotionally (Bucci et al., 2016). Additionally, the supporting adult figure does not have to be a family member. For example, the negative impact of toxic stress on the child's ability to learn, readiness for school, and academic performance can be mitigated in the school, by establishing positive environments and fostering nurturing long-term relationships between students and teachers (McGruder, 2019). This would serve to provide emotional and cognitive support to prevent or reduce the impact of toxic stress. As such, teacher education program curriculum should equip teachers to both identify symptoms of toxic stress, those who are vulnerable to toxic stress, and how to apply interventions. Moreover, the implementation of programs that address toxic stress in the school system should be prioritized across the nation. Future research examining toxic stress among children and youth, its impact on health, and the intersectionality of race that is inclusive of mediating and moderating factors is an important next step in untangling the complexity of these relationships.

Additionally, creating supportive environments are essential in mitigating or preventing toxic stress and its effects (McEwen & McEwen, 2016; Francis et al., 2018). Interventions should be directed at eliminating some of the sources of toxic stress, such as providing safe and stable housing and equitable resources in low-income neighbourhoods. The support would facilitate the reduction of adverse experiences

resulting in toxic stress (Center on the Developing Child, 2021; Francis et al., 2018; Shonkoff et al., 2021). Lastly, several publications have highlighted the importance of addressing social conditions that increase vulnerability to toxic stress such as poverty, food insecurity, housing insecurity, systemic racism/discrimination, community violence, alienation, disenfranchisement, and social isolation that impose significant hardships on children and families to facilitate buffering the impact of toxic stress (Garner & Yogman, 2021; Harris et al., 2017; Shern et al., 2016). They further addressed the need for the creation of community partnerships and policies to address institutional racism to prevent or reduce the effects of toxic stress particularly for racialized peoples. Public policy should include tackling structural inequities by facilitating equitable access to healthcare, educational opportunities, housing, and the creation of wealth (Shonkoff et al., 2021).

Implications for Nursing Education

Given the prevalence of ACEs and the detrimental short-term and long-term impacts on health and social well-being, it is imperative that nursing education programs include content regarding ACEs into their core curriculum to best prepare nurses to work with individuals experiencing adversity. This study demonstrated that among children 4- to 13-years old, over 30% had experienced at least one ACE. For this reason, nurses ought to be educated on the sources of ACEs and how they impact health outcomes across the lifespan. Further, nurses should be educated as to how to provide care within a trauma and violence informed care framework (Center on the Developing Child, 2021; Leitch, 2017), to foster resilience in those who are vulnerable to toxic stress and to screen for and intervene against early adversity to reduce the experience of adverse events.

Additionally, the findings of this study highlight the need for increased awareness of the health disparities experienced by racialized youth in Canada. Moreover, it underscores the need to address implicit racial bias, which is prevalent and persistent in healthcare education and training (Joseph at el., 2021). A systemic review conducted by Fitzgerald and Hurst (2017) found that health care providers exhibited the same levels of implicit bias as lay persons – maintaining stereotypes that are harmful in the provision of care to racialized individuals (for example, Black people feel less pain).

A recent American study of 1.8 million hospital births, after controlling for insurance provider and comorbidities, found that the mortality rate for Black newborns decreased by nearly 60% when cared for by Black physicians, compared to White physicians (Greenwood et al., 2020). These findings further underscore the need for overhauling nursing and medical programs, to address structural racism embedded within curricula and lectures (Atumah et al, 2021). Moreover, barriers to entry medical programs for racialized individuals, particularly Black and Indigenous individuals (Girgulis et al., 2021) ought to be addressed, as it has been documented that racial concordance often result in better patient outcomes among racialized groups (Jetty et al., 2021).

Implications for Nursing Practice

Nurses are the largest group of regulated health professionals in Canada (RNAO, 2017) and work across diverse settings (e.g., hospitals, clinics, schools, shelters, etc.) providing care to individuals, families, groups, and populations across the lifespan – many of whom have been exposed to ACEs. Thus, nurses are well positioned to recognize, intervene, and even prevent toxic stress to limit its negative sequelae (Francis

et al., 2018; Hornor, 2015). However, to effectively combat toxic stress, the causes need to be adequately challenged and addressed. Understanding of the role of socioeconomic status and race in the development of toxic stress among racialized children can guide policy, thus strengthening the nurse's advocacy role. Further, nurses should engage in activism which include support of policies that mitigate against racism, poverty, homelessness, community violence, and other social issues that increase the likelihood of the occurrence of ACEs (Shern et al., 2016).

Further, nurses should be aware of community resources to refer children and families that can provide support for those who are at an increased risk of exposure to toxic stress, such as unstable housing, food insecurity, etc. (Hornor, 2015). Community resources can include, but are not limited to, centres providing affordable therapy, sports programs, income supports, etc. Resources should be targeted at limiting the factors responsible for the adverse event(s) experienced.

Implications for Research

As noted previously, future research should focus on the primary collection of data, to conduct well-powered studies to examine the experience, social context, and consequences of ACEs in Canadian children, specifically racialized children. Data collection should be disaggregated by race to gain insight and perspective about the specific and nuanced social mechanisms that impact various racial groups. Further, in addition to regression models, advanced analytical methods such as random forests using conditional interference and latent class analysis should be used to determine the impact of the type and severity of the stressor on health outcomes. Lastly, this study points to the

importance of longitudinal surveys, needed to monitor the health and well-being of Canadian children and to track the usefulness and effectiveness of interventions overtime. The NLSCY, while imperfect and now retired (Statistics Canada, 2010), made it possible to gain insight into the experiences of Canadian children over-time. Efforts to create a similar survey tracking ACEs, while mitigating mass attrition, should be explored to combat racial/ethnic disparities between racial groups in Canada.

Conclusion

The findings from this research are an important contribution to the paucity of knowledge related to the effects of toxic stress among Canadian children, particularly racialized children. Findings suggest that associations exist between race, the experience of ACEs, and the presence of disease among Canadian children and youth. This study presents insights into the social mechanisms responsible for the experience of toxic stress and resultant disease development and suggests important areas of intervention, public policy and highlights a crucial need for better national level data for public use.

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Curriculum Vitae

Candidate's full name: Ruth Elizabeth Lue

Universities attended: University of New Brunswick, Bachelor of Nursing (2016)

Awards: Diane Brennan Campbell Scholarship (2021)

Social Sciences and Humanities Research Council Scholarship – CGS-M (2021)

New Brunswick Innovation Foundation STEM & Social Innovation Award (2020)

Academic Award of Excellence (2016)

Publications: None

Conference Presentations: None