Urban Youth Exposed to Parental Incarceration: the Biosocial Linkages in an Understudied Adverse Childhood Exposure

Dissertation

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Abstract

In the U.S., parental incarceration (PI) has been increasingly recognized as an understudied adverse childhood experience. In response, a rapidly expanding body of research has begun to investigate the effects of PI on youth health outcomes since more than half of U.S. prisoners are parents of minor children. Studies have found that children exposed to PI are more likely to experience numerous economic, educational, and behavioral difficulties, as well as poor physical and mental health across the life course. However, a paucity of research exists on the pathways through which exposure to PI affects these outcomes as well as on the potential buffers that may mitigate this risk. Guided by the Ecobiodevelopmental and Bioecological Model of Human Development frameworks, the aims of this study include examining 1) the associations between PI and mental health outcomes (attention, externalizing, internalizing, and total behavioral problems) 2) the extent to which chronic physiologic stress (hair cortisol concentration (HCC)) mediates the relationship between exposure to PI and mental health outcomes and 3) whether sociospatial buffers (collective efficacy measured via activity space, (CE)) moderate the relationship between PI and mental health behaviors.
An observational and cross-sectional design was employed for this dissertation utilizing secondary data from Wave 1 of two linked studies, the Adolescent Health and Development in Context (Browning, 1R01DA032371) and Linking Biological and Social Pathways to Adolescent Health and Well-Being (Ford, 1R21DA034960). Analyses included linear multivariable regression modeling including moderating and mediating analyses in order to examine the aims of this dissertation. The analytic sample was drawn from a racially and socioeconomic representative subsample of 613 urban adolescents ages 11 to 17 years. After controlling for a demographics of the youth and socioeconomic characteristics, youth exposed to PI had worse mental health outcomes in comparison to their unexposed peers. However, this effect did not remain significant once total number of adverse childhood exposures was included into the model. In this sample, HCC did not mediate the relationship between youth exposed to PI on mental health difficulties. In addition, CE did not buffer the relationship between youth exposed to PI in comparison to those unexposed. In conclusion, exposure to PI can be viewed as a marker of accumulative risk for intervention since youth impacted by PI are more likely to experience cumulative disadvantage and have more behavioral difficulties, above and beyond, socioeconomic characteristics. Although this study was unable to demonstrate the role of HPA dysregulation and social support on mental health difficulties of youth
exposed to PI, it provides a foundation to guide future research examining biosocial linkages between adverse childhood exposures on mental health difficulties.

**Keywords:** parental incarceration, hair cortisol, prison/jail, activity space, youth mental health, adolescent behaviors
Dedication

Dedicated to both of my grandmothers

and to those incarcerated.
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Chapter 1: Introduction

Statement of the Problem

While estimates vary, the Bureau Justice of Statistics reported that over 2.7 million children, or 1 in every 28 children, have a parent currently incarcerated in jail or prison (Glaze & Maruschak, 2008). Since the majority of U.S. prisoners are parents of minor children (Glaze & Maruschak, 2008), research is rapidly expanding on the consequential impact incarceration may have on their families and communities (Ardetti, 2012; Kruger & De Loney, 2009). Rates are likely to underestimate the number of youth affected by the magnitude of the correctional system since most national estimates include only those currently in jail or prison, and not those serving time on parole or probation. Studies have found that children exposed to parental incarceration (PI) are more likely to experience economic (Geller, Garfinkel, & Western, 2011), educational (Cho, 2011; Hagan & Foster, 2012), and behavioral difficulties (Holly Foster & Hagan, 2013; Geller, Cooper, Garfinkel, Schwartz-Soicher, & Miney, 2012; Rakt, Murray, & Nieuwbeerta, 2012), as well as poor physical (Boch & Ford, 2014; Roettger & Boardman, 2012), and mental health outcomes (Foster & Hagan, 2013; Lee, Fang, & Luo, 2013; Murray, Farrington, & Sekol, 2012).

However, despite the breadth of evidence supporting the negative effects of PI, few studies have examined the contribution of PI to chronic physiologic stress – a known precursor to poor health (Baum & Posluszny, 1999; McEwen, 2008) and risk-taking
behaviors (Gordon, 2002; Torres & Nowson, 2007). Furthermore, exposure to PI earlier in the life course may have particularly deleterious effects on mental health across the life span. Specifically, studies have found young adults exposed to PI during childhood or adolescence (but not adulthood) had worse social (e.g. substance use) (Rakt et al., 2012; Roettger, Swisher, Kuhl, & Chavez, 2011) and physical outcomes (e.g. inflammation) than adults never exposed to PI (Boch & Ford, 2014; Lee et al., 2013; Roettger & Boardman, 2012). This line of inquiry is consistent with the bioecodevelopmental framework, which posits that exposure to early childhood adversity (e.g. PI) negatively affects mental health and behavior across the life course in part through dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis and consequent elevation or suppression of cortisol levels (Gonzalez, 2013; Hagan, Roubinov, Purdom Marreiro, & Luecken, 2014; Kempke et al., 2015; Koss, Hostinar, Donzella, & Gunnar, 2014; Uchino, 2006). However, a paucity of research exists on proposed physiological pathways that links he exposure to PI, an understudied adversity, to poor mental health outcomes. Mental health outcomes are conceptualized in this framework as being affected by the broader social context to which individuals are exposed (e.g. families and communities). To date, current research on factors that may mitigate the effects of PI on child health has centered on interventions geared towards strengthening the parent-child relationship; a paucity of research exists exploring potential community level processes that may also buffer these effects. Socially supportive communities (e.g. collective efficacy) have been found to have positive effects on mental health outcomes (Browning, Gardner, Maimon, & Brooks-Gunn, 2014; Gunnar & Hostinar, 2015; Karb, Elliott, Dowd, & Morenoff, 2012;
Umberson, Crosnoe, & Reczek, 2010), including individual salivary cortisol levels (Do et al., 2011). This study may expand the interventional scope to community level buffers that may mitigate the negative effects between 1) exposure to PI on chronic physiologic stress and between 2) exposure to PI on mental health problems.

Purpose of the Study

The purpose of this study is to investigate the relationships among exposure to PI, chronic stress (hair cortisol concentration), and mental health outcomes (total behavioral problems, attention behavioral problems, internalizing and externalizing behavioral problems) in a racially and socioeconomic representative sample of urban adolescents aged 11 to 17 years (N=613) and the extent to which a sociospatial buffer (collective efficacy measured via activity space) moderate effects of PI on mental health outcomes (and mediate the effects of PI on HCC and HCC on MH). The study addressed the following specific aims:

Aim 1: To examine the associations between PI and mental health outcomes (*total behavioral problems, attention behavioral problems, internalizing and externalizing behavioral problems*).

Aim 2: To investigate the extent to which physiological stress (*hair cortisol concentration*) mediates the relationship between exposure to PI and mental health outcomes.

Aim 3: To investigate whether a sociospatial buffer (*collective efficacy measured via activity space*) moderate the relationship between PI and mental health outcomes.
Exploratory Aim 3a: To investigate the extent to which sociospatial buffers (*collective efficacy measured via activity space*) moderate the mediated relationship between a) exposure to PI and HCC and between b) HCC and MH outcomes.

See Figure 1 for Visual Interpretation of Dissertation Aims.

Figure 1. Visual Interpretation of Dissertation Aims

Rationale for the Study

Due to the significant proportion of children adversely affected by parental incarceration (PI) in the U.S., this dissertation proposes to advance nursing science through innovative investigation of an understudied phenomenon that may be attributing to the health disparities across the life course. Understanding the relationships between
PI, chronic physiologic stress, and mental health outcomes among urban adolescents will influence the practice of health providers and inform health policy makers on potential community level interventions for those children affected. To date, no study has examined the hair cortisol concentration or sociospatial buffers of those youth affected by PI. This study postulates that during times of adolescence, social support from the community may serve to broaden the scope of interventions from strengthening the parent-child relationship to community level sociospatial buffers. The investigation of community-level buffers may influence health policy by shifting and broadening the scope of available interventions. The knowledge gained from this innovative study will elucidate the impact of exposure to PI on chronic physiologic stress and mental health outcomes of urban adolescents. Examining the linkages between the social environment and the physiologic stress response is consistent with emerging nursing science uncovering the effects of adverse childhood events on health and well-being across the life span - a central theme cross-cutting the National Institute of Nursing Research Strategic Plan.

The specific population for this study was selected due to the paucity of research examining the effects of exposure to PI in earlier childhood on adolescent outcomes as most studies to date have focused on young adult outcomes occurring later in the life course. The dissertation focused on an earlier developmental stage as a critical interventional time period in addition to elucidating a possible physiological stress response as the critical linkage to mental health outcomes of youth exposed to PI. The secondary data to be analyzed for this study provided rich survey, geospatial, and
biological data to begin to test these relationships on a racially and socioeconomic representative sample of urban adolescents. Further, this study provided current information on the lifetime effects of PI during the adolescent developmental periods, in a state with the 4th highest rate of youth affected by PI (National Survey of Children's, 2011) – what sociologists have deemed as the worst, unforeseen, and unintended consequence of our correctional system (Geller et al., 2009; Harris et al., 2010).

Methodologically, an observational study is an appropriate study to understand exposures that are unethical to randomly assign (e.g. the exposure to PI) using experimental designs. Cross-sectional studies are descriptive, and therefore, best used to ascertain understanding of a particular understudied phenomenon. This study addressed several weaknesses in the current literature on exposure to PI by 1) investigating a plausible physiologic mechanism that might contribute to mental health disparities across the life span and 2) including a novel investigation of a sociospatial buffer within the context of exposure to PI in order to inform the potential development of community interventions to expand the current focus on improving parent-child relationships. A recent study by Nichols and colleagues (2015) found that among a nationally representative sample of adolescents, exposure to PI was positively and significantly associated with school truancy and negatively associated with high academic achievement and educational attainment after controlling for individual level (e.g. gender, socioeconomic status, minority status) and school level characteristics (e.g. access to mental health services). Further, the authors found that school connectedness had no discernable effect on later educational attainment for those adolescents exposed to PI,
indicating the need for additional support systems outside of the school and within the community (Nichols et al., 2015).

Overview of the Study Design

The dissertation is a secondary analysis of two parent studies funded by the National Institutes of Health – National Institute on Drug Abuse. The study design is cross-sectional in order to explore the relationships between PI, chronic physiologic stress (hair cortisol), mental health outcomes and potential sociospatial buffers (collective efficacy). The overarching parent studies include the 1) Adolescent Development in Context (AHDC) study which is a large-scale, multilevel, prospective cohort study, and the 2) Linking Biological to Social Pathways to Adolescent Health and Well-Being (Biosocial Linkages) study which includes a probability representative subsample of adolescents (N=613) participating in the first wave of the AHDC study.

The AHDC study employs a representative sampling design of up to 1500 households who have

Figure 2. AHDC Study Design
youth aged 11-17 years in Franklin County, Ohio. The AHDC study was designed to better understand the contributions of various ecological contexts (e.g. activity space, school, social network ties) on adolescent risk behavior, victimization, mental health and physical health. The AHDC study includes two data collection time points, 1 year apart. Within each wave, trained interviewers collect the data over a 1-week span. See Figure 2 for the AHDC Study design. A face-to-face interview and self-administered survey are collected from both the youth and the main caregiver. To enhance confidentiality, the caregiver interview is conducted while the youth completes the self-administered survey, and the caregiver survey is self-administered during the youth’s face-to-face interview.

The study also utilizes smartphones to collect (1) Ecological Momentary Assessment survey data over a seven-day period that include items such as mood, risk behavior and perceptions of informal social control, and (2) GPS location tracking data to retrieve the youth’s activity space exposure.

The Biosocial Linkages study collected chronic stress biomarkers (including hair cortisol) among a representative subsample of adolescents (N=613) participating in the first wave of the AHDC study. The purpose of the Biosocial Linkages study is to understand the relationships between the neuroendocrine pathway (cortisol biomarkers, immune function biomarkers), psychosocial/environmental stressors, and poor health outcomes. For my secondary analysis, only the first wave of data collection is needed to meet study aims.

Due to the burgeoning literature highlighting the negative health outcomes of youth and adults exposed to PI (Boch & Ford, 2014; Lee et al., 2013; Turney, 2014), the
chronic stress response is a plausible biological mechanism that may contribute to poor health outcomes and observed disparities. Understanding these associations will provide the foundational base for a burgeoning nurse researcher interested in conducting future research on the various physiologic linkages between the social environment (e.g., corrections, PI) and mental health outcomes.

Public Health Nursing Significance

The role of public health nurses is centered on the promotion and protection of the health of populations using knowledge garnered from nursing, social, and public health sciences in order to address complex health and systemic problems (Bekemeier, Walker Linderman, Kneipp, & Zahner, 2015). Due to the significant proportion of children adversely affected by PI in the U.S., I propose to advance public health nursing research through innovative investigation of an understudied phenomenon that may be contributing to the observed health disparities across the life course using novel measures of both objective stress and sociospatial support. The proposed study incorporates interdisciplinary knowledge from the social and public health sciences in order to address a vastly unique childhood adversity affecting the United States of America. The study utilizes a cutting-edge measure of the youth’s sociospatial exposures as it occurs throughout their activity space – which consists of all of the locations that individuals come into contact with as a result of their routine activities (Browning & Soller, 2014). To date, current research mitigating the effects of PI on child health has centered on interventions geared towards strengthening the parent-child relationship; although
important, a paucity of research exists exploring community level processes that may buffer these effects. Understanding the relationships between PI, chronic physiologic stress (hair cortisol), health outcomes and potential sociospatial buffers among urban adolescents will influence the practice of health providers and inform health policy makers on potential community level interventions for those affected.

Delimitations

Mental health outcomes include parental report of the child’s total behavioral problems including attention, externalizing, and internalizing behavioral problems using the Child Behavior Checklist- Brief Problem Monitor (T. M. Achenbach & Ruffle, 2000). I limited mental health outcomes to caregiver reported attention, internalizing, and externalizing behavioral issues of the youth in order to capture an array of socioemotional and disruptive problems rather than relying on caregiver report of mental health diagnoses. Further, externalizing behaviors are the most common and costly reasons that youth, particularly male youth, are referred to mental health services (Odgers et al., 2008; Welsh, Loeber, Stevens, Stouthamer-Loeber, & Cohen, 2008). While definitions vary across disciplines and providers, antisocial behavior is generally conceptualized as a type of externalizing behavior interpreted as socially exploitative, irresponsible, guiltless, disruptive, covert, and hostile towards others (Parritz & Troy, 2014; Piotrowska, Stride, Croft, & Rowe, 2015; Sawyer, Borduin, & Dopp, 2015). Frequently observed antisocial behaviors can lead to oppositional defiant or conduct disorder diagnoses in youth (Parritz & Troy, 2014). Antisocial behaviors in childhood and adolescence have been linked to
numerous economic, educational, physical and mental health problems across the life course (Odgers et al., 2008).

Limitations

Sample size precluded the ability to detect a significant effect on exploratory aim 3. For instance, an inadequate proportion of mothers and fathers who were incarcerated limited statistical power to detect significant differences for moderated mediation analyses.

Similar to most investigations examining the negative effects of PI, this study examined the exposure to PI as a dichotomous experience (e.g. ever exposed versus never exposed), and thus, the study is limited in a comprehensive understanding of PI due to the lack of contextual considerations (e.g. type of offense, duration, frequency, distance to institution, witnessing the parental arrest and court trials) among the available literature. Information on the length or reason for PI, parent–child visitation during incarceration, the type of correctional involvement (jail, prison, parole, or probation), or child placement during incarceration (e.g., with other parent, family member, or foster care) are not included in AHDC study, thus I was unable to explore their potential effects on stress and mental health outcomes. Therefore, generalizing the results to the greater population must be considered in context of these limitations.

Prior research, however minimal, suggests that the effects of PI on health may vary based on the gender of the parent and/or the gender of the child (Boch & Ford, 2014; Wildeman, 2009). The AHDC study does include data on the gender of parents who are
incarcerated at the time of the study (current incarceration), but preliminary analyses indicate the prevalence of current incarceration is low. Thus, analyses were conducted on the full sample of 613 youth. To date, the combined parent studies are the only data sources available to examine physiologic measures of stress (hair cortisol) and activity space measures of sociospatial exposures providing a rich data set to examine the effects of PI in context. Last, due to the correlational and retrospective question investigating PI, the current study design precludes any causal associations.
Chapter 2: Literature Review

The following literature review begins with an introductory overview of an understudied childhood adversity, urban youth exposed to parental incarceration (PI). Following the introduction, a summary of the theoretical frameworks, The American Academy of Pediatrics’ *Ecobiodevelopmental (EBD) Framework* and Bronfenbrenner’s *Bioecological Model of Human Development (BMHD)* that sets the foundation through which this study is derived. Next, a critical review on the mental health concerns of urban youth exposed to PI is discussed including the hypothesized linkages between PI and chronic stress (e.g. hair cortisol concentration) and between chronic stress and mental health outcomes. Next, the extent to which sociospatial buffers measured via the youth’s activity space and its potential impact on the health and stress of those youth exposed to PI is theorized. Throughout the literature review, gaps and limitations are identified to help situate how the proposed study will address those gaps and advance interdisciplinary nursing science.

Introduction

An Overview on the Magnitude of Youth Exposed to Parental Incarceration

Compared to all other nations in the world, the United States has maintained the highest rate of incarceration for several decades, housing more inmates than the top 35 European countries combined (International Centre for Prison Studies, 2011). In 2015,
the Bureau of Justice Statistics (BJS) estimated that 1 in every 37 adults, or 6.7 million people were under correctional supervision (prison, jail, parole, or probation) in the U.S. (Kaeble & Glaze, 2016). Furthermore, 52% of the persons incarcerated in state prison and 63% of those incarcerated in federal prison are parents of minor youth (Glaze & Maruschak, 2008). Thus, research is rapidly expanding to understand the consequential effects of incarceration on the public health of families and communities (Dumont, Brockmann, Dickman, Alexander, & Rich, 2012; Kruger & De Loney, 2009).

The most recent prevalence rate of U.S. children and adolescents’ current exposure to parental incarceration (PI) is from the 2007 Bureau of Justice and Statistics report in which approximately 2.3% of youth or 1.7 million youth, had a parent currently in state or federal prison (excluding jails and those on parole) (Glaze & Maruschak, 2008). However, prevalence rates for exposure occurring at any time during childhood or adolescence are much higher. For example, a recent report based on nationally-representative data from the National Survey of Children’s Health (NSCH), 2011-2012 indicated that nearly 7% of youth in the U.S., or more than 5 million youth (approximately one in every 14 youth), had experienced PI at least once during their childhood (Murphey & Cooper, 2015). In addition, the report indicated that exposure to PI is more concentrated among economically disenfranchised youth, as low-income youth were more likely to be exposed in comparison to higher-income youth (approximately 12.5% in comparison to 3.9% respectively) (Murphey & Cooper, 2015). African American (AA)/black youth are also more likely to be disproportionately exposed in comparison to Caucasian/white youth, as one in every nine AA/black youth
had a parent incarcerated in comparison to one in every 17 Caucasian/white youth (Murphey & Cooper, 2015). In another nationally representative study, Lee and colleagues (2013) found that lifetime prevalence rates also increase through young adulthood as by age 24-34 years, up to 12.5% of young adults in the U.S. reported a lifetime history of having either a biological mother or father incarcerated. However, prevalence rates most likely underestimate the number of youth affected by PI since most studies typically include parents in local, state, or federally operated jail and/or prisons, and often exclude those persons serving time on probation or parole, or those housed in privately operated facilities.

Researchers hypothesize that uneven prosecution and disproportionate rates of incarceration perpetuate familial social disadvantage and modify epigenetics of their offspring’s health (Kruger & De Loney, 2009; Mauer & King, 2007; Wakefield & Wildeman, 2011). Therefore, disproportionate incarceration rates may contribute to the health inequity observed between AA/Black children and adults compared to their Caucasian/white counterparts (Kruger & De Loney, 2009; Mauer & King, 2007; Wakefield & Wildeman, 2011). Despite the magnitude of PI in the United States, the effect on youth remains an understudied childhood adversity undoubtedly due to the lack of studies that have been purposely designed to study the role of parent-child separation by incarceration.

The proposed study will investigate the effects of PI in a metropolitan area in the state of Ohio, a state that is currently ranked fourth in the nation for the percentage of children who lived with a parent or guardian who served time in jail or prison after the
child was born (10.1% compared to 6.9% nationwide) (National Survey of Children's National Survey of Children's, 2011). Due to increased national attention on youth exposed to PI, the Ohio Department of Rehabilitation and Corrections conducted a state-wide randomized survey of inmates who have been detained for at least 9 months across Ohio prison institutions in 2014 (n=1,505) (Lamb, 2015). Approximately 75% of the inmates who participated in the survey reported having at least one biological child (average of 2 children, ranging from 1-17 children). Half of those inmates stated that they were dependent children (e.g. a child for whom the inmate has legal, financial, or parental obligations) (Lamb, 2015). Nearly 25% of the children were still living at the inmate’s residence, while 53% reported living in a different residence but in the same town or city as where the inmate used to live (Lamb, 2015).

Out of those inmates who participated in the survey, 1 out of every 3 reported that their own biological parent had spent time in prison, and nearly two-thirds of these inmates reported being involved with one or more correctional youth institutions such as Child Protective services, or juvenile detention centers (Lamb, 2015). These two statistics indicate the cyclical and intergenerational nature the correctional system has on individuals and families. Significant racial and economic disparities in exposure to PI also exist within Ohio with 17.6% of AA/Black children (vs. 8.7% non-Hispanic white children) and 21.5% of poor children (vs. 1.9% of high income children) having experienced parent or guardian incarceration after they were born (National Survey of Children's National Survey of Children's, 2011). As other research suggests, the effects of PI are highly concentrated among poor and AA/Black communities (Sykes & Pettit,
Children of incarcerated parents and communities disproportionately affected by PI are in critical need for community and individual interventions designed to promote overall wellbeing and prevention into the correctional system. Thus, identifying and intervening during the sensitive developmental stages of those youth affected by PI may have impact on reducing the well-documented health and sentencing disparities among AA/Black and white people.

Theoretical Frameworks

The Ecobiodevelopmental Framework

The proposal is guided by an integration of two frameworks: American Academy of Pediatrics’ Ecobiodevelopmental (EBD) Framework and Bronfenbrenner’s Bioecological Model of Human Development (BMHD). In the proposed model for this study, I integrate both of these frameworks to center in on the physiologic response of youth exposed to PI and the potential for the ecological context to serve as a buffer to the adverse effects of PI. The EBD framework centers on early childhood adversity and consequential physiologic adaptations leading to impaired development and later onset of disease processes (Shonkoff, Garner, Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, & Section on Developmental and Behavioral Pediatrics, 2012; Shonkoff, 2012). The EBD framework incorporates a life course perspective to childhood stressors and was developed to guide the practice of advanced level providers in their understanding of disease pathophysiology and the development of policy supportive of youth (Shonkoff et al., 2014).
The EBD framework provides critical theoretical tenants to situate investigation on an adverse exposure that may modify maturation and exert long-term effects on biological aging. The EBD framework was created in direct response to several national concerns plighting the United States. The primary motives for the development of the EBD framework stemmed from the preventative healthcare models and universal healthcare coverage, persistent socioeconomic and racial disparities, the increase in mental health illness and behaviors, and persistent adverse childhood exposures (e.g. sexual abuse, parental incarceration) described in the EBD as ecological “toxic stressors.” Further, the EBD highlights specific time periods that are particularly sensitive to environmental influences. While some developmental scientists focus on the effects garnered from the intrauterine environment (Barker, Eriksson, Forsen, & Osmond, 2002), the EBD centers on adverse exposures in both the prenatal and early childhood stages in relation to outcomes across the life course. Endorsed by the American Academy of Pediatricians, the creators of the EBD theoretical framework explicitly noted three foundational constructs, logically grouped together to influence the new basic science of pediatrics as ecology, biology, and development (Garner et al., 2012; Shonkoff, 2012). The authors explain the EBD framework as the ecology that becomes biology that drives development (Garner, 2013). The constructs in the EBD framework were formulated and derived from the past few decades of research from the developmental neuroscience, biology and social sciences addressing how “stress gets under the skin” (Shonkoff et al., 2012). The EBD framework is a simplified framework from the theoretical work created by the Center on the Developing Child at Harvard University highlighting an
ecobiodevelopmental approach for early childhood policies and programs (Shonkoff, 2012).

Therefore, studies investigating an understudied adverse exposure or phenomenon disproportionately affecting children of color, such as the impact of parental incarceration on youth are guided best by the EBD framework since it posits these adversities in relation to health disparities observed across the lifespan. The creators of the EBD framework hypothesize *improvements in adult health prevention efforts* and *reductions in chronic disease across the life course* by two mechanisms 1) strengthening health foundations in the prenatal and early childhood periods and 2) decreasing adverse exposures and strengthening protective relationships (Shonkoff, 2010; Shonkoff et al., 2012).

Ecology is an overarching construct in the EBD framework and focuses particularly on two empiric concepts of the *physical (or built) environment* (e.g. number of fast food restaurants) and *social environment* (e.g. poverty). Ecology in the larger theoretical framework guiding the EBD framework involves policy and programs, caregiver and community capacities, and foundations of healthy development. The *physical and social environment* are perceived and reacted to by the individual who is situated within deleterious or supportive environments (e.g. an individual exposed to a parent detained under correctional oversight). The EBD framework does not specify explicit types of ecological stressors because the creators acknowledge the vast individual variability in environmental stressor perception (Garner, 2013). In doing so, the EBD framework posits
focus away from labeling types of stressors in order to center the framework onto the
physiologic stress response represented by the second construct of biology.

The difference presented between a tolerable and toxic physiologic disruption relates
to the chronicity of the adaptation and presence (or absence) of social support buffers
primarily via adults. This proposal postulates that during times of adolescence, social
support from the community may serve to broaden the scope of interventions from
primarily adult or parental-child buffers to community level sociospatial buffers. Since
the focus of the EBD framework is buffered through the parent-child relationship, I
incorporate the work by Bronfenbrenner through the Bioecological Model of Human
Development (BMHD) to help highlight the role of contextual considerations important
to the health and wellbeing of youth.

Bioecological Model of Human Development (BMHD)

The BMHD framework centers on the linkages between the multiple environments
across the life course to which humans are exposed and their effect on biological
processes (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006; Bronfenbrenner &
Evans, 2000). I focus on collective efficacy in the youth’s activity space as a potential
moderator of the association between parental incarceration and physiologic stress,
primarily impacting the appraisal and coping mechanisms hypothesized to reduce
physiologic arousal from stressors (Lazarus & Folkman, 1984). The youth’s complex
interaction with their surrounding environment is measured by activity space; versus
census tract or neighborhood level defined social support. Activity space is able to better
capture the breadth of sociospatial exposure to collective efficacy and serves as an ecological buffer, rather than stressor (Browning & Soller, 2014). Further, recent work by Reavis and colleagues, conveys the importance in criminal adult outcomes and linkages to adverse childhood exposures (Reavis, Looman, Franco, & Rojas, 2013) and since youth affected by PI are more likely to be exposed to pathways that lead to incarceration (e.g. increased exposure to illegal substances and consequential increased usage) mitigating stress through community-level buffers, might also assist in reducing entry into corrections. The BMHD is used in conjunction with the EBD framework since the primary aim of the BMHD framework is to provide scientific rationale for effective social policies and programs that counteract disruptive influences, such as parental incarceration (Bronfenbrenner & Morris, 2006). Due to the significant amount of children adversely affected by parental incarceration, I propose to advance nursing science guided by these two frameworks to conduct an innovative investigation of an understudied phenomenon that links prior childhood adversity to mental health disparities during the adolescence.

**Adverse Childhood Experiences and Mental Health Outcomes**

**Adverse Childhood Experiences and Linkages to Mental Health**

The exposure of PI is situated within the EBD framework to build off of the well-documented literature on the negative health effects derived from adverse childhood experiences (ACEs) across the life course. Historically, the effects of PI on child and adolescent health outcomes have been studied within the Adverse Childhood Experiences
(ACES) framework in which household member incarceration is included in a cumulative index measure with other adverse events including abuse (e.g. emotional, physical, or sexual; witnessing violence against mother), household challenges (e.g., living with household members who were mentally ill, suicidal, substance abusers, or imprisoned, etc.) and neglect (e.g. emotional or physical) (Felitti et al., 1998). The original ACE study was a prospective cohort design based on a convenience based sample of over 13,000 adults who sought care from a large medical clinic in the United States and participated in a two-year follow-up survey addressing the total number of adverse exposures the adult experienced in childhood (Felitti et al., 1998). Persons who reported experiencing four or more ACEs in childhood, in comparison to their non-exposed peers, were four to 12 times more likely to report alcoholism, depression, suicide attempts and drug abuse and up to four times more likely to smoke and report over 50 lifetime sexual partners and consequent sexually transmitted infections (Felitti et al., 1998).

The findings from the plethora of research investigating ACES indicate that the greater the number of adverse exposures that children and adolescents endure, the greater the likelihood for increased maladaptive coping behaviors (e.g. cigarette, alcohol, illicit drug use, or violent delinquent behaviors), and poor mental health outcomes (e.g. depression, anxiety, post-traumatic stress disorder) during childhood and adolescence (Hussey, Chang, & Kotch, 2006; Lansford et al., 2002). Furthermore, the cumulative effect of ACES on health outcomes are often evident across the life course in which higher scores on the index have been associated with poor mental health and behaviors (e.g. alcoholism, depression, suicide attempts) in addition to poor physical health (e.g.
ischemic heart disease, cancer, chronic lung disease, skeletal fractures, and liver disease) in adulthood (Felitti et al., 1998). The accumulation of these adverse exposures are hypothesized to contribute to negative physical and mental health outcomes through the dysregulation of the stress response system and concomitant engagement in maladaptive coping behaviors (e.g. smoking, drinking, illicit drug use) (Shonkoff et al., 2012).

Altogether, the findings from the ACES studies have elucidated the long-lasting and significant impact that ACES can have on mental and physical health across the life course and they are increasingly being used to inform the development of public health interventions as well as health and social policies.

Others have replicated these findings and connections in other populations that were not demographically homogenous or convenience-based. In a large, diverse community based sample of urban adults, participants were asked about nine traumatic experiences before the age of 13 and then assessed by lay interviewers who inquired about diagnostic criteria for post-traumatic stress disorder, major depressive disorder, antisocial personality disorder and substance use disorder (Ballard et al., 2015). Findings revealed that among females, childhood sexual assault experiences predicted high levels of antisocial personality disorder and post-traumatic stress (Ballard et al., 2015). While among males, experiences of violence exposure predicted antisocial disorder and post-traumatic stress (Ballard et al., 2015). This study did not include parental incarceration as a traumatic experience but the article did conclude with the importance of investigating other various types of ACEs across both gender and time.
Others have also expressed the impact of ACEs, above and beyond other socioeconomic conditions, using data garnered from 29,000 adults (average age 48 years) who participated in the Behavioral Risk Factor Surveillance System 2012 survey (Font & Maguire-Jack, 2015). This study examined the cross-sectional associations between ACEs and self-reported health risks including depression, obesity, tobacco use, binge drinking and sub-optimal health status. Although examined as a count, one of the ACEs included was whether the child lived with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility. A secondary aim was investigating whether socioeconomic conditions mediated these outcomes using structural equation modeling (Font & Maguire-Jack, 2015). In comparison to those who did not experience any ACEs, those who reported any ACE were more likely to be a high school dropout, and divorced/widowed (Font & Maguire-Jack, 2015). Results revealed that childhood physical, emotional, and sexual abuse were significantly associated to adult health risks, unmediated by socioeconomic conditions (Font & Maguire-Jack, 2015). For those that reported 4 or more ACEs in comparison to those who did not experience any, the model predicted a 23.9% higher probability of ever being diagnosed with depression and tobacco use. However, certain types of ACEs (exposure to domestic violence, parental divorce, and ever lived with someone who was incarcerated) were primarily explained by socioeconomic conditions in adulthood (Font & Maguire-Jack, 2015).

The investigation of ACEs in early adult mental health was investigated on a large probability sample of high school seniors in a large urban metropolitan in the U.S.
(Schilling, Aseltine, & Gore, 2007). Two years after graduating high school, respondents were interviewed over the phone and inquired about depressed mood, frequency of drug use, and frequency of antisocial behavior (Schilling et al., 2007). In this study, exposure to parental incarceration was not included in the ACEs investigated. Despite exclusion, 8 of the 10 ACEs evaluated were significantly related to reports of higher depressive symptoms, increased drug use, and antisocial behavior in early adulthood (Schilling et al., 2007).

A recent meta-analysis in 2013 systematically evaluated available literature investigating the impact of ACEs on mental health outcomes in adulthood (De Venter, Demyttenaere, & Bruffaerts, 2013). Sixty-five articles were included in their review and the authors report that, on average, the occurrence of emotional, sexual, and physical abuse in childhood was an important risk factor in the development of depressive symptomatology in adulthood. Strong correlations were also found between family violence and physical neglect on adulthood substance use (De Venter et al., 2013). Thus, while ACEs investigations are becoming well-documented, types of adversity and the timing of these events are becoming much more important in a society driven by limited resources. Thus, this proposed study investigates the exposure of parental incarceration, an important, legally tracked marker of risk for intervention and systematic form of institutionalized parental-child separation. The exposure is a unique adversity to youth in the United States of America in comparison to other nations with differing correctional policies and rehabilitative programs.
The Conceptualization of Exposure to Parental Incarceration as an Adverse Childhood Experience

Researchers have theorized that exposure to PI is a *process* that begins pre-incarceration (e.g. witnessing of the arrest, pre-trial), through incarceration (e.g. visitation and contact limitations), and post incarceration (e.g. the parent has limited employment opportunities) (Naudeau, 2010). This conceptualization of PI as a process stems from the work of Bronfenbrenner’s *Bioecological Model of Human Development* created to capture the complexity of the developmental perspective within multiple environments (Bronfenbrenner & Morris, 2006). Therefore, the exposure to parental incarceration is not a single discrete event or adverse experience but rather a cumulative burden of *toxic stress*. Toxic stress is a particular type of stress that is *unbuffered by protective factors such as a two-parent household, or social support* (Garner et al., 2012; Shonkoff, 2012).

A toxic stressor is a term endorsed by the American Academy of Pediatrics who advocate for researchers to use the Ecobiodevelopmental (EBD) framework to guide investigations of the health outcomes of children affected by social adversities. The EBD framework centers on toxic stressors of the youth during sensitive developmental stages and the consequential physiologic mechanisms that lead to impaired development and later onset of disease processes (Shonkoff, 2012; Shonkoff et al., 2012). The EBD framework hypothesizes that early life and time-sensitive developmental adversities, such as parental incarceration, induce significant biological changes to the neurological, metabolic, and immune systems (Danese & McEwen, 2012) that modify maturation and exert long-term effects on biological aging and behaviors (Committee on Psychosocial Aspects of et al.,
2012; Danese & McEwen, 2012). Johnston and Gabel (1995) support this notion and suggest that the effects of parental incarceration might be strongest when children experience the event in early childhood due to the malleability of the brain and general inability to cognitively process events.

Thus, exposure to PI can be viewed as a necessary marker of risk for intervention since incarcerated individuals are more likely to have experienced cumulative disadvantage (e.g. poverty, low-education, substance dependence, gang involvement, mental health problems) (Binswanger & Elmore, 2015; Harlow, 2003; Harris, Graham, & Oliver Carpenter, 2010; Western & Pettit, 2010) that can impact all stages of development and well-being of their offspring (Ardetti, 2012; Dawson, Brookes, Carter, Larman, & Jackson, 2013; J. Murray & Murray, 2010). Similarly, due to the well-documented effects of neglect on the developing brain of youth (Font & Maguire-Jack, 2015; Van Niel, Pachter, Wade, Felitti, & Stein, 2014), exposure to lengthy sentences of PI could also be conceptualized as a form of institutionalized neglect (e.g. a year-long sentence for a nonviolent parole violation).

Researchers have hypothesized that separation by incarceration can lead to poor parent–child attachment and relationship bonding due to physical separation (Gabel & Johnston, 1995), childhood subjective weathering (Foster, 2012), and stigma (Schnittker & John, 2007). These mechanisms, in turn, may lead to chronic activation of the hypothalamus-pituitary-adrenocorticoid axis and subsequent poor health and behavioral outcomes (Holly Foster & Hagan, 2013). Qualitative literature identifies PI as a particularly stigmatizing adversity markedly different from other types of parental
absences (e.g. parental separation by divorce or military) (Ardetti, 2012). Since discrimination against offenders during and post incarceration are evident by limited rights (e.g. denial to housing, voting, employment), researchers hypothesize that these ramifications and assumptions likely carryover and affect wellbeing across generations through the process of stigmatization (Pager, 2003; Schnittker & John, 2007).

Phillips and Gates (2010) endorse the use of stigmatization as key to understanding the conceptualization of how children are affected by PI. Link and Phalen (2001) define stigmatization as a process consisting of five elements: 1) a distinguishing label of difference 2) the difference is associated with negative attributes, 3) an “othering” process or “us” versus “them,” 4) discriminatory treatment in informal or formal ways and 5) the label serves to perpetuate socio-political and economic differences. Incarcerated persons are stigmatized due discrimination that is officially sanctioned through voting, housing, and welfare restrictions (Schnittker & John, 2007), and socially sanctioned through discriminatory hiring practices (Pager, 2003). The overt discrimination consequently impacts the overall wellbeing of their offspring through societal stigma and shame (Phillips & Gates, 2011). This is highlighted by recent work where school teachers were given hypothetical student scenarios measuring their expectations of students who had a parent incarcerated (Dallaire, Ciccone, & Wilson, 2010). In the study, school teachers reported that they had lowered expectations of “competency” for female children of incarcerated parents’ in comparison to those female children whose parents were not incarcerated (Dallaire et al., 2010).
In general, persons who are incarcerated are devalued due to the harm they have had on others or themselves. Incarcerated persons are oftentimes ascribed a lower social status in America, all of which, adversely affect their children through societal stigma and shame due to familial association (Phillips & Gates, 2011). Despite their parent’s criminal behavior and/or sentencing, children are inadvertently being affected. Due to the sensitivity of the neurobiological environment of children and pubertal developmental stage of adolescents, population health researchers are interested in ascertaining the physiologic and behavioral effects of toxic stress during these critical time periods (Blakemore, Burnett, & Dahl, 2010; Eiland & Romeo, 2013; Luo et al., 2012; Noppe, van Rossum, Vliegenthart, Koper, & van den Akker, 2014). While some posit that isolating the incarcerated parent may overall benefit the child due to physical separation from a parent who may have been physically or sexually abusive (Johnson & Easterling, 2012), a paucity of research examines parental incarceration by type of offense (Wildeman, Wakefield, & Turney, 2013). Further, transportation support, distance to institution, and communication barriers limit parent-child communication, exacerbating healthy attachment and bonding, two well-theorized buffers for the proper development of children exposed to PI (La Vigne, Davies, & Brazzell, 2008; Makariev & Shaver, 2010).

**Exposure to PI and Mental Health Outcomes**

Most of the quantitative investigations on the mental health of youth exposed to PI have examined the correlations to antisocial or externalizing behaviors, internalizing behaviors, and “problem behaviors.” Antisocial and disruptive behaviors are a common
and costly reason that youth, particularly male youth, are referred to mental health services in the United States (Odgers et al., 2008; Welsh, Loeber, Stevens, Southamer-Loeber, Cohen, et al., 2008). While definitions vary across disciplines and providers, antisocial behavior is generally conceptualized as a type of externalizing behavior interpreted as socially exploitative, irresponsible, guiltless, disruptive, covert, and hostile towards others (Parritz & Troy, 2014; Piotrowska et al., 2015; Sawyer et al., 2015). Frequently observed antisocial behaviors can lead to oppositional defiant or conduct disorder diagnoses, if accessible, in youth (Parritz & Troy, 2014). Others may grade youth on their propensity to conduct antisocial behaviors, termed antisocial propensity (Parritz & Troy, 2014) similar to how Roettger and Swisher (2011) determined the propensity of delinquency in those youth who experienced a father incarcerated. In general, antisocial and externalizing behaviors in childhood and adolescence have been linked to numerous economic, educational, physical and mental health problems across the life course (Odgers et al., 2008).

Overall, few studies have been specifically designed to investigate the experience of PI independently despite evidence of the contribution of PI to negative physical (Boch & Ford, 2014; Lee et al., 2013; Roettger & Boardman, 2012) and mental health outcomes (Foster & Hagan, 2013; Turney, 2014; Wildeman, 2008), in addition to economic (Geller et al., 2011), educational, (Cho, 2011; Hagan & Foster, 2012; Nichols, Loper, & Meyer, 2015), and behavioral difficulties (Foster & Hagan, 2013b; Geller et al., 2012; Wakefield & Wildeman, 2011). Due to the correlated adversity (e.g. poverty) with PI, small, and convenient samples preclude advanced rigorous analyses. A comprehensive
understanding of PI is limited due to the lack of contextual considerations (e.g. type of offense, duration, frequency, distance to institution, witnessing the parental arrest and court trials) among the available literature as evidenced by the majority of literature measuring PI as a dichotomous exposure (e.g. ever exposed versus never exposed). However, much less is known about proposed physiologic pathways linking PI to negative mental health outcomes across the lifespan.

Despite limitations, effects of PI on the mental health outcomes of their offspring have been observed across the lifespan. Work by Lee and colleagues (2013) found long term effects of having a parent incarcerated using data from the National Longitudinal Study of Adolescent to Adult Health (ADD Health). The study found that young adults exposed to PI in childhood (during 0-18 years of life), compared to their nonexposed peers, had an increased odds in self-reporting depression, anxiety, post-traumatic stress disorder, and self-reported fair/poor health in young adulthood (Lee et al., 2013). Foster and Hagen (2013) provided further evidence of poor mental health outcomes in young adulthood also utilizing data from the Add Health study and found a statistically significant positive association between exposure of maternal and paternal incarceration in childhood on depressive symptomatology (9 items on the CES-D scale in the past week) in young adults. Exposure to paternal incarceration, unlike maternal incarceration, was also statistically significant in increasing substance use problems in young adult males (Foster and Hagan, 2013).

Extant literature supports the linkages between exposure to PI during earlier developmental stages and mental health outcomes in children and adolescence (Bocknek,
To date, the only comprehensive meta-analysis on the effects of PI on childhood behavior compiles international research conducted by Murray and colleagues (2012). The meta-analysis examined a total of 40 studies (n=7,374 children exposed to PI) published from 1970 through 2011. Murray and colleagues (2012) demonstrated a statistically significant and positive association between exposure to PI and antisocial behavior (defined broadly as externalizing behaviors that violate societal norms) across both male and female samples using a pooled odds ratio (OR = 1.6, CI [1.4, 1.9], k = 45, p < 0.01). This effect remained significant for all samples evaluated (community-based, clinic-based, and court-based samples), with the strongest effect observed for male youth in comparison to females (Murray, Farrington, & Sevol, 2012). While the effect size was strongest in prospective cohort studies, there were no statistically significant differences across prospective, retrospective or cross-sectional studies included in the review. In studies that derived data from community based-samples, effect sizes were significant for antisocial behaviors (OR= 1.7, CI [1.4, 2.0], k=36), mental health problems (internalizing problems including anxiety and depression; OR=1.2, CI [1.0, 1.4], k = 17), and poor educational outcomes (OR= 1.5, CI [1.1, 2.1], k=11) (Murray, Farrington, & Sevol, 2012). However, it is important to note that this study combined outdated research across 7 countries that vastly differ in governmental regulations and social policies. The review highlighted the need for understanding the role of community-level interventions and more rigorous study designs, as only three of the studies examined changes in children’s behavior from
before PI to after (Murray, Farrington, & Sevol, 2012). In addition, the article highlighted a paucity of research on the effects of maternal incarceration on child well-being and development (Murray, Farrington, & Sevol, 2012).

Most PI researchers investigating the exposure of PI on mental health outcomes of youth, rather than young adults, have primarily used the Childhood Behavior Checklist (CBCL) (Achenbach & Ruffle, 2000). The CBCL is designed to measure behavioral and emotional concerns, a questionnaire widely used and adapted across developmental stages that allow for a primary caregiver to rate the child’s problems (Achenbach & Ruffle, 2000). Caregivers are asked to rate the child’s attention, internalizing, and externalizing behavior problems within a specified or unspecified timeframe (Achenbach & Ruffle, 2000). The literature is mixed on the effect of PI on child externalizing, internalizing, and total problem behaviors dependent on who reported upon the child’s behavior (e.g., teacher, primary caregiver, or child-reported), gender of parent incarcerated, and gender of the child). For example, Wilbur and colleagues (2007) did not find support for an independent effect of father incarceration, after adjustment of covariates between those children exposed to PI in comparison to their non-exposed peers, on internalizing scores (B = 0.70, SE 2.21, p = 0.75) or externalizing scores (B = 4.57, SE = 2.25, p = 0.06) derived from the CBCL. However, despite a small sample size (N = 102), the study did demonstrate a significant difference for those children exposed to father incarceration (n = 31), in comparison to their non-exposed peers, on teacher-reported total externalizing scores (B = 5.87, SE = 2.64, p = 0.03) derived from the Teacher Report Form (where teachers were asked to rate the externalizing behaviors
observed in the past 6 months). However, another study found only an independent effect of PI (mother or father) in predicting teacher-reported internalizing behaviors (B = 0.18, p < 0.05) in a sample of 5 year old homeless children using the McArthur Health and Behavior Questionnaire (HBQ) (measures total scores of internalizing and externalizing behaviors, physical health, and school functioning) (Casey, Shlafer, & Masten, 2015).

The two disenfranchised groups analyzed (homeless children affected by PI or homeless children unaffected by PI) did not differ statistically on familial and individual demographics, indicating an independent effect of PI on increased reports of internalizing problem (N = 138, n = 45).

In a much larger and nationally-representative sample using data derived from the Fragile Families and Child Well-being study, Geller and colleagues (2012) found significant differences between those exposed to father incarceration in comparison to their non-exposed peers using the aggressive subscale of the CBCL. Across 4 different modeling strategies developed to determine if these differences were attributed to family characteristics, socioeconomic characteristics, and timing of father incarceration; exposure to PI was statistically significant in predicting aggressive behavior in children (Geller et al., 2012). Model 1 examined cross-sectional associations between those children ever exposed in comparison to those non-exposed, adjusted by various control variables. Model 2 examined incarceration of the father between 3 and 5 years old and those non-exposed. Model 3 adjusted for socioeconomic characteristics, while model 4 adjusted for family characteristics (Geller et al., 2012). Using data from both the PHDCN and FFCWB datasets, Wakefield and Wildeman (2011) demonstrated that children
exposed to father incarceration in early childhood (less than 5 years of age) significantly increased both caregiver-reported externalizing and internalizing problems (using CBCL) for children at age 5 and 10.

Correlational studies have also found an increased report of depressive symptomatology in children ever exposed to paternal incarceration (Swisher & Shaw-Smith, 2015; Wilbur et al., 2007). After adjustment for child’s age, gender, prenatal cocaine/alcohol exposure and school-age violence exposure, Wilbur and colleagues (2007) also demonstrated a statistically significant association in a small diverse sample (N = 102, n = 31) between ever incarceration of the father after the child was 6 years of age, and an increased report of child depressive symptomatology using the Child-Depressive Inventory at age 9 (Wilbur et al., 2007). While Swisher and Shaw-Smith (2015) used data from the National Longitudinal Study of Adolescent to Adult Health and found that both short-term (less than 1 year) and long-term durations (greater than 10 years) of an incarcerated father were associated with higher reports of depressive symptomatology (in the past week) in both male and female adolescents. However, the researchers measured depressive symptomatology using 5-items assessing the respondent’s most frequent emotions during the past week (being satisfied with life, feeling depressed, being unable to shake the blues, being happy, feeling sad) (Swisher & Shaw-Smith, 2015). There is limited research on the effects of PI on depression that utilize clinically relevant diagnostic criteria that assess behavioral or emotional concerns greater than 2 months. A small descriptive study (n=35) on children (1st through 10th grade) who had any relative in prison demonstrated that 77.1% of the children who
participated in the study reported post-traumatic symptom scores “above the clinical cutoff” using the Child-Report of Posttraumatic Symptoms (CROPS) scale (Bocknek et al., 2009). No study, to date, has investigated suicide ideation or attempts in children who have been exposed to PI.

Others have correlated the adversity of PI to caregiver reported mental health conditions of the child within the household. Utilizing a probability sample of noninstitutionalized U.S. children, telephone survey data from the National Survey of Children’s Health (n=95,677) demonstrated that PI (during 0-17 years of age) was independently and significantly associated with caregiver report on five mental health outcomes that were present in the child (learning disabilities, attention deficit disorder or attention deficit hyperactivity disorder (ADD/ADHD), behavioral or conduct problems, developmental delay, speech/language problems), after adjusting for demographic, socioeconomic, and familial characteristics known to associate with parental incarceration (Turney, 2014). Turney (2014) also found that the effect of exposure to PI on all 5 mental health outcomes was significantly worse in comparison to other types of parental-child separation including parental divorce or separation, and parental death (Turney, 2014). Further, the effect of PI on 4 various mental health in childhood (including learning disabilities, attention deficit disorder or attention deficit hyperactivity disorder (ADD/ADHD), developmental delay, speech/language problems) was also more detrimental than witnessing parental abuse or experiencing a household member with a drug or alcohol problem. Despite these strong associations, the study design was correlational and did not address temporality in the analyses due to limitations in the
measurement of exposure to PI, and thus, causality is limited (Turney, 2014). Another study by Tasca and colleagues (2014) found that incarcerated mothers were more likely to report mental health problems in their children in comparison to incarcerated fathers. Aside from mental health problems, criminal conviction or crime-involvement may serve as general proxies of illegal activities or behaviors that may indirectly measure adverse antisocial behaviors (e.g. substance abuse, externalizing behaviors that have criminal consequences). Using data from the Criminal Career and Life Course Study, researchers found that young adults who experienced paternal incarceration before the age of twelve was strongly correlated to criminal convictions between the ages 18 to 30 (Rakt et al., 2012). This correlation was also demonstrated in the United States, using nationally-representative data garnered from the National Longitudinal Study of Adolescent to Adult Health study. Experiencing father incarceration before the age of 12 increased the odds of delinquent propensity from 18-25 years of age (Roettger & Swisher, 2011). Those with a history of father incarceration post birth was associated with an increase in delinquency propensity as measured by the number of illegal violent (e.g. shooting or stabbing someone) and non-violent acts (e.g. selling drugs) (Roettger & Swisher, 2011). Further, this trend was also observed in adolescence ranging from 12 to 18 years of age. Thus, those experiencing father incarceration in childhood were more likely to engage in risky criminal behavior across all age groups, from adolescent to early adulthood. In addition, those who reported a history of father incarceration was statistically and significantly correlated to an increased self-report of a criminal arrest in early adulthood (M. E. Roettger & Swisher, 2011).
While research on the effects of PI on the health of youth is becoming more methodologically rigorous (e.g. inclusion of propensity score models), overall, there is a lack of contextual considerations of PI that may lead to differential health outcomes, such as the duration (e.g. sentence length) or frequency of incarceration, correctional offense (e.g. violent or nonviolent), distance to correctional placement, type of correctional involvement (e.g. private versus local, state or federally operated facility, parole, probation, jail, or prison), or type of household placement for the child during the incarceration (e.g. other biological parent, foster care, adoption, or other familial member). Further, a paucity of research examines the role of social support buffers outside of the parent-child relationship such as peer support or socially supportive communities (e.g. collective efficacy and intergenerational closure), that have been found to have positive effects on the health of children (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Gunnar & Hostinar, 2015; Uchino, 2006). Understanding these differences among these contextual considerations may help inform the development of behavioral interventions as well as public health and social policies.

Physiologic Chronic Stress and Mental Health Outcomes

*Hair Cortisol Concentration as a Measure of Physiologic Chronic Stress*

Chronic stress is the result of an individual’s reaction, recovery, and physiologic adjustment to toxic unbuffered adversities (Epel & Lithgow, 2014; Shonkoff, 2012). Youth are especially sensitive to chronic stress due to the developmental malleability of their neurobiology (Bauer, Jeckel, & Luz, 2009; Shonkoff et al., 2012). Extant literature
supports the linkages between early childhood adversity (including poor prenatal exposures) and the lasting changes in neurobiological structures affecting how youth learn, behave, and self-regulate across the life span (Danese & McEwen, 2012; Karatereos & McEwen, 2013; Lupien et al., 2009; Lupien, King, Meaney, & McEwen, 2001; B. S. McEwen, 2008). The plasticity of the brain (primarily in the amygdala, hippocampus, and prefrontal cortex) is particularly sensitive to stress hormone dysfunction during early life development which can poorly impact psychopathology and disease progression across the lifespan (McEwen, Nasca, & Gray, 2015).

The measurement of how stress “gets under the skin” or consequentially disrupts physiology and psychology has been extensively studied (Epel & Lithgow, 2014; Li, 2013; Lupien, McEwen, Gunnar, & Heim, 2009; B. McEwen, 2015; McEwen, 2008; B. S. McEwen, Nasca, & Gray, 2016). Multiple mechanisms of action are involved in the stress response and include the complex interplay of the secretion and action of various stress hormones (e.g. glucocorticoids, corticotrophin releasing hormone), neurotransmitters (e.g. dopamine, serotonin and norepinephrine) and inflammatory markers (e.g. IL-6, c-reactive protein) (B. S. McEwen, 2008). However, an important and well-known biological marker of the physiologic stress response and measurement of hypothalamus-pituitary-adrenal (HPA) functioning is the measurement of the cortisol hormone (B. S. McEwen, 2008; Nater, Skoluda, & Strahler, 2013). Cortisol is a glucocorticoid released from the adrenal glands that can become harmful to the body in excess or insufficiency (Bauer et al., 2009; Fraser et al., 1999; Wester & van Rossum, 2015). Since cortisol plays an important role in the metabolism of proteins, lipids, and
glucose, excessive or insufficient cortisol in the body can negatively affect the regulation of cardiovascular, metabolic, and immunologic functioning predisposing individuals to poor mental and physical health across the life course (Fraser et al., 1999; Makras, Toloumis, Papadogias, Kaltsas, & Besser, 2006). Cortisol has most commonly been extracted from serum, saliva and urine to capture a physiologic measure of hypothalamus-pituitary-adrenal (HPA) functioning indicating a single time within the cortisol diurnal rhythm (e.g. serum, saliva) or daily estimate (e.g. 24-hour urine).

A novel biomeasure of chronic stress gaining steady recognition in health research is the noninvasive measurement of cortisol via hair samples. Measurement of hair cortisol is a feasible approach to obtaining an objective retrospective measure of chronic stress; each 1 cm of hair is approximates the mean cortisol level over the prior 1 month of growths (Russell, Koren, Rieder, & Van Uum, 2012; Wennig, 2000). Within the past two decades, methodological studies have endorsed hair cortisol as a valid (Short et al., 2016) and reliable measure of the chronic stress response (Russell et al., 2015; Tobias Stalder & Kirschbaum, 2012; T. Stalder, Steudte, Miller, et al., 2012). Researchers have also demonstrated feasibility of the collection of hair in large community based sample sizes among multiple developmental stages across the life course (Dettenborn, Tietze, Kirschbaum, & Stalder, 2012; Ford, 2016; Sharpley, McFarlane, & Slominski, 2012; Staufenbiel, Penninx, Spijker, Elzinga, & van Rossum, 2013; Vanaelst, De Vriendt, Huybrechts, Rinaldi, & De Henauw, 2012).

While there is some debate about the exact mechanism into how cortisol as a glucocorticoid is leeched into the hair shaft (e.g. either through sebaceous or eccrine
gland, serum, or both), the most common hypothesis supported is that HCC reflects a fraction of the free, inactive, and unbound form of systemic release of cortisol, rather than the total cortisol concentration (free and bound cortisol) found in serum or urine (Raul, Cirimele, Ludes, & Kintz, 2004). Hair is advantageous to collect over other methods since hair samples capture chronicity retrospectively, while serum, urine and saliva samples reflect acute daily releases of cortisol which would require meticulous time point sampling (e.g. bedtime or morning sampling), and repeated collections in order to reflect a longitudinal or chronicity measure (Dettenborn et al., 2012; Raul et al., 2004; Stalder et al., 2012).

Compared to urine, saliva, and serum, hair has a low level of invasiveness associated with the sample collection and thus the cortisol is not affected by the stress of the sampling procedure (Russel et al., 2011). Other advantages to using hair cortisol include low maintenance storage requirements (room temperature, stable for years), and the ability to retrospectively represent cortisol production from months to years. Due to the appeal, chronicity, and relative ease of obtaining hair samples for accumulative and retrospective cortisol concentration, researchers have investigated the various relationships between HCC and various physiological diseases and psychosocial environmental stressors among a variety of populations (D'Anna-Hernandez, Ross, Natvig, & Laudenslager, 2011; Gow et al., 2010; Karlen et al., 2015; Milam, Slaughter, Verma, & McConnell, 2014).

Hypoadrenal and hyperactivity responsiveness of the hypothalamus–pituitary–adrenal (HPA) axis through measurement of cortisol have been correlated to a variety of
mental illnesses and behaviors (Heinze, Lin, Reniers, & Wood, 2016; Lupien et al., 2009; Oitzl, 2010; Shirtcliff, Coe, & Pollak, 2009). Most of the literature investigating the linkages of cortisol and mental illness is mixed partially due to reliance on daily estimates of HPA activity through the extraction of cortisol in urine, blood or saliva which can be highly variable dependent on timing of the collection and stress of the procedure (Burke, Davis, Otte, & Mohr, 2005; Evans, Greaves-Lord, Euser, Franken, & Huizink, 2013). Research provides evidence that the cortisol diurnal rhythm is evident by as young as 3 months of life and that this relationship becomes more pronounced and similar to an adult rhythm between the ages of 5-8 months (Price, Close, & Fielding, 1983).

In 2008, a comprehensive meta-analysis reviewed 59 studies that compared the associations between externalizing behaviors (including aggressive, antisocial, oppositional, disruptive, or overactive behaviors) and morning or evening basal levels of cortisol (measured through saliva, urine, or serum samples) (Alink et al., 2008). The meta-analysis demonstrated an overall small, albeit significant, effect demonstrating an association between lower levels of basal cortisol and higher levels of externalizing behaviors all across all studies ($r = -0.05$, CI $= -0.10, -0.02$, $p < 0.01$) (Alink et al., 2008). Further, the relationship between basal cortisol levels and externalizing behaviors were moderated by age, in that, externalizing behaviors were associated with higher cortisol levels in children ages 0-5 ($r = 0.09$, CI $= 0.002, .17$, $p <0.05$), and lower cortisol levels in children aged 5-12 years old ($r = -0.14$, CI $= -.19, -0.8$, $p <0.01$) (Alink et al., 2008). There was no significant association between basal cortisol levels and externalizing behaviors among children aged 12-19 years of age (Alink et al., 2008). However, 33
studies analyzed the relationship between one cortisol sample and externalizing behaviors, 20 studies analyzed the relationship using 2-5 cortisol samples, and 19 studies analyzed the relationship using greater than 5 cortisol samples (Alink et al., 2008). No study was included that examined hair cortisol concentration.

Due to small homogenous sample sizes, the associations of HCC to the development of adolescent and adult mental health problems are vast and mixed. For example, in one study, clinically depressed adult patients had an increased HCC (24.3 mp/pg) in comparison to non-depressed controls (16.05mp/pg) (Lucia Dettenborn et al., 2012), while a more recent study found lower HCC in patients diagnosed with major depression (27.18 mp/pg) in comparison to healthy controls (31.29 mp/pg) (Steudte-Schmiedgen et al., 2017). In a pooled analysis of 5 community-based samples, researchers demonstrated a statistically significant correlation between high HCC and the use of antidepressants after adjustment for sociodemographic considerations (B = 0.238, p < 0.001) (Wells et al., 2014). Two other studies did not find any correlation between HCC and depression in a group of clinical depressed adult patients with coronary artery disease in comparison to their non-depressed peers with coronary artery disease, in addition to another study comparing adult mothers who had a spontaneous abortion in comparison to adult mothers who delivered full-term (Kramer et al., 2009).

Similar mixed findings have been demonstrated in patients who have generalized anxiety disorder. In one study, adult patients with generalized anxiety disorder had 50% lower HCC levels (8 mp/pg) in comparison to health controls (19mp/pg) (Steudte et al., 2011). However, a more recent study found no statistically significant differences in
HCC levels in patients with generalized anxiety disorder in comparison to healthy controls (Steudte-Schmiedgen et al., 2017). Increased HCC has also been correlated to coping behaviors that may serve as risk factors for clinical depressive or anxious symptomatology. In one study, increased HCC was positively correlated to hazardous drinking and smoking, after adjustment of sociodemographic characteristics (Wells et al., 2014). Increased HCC has also been observed in alcoholic patients in acute withdrawal (51.99 mp/pg) in comparison to long-term abstinent alcoholics (13.98 mp/pg) (T. Stalder et al., 2010).

The literature is also mixed on whether HCC is elevated or suppressed in those who demonstrate post-traumatic stress disorder (PTSD) symptomatology. In one study, HCC was higher in a sample of adults with PTSD (37.2 mp/pg) in comparison to non-PTSD adults exposed to similar socioeconomic adversities (Steudte et al., 2011). However, in a sample of adolescent females, HCC was higher in in adolescents who were non-traumatized (5-7 months after an earthquake) in comparison to their traumatized peers within the same time frame indicating a blunted HPA response (Luo et al., 2012). Despite the mixed findings, most of the research finds support for a dysregulated HPA axis response in relation to various deleterious mental health outcomes.

In children and adolescent samples, the correlations to various socioemotional problems are also mixed. In a sample of 1 year olds (n=297), upper quartiles of HCC levels were positively correlated to an increase in mother-reported socioemotional problems using the Brief- Infant-Toddler Social and Emotional Assessment (p=0.1). While in a sample of 223 elementary school girls, higher cortisol levels were associated
with a higher risk for psychological problems ($r=0.223, p = 0.004$) as indicated from a higher cumulative score on negative life events derived from the Coddington Life Events Scale (higher scores indicate a higher risk for psychological problems) (Vanaelst et al., 2013). However, within the same study, there was no direct correlation of HCC to emotions (reported in the last week) or coping styles as reported by the children (B. Vanaelst et al., 2013). Other emotions have been assessed, such as in one study conducted on a small sample of children (N=42) where HCC increased significantly from before to after school started only in children who scored high on “fearfulness” derived from the Child Behavior Questionnaire (Groeneveld et al., 2013).

However, in general, increased HCC levels have been associated with a variety of chronic stressors that are often risk factors for the development of mental illness like depression and anxiety. For example, increased HCC concentration has been observed in young adults that work nights in comparison to day-shift workers (Manenschijn, 2011), in young adults who reported more major life stressors (e.g. death of a relative) in comparison to those who have experienced adversity (Karlen, Ludvigsson, Frostell, Theodorsson, & Faresjo, 2011), in adults with severe chronic pain in comparison to controls (Van Uum et al., 2008), and in adults with more subjective reports of social overload and increased body mass index (Stalder, Steudte, Alexander, et al., 2012).

In conclusion, due to small homogenous sample sizes, the associations to the development of adolescent mental health problems are vast and mixed. However, in general, most literature does support that the dysregulation (increased or decreased) levels of HCC are potential pathways linking HCC to poor health across the lifespan.
There is much more to be understood in the linkages between adverse childhood experiences such as exposures to PI to the mental health problems of youth.

*The Mechanism of HCC in the Linkages of Exposures to PI on Mental Health*

Most of the literature postulates PI as a *chronic stressor*, and that the ensuing *chronic stress response* (Holly Foster & Hagan, 2013; Turney, 2014) is the probable mechanism leading to deleterious health outcomes later in the life course. However, scant research exists investigating the effects of PI on physiologic stress or linkage to any direct biomeasure of stress. Preliminary research for this dissertation found that exposure to biological father incarceration during 0-17 years of age was independently associated with increased levels of C-reactive protein, a biomarker of low-grade inflammation, in young adult females, controlling for numerous sociodemographic and health conditions and behaviors known to increase C-reactive protein levels (Boch & Ford, 2014). Physiologic stress (irregular cortisol secretion) has been linked to low-grade inflammation in numerous studies (Ayari, 2013; Bauer et al., 2009; Karatoreos & McEwen, 2013; Kiecolt-Glaser & Glaser, 1999). However, Boch and Ford (2014) did not examine the effects by age the child was exposed to parental incarceration nor examine a *chronic* measure of physiologic stress on the contemporary effects of PI. This dissertation hopes to quell the limitations in our previous study in order to shed better understanding on the linkages between PI exposure and mental health behaviors in adolescence.
The Role of Sociospatial Buffers in Urban Youth Mental Health

Introduction to Collective Efficacy

Sampson and colleagues (1989) are revered as conceptualizing collective efficacy through the testing of the theory of social disorganization. In 1989, Sampson and colleagues proposed intervening dimensions or mechanisms of theory of social disorganization, providing the foundational tenants to the concept of collective efficacy. The concept of collective efficacy was developed to help describe why there were differences observed between high-crime communities (Sampson & Groves, 1989). Sampson and colleagues (1989) described important structural characteristics of a community: the ability of a community to supervise and control teenage peer groups (e.g. gangs), local friendship networks, and local participation in formal and voluntary organizations. Sampson and Groves (1989) provided insight on how social disorganization represents the inability of macro-level structures to promote and foster shared values among residents, which consequentially, impacts and impairs the informal controls of social behavior that govern activities of daily living in more influential ways than formal social control mechanisms (e.g. police). Social disorganization may pave the pathway to human disconnection, and collective efficacy serves to test the level of connection within community disorganization.

Using data from Great Britain, Sampson and Groves (1989) found that community structural characteristics best explained the between-community variations in
social disorganization and crime. Using a similar conception of Tilly’s *collective action*, or the application of pooled resources for collective or community gain (Tilly, 1973), Sampson and colleagues proposed the concept of *collective efficacy* (Sampson, 2011). Collective efficacy is comprised of 1) social cohesion and 2) shared expectations for control, and in combination, serves to mediate (or moderate) the relationship between neighborhood characteristics and behavioral outcomes (Sampson, 2011). The two-part summary scale of collective efficacy was a measure officially developed in 1997 by Sampson and colleagues denoting *shared expectations within the community* as “informal social control,” and *collective action* as “social cohesion” (Sampson, Raudenbush, & Earls, 1997). The collective efficacy scale measures both adult-child social ties and expectations for active support and informal social control of local youth by neighborhood adults (including intergenerational closure) and was originally used to examine rates of violence (Leventhal and Brooks-Gunn (2000); (Odgers et al., 2009; Odgers et al., 2009; Sampson et al., 1997). However, the measure of collective efficacy has been used to understand the role of social ties within the neighborhood on an array of developmental outcomes aside from rates of crime and delinquent behavior. Browning and colleagues have expanded the concept of collective efficacy from explaining the variation in crime rates between neighborhoods, to explaining differences in self-rated health (Browning & Cagney, 2002). Browning has also demonstrated the pro-social benefits of living in collective efficacious neighborhoods to women affected by intimate partner violence, as high reports of collective efficacy within the neighborhood was
associated with an increased likelihood to disclose the conflict to other potential sources of support (Browning, 2002).

**Ecometrics of Measuring Sociospatial Buffers**

Numerous linkages on the moderating role and importance of neighborhood collective efficacy on neighborhood characteristics and various health and crime outcomes have been established (Browning et al., 2014; Browning, Leventhal, & Brooks-Gunn, 2004; Odgers et al., 2008; Sampson et al., 1997). However, an important consideration in understanding the effects of collective efficacy involves ecometrics or the quality of ecological contextual measures from which reports of collective efficacy are derived (Browning & Soller, 2014; Sampson, Morenoff, & Earls, 1999). Scales of collective efficacy are typically measured with the context of the neighborhood as reference, a more traditional approach to the context of youth and adults. Oftentimes “neighborhood” is defined arbitrarily through governmental census tracts. Researchers are shifting the ideas from predefined neighborhoods to activity space – an ecological context which consists of all of the locations an individual comes into contact with as a result of their routine activities (Basta, Richmond, & Wiebe, 2010; Browning & Soller, 2014; Chaix et al., 2013; Inagami, Cohen, & Finch, 2007; Matthews & Yang, 2013). Activity space characteristics are estimated by specifying a buffer around the youth’s space-time travel path. An activity space is often defined as all the locations an individual comes into contact with as a result of his or her daily activities (Mason, 2010). The perspective of routine activities of everyday life (e.g. what we do, where we go, and with whom we interact on a daily basis) have foundational roots in Hawley’s theory of human
ecology (Kubrin, Stucky, & Krohn, 2009). Activity space measurement is increasingly being recognized as a more accurate measure of the ecological context, especially for urban youth (Basta et al., 2010; Mason, 2010; Matthews & Yang, 2013), however, more research is needed for those youth who are located within more rural geographies (De Haan, Boljevac, & Schaefer, 2009).

The work of Shaw and McKay (1942/1969) have influenced the primary design of studies incorporating measures of collective efficacy, with most deriving their design using the Theory of Social Disorganization, however, there are studies additionally guided by the General Strain Theory (Fagan, Wright, & Pinchevsky, 2014) the work of Jane Jacobs’ “eyes on the street” (Browning, Soller, & Jackson, 2014a) and the work of Bandura (2001) relaying collective efficacy in relation to self-efficacy (Maimon & Browning, 2012). The effects of collective efficacy on adolescent health and behavior are positively emerging, but debate exists on the extent and precise mechanisms through which sociospatial influence youth well-being and development (Booth & Crouter, 2001; Browning et al., 2015). Debate exists primarily due to the numerous ways to ascertain community-level effects of collective efficacy (e.g. traditional neighborhood approaches vs. activity space vs. school district, etc.) across the lifespan but particularly in adolescence (e.g. primary caregiver/parent or youth report of perceptions). Further, the relationships and strengths of associations to outcomes vary dependent on how the researcher incorporates collective efficacy within the study design as a moderator, mediator, outcome (minimal), or predictor variable of interest. Despite methodological differences, qualitative research conducted on youth and primary caregivers demonstrated
the role of collective efficacy on fostering health and development in the community (Ager & Parquet, 2008).

**Collective Efficacy and Adolescent Health**

The difference between a tolerable stressor and toxic stressor relates to the chronicity of the adaptation and presence (or absence) of protective factors (Gunnar & Hostinar, 2015; Shonkoff et al., 2012). As of yet, scant systematic reviews exist on the association between collective efficacy and mental health in children and adolescence. Only 1 systematic review published within the last 10 years was found, and included 11 different types of neighborhood and social processes effects (neighborhood attitudes, collective efficacy, social capital, etc.) on any type of adolescent alcohol use (drinking in past week, month or year, lifetime drinking, etc.) (Jackson, Denny, & Ameratunga, 2014). The authors concluded that little impact of neighborhood level exposures were found (Jackson et al., 2014). However, the authors compared 23 studies (19 cross-sectional, 4 longitudinal) examining *11 different types* of neighborhood exposures (only 3 involving the measurement of collective efficacy or informal social control), and therefore, perhaps inaccurately concluded on the impact neighborhood social processes have on health due to the wide inclusion criteria of what was deemed sociodemographic neighborhood effect.

Conclusions on the moderating role of high or low collective efficacy on adolescent health and health behavior are vast and mixed. Prior research indicates that communities characterized by higher levels of collective efficacy reduce the negative effects of
exposure to violence on internalizing and externalizing behaviors among urban youth. (C. R. Browning, Gardner, Maimon, & Brooks-Gunn, 2014b). Others found linkages between communities with lower levels of social support and dysregulation of the diurnal cortisol curve. (Do et al., 2011; Karb, Elliott, Dowd, & Morenoff, 2012). The buffering effects of collective efficacy also span widely between types of neighborhoods (activity space versus traditional; rural vs. urban), and types of health (risk behaviors, versus health outcomes). Associations or main effects of collective efficacy also vary on what is included in the measure of collective efficacy (intergenerational closure, social coheision and/or informal social control), on whether the researcher dichotomizes collective efficacy into high levels of connectivity or low levels connectivity, or “trichotomizes” the measure in order to differentiate neighborhood clusters into the highest, lowest, and average levels of perceptive connectivity. Further, the results of most of the studies are varied dependent on the numerous types of confounding variables used within the study and study design (Jackson et al., 2014). Dependent on the outcome of interest, researchers have various opinions on which family level and individual level processes affect the perception and reporting of collective efficacy. However, low levels of neighborhood-level collective efficacy are associated with obesity (Cohen et al., 2006), asthma and breathing problems (Cagney and Browning, 2004), and poor mental health (Xue et al., 2005); high levels of neighborhood-level collective efficacy are associated with delayed sexual onset (Browning et al., 2005) and fewer sexual partners, (Browning et al., 2008).

However, evidence is mixed for alcohol use in adolescence, as three studies included
in the systematic review found no statistically significant association between collective efficacy and alcohol use (De Haan et al., 2009; Ennett et al., 2008; Maimon & Browning, 2012). Despite lack of statistically significant associations to predictor variables of interest, Maimon and Browning (2012) found through moderation analyses, that a high prevalence of alcohol outlets was associated with a higher prevalence of alcohol use in communities with lower levels of collective efficacy. A more recent observational study using two waves of data from the Project of Human Development in Chicago Neighborhoods (PHDCN) found that collective efficacy moderated the relationship between youth victimization and substance, as the relationship was weaker for youth in neighborhoods with higher versus lower levels of collective efficacy (Fagan, 2014). Similarly, a study on adolescents based out of Toronto, found a moderating effect of collective efficacy only in neighborhoods with lower levels of concentrated disadvantage (S. E. Browning, 2012). Similar to the gene-environment interaction, interactions between high collective efficacy and structural neighborhood characteristics matter, as Odgers and colleagues (2009) found that high collective efficacy was inversely associated with antisocial behavior in children but only in those children residing in deprived neighborhoods. Thus, similar to the conclusion Browning and colleagues (2012) demonstrated highlighting stronger effects of collective efficacy on youth who have been exposed to more ecological adversity.

Overall, due to the vast array of ways to design and model collective efficacy, a lack of methodological rigor precludes adequate synthesis on the effects of collective efficacy on adolescent health and behavior. CE has been primarily measured at the census tract
level and that the activity-space approach may better capture true exposures of perceived
collective efficacy. More research is needed to understand the effects of collective
efficacy due to the lack of standardization on measurement utility of collective efficacy
(some incorporate 10 questions, others have included 15 question measures tapping into
intergenerational closure), the shift towards more novel and innovative ways to ascertain
“neighborhood” and ecology, and the numerous ways to investigate the effects of
collective efficacy (as a mediator, moderator, predictor, outcome, etc). Overall, however,
there is an incredible amount of theoretical work, and rather compelling evidence that
sociospatial considerations and buffers matter to health and health behavior not just in
adolescents, but also across the lifespan. Health researchers argue that social
determinants of health, especially during early life development, are the most influential
contributors to the well-documented health disparities observed in the United States,
however, intervening social buffers and hypothesized mechanisms are only beginning to
be investigated during adolescence.

The Potential for CE to Buffer the Effects on PI on Outcomes

Socially supportive communities (e.g. collective efficacy) have been found to have
positive effects on health outcomes, (Browning, Burrington, Leventhal, & Brooks-Gunn,
2008; Browning et al., 2014b; Browning, Soller, & Jackson, 2014; Hostinar & Gunnar,
2013; Karb et al., 2012; Uchino, 2006; Umberson, Crosnoe, & Reczek, 2010). However,
much remains elusive about the precise mechanisms through which collective efficacy is
hypothesized to influence adolescent health and behavior, despite the breadth of evidence
relaying the importance of neighborhood structural considerations shaping developmental wellbeing, crime rates, and criminal behavior (Chaix et al., 2013; Jackson et al., 2014; Pabayo, Molnar, & Kawachi, 2014). The youth or caregiver’s positive perception of community members’ mutual willingness to intervene may be concentrated in neighborhoods or areas with more supportive structural characteristics (e.g. churches, community centers, etc.) or social capital, the quantity and quality of social resources in a community. As neighborhoods or activity spaces that provide more social support may reduce the perception of any stressful event. Social cognitive theory supports this notion and centers the idea of collective efficacy as an extension of a person’s self-efficacy within context (Bandura, 2001).

The Bioecological Model of Human Development framework specifically guides the proposal’s conceptualization of how CE could attenuate the physiologic stress and mental health problems incurred from experiencing the adversity of having a parent incarcerated. The BMHD framework is integrated into the proposal due to the EBD framework’s explicit focus on toxic stress that is unbuffered by parents. The BMHD framework centers on the linkages between the multiple environments across the life course to which humans are exposed and their effect on biological processes (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006; Bronfenbrenner & Evans, 2000). Within the BMHD framework the individual develops over time as a product of the interaction between various actors (e.g. parents, teachers, peers, neighbors) over an array of environmental contexts (e.g. school, community, policy). The BMHD framework was created to provide scientific rationale for effective social policies and programs that counteract disruptive
influences, such as PI (Bronfenbrenner & Morris, 2006). The BMHD framework emphasizes the role of social support on the community level to promote healthy development on the individual level across the lifespan. In short, a youth’s appraisal of perceived cohesiveness of the community during the time period of having a parent incarcerated may mitigate physiologic stress and consequential poor mental health outcomes.

Since researchers have hypothesized that separation by incarceration can lead to childhood subjective weathering (Foster, 2012), and stigma (Schnittker & John, 2007), this proposal investigates the buffering role of strong social ties and social cohesiveness on these particular processes in order to reduce stigma and promote resiliency. Strong social ties, dense networks, intergenerational closure, and social cohesion may promote health and reduce stress by negating isolation, increasing motivation to persevere in times of difficulty, and deterrence to more harmful coping mechanisms (e.g. illicit drug use). One’s perception on social cohesiveness of their community and strength of social ties may be the catalyst to adolescent resiliency in times of adversity. Further, communities with high levels of collective efficacy are those communities where members are more likely to know one another and perhaps take action to assist adolescent resiliency (Sampson, 2011; Sampson et al., 1997; Sampson, Morenoff, & Earls, 1999). Others speculate that residents within a community are more likely to pool resources and services that would benefit all members of the neighborhood in those areas with reports of high levels of collective efficacy (Sampson, 2011). In 2008, Ager and Palquert (2008) conducted a qualitative study involving two African American groups, one involving
adolescent youth (ages 11-13) and another involving primary caregivers of the youth, to ascertain and examine their experiences living in public housing battling high rates of substance abuse in their community. The researchers found that the youth relayed the importance of families working with other families in the communities to keep their neighborhood safe demonstrating the importance in perceived collaboration with others, or social cohesiveness (Ager & Parquet, 2008). Caregivers identified the value of children learning from elders in their community on how to respect others or how to avoid danger (Ager & Parquet, 2008), shedding insight into the importance of intergenerational closure.

The concept of collective efficacy relies on the youth’s perception of, or outlook, on community-level support and can be measured as a group-level variable (a collective group of responses, averaged, on collective efficacy) or as an individual-level variable (e.g. individual perception of the community). For instance, if youth view adults in the neighborhood as willing to help their neighbors, than the youth may, in turn, have a positive outlook on their community and foster healthy growth and development (R. Sampson & Groves, 1989). However, the relationship between perceptions of others and self-perception could also be bidirectional. For instance, if the youth has a more positive outlook on life, the youth may believe that, overall, people and neighbors are willing to help out for the common good. However, if the youth once viewed a neighbor helping out another for the common good, then then youth could, in turn, develop a more positive outlook. Similarly, if parents in the neighborhood do not share cohesive-promoting values, isolation may occur in times of hardship due to stigma, and low levels of
collective efficacy would exacerbate recovery or poor coping. Since willingness to intervene for the common good, willingness to be a role model to others, and willingness to watch out or have “eyes on the street” may stem from one’s role and obligation to others, then collective efficacy might also simultaneously contribute to the sense of purpose the youth has to their community. If adolescents and adult community members have a personal obligation to assist others in some capacity, then this may reduce motivations to engage in behaviors that might harm themselves or others.

Further, collective efficacy may serve as a more empowering mechanism for youth in neighborhoods plighted by more disadvantage than those youths who are protected by more familial support, as Browning and colleagues (2014) suggest. Others have encouraged more research to uncover the exact processes that encourage positive coping and whether collective efficacy would thus, impact the physiology of stress, reducing the duration or perception of toxic stressors.
Chapter 3: Methodology

Purpose of Study

The purpose of this study is to understand 1) the relationships between exposure to PI and mental health behavioral outcomes (attention, externalizing, and internalizing behaviors) of urban youth, 2) the mediating role of chronic physiologic stress (hair cortisol concentration) on the relationship between PI and mental health outcomes and 3) the moderating role of sociospatial buffers (collective efficacy) experienced in the youth’s activity space on the relationship between PI and mental health outcomes, including moderated mediation of collective efficacy on the relationships between PI and chronic stress and between chronic stress and mental health outcomes. The study design and proposal is situated to address the following specific aims:

**Aim 1:** To examine the associations between exposure to PI and mental health outcomes.

**Aim 2:** To investigate the extent to which chronic physiologic stress (HCC) mediates the relationship between exposure to PI and mental health outcomes (total behavioral problems, attention, internalizing and externalizing behavioral problems).

**Aim 3:** To investigate whether sociospatial buffers (collective efficacy measured via activity space) moderate the relationships between PI and mental health outcomes (total behavioral problems, attention, internalizing and externalizing behavioral problems).
**Exploratory Aim 3a:** If sample size is adequate and there is enough power to detect statistically significant differences with confidence, than the extent to which sociospatial buffers (*collective efficacy measured via activity space*) moderates the mediated relationship between a) PI and HCC and between b) HCC and MH outcomes will be explored.

### Hypotheses

**Aim 1:** To examine the associations between exposure to PI and mental health outcomes.

**Hypothesis A1:** Youth exposed to PI will have more mental health problems in comparison to youth unexposed to PI.

**Aim 2:** To investigate the extent to which chronic physiologic stress (*HCC*) mediates the relationship between exposure to PI and mental health outcomes (*total behavioral problems, attention, internalizing and externalizing behavioral problems*).

**Hypothesis A2:** HCC will mediate the relationship between PI and mental health problems.

**Aim 3:** To investigate whether sociospatial buffers (*collective efficacy measured via activity space*) moderate the relationships between PI and mental health outcomes (*total behavioral problems, attention, internalizing and externalizing behavioral problems*).

**Hypothesis A3:** Youth exposed to PI who report higher levels of CE will have less mental health problems than those peers exposed to PI who report lower levels of CE.

**Exploratory Aim 3a:** To investigate the extent to which sociospatial buffers (*collective efficacy measured via activity space*) moderates the mediated relationship between a) PI and HCC and between b) HCC and MH outcomes will be explored.
efficacy measured via activity space) moderate the mediated relationship between a) PI and HCC and between b) HCC and MH outcomes.

**Hypothesis A3a:** Youth exposed to PI who report higher levels of CE will have lower levels of HCC than youth exposed to PI with lower levels of CE, and thus lower mental health problems.

**Hypothesis A3b:** Youth exposed to PI who have higher levels of HCC, but have high levels of CE, will have fewer mental health than those with low levels of CE.

**Study Design**

The dissertation is a secondary analysis of two parent studies funded by the National Institutes of Health – National Institute on Drug Abuse. The study design is cross-sectional in order to explore the relationships between PI, chronic physiologic stress (hair cortisol), mental health outcomes and potential sociospatial buffers (collective efficacy and intergenerational closure). The overarching parent studies include the 1) Adolescent Development in Context (AHDC) study which is a large-scale, multilevel, prospective cohort study, and the 2) Linking Biological to Social Pathways to Adolescent Health and Well-Being (Biosocial Linkages) study which includes a probability subsample of adolescents (N=613) who participated in the first wave of the AHDC study and biospecimen collection. The AHDC study employed a representative sampling design and collected data on youth located in a household within the outer belt of highway 270. Threats to external validity are minimized by attempting to reduce systematic bias, increases representativeness and generalizability of the findings ascertained from the
study (Shadish, Cook, T., & Campbell, 2002). Further, since the social and economic characteristics of the Columbus metropolitan area are similarly representative of other large metropolitan areas located within the United States (The Brookings Institution, 2010), the study location is particularly suitable to sample. Further, Ohio is currently ranked fourth in the nation for the percentage of children who lived with a parent or guardian who served time in jail or prison after the child was born (10.1% compared to 6.9% nationwide) (National Survey of Children's Health., 2011/12). While these rates are unfortunate for Ohioans, it increases the chances to ascertain more youth affected by PI, increasing sample size and consequent statistical power.

Data Sources

Adolescent Health and Developmental Context Study (AHDC study, RO1)

The AHDC study (PI Browning, R01) is a large-scale multilevel prospective cohort study that emphasizes an bioecodevelopmental perspective to the health outcomes of youth. The study employs a representative sampling design of up to 1500 households who have youth aged 11-17 years in Franklin County, Ohio. Sampling and survey design was developed in collaboration with OSU’s Center for Human Resources Research, an established survey research center with extensive experience in large data collection and monitoring. The AHDC study includes two data collection time points, 1 year apart. Within each wave, trained interviewers collect the data over a 1-week span. See Figure 2 for the AHDC Study design. A face-to-face interview and self-administered survey are collected from both the youth and the main caregiver. To enhance confidentiality, the
caregiver interview is conducted while the youth completes the self-administered survey, and the caregiver survey is self-administered during the youth’s face-to-face interview. The study also utilizes smartphones to collect (1) Ecological Momentary Assessment survey data over a seven-day period that include items such as mood, risk behavior and perceptions of informal social control (2) GPS location tracking data to retrieve the youth’s activity space exposure. For this dissertation study, only the first wave of data was examined to meet the study aims. (See Figure 2).

Linking Biological and Social Pathways to Adolescent Health and Well-Being Study (Biosocial Linkages study, R21)

The Biosocial Linkages study (PI, Ford) collected chronic stress biomarkers (including hair cortisol) among the adolescents participating in the AHDC study. A primary aim of the study is to examine the relationships between adverse sociospatial exposures and chronic stress among a diverse sample of urban adolescents. Consistent with other prior stress research, adolescents who have taken oral or inhaled steroids are not eligible for participation since steroid use affects cortisol levels (Russell, Koren, Rieder, & Van Uum, 2012; Sauvé, Koren, Walsh, Tokmakejian, & Van Uum, 2007; Stalder et al., 2012; Vanaelst et al., 2013; Wosu, Valdimarsdottir, Shields, Williams, & Williams, 2013) and they must have at least 1 cm of hair for the hair collection. Adolescents could also refuse the hair biomarker collection. Interviewers (trained by Boch) used thinning shears to cut approximately 25-75 mg of hair from the posterior vertex. Adolescents were also surveyed about vital hair care practices and characteristics.
that might influence the cortisol assay procedure. Adolescents received a $20 cash incentive for participation in hair collection. In 2016, approximately 91.4% of youth participated in the hair collection study (n=472). Of those who did not participate, 18 had insufficient/too short of hair, 9 youth refused and 16 parents refused (Ford, 2016).

Power and Preliminary Analyses (on HCC)

Preliminary analyses of the data (N=472) estimated that approximately 12% of the youth had a parent incarcerated in their lifetime. Monte Carlo-based power analyses were performed by the AHDC research team on a sample size of 1,000 youth at wave 1. The power for testing whether the effect of a predictor (and the interaction) is significantly different from zero at the $\alpha = 0.05$ level in the normal linear mixed regression model for standardized effect sizes, $\delta$, (0.30) is 0.84.

In preliminary examination of the data, bivariable analyses of 167 youth whose hair had been assayed for cortisol found: (1) ever exposed to parental incarceration ($b = 0.34$, $p = 0.11$), (2) exposed to parental incarceration between 0-5 years ($b = 0.48$, $p = 0.019$), (3) exposed to parental incarceration between 6-11 years ($b = 0.25$, $p = 0.38$), and (4) exposed to parental incarceration between 11 years and older ($b = -0.35$, $p =0.26$). Most of the youth were found to be exposed to parental incarceration between 0-5 years of age with a lower prevalence of exposure at older ages.

Measures

*Independent Variable - Exposure to Parental Incarceration*
Consistent with prior research, parental incarceration was measured via three survey items, “Has the parent ever been incarcerated in jail or prison... between the ages of 0-5 years, 6-10 years and 11 years and older?” The items were asked to the child’s primary caregiver, identified as a more reliable source than youth report of stigmatizing questions. (Youngstrom et al., 2011) A dichotomous measure was created to indicate lifetime exposure to parental incarceration if the parent/caregiver responded yes to any of the 3 items. In addition, multinomial categories were created to explore the distribution of the timing of exposure to parental incarceration (e.g. 0-5 years only, 6-11 years only, 11 years and greater only, all 3 age periods, etc.) for descriptive purposes only as sample sizes in the categories were too small for reliable estimation.

**Dependent Variables: Mental Health Outcomes**

Mental health outcomes were measured by 19 items on the Child Behavior Checklist-Brief Problem Monitor (CBCL-BPM; (T. Achenbach & Rescorla, 2001) and included attention, externalizing, internalizing and total problem behaviors. The CBCL-BPM is comprised of items from the Child Behavior Checklist for Ages 6-18 (CBCL/6-18), Teacher’s Report Form (TRF), and Youth Self-Report (YSR). The parent/caregiver-reported items in the CBCL-BPM are widely used in both academic and clinical settings. The items measure the youth’s emotional and behavioral problems that occur in the home or at school (T. M. Achenbach & Ruffle, 2000). The checklist has been reported as a valid measure with strong psychometric properties in a variety of adolescent populations (T. Achenbach & Rescorla, 2001; T. M. Achenbach, Dumenci, & Rescorla, 2003; Ebesutani
et al., 2010; Ferdinand, 2008). Further, research investigating the effects of PI on the mental health of youth has most extensively used the Child-Behavior Checklist (Perry & Bright, 2012; Wakefield & Wildeman, 2011; Wilbur et al., 2007). Caregivers were asked to report on 19 common behavioral problems of the youth and responses ranged from 1 (“not true”) to 3 (“very true”). Mean scores of at least half of the subscale items the caregivers responded to were analyzed. Attention behavioral problems included 6 items: acts too young for his/her age; can’t concentrate, can’t pay attention for long; can’t sit still, restless, or hyperactive; fails to finish things he/she starts; impulsive or acts without thinking; inattentive or easily distracted. Externalizing behavioral items included 7 items: argues a lot; destroys things belonging to his/her family or others; disobedient at home; disobedient at school; stubborn, sullen, or irritable; temper tantrums or hot temper; threatens people. Internalizing behavioral problems included 6 items: feels too guilty; feels worthless or inferior; self-conscious or easily embarrassed; too fearful or anxious; unhappy, sad, or depressed; worries.

Mediator: Hair Cortisol Concentration

A novel biomeasure of chronic stress gaining steady recognition in health research is the noninvasive measurement of cortisol via hair samples. Measurement of hair cortisol is a feasible approach to obtaining an objective retrospective measure of chronic stress; each 1 cm of hair approximates the mean cortisol level over the prior 1 month of growths (Davenport, Tiefenbacher, Lutz, Novak, & Meyer, 2006; Russell et al., 2012). Within the past two decades, methodological studies have endorsed hair cortisol as a
valid and reliable measure of chronic stress response. (DeSantis et al., 2007; Gow, Thomson, Rieder, Van Uum, & Koren, 2010; Janet Yamada et al., 2007; Noppe et al., 2014) Hair samples were processed at Dr. Ford’s lab located at the College of Nursing at The Ohio State University. Hair was washed (via isopropanol), ground (via a Retsch 400 Mill machine) and then assayed (via Salimetric immunoassay cortisol analysis) for the measurement of a mean cortisol content. This protocol for extraction and measurement of hair cortisol was guided by the methodology of D’Anna-Hernandez (D’Anna-Hernandez, Ross, Natvig, & Laudenslager, 2011) and Meyer et al. (Meyer, Novak, Hamel, & Rosenberg, 2014) Before assay procedures, a total of 10-75 mg of hair was washed with isopropanol and then dried over a span of 1-3 days. Hair was placed in a microcentrifuge tube and cut into 2-4 mm lengths and then ground for 5-15 min in Retsch 400 Mill. Methanol (high-grade, ~1.1 ml) was added to the ground sample and incubated for 18-24 hours with constant agitation. The sample was then centrifuged 1000 g for 15 min until a hair pellet formed. The resultant supernatant was transferred to a clean microcentrifuge and the methanol removed by evaporation. The cortisol extract was immediately reconstituted in 100ul of an immunoassay cortisol assay diluent buffer. Samples were assayed in duplicate. Cortisol levels are continuous in nature and expressed in hair as pg/mg and log transformed for analysis.

Covariates- Adolescent Sociodemographic Characteristics

A host of survey measures from the focal youth and parent/caregiver were included as control measures. The primary adolescent and family background domains included
adolescent demographics, socioeconomic characteristics, adolescent pubertal development, adolescent adverse and stressful life events, and adolescent hair care practices (for analyses with hair for cortisol).

Adolescent demographics included sex of youth, race/ethnicity of youth, age of youth, country of origin, and body mass index. Caregivers were asked in the in-home interview by lay community interviewers a series of questions regarding the demographics of the youth. Questions included, “What is this child’s date of birth?” “What is this child’s gender?” “What is this child’s race?” “Is this child of Hispanic or Latino origin?” “In what country was [name of child] born?” For age of the youth, a continuous measure was calculated from the date of birth provided by the caregiver. For sex of youth, a dichotomous categorical variable was created to indicate 1 (“male”) or 0 (“female”). Responses for race included: “White”, “Black or African American”, “Asian”, “Native Hawaiian or other Pacific Islander”, “American Indian or Alaska Native”, “Hispanic-Only”, or “Other.” In conjunction with the question assessing the youth’s Hispanic or Latino origin, several dichotomous categorical variables were created including: Non-Hispanic Black, Non-Hispanic White, Latino/Hispanic, Multi-racial/ethnic, Other (Native Hawaiian, or other Pacific Islander, or Asian, or American Indian or Alaska Native). Non-Hispanic White will serve as the reference category. In addition, if the caregiver reported that the birth of the youth occurred outside the United States, responses were coded as 1 (“yes”) and 0 (“no”). Height and weight of the child were obtained from the lay-interviewer at the second in-home interview. A body-mass-
index z-score was created using the recommendation guidelines on national height and weight averages from the Centers Disease for Control and Prevention.

**Socioeconomic characteristics** include education level of the caregiver/parent, and current economic hardship of the household. Caregivers were asked, “What is your highest education degree obtained?” Responses ranged from 0 (“No formal schooling”) to 10 (“Professional Degree (MD, LLD, DDS)”) to (“Other”). The variables for caregiver education included four dichotomous categorical variables indicating highest degree earned: less than high school degree or high school degree, some college or an associate’s degree, bachelor’s degree, or master’s degree or above (reference category). Economic hardship was measured as the mean score of 3 survey items which asked caregivers to rate several items of economic hardship during the past 12 months on a 5-point likert-type scale. One item asked, “How often did you/your household put off buying something you needed, such as food, clothing, medical care, or housing because you don’t have enough money?” Responses ranged from 1 (“never”) to 5 (“most or all of the time”) with items coded to indicate worsening economic hardship. The next two questions asked, “How much difficulty did you/did your household have paying the rent or mortgage because you didn’t have enough money?”, and “How much difficulty did you/did your household have paying utilities because you didn’t have enough money?” Responses ranged from 1 (“no difficulty at all”) to 5 (“a great deal of difficulty”) with items coded to indicate worsening economic hardship.

**Adolescent adverse and stressful life events** included a count score of up to 30 different adverse childhood experiences and stressful life events that may have occurred
in three different developmental stages. Thus, the count score ranged from 0-90 as it totaled the number of adverse experiences and stressful life events from birth to 5 years, 6-11 years, and 11 years and older. Childhood adversity items included: *Child's parents did not live together (due to separation or divorce); Parent had a partner move into the household; Child lived with neither parent; Parent had a partner move out of the household; Parents divorced; Child lived in a household with only one adult present; Child placed with a new caregiver; Eviction or foreclosure; Bankruptcy; Child went to live with a new caregiver; Child moved into a different parent's household; Child moved out of grandparent household; Child moved into grandparent household; Child moved into a different house in the same neighborhood; Child moved into a different neighborhood/community; Child was hospitalized; Family had difficulty paying bills; Family received SNAP/EBT,TANF, food stamps, or other government support; Mother or father lost job; Sibling went to jail/prison, Child was homeless/lived in homeless shelter or hotel; Child was moved into foster care; Child witnessed family or neighborhood violence; Child was a victim of family or neighborhood violence; Child was in a serious accident where they or someone else were badly hurt; Death of child's mother; Death of child's father; Death of child's sibling; Death of someone else close to child; Been in a serious accident in which they or someone else was badly hurt.*

**Adolescent pubertal development** is an average score measured by 5 survey items asking the adolescent to self-rate their pubertal development (e.g. pubic hair, growth spurt, breast growth, menstruation) consistent with other research (Petersen, Crockett, Richards, & Boxer, 1988). Male youth were asked to select the best category in regards to
growth spurt in height, skin changes, pubic hair, and voice change. Responses ranged from 1 (“not yet started”) to 4 (“seems completed”) with items coded to indicate completion of pubertal development. Female youth were asked to select the best category in regards to breast growth, growth spurt in height, skin changes, and pubic hair. Responses ranged from 1 (“not yet started”) to 4 (“seems completed”) with items coded to indicate completion of pubertal. Female youth were also asked on whether she had completed her first menstruation.

**Adolescent hair care practices** (for analyses with hair for cortisol) such as frequency of washing, chemical treatments (e.g. straighteners, dyes, perms) and hair product use (Wosu et al., 2013). The youth were asked in the survey several questions on adolescent hair practices. Youth were asked “Some people in this study will be donating hair, so we’re interested in how often you wash your hair. Is it…..” Responses were collapsed into a dichotomous variable for 1 (“daily”) to 0 (“less than several times a week”). Youth were also asked, “Is your hair chemically treated with a dye or color, perm or relaxer?” and “Do you currently have any product in your hair, such as gel, hairspray, or oils?” Responses were 1 (“yes”) or 0 (“no”).

The effect of parental incarceration was considered in baseline models including time invariant youth sociodemographic predictors (e.g., sex, race/ethnicity) and pubertal development of the youth. Then models incorporating time-varying control variables such as economic hardship and highest degree earned by caregiver (some of which may be in the causal pathway between parental incarceration and chronic stress during
adolescence). An advantage of the AHDC is the availability of rich data on the timing of other potentially confounding adverse and stressful events (i.e., at age 0-5, 6-10, 11+).

**Moderating Variable: Activity Space – Collective Efficacy**

The AHDC study measures youth’s activity space via youth and parental report of their routine activity locations over the month prior to the survey and the continuous GPS data collected over a 7-day tracking period. Activity space characteristics are estimated by specifying a buffer around the youth’s space-time travel path and characteristics of the youth’s resulting activity space are aggregated. Measures of activity space exposure were weighted by time spent inside and outside the home.

Collective efficacy is measured by caregiver report on three survey items assessing informal social control on specific locations and areas the youth typically goes during a typical week, including weekends. These three items were selected from the well-documented sociological research on informal social control, a component of collective efficacy, found to be reliable and valid in prior research (Browning & Cagney, 2002; Browning, Gardner, Maimon, & Brooks-Gunn, 2014; Browning, Soller, & Jackson, 2014; Leventhal & Brooks-Gunn, 2000; Maimon, Browning, & Brooks-Gunn, 2010; Odgers et al., 2009; Sampson, Raudenbush, & Earls, 1997). The collective efficacy scale measures adult-child social ties and expectations for active support neighborhood adults (Leventhal & Brooks-Gunn, 2000; Odgers et al., 2009; Sampson et al., 1997).

The three survey items measure the caregiver’s perceptions on locations in and around the community where the youth goes during a typical week (time spent out of
Ohio and travel time were excluded. The possible list of locations for everyday routine activities include: workplace, caregiver’s school/training, library, place of worship, grocery store, relative’s house, friend’s house, park/recreation center, restaurant, store/business, civic organization, neighborhood organization, and other. Stationary locations were linked with the 2009-2013 American Community Survey (ACS) data. The key locations, activities, behaviors, and network partners were captured by Global Positioning System (GPS) tracking and Ecological Momentary Assessment (EMA) using the youth’s smartphone throughout the week of Wave 1 of the AHDC study. Once verified, the caregivers were then asked to complete a module in which the lay-interviewer asked the caregiver to respond to various questions on the youth’s specified routine activity locations during the daytime and at night. The caregivers were then asked to rate their perception of the social climate around the area and at each location within the neighborhood. Caregivers were asked to report their level of agreement on each of the three following survey items: 1) whether people on the streets can be trusted, 2) whether people are watching what’s happening on the streets, and 3) whether people would come to the defense of others being threatened. Responses ranged from 1 (“strongly disagree”) to 5 (“strongly agree”), with items coded to indicate better perception and agreement on informal social control. These three items were asked separately regarding conditions in the respondent’s neighborhood during the daytime and at night.

The scores from these locations were then statistically modeled in order to estimate a latent collective efficacy score associated with various geographic locations. Because of the density of sampling within the study area and the number of geographically
referenced location reports (neighborhood and activity space locations) collected from respondents, sufficient information was available to reliably estimate the characteristics of individual activity spaces from aggregated data.

Once location reports and ratings were obtained from the caregiver, block group collective efficacy scores were estimated using Bayesian hierarchical statistical modeling (in order to account for the complex multi-level design generating the reports on the locations). The statistical modeling conducted to estimate the block group collective-efficacy score accounted for numerous family and block group characteristics that may account for differences across caregiver ratings on specific locations. Family characteristics in the model included caregiver race/ethnicity, marital status, caregiver education level, household income, home ownership and years in the neighborhood. Block group characteristics included economic disadvantage (measured by a standardized scale including poverty rate, unemployment rate, and percentage of households that are female-headed), residential instability (measured by percentage of residents who have moved in the past year and the percentage of occupied housing units), racial diversity (measured by the proportion of white, Latino, black, Asian, and other race/ethnicity populations), proportion of African American residents, proportion of foreign born residents, and population density per square mile. Once census block group scores were appropriately modeled to various geographic locations, these scores were then connected to the individual locations that the youth has visited throughout the week. Therefore, there were multiple reports from various caregivers within the community rating the locations of the specific youth. Due to the EMA tracking of the youth, mean exposures to
block group characteristics across all locations during the week, were weighted by time spent in minutes at each location during waking hours, as well as the standard deviation of the weighted mean exposure. Thus, the activity-space collective efficacy latent score accounts for the duration of time spent in a specific location associated with certain attributes of block group characteristics.

The primary advantage to using an activity space measure over traditional neighborhood approaches (e.g. census residential tracts) is to ascertain a more evolved and relevant measure to capture the ecological context of all the places and locations urban youth travel through. Activity space moves beyond traditional approaches such as census tracts, which may often be defined arbitrarily, allowing for a more encompassing ecological context of the adolescent’s daily level of not only risk exposure and social capital, but of informal social control (Browning & Soller, 2014; Cummins, Curtis, Diez-Roux, & Macintyre, 2007; Leventhal & Brooks-Gunn, 2000; Ross & Jang, 2000). Activity space is an innovative approach to more traditional measures and therefore, its innovation is both an advantage and disadvantage. Despite the increased recognition of a more valid measure of the ecological context of urban youth (Basta, Richmond, & Wiebe, 2010; Mason, 2010; Matthews & Yang, 2013), reliability has yet to be ascertained due to the limited research utilizing the measure.

Most literature suggesting interventions for those children adversely affected by parental incarceration focuses on improving the parent-child relationship (Ardetti, 2012; Poehlmann, Dallaire, Loper, & Shear, 2010) neglecting broader ecological factors such as the social support within the adolescent’s activity space. This may be particularly
pertinent for youth who are exposed to parental incarceration, as these youth often reside in socially disadvantaged neighborhoods (Ardetti, 2012; Western & Pettit, 2010). By measuring activity space, I can capture the breadth of youths’ sociospatial exposures moving beyond investigations solely focused on residential neighborhood. However, there is limited research to ascertain reliability due to the innovation of the ecological measure.

Data Analysis

Descriptive statistics were conducted on all variables in the analyses in order to describe the sample and reveal distributional characteristics that may violate statistical assumptions of normality and homoskedasticity. Log transformation of the mediator, hair cortisol concentration was conducted, consistent with hair cortisol literature. (Braig et al., 2015; Wosu et al., 2013; Wosu et al., 2015; Younge et al., 2015). Sources of missing data were examined and multiple imputation procedures were implemented. Given the exploratory observational descriptive design, an alpha level for all significance tests was set at 0.05.

Aim 1

Aim 1: To examine the associations between exposure to PI and mental health outcomes.

Hypothesis A1: Youth exposed to PI will have more mental health problems in comparison to youth unexposed to PI.
I began by fitting a multivariable linear regression model that include several predictors of interest known to confound either the independent variable (parental incarceration) and primary outcome of interest (mental health problems) based on theory and prior research. Multicollinearity was also examined to determine whether high correlations between pairs of independent variables exist.

The linear multivariable regression model is: 

\[ Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + e \]

In this model, Y is total mental health problems of the youth. The mental health outcome will analyze the relationship between exposure to PI to total score on internalizing problems and between exposure to PI to total score on externalizing problems. The intercept, \( \alpha \), indicates the predicted value of Y when \( X_1 \ldots X_k \) are 0. \( \beta_1 \) is the expected change in Y for youth are exposed to parental incarceration (vs not exposed), holding constant the values of all other explanatory variables included in the model; \( e \) is an independently and identically distributed error term.

**Aim 2**

**Aim 2:** To investigate the extent to which physiologic stress (HCC) mediates the relationship between exposure to PI and mental health outcomes (*total behavioral problems, attention, internalizing and externalizing behavioral problems*).

**Hypothesis A2:** HCC will mediate the relationship between PI and mental health problems.
After fitting the linear multivariable regression model, I examined the test of significance of the direct effect of HCC on mental health. The regression coefficient for the direct effect represents the change in mental health outcomes for every unit change in PI that is mediated by HCC. I estimated the indirect coefficient by examining the difference and change in the parameter estimate of those youth ever exposed to PI

\[
\text{Model 1: } Y = \alpha + \beta_1X_1 + \beta_2M_2 + \ldots \beta_kX_k + e
\]

\[
\text{Model 2: } Y = \alpha + \beta_1X_1 + \beta_2X_2 + \ldots \beta_kX_k + e
\]

Thus, the indirect effect is the difference in the coefficient between the model including the mediator from the model that does not include the mediator.

\textit{Aim 3}

\textbf{Aim 3:} To investigate whether sociospatial buffers (\textit{collective efficacy measured via activity space}) moderate the relationships between PI and mental health outcomes (\textit{total behavioral problems, attention, internalizing and externalizing behavioral problems}).

\textbf{Hypothesis A3:} Youth exposed to PI who report higher levels of CE will have less mental health problems than those peers exposed to PI who report lower levels of CE.

I then introduced an interaction term (sociospatial buffer) to the linear regression model equation in order to determine whether there was a statistically significant moderating interaction between PI and mental health problems using the sociospatial buffer collective efficacy measured via the activity space. To test this hypothesis, I introduced
an interaction term (collective efficacy*parental incarceration) to the linear regression model equation in order to determine whether activity space collective efficacy moderated the relationship PI and mental health problems. The model is specified as:

\[ Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2 + e \]

Where \( Y \) = mental health outcomes, \( \alpha \) is the expected value of \( Y \) when \( X_1 \) and \( X_2 \) are set to zero; \( \beta_1 \) is now the expected change in \( Y \) for one-unit change in \( X_1 \) for reference category (\( X_2 = 0 \)). \( \beta_2 \) is now the expected change in \( Y \) for one-unit change in \( X_2 \) for reference category (\( X_1 = 0 \)). A negative and statistically significant coefficient (\( \beta_3 \)) for the product term interaction between collective efficacy and parental incarceration would offer evidence in favor of the hypothesis that the adverse effect of PI on mental health outcomes is reduced when activity space CE increases. I examined the change in R-squared with the inclusion of \( \beta_1-\beta_3 \) to determine if the interaction term constituted a significant improvement in the explanatory power of the model, taking into account the change in degrees of freedom.

**Exploratory Aim 3a:** To investigate the extent to which sociospatial buffers (*collective efficacy measured via activity space*) moderate the mediated relationship between a) PI and HCC and between b) HCC and MH outcomes.

**Hypothesis A3a:** Youth exposed to PI who report higher levels of CE will have lower levels of HCC than youth exposed to PI with lower levels of CE, and thus lower mental health problems.
**Hypothesis A3b**: Youth exposed to PI who have higher levels of HCC, but have high levels of CE, will have fewer mental health than those with low levels of CE.

Exploratory aims were not able to be conducted due to inadequate sample sizes to determine statistically significant differences. However, if the sample size was adequate, conditional process analyses were to be explored in order to answer whether 1) the linkage to between PI to HCC is contingent on upon the amount of sociospatial buffering support, and 2) the extent to which the mechanism linking PI to mental health outcomes is contingent on the extent to whether the individual has sociospatial buffering support. Using conditional process and path analyses, moderated mediation models would be represented as:

\[
\begin{align*}
\hat{M} &= i_M + \alpha_1 X + \alpha_2 XW + \alpha_3 XW \ldots + e_M \\
\hat{Y} &= i_Y + c'X + bM \ldots + e_Y
\end{align*}
\]

Therefore, the model of \( M \) can be written in equivalent form as

\[
M = i_M + (\alpha_1 + \alpha_3)W + \alpha_2 W \ldots + e_M
\]

a) The indirect effect of \( X \) (PI) on (HCC) through \( M \) (sociospatial buffer) is the product of the effect of \( X \) (PI) on \( M \) (sociospatial buffer) and the effect of \( M \) on \( Y \) (HCC) controlling for \( X \) (PI). Because the effect of \( X \) on on \( M \) is modeled as a function of \( W \) and therefore is dependent on \( W \), so too is the indirect effect of \( X \) on \( Y \) a function of \( W \): \((a_1 + a_3W)b_1\). Thus, the indirect effect of \( X \) is dependent on \( W \).
b) The indirect effect of $X$ (HCC) on (MH) through $M$ (sociospatial buffer) is the product of the effect of $X$ (PI) on $M$ (sociospatial buffer) and the effect of $M$ on $Y$ (MH) controlling for $X$ (PI). Because the effect of $X$ on $M$ is modeled as a function of $W$ and therefore is dependent on $W$, so too is the indirect effect of $X$ on $Y$ a function of $W$: $(a_1 + a_3W)b_1$.

Therefore, an inferential test regarding the slope of this function— the “index of moderated mediation” is a simple way to test a moderated mediation hypothesis. If the point estimate of $a_3b_1$ is statistically different from zero, then moderated mediation would have occurred.
Chapter 4: Results

**Aim 1:** To examine the associations between exposure to PI and mental health outcomes (*total behavioral problems, attention, internalizing, and externalizing behavioral problems*).

**Hypothesis A1:** Youth exposed to PI will have more mental health problems in comparison to youth unexposed to PI.

**Aim 2:** To investigate the extent to which chronic physiologic stress (*hair cortisol concentration [HCC]*) mediates the relationship between exposure to PI and mental health outcomes (*total behavioral problems, attention, internalizing and externalizing behavioral problems*).

**Hypothesis A2:** HCC will mediate the relationship between PI and mental health problems.

**Aim 3:** To investigate whether sociospatial buffers (*collective efficacy [CE] measured via activity space*) moderate the relationships between PI and mental health outcomes (*total behavioral problems, attention, internalizing and externalizing behavioral problems*).

**Hypothesis A3:** Youth exposed to PI who report higher levels of CE will have fewer mental health problems than those peers exposed to PI who report lower levels of CE.

**Exploratory Aim 3a:** To investigate the extent to which sociospatial buffers (*collective
efficacy [CE] measured via activity space) moderate the mediated relationship between a) PI and HCC and between b) HCC and MH outcomes.

**Hypothesis A3a:** Youth exposed to PI who report higher levels of CE will have lower levels of HCC than youth exposed to PI with lower levels of CE, and thus lower mental health problems.

**Hypothesis A3b:** Youth exposed to PI who have higher levels of HCC, but have high levels of CE, will have fewer mental health than those with low levels of CE.

**Sample and Overall Analytic Strategy**

All analyses for this dissertation were generated using SAS 9.4 software.

Copyright © 2016 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA. The sampling frame included adolescents between 11 to 17 years of age who participated in wave I of the AHDC Study (N = 1,402). The analytic sample for this study included only the sub-sample of youth in the hair biomarker collection who had hair assayed for cortisol (N=613). Exploration of the missing data in the analytic sub-sample found that 395 of 613 youth had complete data on all items.

Table 1 in the Appendix includes the amount of missing cases on each variable of interest. The majority of missing cases were primarily missing data on stage of pubertal development (n=138 cases, approximately 22% of the proposed analytic sample), however, other variables of interest were also missing data on the HCC control variables (e.g. items missing on whether the youth had hair product in the sample). Of those
missing on stage of pubertal development (N=138), characteristics of those missing on this particular variable of interest were primarily youth residing with caregivers with some college or an Associate’s degree (40% in comparison to only 15% of those residing with a caregiver with a Master’s degree), youth who identified as male (43%), youth residing in households with no economic hardship, youth who were older, youth with less number of adverse childhood experiences/stressful life events (ACEs), and youth who identified as non-Hispanic White (41%) or non-Hispanic Black youth (40%). No specific pattern emerged on those missing on stage of pubertal development and thus, those observations missing were considered missing at random. In addition, approximately, 40 patterns of missing items resulted by using the PROC MI data command. Due to the high proportion of cases missing at random on stage of pubertal development and also due to the high number of various missing patterns, multiple imputation procedures were conducted and included all variables of interest (10 imputations). Multiple imputation, unlike monotonic imputation, ensures that the error associated with the missing data is built into the model, and thus, the standard errors are larger due to the incorporation of uncertainty (Allison, 2002; McNeish, 2017). Multiple imputation diagnostics included examination of the relative efficiency of the pooled parameter estimates. Across all models, the relative efficiency remained high (>0.98) indicating confidence in the accuracy of parameter estimation.

Descriptive analyses were examined on the total sample of the AHDC wave I and the hair cortisol sub-sample without imputation. Univariable and bivariable analyses are described to interpret the characteristics of the cortisol sub-sample (prior to imputation).
In addition, multinomial logistic regression analyses were conducted on the cortisol subsample prior to MI procedures to also examine the associations between 1) variables of interest on high vs medium HCC values and 2) variables of interest on low vs medium HCC values (models were analyzed with and without adjustment for hair weight, length and hair care practices).

The hypotheses for this dissertation were tested using a series of ordinary least squares (OLS) linear regression models for each of the four dependent variables of interest- total behavioral problems, attention problems, externalizing behavioral problems, and internalizing behavioral problems. The results for the OLS regression models are reported as pooled parameter estimates and a p-value of less than 0.05 was the criterion employed to determine the level of significance for rejecting the null hypothesis. Due to the limited sample size of the cells when examining the timing and frequency of PI, only lifetime exposure of PI was considered the main independent variable of interest. Sensitivity analyses were conducted using PROCESS, a conditional process model (Hayes, 2013). PROCESS is a modeling tool that relies on OLS regression, but is considered less biased in the estimation of effects than stepwise OLS regression due to random measurement error (Darlington & Hayes, 2017). Sensitivity analyses revealed similar directions and statistically significant effects as the OLS regression analyses performed for interpretation in this dissertation.

Last, all dependent variables of interest demonstrated strong reliability as evident by Cronbach’s alpha coefficients greater than 0.70 indicating strong internal consistency by all items in each subscale in the CBCL and by all items in the CBCL. The attention
difficulties subscale consisted of 6 items (a = 0.85), the externalizing behavioral difficulties subscale consisted of 7 items (a = 0.83), the internalizing behavioral difficulties subscale consisted of 6 items (a = 0.82), and the total behavioral problems subscale consisted of averaging all 19 items (a = 0.90).

Aim 1 - Modeling Strategy

The aim of the first hypothesis was to examine the associations between exposure to PI and mental health outcomes. I hypothesized that youth exposed to PI will have more mental health problems in comparison to youth unexposed to PI. A series of four regression models were used to test the first hypothesis on each dependent variable of interest (total, attention, internalizing, and externalizing behavioral problems) in the cortisol subsample. The total behavioral problem score was an average of the three subscale means of the CBCL (attention, internalizing, externalizing), and thus, provides a general overview of behavioral difficulties. In addition, socioeconomic characteristics (model 3) and additional adverse childhood exposures or stressful life events (ACEs) (model 4) were included into the modeling strategy in order to examine the potential mediating effect of these adversities on the relationship between youth exposed to PI and mental health outcomes.

Model 1: the baseline model which included the association between youth ever exposed to PI on behavioral problems without covariates. Youth ever exposed was a dichotomous categorical variable indicating lifetime exposure of PI.
Model 2: Sociodemographic variables of the youth were entered into the model including race/ethnicity of the youth, age of the youth (continuous variable), sex of the youth (dichotomous variable, female youth was the reference group), foreign birth (dichotomous variable, born within the United States was the reference group) and pubertal development of the youth (ordinal scale, range 1-4, higher scores indicating near completion of puberty). Race/ethnicity of the youth was measured via five dichotomous categorical variables (non-Hispanic white was the reference group and excluded).

Model 3: Socioeconomic characteristics including economic hardship and level of parental/caregiver educational attainment were entered into the model as potential mediators. Economic hardship was an ordinal scale, range 1-4, with higher scores indicating more household economic disadvantage. Level of education of the caregiver was measured via four categorical dichotomous variables ranging from less than high school degree, some college or an associate’s degree, Bachelor’s degree, or Master’s degree (reference group).

Model 4: Total number of adverse childhood experiences and stressful life events (ACEs) were included into the model. Total ACEs were summed across three developmental stages of the youth (0-5, 6-10, 11 years and older) and thus, 90 ACEs could have been experienced.

Aim 2 – Modeling Strategy

The second aim of this dissertation investigated the extent to which physiologic stress (hair cortisol concentration [HCC]) mediates the relationship between exposure to

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PI and mental health outcomes (total behavioral problems, attention, internalizing and externalizing behavioral problems).

Model 5: HCC was included in the model to examine the direct effect on behavioral outcomes of interest. In addition, control variables known to affect the results of HCC were included into the fifth model. HCC control variables included three dichotomous categorical variables (frequency of hair washing (daily, less than daily served as the reference), recent chemical treatment, and current hair product) and two continuous variables (hair sample weight and hair sample length). HCC was logged before imputation procedures.

Aim 3 - Modeling Strategy

The third aim of this dissertation investigated whether sociospatial buffers (collective efficacy measured via activity space) moderate the relationships between PI and mental health outcomes (total, attention, externalizing and internalizing behavioral problems). To test this hypothesis, a new imputation procedure was implemented after mean centering all variables of interest except for mental health outcomes and the exposure to PI. Model 6 included the examination of the direct effect of the sociospatial buffer by adding activity space collective efficacy (CE) as a continuous variable. Model 7 then tested the indirect effect of the interaction between youth exposed to PI and activity-space collective efficacy.
Model 6: Activity-space CE was included in the model to examine the direct effect on behavioral outcomes of interest. Activity space collective efficacy (CE) was entered as a continuous variable.

Model 7 (mean centered imputation): An interaction term (youth ever exposed to PI*activity space collective efficacy) was included in Model 7 in order to test the indirect effect of those youth exposed to PI spending more time in areas with better CE.

*Exploratory Aim Modeling Strategy*

Exploratory aims will only be conducted if two conditions are met 1) support for all hypotheses are demonstrated and 2) adequate sample size exists to statistically determine statistically significant differences. If these two conditions are met, then the interaction terms HCC*CE and youth ever exposed to PI and HCC were introduced in subsequent models to test for moderated mediation.

*Results of Univariable Analyses*

*Characteristics of the Cortisol Sub-Sample*

The cortisol sub-sample consisted of 613 adolescents between the age of 11-17 years residing in the study area (Table 2). The average age of the youth was 14-15 years and most youths identified as non-Hispanic White (54.5%, n = 334) or non-Hispanic Black (30.7%. n = 188). Approximately, 5.6% of youth identified as Hispanic (n = 34), 7.3% identified as multiracial/ethnic (n = 45), and 1.8% were classified as “Other” (Native Hawaiian/other Pacific Islander, Asian, American Indian, or Alaska Native, n =
11). Results also revealed that approximately 3.8% of the sample was born outside of the United States (n = 23). The mean pubertal developmental score was 3.06 (SD = 0.69) on a scale of 1-4 with higher scores indicating completion of puberty. The average score for total behavioral problems in the full cortisol subsample was 1.42 (SD = 0.36, range 1-3), 1.46 (SD = 0.51, range 1-3) for attention behavioral problems, 1.35 (SD = 0.40, range 1-3) for externalizing behavioral problems, and 1.45 (SD = 0.43, range 1-3) for internalizing behavioral problems, with higher scores indicating more problematic behaviors.

The majority of caregivers had completed some college or their associate’s degree (31.8%, n = 195), while 28.4% (n = 174) obtained their Bachelor’s degree, 31.4% obtained a Master’s degree or higher, and 17.5% of the sample had a high school diploma or less. The total number of adverse childhood experiences the youth’s caregiver reported was approximately 6 (indicating 6 adverse events occurred across three developmental stages – 0-5 years, 6-11 years, and 11 years and older).

Approximately, 11.6% of the cortisol subsample (n = 67) had ever been exposed to a parent incarcerated in jail and/or prison in at least one developmental stage of interest (0-5 years, 6-10 years, 11 years and older). Of those youth ever exposed to PI (n = 67), approximately 61% (n = 41) experienced a parent incarcerated in only one developmental stage (0-5 years, 6-10 years, 11 and older), while 39% (n = 46) experienced the event across multiple developmental stages (or 2-3 times). In addition, of the youth who had ever been exposed in at least one developmental stage, 68% of the caregivers reported the exposure occurred from birth to 5 years of age. Approximately, 22% of the caregivers
reported the exposure occurred between 6-10 years (n = 9) and 10% reported the exposure occurred after the age of 11 years (n = 4).

**Results of Bivariable Analyses**

A series of bivariable analyses employing logistic regression and ordinary least squares regression were conducted to gain a better understanding of the relationships between the variables in this study. First, differences in means and proportions of the main predictor of interest by exposure of PI were examined. Second, relationships between each mental health outcome (total behavioral problems, attention behavioral problems, externalizing behavioral problems and internalizing behavioral problems) and predictor variables of interest were also examined. Third, the relationships between the measure of physiologic stress (HCC) and variables of interest were examined to gain a better understanding of potential disparities in physiologic stress in this sample of adolescents. Fourth, the relationships between variables of interest on HCC levels using multinominal logistic regression analyses examined the relationships between 1) predictor variables of interest and low cortisol concentration (0-25% tertile in comparison to 25-75%) and 2) predictor of variables of interest and high cortisol concentration (75-100% in comparison to 25-75%).
Characteristics of the Sample by Exposure to PI

Table 4 describes the proportions, means, and statistically significant differences between youth ever exposed to PI and youth unexposed across all variables of interest. Tests comparing the means and proportions of the variables of interest were tested using logistic regression analyses for dichotomous categorical variables of interest and regression analyses for continuous variables of interest.

Results revealed statistically significant differences across all dependent variables of interest – total behavioral problems, attention behavioral problems, internalizing behavioral problems and externalizing behavioral problems. In general, behavioral problem mean scores were higher for youth ever exposed to PI in comparison to youth unexposed. The mean total behavioral problem score was 1.60 (SE = 0.44) for youth exposed to PI in comparison to 1.39 (SE=0.33, p <0.001) for youth unexposed to PI. The mean attention problem score was 1.69 (SE = 0.58) for youth ever exposed to PI and 1.42 (SE = 0.47, p <0.01) for youth unexposed. The mean externalizing behavioral problem score was 1.53 (SE = 0.51) for youth ever exposed to PI in comparison to 1.32 (SE = 0.36, p < 0.001) for those unexposed, and the mean internalizing behavioral problem score was 1.57 (SE = 0.48) for those exposed in comparison to 1.44 (SE = 0.42, p < 0.05) for those never exposed to PI.

For youth demographic variables of interest, several statistically significant differences between the two groups were found. Youth exposed to PI were more likely to identify as non-Hispanic Black or multi-racial/ethnic. Approximately, 43% (n = 29, p < 0.01) of those exposed to PI identified as non-Hispanic Black while only 26% (n=137)
identified as non-Hispanic Black in youth never exposed. Results revealed that 33% (n = 22, p < 0.001) of youth exposed to PI identified as non-Hispanic White in comparison to 60% (n = 306) of those unexposed to PI. While 13.4% (n = 9, p < 0.05) of youth exposed to PI identified as multi-racial or ethnic, in comparison to 6% (n = 33) of those youth unexposed. No youth exposed to PI were born outside of the United States, while 21 youth unexposed to PI had (p < 0.001). The average age of youth ever exposed to PI was 14.1 (SE = 1.6, p < 0.05), while the average of youth unexposed was 14.6 (SE = 1.8). Both groups had a similar pubertal stage of development and proportion of males in comparison to females.

In regards to socioeconomic considerations, statistically significant differences were found across all economic variables of interest comparing youth exposed to PI and youth unexposed to PI. Youth ever exposed to PI were more likely to have parents/caregivers who had a high school education or less, than youth unexposed to PI (25%, n = 17 in comparison to 15%, n = 77, p < 0.05). Youth exposed to PI were also less likely to have a parent/caregiver with a Master’s degree (6%, n = 4 in comparison to 24%, n = 125, p < 0.01) and less likely to have a caregiver with a Bachelor’s degree (9%, n = 6 in comparison to 32%, n = 164, p < 0.001) than youth unexposed. Similarly, caregivers of youth ever exposed to PI were more likely to report economic hardship in comparison to youth never exposed to PI (2.6 in comparison to 1.8, p < 0.001), and more adverse childhood experiences/stressful life events than those unexposed (15.5 additional adverse events in comparison to 4.8 adverse events, p < 0.001).
There were no statistically significant differences between control variables for HCC and exposure to PI. However, a statistically significant difference was observed in HCC by youth exposed to PI (1.22 in comparison to 0.92, p < 0.05) but this analysis did not adjust for considerations known to impact cortisol concentration levels. Last, there were no statistically significant differences between youth exposed to PI and activity-space CE in comparison to those unexposed to PI (0.16 in comparison to 0.14).

In addition, youth exposed to PI were more likely than youth unexposed to PI to be residing with a caregiver who was not the biological parent (p < 0.05). Approximately 20% of the youth exposed to PI (n = 13) resided with a caregiver who was not a biological parent in comparison to youth unexposed to PI (11%, n = 56). Of those youth ever exposed to PI (n = 67), 80% of the caregivers were identified as the biological parent, 12% of the caregivers identified as the grandparent, 3% of the caregivers identified as the stepparent, 1% of the caregivers identified as the legal guardian, and 3% of the caregivers identified “other.” Of those youth unexposed to PI (n = 513), approximately 89% of the caregivers identified as the biological parent, 3% of the caregivers identified as the grandparent, 4.5% of the caregivers identified as the stepparent, less than 1% identified as the legal guardian, less than 1% identified as “other” and less than 1% identified as “other relative.”

Mental Health of Youth Exposed to PI

Table 5 highlights the bivariable associations between youth exposed to PI across all mental health outcomes of interest. In general, youth exposed to PI was more likely
than their unexposed peers to worse behavioral problem scores. For total behavioral problems, youth ever exposed to PI was associated with a 0.20-unit increase in total behavioral problems in comparison to youth unexposed to PI (B = 0.20, SE = 0.04, p < 0.001). Similarly, on average, youth ever exposed to PI was associated with a 0.27-unit increase in attention behavioral problems in comparison to youth unexposed to PI (B = 0.27, SE = 0.06, p < 0.001), a 0.22-unit increase in externalizing behavioral problems (SE = 0.05, p < 0.001) and 0.13-unit increase in internalizing behavioral problems (SE = 0.05, p < 0.05) in comparison to youth unexposed to PI.

The effect on total behavioral problems was stronger for youth who experienced PI only once in comparison to those unexposed (B = 0.25, SE = 0.07), than for youth who experienced PI up to three times in comparison to those unexposed (B= 0.15, SE = 0.06). This trend was observed across all dependent variables of interest – attention behavioral problems, externalizing behavioral problems, and internalizing behavioral problems. The strongest effect observed was in those youth who experienced PI only once, in comparison to those unexposed, on attention behavioral problems (B = 0.32, SE=0.10, p<0.05).

*Total Behavioral Problems*

Bivariant associations were conducted to examine the relationships between the remaining predictor variables of interest on total behavioral problem scores using ordinary least square regression analyses (results revealed in Table 5). Aside from exposure to PI, youth with more adverse childhood exposures and economic hardship were more likely to have worse mean total behavioral problem scores. For every
additional adverse childhood exposure, on average, predicted a 0.02-unit increase in mean total behavioral problem scores (SE = 0.002, p < 0.001). On average, for every unit increase in economic hardship, there was an associated 0.08 increase in mean total behavioral problem scores (SE = 0.08, p < 0.001). In addition, youth with a parent/caregiver with a Bachelor’s degree, on average, was associated with lower total behavioral problem scores than youth residing with a parent/caregiver who had a Master’s degree or above (B = -0.07, SE = 0.03, p < 0.05). However, on average, youth residing with a parent/caregiver who completed some college or an Associate’s degree was positively associated to mean total behavioral problems in comparison to those youth residing with a parent/caregiver with a Master’s degree or higher (B = 0.07, SE = 0.03, p < 0.05). No other statistically significant differences were observed between youth of various race/ethnicities in comparison to non-Hispanic White youth, between male and female youth, between youth born outside of the United States in comparison to those born within the United States and youth in various pubertal developmental stages.

**Attention Behavioral Problems**

Next, a series of bivariable associations were conducted to examine the relationships between the remaining predictor variables of interest on attention behavioral problem scores using ordinary least square regression analyses (results revealed in Table 5). Among youth demographic variables of interest, Non-Hispanic Black youth were less likely to have attention behavioral problems in comparison to non-Hispanic White youth (B = -0.09, SE = 0.04, p < 0.05). Male youth were more likely to have attention
behavioral problems in comparison to female youth (B = 0.13, SE = 0.04, p < 0.05). In addition, youth further along in pubertal development or near pubertal development completion were less likely to have attention behavioral problems in comparison to those in earlier pubertal developmental stages.

In regards to socioeconomic considerations, youth with more adverse childhood exposures (ACEs), economic hardship, and caregivers with lower levels of educational attainment were all more likely to have worse mean attention problem scores. On average, every additional ACE a youth experienced, predicted a 0.02-unit increase on mean attention problem scores. On average, for every one-unit increase in economic hardship, there was an associated 0.10-unit increase in mean attention problem scores (SE = 0.02 p < 0.001). However, on average, youth residing with a parent/caregiver who completed some college or an Associate’s degree was positively associated to mean attention behavioral problems in comparison to those youth residing with a parent/caregiver with a Master’s degree or higher (B = 0.13, SE = 0.04, p <0.05).

No other statistically significant differences were observed between youth of various race/ethnicities in comparison to non-Hispanic White youth, or between youth born outside of the United States in comparison to those born within the United States and youth in various pubertal developmental stages. In addition, there were no statistically significant differences for those with high HCC in comparison to low HCC, or between youth who live in areas with more informal social control than in areas with less informal social control on mean attention behavioral problem scores.
Next, a series of bivariable associations were conducted to examine the relationships between the remaining predictor variables of interest on externalizing behavioral problem scores using ordinary least square regression analyses (results revealed in Table 5). Among youth demographic variables of interest, Non-Hispanic Black youth were less likely to have externalizing behavioral problems in comparison to non-Hispanic White youth ($B = -0.07$, $SE = 0.03$, $p < 0.05$). No statistically significant differences were observed comparing male youth to female youth, comparing youth in later pubertal developmental stages to youth in earlier developmental stages of puberty, and between youth born outside the United States in comparison to those who were born within the United States on externalizing behavioral problem scores.

In regards to the effect of other socioeconomic considerations on mean externalizing behavioral problem scores, youth with more adverse childhood exposures, economic hardship, and caregivers with lower levels of educational attainment were all more likely to have more externalizing behavioral problems. On average each additional adverse childhood exposure youth experienced predicted a 0.02 increase in externalizing behavioral problems ($SE = 0.002$, $p < 0.001$). On average, for every unit increase in economic hardship, there was an associated 0.09 increase in mean attention problem scores ($SE = 0.02$, $p < 0.001$). In addition, youth with a parent/caregiver with some college or an Associate’s degree, on average, was associated with higher externalizing
behavioral problem scores than youth residing with a parent/caregiver who had a Master’s degree or above (B = -0.07, SE = 0.03, p < 0.05). However, on average, youth residing with a parent/caregiver who completed some college or an Associate’s degree was positively associated to mean externalizing behavioral problems in comparison to those youth residing with a parent/caregiver with a Master’s degree or higher (B = 0.0, SE = 0.03, p < 0.05). However, youth who resided with a caregiver with a Bachelor’s degree was more likely to have better scores on mean attention behavioral problems than youth residing with a parent who has a Master’s degree or higher (B = -0.8, SE = 0.04, p < 0.05).

In addition, there were no statistically significant differences for those with high HCC in comparison to low HCC, or between youth who live in areas with more informal social control than in areas with less informal social control.

**Internalizing Behavioral Problems**

Next, a series of bivariable associations were conducted to examine the relationships between the remaining predictor variables of interest on internalizing behavioral problem scores using ordinary least square regression analyses (results revealed in Table 5). Among youth demographic variables of interest, Non-Hispanic Black youth were less likely to have internalizing behavioral problems in comparison to non-Hispanic White youth (B = -0.19, SE = 0.04, p < 0.001). In addition, unlike attention behavioral problems, youth in later pubertal developmental stages in comparison to youth in earlier developmental stages of puberty, were more likely to have internalizing
problems (B = 0.06, SE = 0.03, p < 0.05). No statistically significant differences were observed comparing male youth to female youth, and between youth born outside the United States in comparison to those who were born within the United States on internalizing behavioral problem scores.

In regards to socioeconomic considerations, youth with more ACEs and economic hardship were also more likely to have worse internalizing behavioral problems. On average each additional adverse childhood exposure youth experienced predicted a 0.01 increase in internalizing behavioral problems (SE = 0.02, p <0.001). On average, for every unit increase in economic hardship, there was an associated 0.04 increase in mean internalizing behavioral problem scores (SE = 0.02 p < 0.001). In addition, youth with a parent/caregiver with some college or an Associate’s degree, on average, was associated with higher externalizing behavioral problem scores than youth residing with a parent/caregiver who had a Master’s degree or above (B = -0.07, SE = 0.03, p <0.05).

Last, statistically significant differences were observed for those with high HCC in comparison to low HCC, as youth with higher cortisol concentration levels was negatively correlated with internalizing behavioral problems (B=-0.04, SE = 0.01, p <0.01). However, no statistically significant differences were revealed between youth who live in areas with more informal social control than in areas with less informal social control on internalizing behavioral problems.
Hair Cortisol Concentration by Predictor Variables of Interest

Table 6 reveals the bivariable associations between predictor variables of interest on HCC (logged) in addition to multinomial logistic regression models to determine statistically significant differences between predictors of interest on low HCC (0-25%) and high cortisol (75-100%) concentration. First, bivariable relationships were examined between variables of interest on HCC logged. Results demonstrated that HCC was 30% higher in youth exposed to HCC in comparison to youth unexposed (B = 0.31, SE = 0.15, p < 0.05). In addition, HCC was 70% higher in non-Hispanic Black youth, in comparison to non-Hispanic white youth (B = 0.54, SE = 0.10, p < 0.001). No other statistically significant differences were observed between predictor variables of interest on demographic characteristics of the youth. Statistically significant differences were only found between one mental health outcome of interest. Results revealed that, every one-unit increase in mean internalizing scores was associated with a 37% decrease in hair cortisol (B= -0.32, SE= 0.11, p < 0.001). No other statistically significant differences were observed between other mental health difficulties on HCC. Last relationships between control variables on HCC values were examined before examining the differences on low and high cortisol concentration levels. On average, every one-unit increase in hair weight predicted a 1% increase in HCC values, while each additional centimeter in hair length predicted 18% decrease in HCC values (B = -0.17, SE = 0.07, p < 0.001).

Table 6 also reveals the associations between predictor variables of interest and 1) low cortisol concentration (0-25%) (using medium cortisol concentration values (25-
75%) as the reference group) and 2) high cortisol concentration values (75-100%) (using medium cortisol concentration values (25-75%) as the reference group). A series of multinomial logistic regression analyses were conducted to examine statistically significant differences on predictor variables of interest. Several statistically significant differences were observed among predictor variables of interest across both tertiles of interest (low and high cortisol concentration tertile values in comparison to medium cortisol concentration tertile). First, youth exposed to PI in comparison to those unexposed, was associated with a 0.31 decrease in the relative log odds of having high cortisol concentration values. In addition, males relative to females, is associated with 0.69 decrease in the relative log odds of having low cortisol concentration values relative to medium cortisol concentration values (OR: 0.67, [0.44, 0.98], p <0.05). A larger effect was observed comparing non-Hispanic Black youth in relation to non-Hispanic White youth. Non-Hispanic Black youth relative to non-Hispanic White youth, is associated with a 2.0-unit increase in the relative log odds of having a having a high cortisol concentration value (0-25% tertile estimate) relative to medium cortisol concentration values (OR: 2.0, [1.33, 2.98], p < 0.001). In addition, youth with a caregiver who had some college or an Associate’s degree or less, in comparison to those with youth residing with caregivers who have a Master’s degree was associated with a 0.59-unit decrease in the relative log odds of having low HCC in relative to medium HCC. No other statistically significant differences were observed across other socioeconomic and demographic variables of interest. Last, a one-unit increase in hair weight is associated with a 1.01-unit increase in the relative log odds of having low HCC relative to medium
HCC. In addition, a one-unit increase in hair weight was associated with a 0.97-unit decrease in the relative log odds of having high HCC relative to medium HCC. In addition, every one-unit increase in hair length was associated with a 1.63-unit increase in the relative log odds of having a low HCC relative to a high HCC.

Next, Table 7 reveals the ordinary least square regression associations between predictor variables of interest on HCC (logged) in addition to multinomial logistic regression models to determine statistically significant differences between predictors of interest on low HCC (0-25%) and high cortisol (75-100%) concentration adjusting for controls variables known to affect the HCC to obtain a better understanding on youth with dysregulated HCC. First, regression analyses predicting logged cortisol concentration values demonstrated several statistically significant differences once adjusted by HCC controls. However, unlike Table 6, once controls were included, there was no statistically significant difference between youth exposed to PI in relation to youth unexposed to PI once adjusted by HCC controls (B=0.28, SE=0.15, p = 0.066). In addition, HCC was 68% higher in non-Hispanic Black youth, in comparison to non-Hispanic white youth (B = 0.52, SE = 0.10, p < 0.001) after adjusting for HCC controls. However, once HCC controls were included, HCC was 41% higher in male youth in comparison to female youth (B=0.35, SE=0.12, p < 0.01). In addition, and similar to Model 6, every one-unit increase in internalizing problems was associated with a 38% decrease in HCC (B= -0.32, SE= 0.11, p < 0.001). No other statistically significant differences were observed between other mental health difficulties on HCC.
Table 7 also reveals the associations between predictor variables of interest and 1) low cortisol concentration (0-25%) (using medium cortisol concentration values (25-75%) as the reference group) and 2) high cortisol concentration values (75-100%) (using medium cortisol concentration values (25-75%) as the reference group). A series of multinomial logistic regression analyses, adjusting for HCC control variables, were conducted to examine statistically significant differences on predictor variables of interest. Two statistically significant differences were observed among predictor variables of interest across both tertiles of interest (low and high cortisol concentration tertile values in comparison to medium cortisol concentration tertile). First, holding control variables constant, males relative to females, was associated with a 0.54-unit decrease in the relative log odds of having low HCC versus medium HCC values (OR: 0.54, [0.32, 0.90] p< 0.05). In addition, males relative to females, was associated with a 2.0-unit increase in the relative log odds of having high HCC versus medium HCC (OR: 2.0, [1.20, 3.36] p < 0.001) adjusting for HCC controls. A similar effect was observed comparing non-Hispanic Black youth in relation to non-Hispanic White youth. Holding control variables constant, the non-Hispanic Black youth relative to non-Hispanic White youth, was associated with a 0.56-unit decrease in the relative log odds of having low HCC in comparison to high HCC (OR: 0.56, [0.32, 0.97], p < 0.05). Also, holding control variables constant, non-Hispanic Black youth relative to non-Hispanic White youth, was associated with a 2.0-unit increase in the relative log odds of having high HCC in comparison to medium HCC values. Upon examination of mental health difficulties, every unit increase in internalizing problems was associated with a 0.53-unit
decrease in the relative log odds of having high HCC in comparison to low HCC (OR: 0.53, [0.30, 0.94], p < 0.05). Last, holding HCC controls constant, youth residing with caregivers with some college or an Associate’s degree, in comparison to youth residing with caregivers with a Master’s degree, was associated with a 0.48-unit decrease in the relative log odds of having low HCC in comparison to medium HCC (OR: 0.48, [0.29, 0.78], p < 0.01).

Results of Multivariable Analyses

Total Behavioral Problems

Table 8 in the Appendix summarizes the results of the first four models that tested the first hypothesis for the dependent variable, total behavioral problems, in the full sample. The results of Model 1, the baseline model, indicated that, on average, youth ever exposed to PI significantly predicted a 0.17-unit increase in mean total problem behavioral scores ($B = 0.17, SE = 0.05, p < 0.01$). Model 2 estimated the effects of sociodemographic variables of the youth. The findings revealed that, on average, holding youth demographic variables of interest constant, youth exposed to PI predicted a 0.17-unit increase in their mean externalizing behavioral problem score ($B = 0.17, SE = 0.05, p < 0.01$). No other direct effects on total behavioral problems were observed in Model 2.

Model 3 then examined the extent to which socioeconomic characteristics influenced mean total problematic behavior scores, above and beyond the youth’s demographic characteristics, as well as the extent to which socioeconomic characteristics mediated the relationship between youth exposed to PI and mean total problematic
behavioral scores. A direct effect of economic hardship on mean total behavioral problems was noted. Specifically, after adjusting for demographic controls of the youth, caregiver level of educational attainment, and exposure to PI, results indicated, on average, that for every one-unit increase in economic hardship (or worsening economic hardship), predicted a 0.07-unit increase in the total problematic behavioral scores (SE = 0.02, \( p < 0.001 \)). In comparing Model 2 to Model 3, the main effect of PI on total behavioral problems decreased in strength from 0.17 to 0.11 units once socioeconomic characteristics were included into the model. However, even after adjusting for socioeconomic variables of the youth, exposure to PI remained a statistically significant predictor in mean total problematic behavioral scores in comparison to those unexposed (\( B = 0.11, \ SE = 0.05, \ p < 0.05 \)).

Significant differences across race were also observed in Model 3. On average, non-Hispanic Black youth in comparison to non-Hispanic white youth predicted a lower mean score on total behavioral problems (\( B = -0.09, \ SE = 0.04, \ p < 0.01 \) controlling for other sociodemographic variables, socioeconomic characteristics, and exposure to PI. However, there were no statistically significant differences in predicting total behavioral problems between youth who were born abroad in comparison to those who were not (\( B = -0.08, \ SE = 0.09, \ p > 0.05 \)), or among male adolescents in comparison to female adolescents (\( B = 0.002, \ SE =0.03, \ p > 0.05 \), or in adolescents in various stages of pubertal development (\( B = 0.01, \ SE =0.09, \ p > 0.05 \), adjusting for socioeconomic and demographic variables. Similarly, no significant direct effect was observed among youth residing with caregivers of various educational attainment on mean score of total
behavioral problems. In comparing Model 2 to Model 3, the parameter estimate and significance of the intercept remained relatively unchanged, which indicated that there was still significant variation in the prediction of total behavioral problems across adolescents after accounting for youth demographics and socioeconomic characteristics.

In Model 4, total number of adverse childhood experiences and stressful life events (ACEs) were included in the model. Model 4 examined the extent to which total number of ACEs, above and beyond, socioeconomic and demographic considerations in addition to the extent to which total number of ACEs mediated the relationship between youth exposed to PI and total mental health behaviors. Results indicated that, on average, adjusting for demographic characteristics, socioeconomic characteristics, and exposure to PI, total number of ACEs did not significantly predict an increase in the mean score of total behavioral problems of the youth ($B = 0.01, SE = 0.004, p > 0.05$). However, the effect between exposure to PI on total behavioral problems did not remain significant once total number of adverse childhood exposures was included into the model ($B = 0.07, SE = 0.06$). The intercept remained statistically significant, which indicated that there was still variation in the prediction of total behavioral problems in youth after adjusting for demographics, socioeconomic characteristics and total lifetime ACEs score.

In Model 5, no direct effects were observed between HCC on total behavioral problems ($B= -0.01, SE = 0.01, p > 0.05$) after adjusting for demographic variables, stressful life events, and socioeconomic characteristics of interest. No statistically significant differences were observed for youth with high HCC values in comparison to those with low HCC values. Consistent with Models 1-4, Model 5 also indicated that, on
average, non-Hispanic Black youth, in comparison to non-Hispanic White youth were less likely to have total behavioral problems after adjusting for other demographics of the youth, socioeconomic characteristics, physiologic stress and activity-space CE \((B = -0.08, \text{SE} = 0.04, p < 0.01)\). In addition, every one-unit increase in economic hardship, predicted a 0.06-unit increase in the total behavioral problem score \((\text{SE} = 0.02, p < 0.01)\) after adjusting for demographics of the youth, socioeconomic characteristics, physiologic stress, and activity-space CE.

In Model 6 no direct effect between activity-space CE on total behavioral problems of youth \((B = 0.12, \text{SE} = 0.14, p > 0.05)\) was observed, adjusting for demographics of the youth, socioeconomic considerations, total ACEs, and physiologic stress. No statistically significant differences were observed for youth who spend more time in spaces with higher CE in comparison to those spending more time in spaces with lower CE. In addition, similar strength and directions of the two direct effects observed in Models 1-5, were also evident and unchanged in Model 6.

When Model 7 was analyzed with the inclusion of the interaction between youth exposed to PI and activity space CE, results were similar to Model 6 but with one notable difference- a direct effect of the total number of stressful life events on total behavioral problems was observed. Thus, each additional adverse childhood exposure and stressful life event, predicted a 0.01-unit increase in total behavioral problems \((\text{SE} = 0.003, p < 0.001)\) controlling for socioeconomic characteristics, stressful life events, physiologic stress, CE, exposure to PI, and the interaction between exposure to PI and activity-space CE. The intercept remained statistically significant in Model 6 and Model 7, which
indicated that there was still variation in the prediction of total behavioral problem scores in youth after adjusting for demographics, socioeconomic characteristics, stressful life events, physiologic stress, and activity space CE.

Attention Problems

Table 9 in the Appendix summarizes the results of the first four models that tested the first hypothesis for the dependent variable, attention problems in the full sample. The results of Model 1, the baseline model, indicated that, on average, youth ever exposed to PI predicted a 0.22-unit increase in their mean attention problem score (B = 0.22, SE = 0.07, p < 0.01). Model 2 estimated the effects of demographic variables of the youth on mean attention problem scores. The findings revealed that, on average, holding youth demographic variables of interest constant, youth exposed to PI predicted a 0.19-unit increase in their mean attention problem score (B = 0.19, SE = 0.07, p < 0.01). No other direct effects between demographics of the youth on attention problems were observed in Model 2.

Model 3 examined the extent to which socioeconomic characteristics influenced attention problems, above and beyond the youth’s demographic characteristics, as well as the extent to which socioeconomic characteristics mediated the relationship between youth exposed to PI and mean attention problems score. A direct effect of economic hardship on men attention problems was noted. Specifically, after adjusting for demographic controls of the youth, caregiver level of educational attainment, and exposure to PI, the results indicated, on average, that every one-unit increase in economic
hardship (or worsening economic hardship), predicted a 0.07-unit increase in the overall mean attention problem score (SE = 0.02, p < 0.01). In comparing Model 2 to Model 3, the total effect of PI on mean attention problems decreased in strength from 0.19 to 0.14 units once socioeconomic characteristics were included into the model. However, even after adjusting for socioeconomic variables of the youth, exposure to PI remained a statistically significant predictor in mean attention problem scores in comparison to those unexposed (B = 0.14, SE = 0.07, p < 0.05). Significant differences across males and females were also observed. On average, male youth in comparison to female youth predicted, on average, a higher mean score on mean attention problems (B = 0.10, SE = 0.05, p < 0.01) controlling for other demographic variables, socioeconomic characteristics, and exposure to PI. However, there were no statistically significant differences in predicting the mean score of attention problems between youth who were born abroad in comparison to those who were not (B = -0.001, SE = 0.02, p > 0.05), among youth of various race/ethnicities in comparison to non-Hispanic White youth, or among adolescents in various stages of pubertal development (B = -0.05, SE =0.05, p > 0.05), adjusting for socioeconomic characteristics. Similarly, no significant direct effect was observed among youth residing with caregivers of various educational attainment on total mean attention problems. In comparing Model 2 to Model 3, the parameter estimate and significance of the intercept remained relatively unchanged, which indicated that there was still significant variation in the prediction of mean attention problems across adolescents after accounting for youth demographics and socioeconomic characteristics.
In Model 4, total number of adverse childhood experiences and stressful life events (ACEs) were included in the model. Model 4 examined the extent to which total number of ACEs, above and beyond, socioeconomic and demographic considerations in addition to the extent to which total number of ACEs mediated the relationship between youth exposed to PI and attention problems. Results indicated that, on average, adjusting for demographic characteristics, socioeconomic characteristics, and exposure to PI, total number of ACEs did not significantly predict an increase in the mean score of attention problems of the youth (B = 0.01, SE = 0.01, p > 0.05). However, the effect between exposure to PI on mean attention problem scores did not remain significant once total number of adverse childhood exposures was included into the model (B = 0.10, SE = 0.06, p < 0.05). The intercept remained statistically significant, which indicated that there was still variation in the prediction of mean attention problem scores in youth after adjusting for demographics, socioeconomic characteristics and total lifetime ACEs score.

In Model 5, no direct effect was observed between HCC on attention problems (B= 0.001, SE = 0.02, p > 0.05) after adjusting for demographic variables, total number of ACEs, and socioeconomic characteristics of interest. No statistically significant differences were observed for youth with high HCC values in comparison to those with low HCC values. Consistent with Models 3 and Model 4, Model 5 also indicated that, on average, male youth, in comparison to non-female youth were more likely to have attention problems after adjusting for other demographics of the youth, socioeconomic characteristics, physiologic stress (B = 0.11, SE= 0.05, p < 0.05). In addition, every one-unit increase in economic hardship, predicted a 0.06-unit increase in mean attention
problem scores (SE = 0.03, p < 0.05) after adjusting for demographics of the youth, socioeconomic characteristics, and physiologic stress.

In Model 6 no direct effect between activity-space CE on attention problems of youth (B = 0.10, SE = 0.23, p > 0.05) was observed, adjusting for demographics of the youth, socioeconomic considerations, total ACEs, and physiologic stress. No statistically significant differences were observed for youth who spend more time in spaces with higher CE in comparison to those spending more time in spaces with lower CE. In addition, similar strength and directions of the two direct effects observed in Models 1-5, were also evident and unchanged in Model 6.

When Model 7 was analyzed with the inclusion of the interaction between youth exposed to PI and activity space CE results were similar to Model 6 but with one notable difference- a direct effect of the total number of stressful life events on mean attention problems was observed. Thus, each additional adverse childhood exposure and stressful life event, predicted a 0.01-unit increase in mean attention problem scores (SE = 0.005, p < 0.05) controlling for socioeconomic characteristics, stressful life events, physiologic stress, CE, exposure to PI, and the interaction between exposure to PI and activity-space CE. The intercept remained statistically significant in Model 6 and Model 7, which indicated that there was still variation in the prediction of mean attention problem scores in youth after adjusting for demographics, socioeconomic characteristics, stressful life events, physiologic stress, and activity space CE.
Table 10 in the Appendix summarizes the results of the first four models that tested the first hypothesis for the dependent variable, externalizing behaviors in the full sample. The results of Model 1, the baseline model, indicated that, on average, youth ever exposed to PI significantly predicted a 0.18-unit increase in their mean externalizing behavioral problem scores (B = 0.18, SE = 0.05, p < 0.01). Model 2 estimated the effects of demographic variables of the youth. The findings revealed that, on average, holding youth demographic variables of interest constant, youth exposed to PI predicted a 0.17-unit increase in their mean externalizing behavioral problem score (B = 0.17, SE = 0.06, p < 0.01). No other direct effects were observed between demographics of interest on mean externalizing behavioral problems in Model 2.

Model 3 examined the extent to which socioeconomic characteristics influenced mean externalizing behavioral problem scores, above and beyond the youth’s demographic characteristics, as well as the extent to which socioeconomic characteristics mediated the relationship between youth exposed to PI and mean externalizing behavioral problems. A direct effect of economic hardship on externalizing behavioral problems was noted. Specifically, after adjusting for demographic controls of the youth, caregiver level of educational attainment, and exposure to PI, the results indicated, on average, that every one-unit increase in economic hardship (or worsening economic hardship), predicted a 0.07-unit increase in the mean externalizing behavioral score (SE = 0.02, p < 0.001). In comparing Model 2 to Model 3, the total effect of PI on mean total externalizing behavioral score decreased in strength from 0.17 to 0.11 units once socioeconomic
characteristics were included into the model. However, even after adjusting for socioeconomic variables of the youth, exposure to PI remained a statistically significant predictor in mean externalizing behavioral problems in comparison to those unexposed ($B = 0.11$, $SE = 0.05$, $p < 0.05$). A direct effect was also observed between caregiver education level on externalizing behavioral problems. On average, youth who resided with a caregiver with a high school degree or less, in comparison to youth who resided with a caregiver with a Master’s degree or higher, predicted a 0.14-unit increase in mean externalizing behavioral scores ($SE= 0.05$, $p < 0.05$), controlling for youth demographics and economic hardship. Similarly, on average, youth who resided with a caregiver with some college or an Associate’s degree, in comparison to youth who resided with a caregiver with a Master’s degree or higher, predicted a 0.11-unit increase in mean externalizing behavioral scores ($B= 0.11$, $SE= 0.05$, $p < 0.05$), controlling for youth demographics and economic hardship.

No significant differences were observed comparing males and females. In addition, there were no statistically significant differences in predicting mean externalizing behavioral score problems between youth who were born abroad in comparison to those who were not ($B = -0.001$, $SE = 0.02$, $p > 0.05$), among youth of various race/ethnicities, or among adolescents in various stages of pubertal development ($B = -0.05$, $SE = 0.05$, $p > 0.05$), adjusting for socioeconomic characteristics. In comparing Model 2 to Model 3, the parameter estimate and significance of the intercept remained relatively unchanged, which indicated that there was still significant variation
in the prediction of mean externalizing behavioral problems across adolescents after accounting for youth demographics and socioeconomic characteristics.

In Model 4, total number of adverse childhood experiences and stressful life events (ACEs) were included in the model. Model 4 examined the extent to which total number of ACEs, above and beyond, socioeconomic and demographic considerations in addition to the extent to which total number of ACEs mediated the relationship between youth exposed to PI and externalizing behavioral problems. Results indicated that, on average, adjusting for demographic characteristics, socioeconomic characteristics, and exposure to PI, total number of ACEs did not significantly predict an increase in the mean score of attention problems of the youth (B = 0.01, SE = 0.01, p > 0.05). However, the effect between exposure to PI on externalizing behavioral problems did not remain significant once total number of ACEs was included into the model (B = 0.07, SE = 0.06, p > 0.05). The intercept remained statistically significant, which indicated that there was still variation in the prediction of mean externalizing behavioral problem scores in youth after adjusting for demographics, socioeconomic characteristics and total ACEs score.

In Model 5, no direct effects were observed between HCC on externalizing behavioral problem scores (B = -0.01, SE = 0.01, p > 0.05) after adjusting for demographic variables, stressful life events, socioeconomic characteristics, and exposure to PI. Consistent with Models 3 and Model 4, Model 5 also indicated direct effects between caregiver education level on externalizing behavioral problems. On average, youth who resided with a caregiver with a high school degree or less, in comparison to youth who resided with a caregiver with a Master’s degree or higher, predicted a 0.14-
unit increase in mean externalizing behavioral scores (SE= 0.05, p < 0.05), controlling for youth demographics, economic hardship, physiologic stress, and total number of ACEs. Similarly, on average, youth who resided with a caregiver with some college or an Associate’s degree, in comparison to youth who resided with a caregiver with a Master’s degree or higher, predicted a 0.10-unit increase in mean externalizing behavioral scores (SE= 0.05, p < 0.05), controlling for youth demographics, economic hardship, physiologic stress, and total ACEs. In addition, every one-unit increase in economic hardship, predicted a 0.06-unit increase in mean externalizing behavioral problem scores (SE = 0.02, p < 0.05) after adjusting for youth demographics, economic hardship, physiologic stress, and total stressful life events.

In Model 6 no direct effect between activity-space CE on externalizing behavioral problems of youth (B = 0.14, SE = 0.18, p > 0.05) was observed, adjusting for demographics of the youth, socioeconomic considerations, total ACEs, and physiologic stress. No statistically significant differences were observed for youth who spend more time in spaces with higher CE in comparison to those spending more time in spaces with lower CE. In addition, similar strength and directions of the three direct effects observed in Models 1-5, were also evident and unchanged in Model 6.

When Model 7 was analyzed with the inclusion of the interaction between youth exposed to PI and activity space CE results were similar to Model 6 but with one notable difference- a direct effect of the total number of stressful life events on mean attention problems was observed. Thus, each additional adverse childhood exposure and stressful life event, predicted a 0.01-unit increase in mean attention problem scores (SE = 0.005, p
controlling for socioeconomic characteristics, stressful life events, physiologic stress, CE, exposure to PI, and the interaction between exposure to PI and activity-space CE. The intercept remained statistically significant in Model 6 and Model 7, which indicated that there was still variation in the prediction of mean externalizing behavioral problem scores in youth after adjusting for demographics, socioeconomic characteristics, stressful life events, physiologic stress, and activity space CE.

**Internalizing Behavioral Problems**

Table 11 in the Appendix summarizes the results of the first four models that tested the first hypothesis for the dependent variable, internalizing behavioral problems in the full sample. The results of Model 1, the baseline model, indicated no significant difference between youth exposed to PI on internalizing behaviors, in comparison to those unexposed (B = 0.10, SE = 0.05, p > 0.05). Model 2 estimated the effects of demographic variables of the youth on mean internalizing behavioral problem scores. The findings revealed that, on average, holding youth demographic variables of interest constant, youth exposed to PI predicted a 0.13-unit increase in mean internalizing behavioral scores (SE = 0.06, p < 0.01). In addition, direct effects were observed in male youth in comparison to female youth and non-Hispanic Black youth in comparison to non-Hispanic White youth. On average, male youth, in comparison to female youth, predicted a 0.08 decrease in total internalizing behavioral problems (SE= 0.04, p < 0.001) controlling for other youth demographics. On average, non-Hispanic Black youth, in
comparison to non-Hispanic white youth, predicted a 0.21 decrease in total internalizing behavioral problems (SE = 0.04, p < 0.05) adjusting for other youth demographics.

Model 3 examined the extent to which socioeconomic characteristics influenced internalizing behavioral problems, above and beyond the youth’s demographic characteristics, as well as the extent to which socioeconomic characteristics mediated the relationship between male youth exposed to PI and mean internalizing behavioral problem scores. A direct effect of economic hardship on internalizing behavioral problems was noted. Specifically, after adjusting for demographic controls of the youth, caregiver level of educational attainment, and exposure to PI, the results indicated, on average, that every one-unit increase in economic hardship (or worsening economic hardship), predicted a 0.07-unit increase in the overall internalizing behavioral problem score (SE = 0.02, p < 0.01). In comparison to Model 2 however the direct effect between non-Hispanic black youth on internalizing behavioral problems slightly increased in strength once socioeconomic characteristics were included into the model. In comparing Model 2 to Model 3, the total effect of PI on mean internalizing behavioral problems decreased in strength from 0.13 to 0.07 units once socioeconomic characteristics were included into the model. However, exposure to PI did not remain a statistically significant predictor in mean internalizing behavioral problems in comparison to those unexposed (B = 0.07, SE = 0.06, p > 0.05) indicating full mediation.

Significant differences across males and females were also observed. On average, male youth in comparison to female youth predicted, on average, a lower score on mean internalizing behavioral problems (B = -0.08, SE = 0.05, p < 0.01) controlling for other
sociodemographic variables, socioeconomic characteristics, and exposure to PI. However, there were no statistically significant differences in predicting mean score of internalizing behavioral problems between youth who were born abroad in comparison to those who were not (B = -0.16, SE = 0.10 p > 0.05), or among adolescents in various stages of pubertal development (B = 0.05, SE =0.04, p > 0.05), adjusting for socioeconomic characteristics. Similarly, no significant direct effect was observed among youth residing with caregivers of various educational attainment on total mean internalizing problems. In comparing Model 2 to Model 3, the parameter estimate and significance of the intercept remained relatively unchanged, which indicated that there was still significant variation in the prediction of mean internalizing behavioral problems across adolescents after accounting for youth demographics and socioeconomic characteristics.

In Model 4, total number of events ACEs were included in the model. Model 4 examined the extent to which total number of ACEs, above and beyond, socioeconomic and demographic considerations in addition to the extent to which total number of ACEs mediated the relationship between youth exposed to PI and internalizing behavioral problems. Results indicated that, on average, adjusting for demographic characteristics, socioeconomic characteristics, and exposure to PI, total number of ACEs did not significantly predict an increase in the mean score of internalizing behavioral problems of the youth (B = 0.01, SE = 0.0004, p > 0.05). However, the effect between exposure to PI on mean internalizing behavioral problem scores did not remain significant once total number of adverse childhood exposures was included into the model (B = 0.04, SE =
0.07). The intercept remained statistically significant, which indicated that there was still variation in the prediction of mean internalizing problematic behavior scores in youth after adjusting for demographics, socioeconomic characteristics and total lifetime ACEs score.

In Model 5, no direct effects were observed between HCC on internalizing behavioral problem scores (B= -0.03, SE = 0.02, p > 0.05) after adjusting for demographic variables, stressful life events, socioeconomic characteristics, and exposure to PI. Consistent with Models 3 and Model 4, Model 5 also indicated direct effects comparing non-Hispanic Black youth to non-Hispanic white youth on internalizing behavioral problems and between youth in households with more economic hardship in comparison to youth with less economic hardship on internalizing behavioral problems. On average, non-Hispanic Black youth in comparison to non-Hispanic White youth predicted a lower score on mean internalizing behavioral problems (B = -0.26, SE = 0.05, p < 0.001) controlling for other sociodemographic variables, socioeconomic characteristics, and exposure to PI. Similarly, a one-unit increase in economic hardship predicted a 0.01-unit increase in mean internalizing behavioral problem scores (SE= 0.02, p < 0.001) controlling for youth demographics, economic hardship, physiologic stress, and total number of ACEs. However, the effect between male youth in comparison to female youth on externalizing behavioral problems disappeared once physiologic stress and activity-space CE was included in the model (B = -0.03, SE = 0.04, p >0.05).

In Model 6 no direct effect between activity-space CE on internalizing problems of youth (B = 0.10, SE = 0.18, p > 0.05) was observed, adjusting for demographics of the
youth, socioeconomic considerations, total ACEs, and physiologic stress. No statistically significant differences were observed for youth who spend more time in spaces with higher CE in comparison to those spending more time in spaces with lower CE. In addition, similar strength and directions of the two direct effects observed in Models 1-5, were also evident and unchanged in Model 6.

When Model 7 was analyzed with the inclusion of the interaction between youth exposed to PI and activity space CE. Results were similar to Model 6 but with one notable difference- a direct effect of total number of ACEs on internalizing behaviors behaviors was observed. Thus, each additional adverse childhood exposure and stressful life event, predicted a 0.01-unit increase in mean internalizing behavioral problem scores (SE = 0.003, p < 0.001) controlling for socioeconomic characteristics, stressful life events, physiologic stress, CE, exposure to PI, and the interaction between exposure to PI and activity-space CE. The intercept remained statistically significant in Model 6 and Model 7, which indicated that there was still variation in the prediction of mean internalizing behavioral problem scores in youth after adjusting for demographics, socioeconomic characteristics, stressful life events, physiologic stress, and activity space CE.
Chapter 5: Conclusion

Summary of Overall Findings

This study is among the first to investigate biosocial mechanisms and important socioeconomic considerations linking the childhood adversity of experiencing PI to mental health outcomes in adolescents. The primary aims of the study were to 1) examine the associations between youth ever exposed to PI on mental health outcomes, 2) to examine the potential mediating role of HCC on the relationship between youth ever exposed to PI on mental health outcomes and 3) to examine the potential moderating role of activity-space CE on the relationship between youth ever exposed to PI on mental health outcomes.

Exposure to PI on Mental Health Outcomes

Findings from this study demonstrate overall support for the first hypothesis, consistent with extant research examining the adversity of PI on behavioral outcomes of youth (Murray et al., 2012; Turney, 2014; Wilbur et al., 2007). In this sample of adolescents, on average, youth ever exposed to PI, in comparison to youth never exposed to PI, were more likely to have their caregiver report mental health difficulties in sustaining attention, internalizing behaviors, and externalizing behaviors, even after controlling for demographic considerations of the youth including stage of pubertal
development. Findings also revealed that youth exposed to PI were more likely to have poor attention (e.g. inability to sustain attention, concentrate) and externalizing behaviors (e.g. destroys things belonging to his/her family, disobedient at home), above and beyond, socioeconomic characteristics (household economic hardship and education level of the caregiver). While the effect of PI on mental health difficulties remained significant after adjustment of socioeconomic characteristics, it is important to note that the effect of PI on poor attention and externalizing behaviors decreased in strength. In addition, and more notably, the effect of PI on problematic internalizing behaviors (e.g. feels worthless, too fearful or anxious) was fully explained by socioeconomic characteristics after controlling for demographic considerations of the youth and stage of pubertal development. Recall that economic hardship was measured in this study by the caregiver’s report of difficulty in paying rent, paying utilities, or providing basic amenities for the household (such as food, clothing, medical care) within the last year. These findings suggest that providing financial assistance for basic amenities in households of adolescents ever affected by PI may potentially ameliorate adolescent internalizing behavioral problems or reduce the severity of problematic attention and externalizing behaviors. However, even after controlling for exposure to PI, demographics of the youth, education of the caregiver, physiologic stress, and community social buffers, youth residing in households with more economic hardship were found to have more mental health difficulties with sustaining attention, internalizing behaviors, and externalizing behaviors. This finding is consistent with the well-documented body of research demonstrating the detrimental effects of poverty on the overall wellbeing and
mental health of children and adolescents (Miller, Chen, & Parker, 2011; Sripada, Swain, Evans, Welsh, & Liberzon, 2014).

However, PI has also been linked to an increased risk of adverse childhood exposures and social stressors aside from economic hardship (Geller et al., 2011; Western, 2002) that could also be contributing to mental health difficulties in sustaining attention, internalizing behaviors, and externalizing behaviors. Thus, further analyses were conducted to understand the role of other ACEs (e.g. death of child’s sibling, witnessed family or neighborhood violence, child was in a serious accident) on the relationship between youth exposed to PI on mental health difficulties. First, results from the bivariable analyses revealed a highly disconcerting finding; youth ever exposed to PI experienced an average of 15 additional ACEs, in comparison to youth unexposed to PI, who experienced an average of 4 ACEs. This finding is approximately 7.5 times higher than the average reported in a recent Child Trends report highlighting the impact of PI on youth using data from the National Survey of Children’s Health (NSCH) study (Murphey & Cooper, 2015). In this report, Murphey and Cooper (2015) reported that, on average, youth ever exposed to PI experienced 2-3 additional ACEs, out of the 8 ACEs included in the NSCH survey checklist, in comparison to youth unexposed to PI who averaged less than one ACE in their lifetime (ACEs in the NSCH study included: frequent economic hardship, parental separation or divorce, parental death, witnessing domestic violence, living with someone who was mentally ill or suicidal, living with someone who had a substance abuse problem, experiencing racism). Due to the amount of questions contained within the ACEs checklist used within the AHDC study, our checklist was
more comprehensive and summed the total number of adversities across three
developmental stages (0-5, 6-10, 11 and older). However, in both studies, children
exposed to PI had experienced approximately 3 times as many ACEs than their
unexposed peers. This finding, in conjunction with the well-documented research
investigating the cumulative effect of ACEs, indicates that youth exposed to PI may have
a much greater likelihood for engaging in maladaptive coping behaviors (e.g. cigarette,
alcohol, illicit drug use, or violent delinquent behaviors) and experiencing depression,
anxiety and post-traumatic stress disorder (Hussey et al., 2006; Lansford et al., 2002)
throughout adolescence and across the lifespan (Felitti et al., 1998). Thus, exposure to PI
may be viewed as a marker of accumulative risk for intervention, including health and
social policy consideration.

In response to this finding, the modeling strategy of this study incorporated the
inclusion of the more comprehensive ACEs measure available in the AHDC study in
order to examine its influence on the relationship between youth exposed to PI on mental
health outcomes. Results revealed, after adjusting for socioeconomic characteristics,
demographic considerations, and total number of ACEs, the effect of PI on total
behavioral problems, attention problems, and externalizing behaviors was attenuated and
fully mediated by the ACEs measure. Thus, the ACEs included in the AHDC checklist
appear to be in the pathway or occur in direct consequence of having a parent
incarcerated (e.g. child went to live with a new caregiver, child was moved into foster
care). However, this study was unable to disentangle the temporality of additional
adverse exposures in relation to the timing, duration, and frequency of PI due to the
cross-sectional design and sample size limitations to investigate PI exposure by developmental stage (0-5 years, 6-11 years, 11 years and greater, multiple stages).

In addition, several other notable differences and trends became apparent through the testing of the first hypothesis. In the first set of models examining predictors of general behavioral problems (a broad summation of the three behavioral domains assessed) of the youth, it was noted that caregivers of non-Hispanic Black youth reported less mental health difficulties than caregivers of non-Hispanic White youth, after adjusting for other demographic considerations, socioeconomic characteristics and number of ACEs. Since the mean score of total behavioral problems included the average of the three behavioral subscales of interest, closer examination of the three domains (or subscales of the CBCL) revealed that this effect was only statistically significant in caregivers who reported on internalizing behavioral problems. Thus, controlling for other demographics of the youth, socioeconomic characteristics, and total number of ACEs, caregivers of non-Hispanic White youth reported more internalizing problems (e.g. feels worthless, self-conscious or easily embarrassed, sad) than caregivers of non-Hispanic Black youth. While more research is needed to help explain this difference, research highlights racial/ethnic disparities in the treatment, and diagnosis of depression and other adolescent mental health problems, in addition to racial/ethnic differences in perceptions of psychopathology (Alegria, Vallas, & Pumariega, 2010; Coker et al., 2016; Thomas, Temple, Perez, & Rupp, 2011).

Other findings were consistent with the literature examining the differences between male and female youth on mental health difficulties. Specifically, it was noted
that caregivers of male youth, on average, reported less internalizing difficulties than

caregivers of female youth, after adjusting for other demographic considerations,
socioeconomic characteristics, and number of ACEs. This finding is consistent with
extant literature reporting national trends from 2005 to 2014 demonstrating a higher
prevalence rate of major depressive episodes in females in comparison to males
(Mojtabai, Olfson, & Han, 2016).

In addition, on average, caregivers of male youth, reported more difficulty
sustaining attention than caregivers of female youth, after adjusting for other
demographic considerations, socioeconomic characteristics, and number of ACEs. These
gender differences are also consistent with extent research demonstrating the well-
documented gender differences in the diagnosis, and treatment of depression and
Attention Deficit Hyperactivity Disorder/Attention Deficit Disorder (ADHD/ADD), as
ADHD/ADD is more common in males at a rate of about 2:1 in children (American
Psychiatric Association, 2013). However, recent research has highlighted how female
youth may not present with the typical presentation of hyperactivity, consistent with
ADHD/ADD diagnostic criteria, and typically involve other internalizing
symptomatology such as low-self-esteem, underachievement and problems like
depression and anxiety in relation to their inability to sustain attention (American
Psychiatric Association, 2013). However, recent longitudinal research is now
investigating ADHD/ADD in females across the life course. Research has found that
female youth (ages 6-12) diagnosed with ADHD/ADD in childhood continued to display
more severe and detrimental impairment in young adulthood in a 10-year prospective
with more self-harm (e.g. suicide attempts, self-injury), substance use, and functional impairment in young adulthood in comparison to a matched female comparison group (Hinshaw et al., 2012).

Summary of the Physiologic Stress Linkage

Bivariable analyses did reveal that youth exposed to PI were more likely to have higher hair cortisol concentration values than youth never exposed to PI. However, once HCC control variables were included into the analysis, no statistically significant difference was observed. In addition, multinomial logistic regression models that included HCC control variables revealed no statistically significant differences on HCC dysregulation between youth exposed to PI and youth unexposed to PI. In addition, other bivariable results revealed that youth with more internalizing behavioral problems in comparison to youth with less internalizing behavioral problems had lower HCC values, adjusted by HCC control variables. In addition, results from the multinomial logistic regression models, adjusting for HCC control variables, revealed that youth with more internalizing behavioral problems in comparison to youth with less internalizing behavioral problems were less likely to have high HCC (only in relation to medium HCC values). Results also revealed that male youth in comparison to female youth and non-Hispanic Black youth in comparison to non-Hispanic White youth were more likely to have high cortisol concentration values in reference to medium HCC. More research is needed to understand the gender and racial/ethnic differences in HCC, and more specifically, on their relationships to mental health behaviors. However, since males typically engage in more externalizing behaviors (e.g. physical aggression) than female
youth, than this might increase HCC via the activation of the sympathetic nervous system (Batrinos, 2012). However, a recent study conducted on young adult college males demonstrated lower salivary cortisol levels (across three time points) and higher testosterone levels were associated with higher levels of anger (Brown et al., 2008).

Results from the multivariable regression analyses revealed no statistically significant differences on HCC values for youth exposed to PI in comparison to their unexposed peers, after adjusting for demographics of the youth, socioeconomic characteristics, HCC control variables, and total number of ACEs in this sample of adolescents. Thus, no support for the second hypothesis was found proposing that HCC would mediate the relationship between youth exposed to PI on mental health difficulties. This may be because of a number of variables included in the model could also be associated with dysregulated physiologic stress mechanisms (e.g. economic hardship, adverse childhood experiences).

Although, this study did not demonstrate evidence of mediation through HCC, it was unable to examine the impact HCC may have had or influenced other various stress hormones, neurotransmitters, and inflammatory markers that may have had a role on the development of adolescent psychopathology. Multiple mechanisms of action are involved in the stress response and include the complex interplay of the secretion and action of various stress hormones (e.g. glucocorticoids, corticotrophin releasing hormone), neurotransmitters (e.g. dopamine, serotonin and norepinephrine) and inflammatory markers (e.g. IL-6, c-reactive protein) (McEwen, 2008). Further, HPA axis dysregulation and physiologic stress mechanisms may influence the development of psychopathology
or psychopathology may influence the dysregulation of the HPA axis. For example, externalizing behaviors (e.g. physical aggression) of an adolescent typically increases the autonomic nervous response and thus, increases production of cortisol concentration. However, dysregulated HPA axis functioning could impact the behavioral response of the adolescent, especially in various stages of pubertal development. But research is limited on the role chronic physiologic stress has on various types of adolescent psychopathology. Researchers who study PI have argued that gender of the parent and child are important considerations in understanding the stress response and mental health of youth exposed (Foster & Hagan, 2013), however, minimal research exists on ascertaining the directional associations between HPA axis functioning and psychopathology across various genders and various adverse exposures (Parritz. & Troy, 2014). Before adolescence, rates of depressive disorders are generally the same for males and females; however, beginning in adolescence, the rate of depression and suicidal behavior are much greater for females than males (Parritz & Troy, 2014). More research is needed to truly ascertain the role physiologic mechanisms serve in the etiological development or mitigation of psychopathology in adolescence across genders exposed to adverse environments and toxic stressors such as PI.

To date, the only investigation exploring other physiologic linkages with PI was conducted by Boch and Ford (2014). The study (2014) found that exposure to biological father incarceration during 0-17 years of age was independently associated with increased levels of C-reactive protein, a biomarker of low-grade inflammation, in young adult females, controlling for numerous sociodemographic and health conditions and behaviors.
known to increase C-reactive protein levels. This line of inquiry is consistent with the bioecodevelopmental framework (Shonkoff et al., 2012) and ACEs framework (Felitti et al., 1998), which posits that exposure to early childhood adversity (e.g. parental incarceration) negatively affects health and behavior across the life course in part through dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis and consequent elevation or suppression of cortisol levels (Gonzalez, 2013; Hagan et al., 2014; Kempke et al., 2015; Koss et al., 2014; Palmer et al., 2013).

**Summary of the Sociospatial Buffer**

The examination of CE in the activity space in relation to youth exposed to PI on mental health outcomes has not previously been investigated. Bivariable results (results not included in Appendix) examining the role of activity-space CE demonstrated no statistically significant differences between youth exposed to PI in comparison to youth unexposed on mental health difficulties. However, youth with more ACEs in comparison to youth with less ACEs and older youth in comparison to younger youth were both positively correlated with activity-space CE. In addition, male youth in comparison to female youth was negatively correlated with activity-space CE.

Multivariable results revealed no direct effect on activity space CE on attention, internalizing, and externalizing behaviors after adjusting for demographics of the youth, socioeconomic characteristics, and physiologic stress. Thus, no evidence of moderation was found in this sample of adolescents. Interestingly, the direct effect of ACEs on each of the behavioral outcomes was statistically significant when the interaction term
between youth ever exposed and activity-space CE was included into the last model. Thus, adjusting for demographics of the youth, socioeconomic characteristics, and physiologic stress, the interaction between youth ever exposed to PI and activity-space CE explained some of the variation in youth with more ACEs in comparison to youth with less ACEs on mental health difficulties. This finding was demonstrated by the reduction in the standard error of the total ACEs variable in Model 7 in comparison to Model 6 (across all mental health difficulties) and may be attributed to the measurement of activity space CE as it accounted for certain family and block-group characteristics (e.g. poverty rate, unemployment rate, and racial diversity, population density) that influenced the direct effect of total number of ACEs across mental health difficulties. Further research is needed in order to understand the direct effects of total ACEs on mental health and to further disentangle the effects of youth exposed to PI on mental health.

Despite the beneficial effects of CE on adolescent health and risk behaviors (Browning et al., 2008; Browning & Cagney, 2002; Fagan, 2014), there was no evidence of this in this particular study. Future research may want to consider the youth’s perception of CE as the measurement of CE in this study aggregated responses of caregivers on the specific locations of the youth’s activity space, and results may differ if the youth’s perception of social support is considered. Debate exists on the extent and precise mechanisms through which sociospatial factors influence youth well-being and development (Booth & Crouter, 2001; Browning et al., 2015), in part, due to the numerous ways to assess community-level effects of collective efficacy (e.g. traditional
neighborhood approaches vs. activity space vs. school district, etc.) across the lifespan but particularly in adolescence (e.g. primary caregiver/parent or youth report of perceptions). However, recent research has highlighted the long-term impact of paternal and maternal imprisonment on social exclusion processes (e.g. feelings of powerlessness, perceived socioeconomic status) and the buffering effect of the successful completion of college on social exclusion (Foster & Hagan, 2015; Hagan & Foster, 2012). Thus, policies designed to promote social support, not only in the community, but other social processes such as higher education, across the lifespan, may also assist in attenuating the negative effects of PI.

Limitations

Several limitations to this study warrant discussion. The most significant limitation to this study was related to sample size and consequent reliance on multiple imputation procedures to test the aims of this dissertation. Due to the amount of cases that were missing information on variables of interest in the cortisol subsample, multiple imputation procedures were conducted in order to preserve cases. Consequently, results of this study may differ if this study were to be repeated once all cortisol samples are assayed across all youth in Wave I of the AHDC Study (N = 1,402). In addition, the multiple imputation procedure conducted in SAS was implemented on the cortisol subsample, and thus, cases missing observations on variables of interest was consequently imputed using characteristics of only 67 youth exposed to PI, in comparison to the 188 youth exposed to PI in the full sample of the AHDC Study.
Second, the primary aims of the AHDC and Biosocial Linkages Study did not include the examination of the impact of PI on youth. Thus, there is a lack of contextual information on PI that may elicit differential effects on mental health outcomes of adolescents, such as the duration of PI (e.g. sentence length), correctional offense (e.g. violent or nonviolent), distance to correctional placement, or type of correctional involvement (e.g. private versus local, state or federally operated facility, parole, probation, jail, or prison). Information on parent-child visitation during incarceration or type of household placement for the child during the incarceration (e.g. other biological parent, foster care, adoption, or other familial member) was not included in the AHDC study, thus we were unable to explore their potential effects on mental health outcomes. Further, the AHDC design excluded institutionalized children and included only youth residing in households and thus excludes some of the more disadvantaged youth likely producing conservative estimates of those youth exposed to PI (e.g. youth residing in homeless shelters, or juvenile detention centers). Further, limited sample sizes precluded the ability to detect statistically significant differences by gender of the youth impacted by PI. Understanding these differences among these contextual considerations may help inform the development of behavioral interventions as well as public health and social policies.

Third, although the study included the examination of three types of mental health difficulties, in addition to an array of time varying/time invariant social and health measures, the analysis was not exhaustive and cross-sectional in design. Consistent with other cross-sectional survey and observational designs investigating the impact of
incarceration on the health of children (Joseph Murray et al., 2012), the analyses preclude causal conclusions. A longitudinal research design with repeated measures of PI and adolescent mental health measures would be ideal, in addition to time-varying and time-invariant social and health measures to better understand the impact of incarceration on youth. Qualitative and longitudinal research to better understand the mechanisms (e.g. exposure to a specific adverse life event, post-traumatic stress disorder, stigma, physiological stress, etc.) linking the exposure to PI to other poor mental health outcomes is needed.

Despite these limitations, the study contributes novel findings and a foundational understanding on the effects of PI on the mental health of adolescents. Overall, the findings add to the burgeoning literature of the collateral health consequences of the American correctional system on children, an ever-growing childhood adversity and risk factor for poor health outcomes across the life course.

Implications for Public Health Nursing

Examining the linkages between the social environment and the physiological stress response is consistent with emerging nursing science uncovering the adverse health effects of childhood experiences across the life course. Due to the significant proportion of children adversely affected by PI in the U.S., PI is an adversity steadily gaining more attention as a deleterious social determinant of health. Public health nurses must be able
to identify and understand the detrimental effects of adverse childhood experiences and social determinants of health in particularly vulnerable youth. In addition, public health nurses have a duty to promote and protect the health of populations using interdisciplinary knowledge garnered from criminology, sociology, biology, and public health sciences in order to address complex health and systemic problems (Bekemeier et al., 2015). Public health nurses should strategize with community organizations and correctional systems to help build supportive environments and integrate meaningful behavioral intervention strategies geared towards particularly vulnerable youth including youth who have parents incarcerated. Understanding the impact of PI on chronic physiologic stress and mental health outcomes among urban adolescents helps inform health policymakers targeting innovative individual and community level interventions for those exposed to PI.

Directions for Future Research

While research on the effects of PI on the mental health of youth is burgeoning, overall, there is a lack of contextual consideration of PI that may elicit differential mental health outcomes of adolescents, such as the duration of PI (e.g. sentence length) or frequency of incarceration, correctional offense (e.g. violent or nonviolent), distance to correctional placement, type of correctional involvement (e.g. private versus local, state or federally operated facility, parole, probation, jail, or prison), or type of household placement for the child during the incarceration (e.g. other biological parent, foster care, adoption, or other familial member). In this study, youth exposed to PI were more likely
to be living with their grandparents than their unexposed peers, consistent with other research examining household placement post incarceration of the parent (Mackintosh et al., 2006). As qualitative literature suggests, the additional strain of caregiving a grandchild can consequently worsen the older caregiver’s own health (Clottey, Scott, & Alfonso, 2015), providing other areas of opportunity to research the tangential effects of mass incarceration the health of the older adult population who may be unexpectedly caregiving into later adulthood. While several studies endorse the overall benefit that parent management training and visitations have for incarcerated parents and their children (Poehlmann, Dallaire, Loper, & Shear, 2010), a paucity of research exists on the extent to which continued contact might mitigate the stress of experiencing PI. Further research is needed to better understand the context of PI with respect to timing of the incarceration in the life course for youth and those providing care. Thus, identifying and intervening during the sensitive developmental stages of those youth affected by PI may have an impact across the lifespan.

In addition, further nursing research investigating the linkages between the social and biological mechanisms through which PI contributes to mental health difficulties needed to facilitate the development of interventions for the prevention of future clinical disease. Due to the complex interplay of the secretion and action of various stress hormones (e.g. glucocorticoids, corticotrophin releasing hormone), neurotransmitters (e.g. dopamine, serotonin and norepinephrine) and inflammatory markers (e.g. IL-6, c-reactive protein) (McEwen, 2008) in the stress and disease process, future research could investigate the effects of pharmacological management during adolescence on the
dysregulation of the HPA axis across the lifespan. This study did not control for adolescents on certain types of medication and thus, was unable to examine the effects of stimulants or anti-depressants that may impact the release of cortisol through the HPA axis.

Further, a paucity of research examines the role of other social support buffers outside of the parent-child relationship such as peer support or socially supportive communities (e.g. intergenerational closure), that have been found to have positive effects on the health of adolescents (C. R. Browning et al., 2008; Gunnar & Hostinar, 2015; Uchino, 2006). Further investigation on the context surrounding incarceration and the subsequent changes in the home and community are needed to better understand adolescents’ experiences and their impact on long-term outcomes. Understanding these differences among these contextual considerations may help inform the development of behavioral interventions as well as public health and social policies.

Conclusion

Children of incarcerated parents and communities disproportionately affected by PI are in critical need for community and individual interventions designed to promote overall wellbeing and prevention into the correctional system. Identifying and intervening during the sensitive developmental stages of those youth affected by PI may reduce the
well-documented health and sentencing disparities between AA/Black and white people. Despite the magnitude of PI in the United States, the effect on youth remains an understudied childhood adversity undoubtedly due to the lack of studies that have been purposely designed to study the role of parent-child separation by incarceration. However, results of this study indicated that exposure to PI can be viewed as a marker of accumulative risk for intervention. Since youth impacted by PI are more likely to experience cumulative disadvantage (Binswanger & Elmore, 2015; Harlow, 2003; Harris et al., 2010; Western & Pettit, 2010) that can impact development and well-being across the lifespan (Ardetti, 2012; Dawson et al., 2013; Murray & Murray, 2010). Similarly, due to the well-documented effects of neglect on the developing brain of youth (Font & Maguire-Jack, 2015; Van Niel et al., 2014), exposure to lengthy sentences of PI could also be conceptualized as a form of institutionalized neglect (e.g. a year-long sentence for a nonviolent parole violation).

To date, this study is the first to examine the potential role of a physiologic linkage using HCC and a sociospatial buffer using an innovative ecometric approach on the relationship between youth exposed to PI on mental health difficulties. Although this study was unable to demonstrate the role of HPA dysregulation and social support on mental health difficulties of youth exposed to PI, it provides a foundation to guide future research examining biosocial linkages between adverse childhood experiences on mental health difficulties.
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Appendix A: Tables
Table 1- Number of youth in the AHDC wave I cortisol subsample missing data on variables of interest (N=613).

<table>
<thead>
<tr>
<th>Variable of Interest</th>
<th>Amount Missing (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever exposed to parental incarceration</td>
<td>33</td>
</tr>
<tr>
<td>Mental health outcomes</td>
<td></td>
</tr>
<tr>
<td>Total behavioral problems</td>
<td>7</td>
</tr>
<tr>
<td>Attention behavioral problems</td>
<td>8</td>
</tr>
<tr>
<td>Externalizing behavioral problems</td>
<td>8</td>
</tr>
<tr>
<td>Internalizing behavioral problems</td>
<td>9</td>
</tr>
<tr>
<td>Youth Demographics</td>
<td></td>
</tr>
<tr>
<td>Youth race/ethnicity</td>
<td>0</td>
</tr>
<tr>
<td>Black/African American, non-Hispanic</td>
<td>0</td>
</tr>
<tr>
<td>Caucasian/White, non-Hispanic</td>
<td>0</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
<tr>
<td>Male Youth</td>
<td>0</td>
</tr>
<tr>
<td>Youth age</td>
<td>0</td>
</tr>
<tr>
<td>Youth foreign born</td>
<td>0</td>
</tr>
<tr>
<td>Pubertal developmental stage</td>
<td>138</td>
</tr>
<tr>
<td>Socioeconomic Characteristics</td>
<td></td>
</tr>
<tr>
<td>Caregiver education level</td>
<td>0</td>
</tr>
<tr>
<td>&lt; High school degree</td>
<td>0</td>
</tr>
<tr>
<td>Some college or associate’s degree</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>0</td>
</tr>
<tr>
<td>Master’s degree or higher</td>
<td>0</td>
</tr>
<tr>
<td>Economic Hardship</td>
<td>10</td>
</tr>
<tr>
<td>Total ACEs</td>
<td>33</td>
</tr>
<tr>
<td>Biosocial Mechanisms</td>
<td></td>
</tr>
<tr>
<td>Hair cortisol concentration (HCC), (mg/pg)</td>
<td>0</td>
</tr>
<tr>
<td>HCC controls</td>
<td></td>
</tr>
<tr>
<td>Hair chemical treatment</td>
<td>17</td>
</tr>
<tr>
<td>Hair product</td>
<td>20</td>
</tr>
<tr>
<td>Hair weight, (mg)</td>
<td>0</td>
</tr>
<tr>
<td>Hair length</td>
<td>5</td>
</tr>
<tr>
<td>Hair wash frequency</td>
<td>28</td>
</tr>
<tr>
<td>Youth BMI</td>
<td>14</td>
</tr>
<tr>
<td>Activity Space-Collective Efficacy</td>
<td>31</td>
</tr>
</tbody>
</table>

Abbreviations: ACEs - Adverse Childhood Experiences and Stressful Life Events Checklist, BMI – Body Mass Index z-scores
Table 2 – Proportions and means of the AHDC sampling frame (N=1,402) and cortisol sub-sample restricted sample (N=613)

<table>
<thead>
<tr>
<th></th>
<th>AHDC Sampling Frame</th>
<th>Cortisol Sub-Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome variable of interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral Problems (CBCL-BPM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total behavioral problems, range 1-3</td>
<td>1.43 (0.43)</td>
<td>1.42 (0.36)</td>
</tr>
<tr>
<td>Attention problems, range 1-3</td>
<td>1.48 (0.51)</td>
<td>1.46 (0.51)</td>
</tr>
<tr>
<td>Externalizing problems, range 1-3</td>
<td>1.36 (0.41)</td>
<td>1.35 (0.40)</td>
</tr>
<tr>
<td>Internalizing problems, range 1-3</td>
<td>1.44 (0.43)</td>
<td>1.45 (0.43)</td>
</tr>
<tr>
<td><strong>Predictor variables of interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever Exposed to PI (at least one stage)</td>
<td>13.9% (181)</td>
<td>11.6% (67)</td>
</tr>
<tr>
<td><strong>Youth demographic variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youth race and ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black-African American</td>
<td>37.7% (530)</td>
<td>30.7% (188)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.4% (76)</td>
<td>5.6% (34)</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td>8.4% (118)</td>
<td>7.3% (45)</td>
</tr>
<tr>
<td>Other</td>
<td>1.6% (23)</td>
<td>1.8% (11)</td>
</tr>
<tr>
<td>White (reference group)</td>
<td>46.3% (651)</td>
<td>54.5% (334)</td>
</tr>
<tr>
<td>Male Youth</td>
<td>47% (663)</td>
<td>51.2% (314)</td>
</tr>
<tr>
<td>Youth age, range 11-17</td>
<td>14.2 (1.86)</td>
<td>14.5 (1.81)</td>
</tr>
<tr>
<td>Youth foreign birth</td>
<td>3.3% (46)</td>
<td>3.8% (23)</td>
</tr>
<tr>
<td>Youth pubertal development, range 1-4</td>
<td>3.02 (0.70)</td>
<td>3.06 (0.69)</td>
</tr>
<tr>
<td><strong>Socioeconomic variables of interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caregiver Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school degree or less</td>
<td>21% (295)</td>
<td>17.5% (107)</td>
</tr>
<tr>
<td>Some college or Associate’s degree</td>
<td>34.8% (489)</td>
<td>31.8% (195)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>24.8% (348)</td>
<td>28.4% (174)</td>
</tr>
<tr>
<td>Master’s degree or more (reference group)</td>
<td>18.2% (256)</td>
<td>21.4% (131)</td>
</tr>
<tr>
<td>Economic Hardship, range 1-5</td>
<td>2.0 (1.02)</td>
<td>1.91 (0.96)</td>
</tr>
<tr>
<td>Adverse Childhood Exposure (ACE), range 0-46</td>
<td>6.7 (6.96)</td>
<td>6.03 (6.42)</td>
</tr>
<tr>
<td><strong>Mediator and control variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair cortisol concentration, logged, range ~4.19-5.92 mg/pg</td>
<td>0.97 (0.38)</td>
<td>0.97 (1.18)</td>
</tr>
<tr>
<td>Hair sample weight, range 0.40 – 260 mg</td>
<td>35.0 (26)</td>
<td>35.4 (26.2)</td>
</tr>
<tr>
<td>Hair sample length, range 0.5 – 10 cm</td>
<td>2.79 (0.70)</td>
<td>2.79 (0.71)</td>
</tr>
<tr>
<td>Washing hair frequency</td>
<td>34.5% (450)</td>
<td>39.8% (233)</td>
</tr>
<tr>
<td>Chemical treatment (current)</td>
<td>18.1% (242)</td>
<td>18.6% (111)</td>
</tr>
<tr>
<td>Current hair product</td>
<td>29% (388)</td>
<td>26.1% (155)</td>
</tr>
</tbody>
</table>

(continued)
Table 2 continued

**Moderator**
Activity-space collective efficacy, range 0-0.65  
0.15 (0.10) 0.14 (0.09)

*p < 0.05, **p < 0.01, ***p < 0.001

Table 3– Proportions and means of exposure to PI in the AHDC sampling frame (N=1,402) and cortisol sub-sample restricted sample (N=613)

<table>
<thead>
<tr>
<th>AHDC Sampling Frame</th>
<th>Cortisol Subsample</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
</tr>
</tbody>
</table>

**Timing of Parental Incarceration (PI)**
- PI exp. only during 0-5 years 5.6% (73) 4.8% (28)
- PI exp. only during 6-10 years 1.8% (23) 1.6% (9)
- PI exp. only during 11 years - present 1.3% (17) 0.7% (4)

**Frequency of PI**
- 1 Time (developmental stage) 8.7% (113) 7.1% (41)
- 2-3 Times (multiple development stages) 5.2% (68) 4.5% (26)

**Ever Exposed to PI (at least one stage)** 13.9% (181) 11.6% (67)
Table 4 – Proportions, means, and bivariable tests of significance comparing youth in AHDC wave I cortisol subsample by exposure to parental incarceration (N=613)

<table>
<thead>
<tr>
<th>Outcome variable of interest</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavioral Problems (CBCL-BPM)</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total behavioral problems, range 1-3</td>
<td>1.60 (0.44)*****</td>
<td>1.39 (0.33)</td>
</tr>
<tr>
<td>Attention problems, range 1-3</td>
<td>1.69 (0.58)**</td>
<td>1.42 (0.47)</td>
</tr>
<tr>
<td>Externalizing problems, range 1-3</td>
<td>1.53 (0.51)*****</td>
<td>1.32 (0.36)</td>
</tr>
<tr>
<td>Internalizing problems, range 1-3</td>
<td>1.57 (0.48)*</td>
<td>1.44 (0.42)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Youth demographic variables</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
<th>Youth race and ethnicity</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black-African American</td>
<td>43% (29)**</td>
<td>26% (137)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>9.0% (6)</td>
<td>5.3% (27)</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td>13.4% (9)*</td>
<td>6.0% (33)</td>
</tr>
<tr>
<td>Other</td>
<td>1.5% (1)</td>
<td>2.0% (10)</td>
</tr>
<tr>
<td>White (reference group)</td>
<td>33% (22)*****</td>
<td>60% (306)</td>
</tr>
<tr>
<td>Male Youth</td>
<td>57% (38)</td>
<td>50% (258)</td>
</tr>
<tr>
<td>Youth age, range 11-17</td>
<td>14.1 (1.6)*</td>
<td>14.6 (1.8)</td>
</tr>
<tr>
<td>Youth foreign birth</td>
<td>0% (0) ***</td>
<td>4% (21)</td>
</tr>
<tr>
<td>Youth pubertal development, range 1-4</td>
<td>3.0 (0.61)</td>
<td>3.07 (0.71)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Socioeconomic variables of interest</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caregiver Education</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school degree or less</td>
<td>25% (17)*</td>
<td>15% (77)</td>
</tr>
<tr>
<td>Some college or Associate’s degree</td>
<td>60% (40)***</td>
<td>27% (141)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>9.0% (6)***</td>
<td>32% (164)</td>
</tr>
<tr>
<td>Master’s degree or more (reference group)</td>
<td>6.0% (4)**</td>
<td>24% (125)</td>
</tr>
<tr>
<td>Economic Hardship, range 1-5</td>
<td>2.6 (1.02)***</td>
<td>1.8 (0.92)</td>
</tr>
<tr>
<td>Adverse Childhood Exposure (ACE), range 0-46</td>
<td>15.5 (8.7)***</td>
<td>4.8 (4.8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mediator and control variables</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hair cortisol concentration, logged, range -4.19 - 5.92 mg/pg</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22 (1.17)*</td>
<td>0.92 (1.18)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hair sample weight, range 0.40 – 260 mg</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.9 (22)</td>
<td>36 (27.8)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hair sample length, range 0.5 – 10 cm</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7 (0.69)</td>
<td>2.8 (0.70)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Washing hair frequency</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>32% (20)</td>
<td>42% (208)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical treatment (current)</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>22% (14)</td>
<td>18% (89)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current hair product</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>28% (17)</td>
<td>26% (128)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderator</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n) or mean (SD)</td>
<td>% (n) or mean (SD)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity-space collective efficacy, range 0-0.65</th>
<th>Ever Exposed to PI</th>
<th>Never Exposed to PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.16 (0.10)</td>
<td>0.14 (0.09)</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05 **p < 0.01 ***p < 0.001
Table 5 - Bivariable associations using ordinary least squares regression analyses to compare predictors of interest on total behavioral problems, attention behavioral problems, externalizing, and internalizing behavioral problems, AHDC wave I cortisol subsample (N=613)

<table>
<thead>
<tr>
<th>Predictor of Interest</th>
<th>Total Behavioral Problems</th>
<th>Attention Behavioral Problems</th>
<th>Externalizing Behavioral Problems</th>
<th>Internalizing Behavioral Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter Estimate (SE)</td>
<td>Parameter Estimate (SE)</td>
<td>Parameter Estimate (SE)</td>
<td>Parameter Estimate (SE)</td>
</tr>
<tr>
<td>Ever Exposed to PI Youth</td>
<td>0.20 (0.04)***</td>
<td>0.27 (0.06)***</td>
<td>0.22 (0.05)***</td>
<td>0.13 (0.05)*</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>-0.01 (0.03)</td>
<td>-0.09 (0.04)*</td>
<td>-0.07 (0.03)*</td>
<td>-0.19 (0.04)***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.02 (0.06)</td>
<td>0.13 (0.10)</td>
<td>0.02 (0.07)</td>
<td>-0.08 (0.08)</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td>0.05 (0.06)</td>
<td>0.03 (0.08)</td>
<td>-0.002 (0.06)</td>
<td>0.13 (0.07)</td>
</tr>
<tr>
<td>Other</td>
<td>-0.21 (0.10)</td>
<td>-0.27 (0.15)</td>
<td>-0.16 (0.12)</td>
<td>-0.20 (0.13)</td>
</tr>
<tr>
<td>White (reference)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Youth</td>
<td>0.001 (0.03)</td>
<td>0.13 (0.04)**</td>
<td>-0.02 (0.03)</td>
<td>-0.11 (0.03)**</td>
</tr>
<tr>
<td>Youth age, range 11-17</td>
<td>-0.001 (0.01)</td>
<td>-0.01 (0.01)</td>
<td>0.01 (0.09)</td>
<td>0.002 (0.01)</td>
</tr>
<tr>
<td>Youth foreign birth</td>
<td>-0.13 (0.07)</td>
<td>-0.11 (0.11)</td>
<td>-0.10 (0.09)</td>
<td>-0.19 (0.10)*</td>
</tr>
<tr>
<td>Pubertal Development</td>
<td>0.01 (0.02)</td>
<td>-0.07 (0.03)*</td>
<td>0.03 (0.03)</td>
<td>0.06 (0.03)*</td>
</tr>
<tr>
<td>Socioeconomic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG: HS degree or less</td>
<td>0.07 (0.04)</td>
<td>0.10 (0.05)</td>
<td>0.11 (0.04 )**</td>
<td>-0.01 (0.05)</td>
</tr>
<tr>
<td>CG: Some college or Associate’s degree</td>
<td>0.07 (0.03)*</td>
<td>0.13 (0.04)**</td>
<td>0.11 (0.03)**</td>
<td>-0.02 (0.04)</td>
</tr>
<tr>
<td>CG: Bachelor’s degree</td>
<td>-0.06 (0.03)*</td>
<td>-0.09 (0.04)</td>
<td>-0.08 (0.04)*</td>
<td>-0.03 (0.04)</td>
</tr>
<tr>
<td>CG: Master’s degree or higher (reference)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Hardship</td>
<td>0.08 (0.01)***</td>
<td>0.10 (0.02)***</td>
<td>0.09 (0.02)***</td>
<td>0.04 (0.02)*</td>
</tr>
<tr>
<td>Adverse Childhood</td>
<td>0.02 (0.002)***</td>
<td>0.02 (0.003)***</td>
<td>0.02 (0.002)***</td>
<td>0.01 (0.003)***</td>
</tr>
<tr>
<td>Exposure Count (ACE), range 0-46</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued)
### Table 5 continued

**Biosocial Mechanisms**

<table>
<thead>
<tr>
<th></th>
<th>Hair Cortisol</th>
<th>Activity Space</th>
<th>Collective Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.01 (0.01)</td>
<td>0.16 (0.16)</td>
<td>0.19 (0.19)</td>
</tr>
<tr>
<td></td>
<td>0.02 (0.02)</td>
<td>0.07 (0.22)</td>
<td>0.19 (0.19)</td>
</tr>
<tr>
<td></td>
<td>-0.001 (0.01)</td>
<td>0.22 (0.17)</td>
<td>0.19 (0.19)</td>
</tr>
<tr>
<td></td>
<td><strong>-0.04 (0.01)</strong></td>
<td>-0.19 (0.19)</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05*  
*p < 0.01**  
*p < 0.001***

Note: the bivariable associations between HCC and outcomes did not control for cortisol analyses.
Table 6 - Associations between variables of interest on hair cortisol concentration, AHDC Wave I cortisol subsample (N = 613), excluding HCC controls

<table>
<thead>
<tr>
<th>Predictor of Interest</th>
<th>Bivariable Outcome</th>
<th>Multinomial Logistic Regression</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous HCC</td>
<td>Low HCC 0-25% vs 25-75%</td>
<td>High HCC 75% vs 25-75%</td>
</tr>
<tr>
<td></td>
<td>Parameter Estimate (SE)</td>
<td>Odds Ratio Estimate [CI]</td>
<td>Odds Ratio Estimate [CI]</td>
</tr>
<tr>
<td>Ever Exposed to PI</td>
<td>0.31 (0.15)*</td>
<td>0.65 [0.33, 1.30]</td>
<td>1.31 [0.73, 2.36]</td>
</tr>
<tr>
<td>Mental Health Outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total behavioral problems</td>
<td>-0.10 (0.13)</td>
<td>1.33 [0.78, 2.28]</td>
<td>0.98 [0.56, 1.72]</td>
</tr>
<tr>
<td>Attention behavioral problems</td>
<td>0.10 (0.33)</td>
<td>1.10 [0.75, 1.63]</td>
<td>1.30 [0.89, 1.90]</td>
</tr>
<tr>
<td>Externalizing behavioral problems</td>
<td>-0.01 (0.12)</td>
<td>1.15 [0.71, 1.88]</td>
<td>1.09 [0.66, 1.77]</td>
</tr>
<tr>
<td>Internalizing behavioral problems</td>
<td>-0.32 (0.11)**</td>
<td>1.39 [0.90, 2.16]</td>
<td><strong>0.58 [0.35, 0.96]</strong></td>
</tr>
<tr>
<td>Youth Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0.54 (0.10)**</td>
<td>0.69 [0.44, 1.10]</td>
<td>2.0 [1.33, 2.98]***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.11 (0.21)</td>
<td>0.46 [0.16, 1.24]</td>
<td>0.74 [0.32, 1.72]</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td>0.20 (0.18)</td>
<td>0.68 [0.30, 1.56]</td>
<td>1.23 [0.61, 2.46]</td>
</tr>
<tr>
<td>Other</td>
<td>-0.14 (0.36)</td>
<td>0.25 [0.30, 1.98]</td>
<td>0.49 [0.10, 2.34]</td>
</tr>
<tr>
<td>White (reference)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Youth</td>
<td>0.07 (0.10)</td>
<td>0.67 [0.45, 0.98]*</td>
<td>0.88 [0.60, 1.29]</td>
</tr>
<tr>
<td>Youth age, range 11-17</td>
<td>0.02 (0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Youth foreign birth</td>
<td>-0.22 (0.25)</td>
<td>0.61 [0.19, 1.89]</td>
<td>0.91 [0.34, 2.45]</td>
</tr>
<tr>
<td>Pubertal Development</td>
<td>-0.05 (0.08)</td>
<td>1.02 [0.74, 1.40]</td>
<td>0.96 [0.70, 1.32]</td>
</tr>
<tr>
<td>Youth BMI</td>
<td>0.04 (0.03)</td>
<td>0.90 [0.78, 1.03]</td>
<td>1.06 [0.94, 1.20]</td>
</tr>
<tr>
<td>Socioeconomic Characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG: HS degree or less</td>
<td>0.22 (0.13)</td>
<td>0.89 [0.52, 1.51]</td>
<td>1.36 [0.84, 2.22]</td>
</tr>
<tr>
<td>CG: Some college or Associate’s degree</td>
<td>0.14 (0.10)</td>
<td><strong>0.59 [0.38, 0.91]</strong>*</td>
<td>0.88 [0.59, 1.33]</td>
</tr>
<tr>
<td>CG: Bachelor’s degree</td>
<td>-0.05 (0.11)</td>
<td>1.27 [0.83, 1.93]</td>
<td>1.01 [0.65, 1.56]</td>
</tr>
<tr>
<td>CG: Master’s degree or higher (reference)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Hardship</td>
<td>0.09 (0.05)</td>
<td>0.89 [0.71, 1.20]</td>
<td>1.07 [0.88, 1.31]</td>
</tr>
<tr>
<td>Adverse Childhood</td>
<td>0.01 (0.007)</td>
<td>0.99 [0.96, 1.02]</td>
<td>1.01 [0.98, 1.04]</td>
</tr>
<tr>
<td>Exposure Count (ACE), range 0-46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biosocial Mechanisms</td>
<td>-0.35 (0.51)</td>
<td>3.88 [0.50, 30]</td>
<td>0.89 [0.07, 5.29]</td>
</tr>
<tr>
<td>Hair sample weight</td>
<td>-0.01 (0.002)**</td>
<td>1.01 [1.01, 1.02]**</td>
<td><strong>0.97 [0.96, 0.98]</strong>***</td>
</tr>
<tr>
<td>Hair sample length</td>
<td>-0.17 (0.07)*</td>
<td>1.63 [1.16, 2.31]**</td>
<td>0.94 [0.71, 1.25]</td>
</tr>
</tbody>
</table>

(continued)
Table 6 continued

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing hair frequency</td>
<td>-0.19 (0.10)</td>
<td>1.01 [0.68, 1.51]</td>
<td>0.72 [0.48, 1.10]</td>
</tr>
<tr>
<td>Current chemical treatment</td>
<td>-0.02 (0.12)</td>
<td>1.57 [0.96, 2.57]</td>
<td>1.38 [0.83, 2.28]</td>
</tr>
<tr>
<td>Current hair product</td>
<td>0.07 (0.11)</td>
<td>1.11 [0.71, 1.74]</td>
<td>1.10 [0.70, 1.72]</td>
</tr>
</tbody>
</table>

*p < 0.05  **p < 0.01  ***p < 0.001
Table 7 – Associations between variables of interest on hair cortisol concentration, AHDC Wave I cortisol subsample (N = 613) including HCC controls

<table>
<thead>
<tr>
<th>Predictor of Interest</th>
<th>Outcome</th>
<th>Continuous HCC</th>
<th>Low HCC 0-25% vs 25-75%</th>
<th>High HCC 75% vs 25-75%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Parameter Estimate (SE)</td>
<td>Odds Ratio Estimate [CI]</td>
<td>Odds Ratio Estimate [CI]</td>
</tr>
<tr>
<td>Ever Exposed to PI</td>
<td></td>
<td>0.28 (0.15)</td>
<td>0.54 [0.25, 1.19]</td>
<td>1.12 [0.62, 2.26]</td>
</tr>
<tr>
<td>Mental Health Outcomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total behavioral problems</td>
<td></td>
<td>-0.04 (0.14)</td>
<td>1.20 [0.66, 2.20]</td>
<td>1.07 [0.57, 2.00]</td>
</tr>
<tr>
<td>Attention behavioral problems</td>
<td></td>
<td>0.12 (0.10)</td>
<td>1.02 [0.66, 1.56]</td>
<td>1.45 [0.95, 2.21]</td>
</tr>
<tr>
<td>Externalizing behavioral problems</td>
<td></td>
<td>0.02 (0.12)</td>
<td>1.12 [0.65, 1.92]</td>
<td>1.19 [0.68, 2.08]</td>
</tr>
<tr>
<td>Internalizing behavioral problems</td>
<td></td>
<td>-0.31 (0.12)**</td>
<td>1.29 [0.78, 2.14]</td>
<td>*<em>0.53 [0.30, 0.94]</em></td>
</tr>
<tr>
<td>Youth Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td>0.52 (0.11)*****</td>
<td>0.56 [0.32, 0.97]*</td>
<td>2.0 [1.20, 3.36]*****</td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td>0.07 (0.20)</td>
<td>0.68 [0.19, 1.43]</td>
<td>0.68 [0.27, 1.69]</td>
</tr>
<tr>
<td>Multi-racial/ethnic</td>
<td></td>
<td>0.26 (0.18)</td>
<td>0.43 [0.16, 1.19]</td>
<td>1.35 [0.65, 2.8]</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>-0.23 (0.36)</td>
<td>0.33 [0.04, 2.8]</td>
<td>0.53 [0.11, 2.67]</td>
</tr>
<tr>
<td>White (reference)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Youth</td>
<td></td>
<td>0.35 (0.11)**</td>
<td>0.54 [0.32, 0.90]*</td>
<td>1.68 [1.003, 2.81]*</td>
</tr>
<tr>
<td>Youth age, range 11-17</td>
<td></td>
<td>0.04 (0.03)</td>
<td>0.94 [0.84, 1.06]</td>
<td>1.002 [0.89, 1.13]</td>
</tr>
<tr>
<td>Youth foreign birth</td>
<td></td>
<td>-0.27 (0.24)</td>
<td>0.70 [0.22, 2.24]</td>
<td>0.97 [0.34, 2.73]</td>
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<tr>
<td>Pubertal Development</td>
<td></td>
<td>-0.07 (0.08)</td>
<td>0.96 [0.67, 1.38]</td>
<td>0.89 [0.63, 1.25]</td>
</tr>
<tr>
<td>Youth BMI</td>
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<td>0.02 (0.03)</td>
<td>0.96 [0.67, 1.38]</td>
<td>0.89 [0.63, 1.25]</td>
</tr>
<tr>
<td>Socioeconomic Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG: HS degree or less</td>
<td></td>
<td>0.17 (0.13)</td>
<td>0.95 [0.54, 1.69]</td>
<td>1.46 [0.84, 2.54]</td>
</tr>
<tr>
<td>CG: Some college or Associate’s degree</td>
<td></td>
<td>0.16 (0.10)</td>
<td>0.48 [0.29, 0.78]**</td>
<td>0.85 [0.54, 1.33]</td>
</tr>
<tr>
<td>CG: Bachelor’s degree</td>
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<td>-0.10 (0.10)</td>
<td>1.41 [0.90, 2.23]</td>
<td>0.92 [0.58, 1.48]</td>
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<tr>
<td>CG: Master’s degree or higher (reference)</td>
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<tr>
<td>Economic Hardship</td>
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<td>0.09 (0.05)</td>
<td>0.80 [0.63]</td>
<td>1.09 [0.89, 1.36]</td>
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<td>Adverse Childhood Exposure Count (ACE), range 0-46</td>
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<td>0.01 (0.01)</td>
<td>0.98 [0.94, 1.01]</td>
<td>1.01 [0.94, 1.01]</td>
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<tr>
<td>Biological Mechanisms</td>
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<td></td>
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<tr>
<td>Activity Space Collective Efficacy</td>
<td></td>
<td>-0.23 (0.49)</td>
<td>2.52 [0.302, 21.14]</td>
<td>0.37 [0.03, 4.14]</td>
</tr>
</tbody>
</table>

*p < 0.05  **p < 0.01  ***p < 0.001

Note: All analyses controlled for hair wash frequency, chemical treatment, current hair product use, hair sample weight, and hair sample length.
Table 8 - OLS regression pooled parameter estimates and standard errors of models predicting total behavioral problems of using multiple imputation procedures
N=613

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever exposed to PI</td>
<td>0.17</td>
<td>0.17 (0.05)**</td>
<td>0.11 (0.05)**</td>
<td>0.07 (0.06)</td>
<td>0.06 (0.06)</td>
<td>0.06 (0.06)</td>
<td>0.02 (0.06)</td>
</tr>
</tbody>
</table>

Youth Demographics
Youth race and ethnicity
- Black/AA: -0.03 (0.03) -0.09 (0.04)** -0.10 (0.04)** -0.08 (0.04)* -0.08 (0.04)* -0.09 (0.04)*
- Hispanic: 0.02 (0.06) -0.02 (0.06) -0.03 (0.06) -0.02 (0.07) -0.02 (0.07) -0.03 (0.07)
- Multiracial: -0.001 (0.06) -0.01 (0.06) -0.02 (0.06) -0.01 (0.06) -0.01 (0.06) -0.03 (0.06)
- Other: -0.17 (0.12) -0.15 (0.06) -0.16 (0.11) -0.17 (0.11) -0.18 (0.11)

Youth male: 0.002 (0.03) 0.001 (0.03) -0.003 (0.03) 0.02 (0.04) 0.02 (0.04) 0.01 (0.04)
Youth age: -0.001 (0.03) -0.003 (0.01) -0.003 (0.01) -0.01 (0.01) -0.01 (0.01) -0.01 (0.01)
Youth foreign-born: -0.08 (0.09) -0.06 (0.08) -0.05 (0.08) -0.05 (0.08) -0.05 (0.08) -0.02 (0.08)
Youth pubertal development: 0.01 (0.03) 0.01 (0.04) 0.003 (0.01) 0.01 (0.04) 0.01 (0.04) 0.01 (0.04)

Socioeconomic characteristics
Caregiver Education
- HS or less: 0.07 (0.05) 0.07 (0.05) 0.07 (0.05) 0.07 (0.05) 0.07 (0.05) 0.07 (0.05)
- Associate’s or some college: 0.05 (0.04) 0.04 (0.04) 0.04 (0.04) 0.04 (0.04) 0.04 (0.04)
- Bachelor’s degree: -0.004 (0.04) -0.01 (0.04) -0.006 (0.04) -0.01 (0.04) 0.001 (0.04)
- Master’s degree or > (reference group): 0.07 (0.02)** 0.06 (0.02)** 0.06 (0.02)** 0.06 (0.02)** 0.05 (0.02)**

Economic hardship
- Economic hardship: 0.07 (0.02)** 0.06 (0.02)** 0.06 (0.02)** 0.06 (0.02)** 0.05 (0.02)**

Adverse childhood experiences
- Hair cortisol concentration, logged: -0.01 (0.01) -0.01 (0.01) -0.01 (0.01) -0.01 (0.01) -0.01 (0.01)
Table 8 continued

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<td>-0.001 (0.0001)</td>
<td>-0.001 (0.0001)</td>
<td>-0.001 (0.002)</td>
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<tr>
<td>Hair length</td>
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<td>0.03 (0.02)</td>
<td>0.03 (0.02)</td>
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<td>Hair product</td>
<td>-0.02 (0.04)</td>
<td>-0.02 (0.04)</td>
<td>-0.02 (0.04)</td>
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<td>0.04 (0.04)</td>
<td>0.04 (0.04)</td>
<td>0.05 (0.04)</td>
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<td>Frequency of wash</td>
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<td>0.02 (0.03)</td>
<td>0.02 (0.03)</td>
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<td>Youth BMI</td>
<td>-0.01 (0.01)</td>
<td>-0.01 (0.01)</td>
<td>-0.01 (0.01)</td>
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<tr>
<td>Activity Space -Collective Efficacy</td>
<td>0.12 (0.16)</td>
<td>0.14 (0.17)</td>
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<td>CE*Everexp interaction</td>
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<td>-0.43 (0.5)</td>
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<td>Intercept estimate</td>
<td>1.41 (0.02)***</td>
<td>1.39 (0.12)***</td>
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<td>1.31 (0.12)***</td>
<td>1.31 (0.12)***</td>
<td>1.25 (0.14)***</td>
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<td>1.25 (0.14)***</td>
<td>1.42 (0.16)***</td>
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p < 0.05*  p < 0.01**  p < 0.001**
Table 9 - OLS regression pooled parameter estimates and standard errors of models predicting attention behavioral problems of youth using multiple imputation procedures, N=613

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<tr>
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<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever exposed to PI</td>
<td>0.22 (0.07)**</td>
<td>0.19 (0.07)**</td>
<td>0.14 (0.07)*</td>
<td>0.10 (0.08)</td>
<td>0.09 (0.07)</td>
<td>0.09 (0.07)</td>
<td>0.05 (0.10)</td>
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<tr>
<td>Youth demographics</td>
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<tr>
<td>Black/AA</td>
<td>0.08 (0.05)</td>
<td>0.002 (0.05)</td>
<td>-0.004 (0.05)</td>
<td>0.03 (0.06)</td>
<td>0.03 (0.06)</td>
<td>0.02 (0.06)</td>
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</tr>
<tr>
<td>Hispanic</td>
<td>0.12 (0.09)</td>
<td>0.08 (0.09)</td>
<td>0.08 (0.09)</td>
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<tr>
<td>Multiracial</td>
<td>0.04 (0.08)</td>
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<td>-0.02 (0.08)</td>
<td>0.002 (0.08)</td>
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<td>-0.21 (0.17)</td>
<td>-0.18 (0.16)</td>
<td>-0.19 (0.16)</td>
<td>-0.22 (0.17)</td>
<td>-0.22 (0.17)</td>
<td>-0.24 (0.16)</td>
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<td>Male Youth</td>
<td>0.09 (0.05)</td>
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<tr>
<td>Youth age</td>
<td>0.01 (0.02)</td>
<td>-0.001 (0.02)</td>
<td>0.003 (0.02)</td>
<td>-0.001 (0.02)</td>
<td>-0.001 (0.02)</td>
<td>-0.001 (0.02)</td>
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<tr>
<td>Youth foreign-born</td>
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<td>-0.007 (0.12)</td>
<td>0.001 (0.12)</td>
<td>0.01 (0.12)</td>
<td>0.01 (0.12)</td>
<td>0.01 (0.12)</td>
<td>0.04 (0.12)</td>
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<tr>
<td>Youth pubertal development</td>
<td>-0.04 (0.05)</td>
<td>-0.05 (0.05)</td>
<td>-0.05 (0.05)</td>
<td>-0.04 (0.05)</td>
<td>-0.04 (0.05)</td>
<td>-0.04 (0.05)</td>
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<td>HS or less</td>
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<td>0.11 (0.07)</td>
<td>0.11 (0.07)</td>
<td>0.11 (0.07)</td>
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<tr>
<td>Associate’s or some college</td>
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<td>0.10 (0.06)</td>
<td>0.11 (0.06)</td>
<td>0.11 (0.06)</td>
<td>0.11 (0.06)</td>
<td>0.10 (0.06)</td>
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<tr>
<td>Bachelor’s degree</td>
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<td>0.04 (0.06)</td>
<td>0.03 (0.06)</td>
<td>0.03 (0.06)</td>
<td>0.03 (0.06)</td>
<td>0.04 (0.06)</td>
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<tr>
<td>Master’s degree or &gt; (reference group)</td>
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<tr>
<td>Economic hardship</td>
<td>0.07 (0.02)**</td>
<td>0.06 (0.03)*</td>
<td>0.06 (0.03)*</td>
<td>0.06 (0.03)*</td>
<td>0.05 (0.03)*</td>
<td>0.01 (0.005)*</td>
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<td>Adverse childhood experiences</td>
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<td>Hair cortisol concentration, logged</td>
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<td>-0.0006 (0.001)</td>
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<td>Hair length</td>
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<td>Hair product (continued)</td>
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<tr>
<td>Chemical treatment</td>
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<td>0.06 (0.06)</td>
<td>0.06 (0.06)</td>
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<td>Frequency of wash</td>
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<td>0.07 (0.05)</td>
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<td>Youth BMI</td>
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<td>-0.01 (0.01)</td>
<td>-0.01 (0.01)</td>
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<td>Activity space-collective efficacy (CE)</td>
<td>0.10 (0.23)</td>
<td>0.11 (0.23)</td>
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<td>CE*Everexp interaction</td>
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<td>Intercept estimate</td>
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< 0.05* p < 0.01** p < 0.001***
Table 10- OLS regression pooled parameter estimates and standard errors of models predicting mean scores of externalizing behavioral problems of youth using multiple imputation procedures, N=613

<table>
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<th></th>
<th>Model 1</th>
<th>Model 2</th>
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<th>Model 5</th>
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<th>Model 7</th>
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<tr>
<td>Ever exposed to PI</td>
<td>0.18</td>
<td>0.17</td>
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<td>0.07</td>
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<td></td>
<td>(0.05)**</td>
<td>(0.06)**</td>
<td>(0.05)*</td>
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<td>Youth race and ethnicity</td>
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<td>Black/AA</td>
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<td>(0.12)</td>
<td>(0.12)</td>
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<tr>
<td>Male Youth</td>
<td>-0.007</td>
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<td>-0.01</td>
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<td>(0.04)</td>
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<td>Youth foreign-born</td>
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*p < 0.05*  *p < 0.01*  **p < 0.001***
Table 11 - OLS regression pooled parameter estimates and standard errors of models predicting mean scores of internalizing behavioral problems of youth using multiple imputation procedures, N=613

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<th>Model 1</th>
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