

**Effects of Early Adverse Risks on Middle Childhood Behavior Development,
Adolescent Physical and Mental Health, and First Juvenile Arrest for Low-Income Youth**

by

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Abstract

The current dissertation investigates the effects of early adverse risks on middle childhood behavior development, adolescent physical and mental health, and first juvenile arrest in a high-risk national Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) sample of youth from mostly single-mother headed families who receive public assistance. Study one uses Structural Equation Modeling (SEM) and multi-domain growth modeling to examine mediation of the relationship between early poor maternal health and poor adolescent physical and mental health outcomes by middle childhood aggression, withdrawal, and social problem development. Overall, both non-maltreated and maltreated children decrease in aggression and social problems but only maltreated children increase in withdrawal during middle childhood. Social problems at age 8 mediate the relationship between maternal and adolescent overall physical and mental health (but not BMI or depression) for both groups. The slope of withdrawal behavior from 8-14 years old mediates the relationship between maternal health and overall adolescent health (not BMI or depression) for maltreated youth alone. Study two utilizes discrete-time survival analysis to examine juveniles' risk of first arrest and how this risk is predicted by time-varying effects of juveniles' sex, maltreatment type before age 8, race, and associated interactions. Overall, developmental risk of first arrest peaks at age 16 and subsequently declines. Significant predictors of juveniles' risk include time-varying effects of sex, time-varying effects of maltreatment type, and the interaction of sex and maltreatment type; however, race is not a significant predictor when controlling for these interaction effects. Physically neglected males are most at risk of arrest for the first time at 15 years old compared to all other males (who are most at risk at age 16) but physically abused 16 year-old males have the highest risk of all juveniles. Females who have been both physically abused and neglected

experience the highest risk of arrest compared to all other females at age 16. Overall, the current dissertation extends previous research in several important areas and may provide useful implications for prevention and intervention efforts with high-risk youth.

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Table of Contents

Abstract.....	ii
Acknowledgements.....	iv
List of Tables.....	vi
List of Figures.....	vii
List of Abbreviations.....	viii
Chapter 1 – General Introduction.....	1
Chapter 2 – Study 1.....	6
Introduction.....	6
Methods.....	13
Results.....	19
Discussion.....	33
Chapter 3 – Study 2.....	41
Introduction.....	38
Methods.....	47
Results.....	54
Discussion.....	71
Chapter 4 – General Conclusion.....	76
References.....	79

List of Tables

Study 1

Table 1.....27

Appendix A.....93

Study 2

Table 1.....51

Table 2.....52

Table 3.....57

Table 4.....64

Appendix A.....95

Appendix B.....99

Appendix C.....100

List of Figures

Study 1

Figure 1.....18

Figure 2.....20

Figure 3.....26

Figure 4a.....30

Figure 4b.....31

Figure 4c.....32

Study 2

Figure 1.....68

Figure 2.....69

Figure 3.....70

List of Abbreviations

LONGSCAN	Longitudinal Studies of Child Abuse and Neglect
FIML	Full information maximum likelihood
RMSEA	Root mean square error of approximation

I. General Introduction

Child maltreatment (CM), defined as any form of abuse and/or neglect occurring during childhood, is a major public health and social welfare problem in modern society. Despite the abundance of child maltreatment research, prevalence rates and economic burden remain high and countless questions still exist about how to prevent maltreatment and lessen the negative effects on behavioral development, physical and mental health, and criminal outcomes. In 2012, 3.4 million Child Protective Services (CPS) referrals involving roughly 6.3 million children in the United States were made (U.S. Department of Health and Human Services (HHS), 2014). Child maltreatment (CM) not only greatly affects its victims but also our society as a whole. In the U.S., the average lifetime cost per nonfatal CM victim was estimated at approximately \$210,000 in 2010, including costs of childhood health care, adult medical, child welfare, and criminal justice (Fang, Brown, Florence, & Mercy, 2012).

Child maltreatment has been associated with many negative criminal, behavioral, physical, and mental health outcomes throughout victims' lifespans. Early maltreatment, especially physical abuse, has been found to predict greater adolescent behavioral problems such as aggression, withdrawal, and social problems compared to non-maltreated children (Lansford et al., 2002) and has been linked with later delinquency and even juvenile arrest (Gilbert et al., 2009; Keiley & Martin, 2005; Lansford, Berlin, Bates, & Pettit, 2007). Early child maltreatment has been associated with health problems including poor physical health status and obesity (Bonomi, Cannon, Anderson, Rivara, & Thompson, 2008; Danese & Tan, 2014; Gilbert et al., 2009). Mental health effects for maltreated children often include depression, anxiety, general psychological problems, specific phobias or panic attacks, and body dissatisfaction (Dunkley, Masheb, & Grilo, 2010; Fergusson, Boden, & Horwood, 2008; Lansford et al., 2002; Widom, DuMont, & Czaja, 2007). Increased knowledge about maltreatment effects and investment in prevention and intervention strategies are needed due to the continued prevalence, serious societal burden, and

potential long-term, severe consequences to juveniles' behavioral, physical and mental health, and criminal outcomes.

Child Maltreatment (CM) and Maternal Physical and Mental Health Problems for Low Socioeconomic Status (SES) Children

Low SES children are more at-risk for being exposed to adverse childhood risks, such as maltreatment and parents' physical and mental health problems. According to the National Incidence Study (NIS-4), children in low SES households have significantly higher rates of maltreatment, experiencing more than five times the rate when compared to other children. Specifically, low SES children are found to be more than three times as likely to be abused and seven times as likely to be neglected (Sedlak et al., 2010). In the general U.S. population, nearly half of American women, 65% who are mothers, report a lifetime prevalence of mental illness or psychiatric disorder (Nicholson, Biebel, Hinden, Henry, & Stier, 2001). In turn, both maternal mental illness and alcohol abuse are risks for perpetration of child abuse and/or neglect (Gilbert et al., 2009). Mental health disorders in adulthood are often associated with a general pattern of disadvantaged social status, including having low SES and being female and unmarried (Kessler, Chiu, Demler, & Walters, 2010). Mothers in low-income households report more persistent health difficulties compared to mothers in higher income households (Mensah & Kiernan, 2011). When compared to the general population, low income is associated with higher rates of mental and physical health problems for both parents and children (Ghate & Hazel, 2002). This leaves children from low-income, single-mother headed households at increased risk of being exposed to both maternal physical and mental health problems and maltreatment experience.

Developmental Psychopathology and Cumulative Risk

The effects of adverse risks, including child maltreatment, are multi-faceted. Unfortunately, these risks cannot be explained using straightforward single risk variable models in which one risk factor consistently leads to the same negative outcomes (MacKenzie, Kotch, Lee, Augsberger, & Hutto, 2011). Maltreated children are at greater risk for problems in multiple behavioral (Alink, Cicchetti, Kim, & Rogosch, 2012), physical and mental health (Flaherty et al., 2006, 2009; Herrenkohl, Hong, Klika,

Herrenkohl, & Russo, 2012; Shin & Miller, 2012), and criminal (Keiley & Martin, 2005) domains. However, some maltreated children show resiliency and do not experience the same difficulties (Jaffee, Caspi, Moffitt, Polo-Tomas, & Taylor, 2007). This emphasizes the need to study the effects of maltreatment on children's development and outcomes in the context of other child characteristics and experiences (e.g., low-income, sex, race, maternal health problems) that may also place children at greater risk. The developmental psychopathology framework focuses on the interactions among biological, psychological, and social-contextual aspects of both normal and abnormal developmental processes across the life course (Cicchetti & Toth, 2009). It can be utilized to understand both resilience and risk associated with maltreatment because both positive and negative adaptations develop over time. This framework enhances understanding of negative maltreatment consequences as well as the processes that result in resilient functioning in some maltreated children despite their adverse experiences (Cicchetti, 2013; Toth & Cicchetti, 2013). Developmental psychopathology 'cascades' describe the way in which functioning at one level, time point, or domain of behavior affects functioning at higher levels, later time points, or later developing domains (Cox, Mills-Koonce, Propper, & Gariépy, 2010). For example, caregiver-child interaction quality influences functioning in numerous child domains. All children adapt to their caregivers and specific caregiving environments by developing distinctive behavioral strategies that begin early in life and these behavioral strategies influence later outcomes (Cox et al., 2010; e.g., aggression predicts juvenile arrest, Vazsonyi & Chen, 2010). Cumulative developmental consequences exist because numerous interactions in developing systems spread across levels, among domains at the same level, and across different systems or generations which alter the course of individual development (Masten & Cicchetti, 2010) and influence later outcomes.

Accumulation of Adverse Risks and their Effects

The effects of child characteristics and early adverse childhood experiences can be especially pronounced if they occur in the context of other adverse risks. For high-risk children, strong relations exist between the accumulation of risks (above that of maltreatment experience alone) and poorer outcomes. For example, the cumulative level of risk more strongly predicts long-term clinical behavioral

difficulty (MacKenzie et al., 2011) and physical health problems (Flaherty 2006, 2009) than one risk factor alone. Children raised in high-risk families (e.g., low-income, public assistance, maternal depression) show poorer outcomes than children from families with few of these risks (MacKenzie et al., 2011). Specifically, maltreated children often come from high-risk families characterized by other adverse risks such as poverty and parental health issues (Jaffee, 2005) which may leave these children even more vulnerable to develop negative outcomes. Studies should consider the cumulative effects of multiple biological and environmental risk factors such as age, sex, race, and maltreatment experience and the interaction effects among these risks when examining the relationship between early adversities and juvenile outcomes. Our studies utilize a cumulative risk, developmental psychopathology approach in the examination of the long-term effects of child maltreatment and early adverse maternal health risks on behavioral development, physical and mental health, and criminal outcomes.

Current Studies

The following two studies examine the effects of early maltreatment in the context of the developmental psychopathology and cumulative risk models. Although associations among our study constructs have been well-documented in previous research, many theoretical and methodological limitations in these findings exist. For instance, maternal health problems are often linked with children's behavior problems (Mensah & Kiernan, 2011) and health problems (Flaherty et al., 2006, 2009); however, these associations are rarely assessed in the same study with few examining maltreatment differences in pathways to poor adolescent health outcomes. In addition, most information on juvenile arrests has been on the associations between maltreatment and arrest rates using familiar methodological designs that have been unable to adequately address the unique contributions of certain child characteristics and environmental experiences to the risk of juvenile arrest over time. The present prospective longitudinal design studies will address several of these limitations in order to provide a more complete picture of youth's behavioral development, physical and mental health, and criminal outcomes. Study one examines the long-term effects of early poor maternal health on middle childhood behavior development and adolescent physical and mental health outcomes for both non-maltreated and maltreated

children. Our study is the first, to our knowledge, to examine whether the effects of early maternal health on later adolescent health are mediated by the development of aggression, withdrawal, and social problems and which, if any, of these effects are moderated by maltreatment status (non-maltreated and maltreated). Study two is a discrete-time survival analysis in which we examine the effects of early child maltreatment type (non-maltreatment, physical abuse, physical neglect, and both) on first juvenile arrest in the context of juveniles' age, sex, and race. This study, to our knowledge, is one of the first to examine the time-varying and interaction effects among juveniles' sex, specific maltreatment type, and race on risk of first juvenile arrest.

II. Study 1 – Mediation of Early Maternal Health Predicting Adolescent Physical and Mental Health by Middle Childhood Behavior Growth: Maltreatment Status Moderation

Adolescence is a developmental period characterized by marked biological and psychological changes placing adolescents at risk for physical and mental health problems. One of the biggest health issues for U.S. adolescents is being overweight or obese with approximately 34% of 12-19 year olds classified as overweight and 18% as obese in 2007-2008 (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Being overweight or obese puts adolescents at risk for additional physical health problems such as poor physical health status and risky health behaviors (CDC, 2014b), social problems (Strauss & Pollack, 2003), and mental health problems such as depression (Swallen, Reither, Haas, & Meier, 2005). According to the 2013 national Youth Risk Behavior Surveillance (YRBS) study, approximately 13% of adolescents did not eat for 24 or more hours, 5% took diet pills, powders, or liquids, and 4% vomited or took laxatives in an attempt to lose weight or keep from gaining weight (CDC, 2014b). In addition to these physical health concerns, behavior and mental health problems often emerge for the first time during middle childhood and adolescence with U.S. median ages of onset for different classes of disorders as follows: anxiety (e.g., generalized, phobias, panic attacks) at 6, behavior (e.g., conduct, oppositional defiant) at 11, and mood (e.g., major depression) at 13. A nationally-representative study of U.S. adolescents found prevalence rates for adolescent behavioral and mental health disorders including anxiety (32%), behavior (19%), and mood (14%) (Merikangas et al., 2010).

Maternal Physical and Mental Health Problem Effects

Maternal physical and mental health problems put children at risk for behavioral, physical, and mental health problems (Whitaker, Orzol, & Kahn, 2006). It is difficult to disentangle these effects since maternal health issues often co-occur and influence one another. Many mothers experience co-occurring

physical and psychological difficulties after the birth of their children that can continue through early child-rearing years and are associated with children's physical health and behavior problems (Kahn, Zuckerman, Bauchner, Homer, & Wise, 2002; Zubaran et al., 2010). When mothers experience physical health problems or psychological concerns, their children's development also suffers. Self-reported maternal health status predicts children's behavior development even when maternal psychological distress is taken into account (Mensah & Kiernan, 2011). Maternal health status is associated with child health status; children who have mothers who self-report worse health have poorer health conditions and outcomes than those who have mothers with better self-reported health (Pastor & Reuben, 2011). Parents with alcohol problems have children who are at greater risk for emotional and behavioral difficulties (Keller, Cummings, Davies, & Mitchell, 2008). Mothers who engage in problem drinking often are experiencing environmental (e.g., low-income) or health (e.g., mental health issues) stressors that can also influence child outcomes.

In regards to maternal mental health, the most common psychiatric diagnosis among mothers is depression (Riley et al., 2009) and sub-clinical levels of depressive symptoms are even more prevalent (Cummings, Keller, & Davies, 2005). Maternal depression is associated with children's overall levels of internalizing and externalizing behavior problems (Goodman et al., 2011; Tompson et al., 2010), low social competence (Luoma et al., 2001; Weissman et al., 2006), and depressive symptoms and physical functioning into adulthood (Timko et al., 2008). Adolescent children of depressed parents have higher rates of other mental health disorders including anxiety, social phobias, and disruptive behavior disorders, when compared to a control group of adolescents with non-depressed parents (Goodman & Tully, 2008). Depression and anxiety disorders are twice as likely for adolescents who have mothers with a depression history than those whose mothers have no depression history (Hammen & Brennan, 2003). Similar to findings on the effects of parental depression, children of parents with anxiety disorders (e.g., panic disorder alone or comorbid with depression) are at an increased risk for developing multiple anxiety disorders (Biederman et al., 2001).

These children may be susceptible to difficulties for numerous reasons including genetic vulnerabilities, exposure to mothers' symptoms, diminished caregiver-child relationship quality, social learning (Bandura, 1977), and/or the cumulative effects of these risks. Physically- or mentally-ill mothers or mothers who engage in risky health behaviors such as problem drinking may be less attentive or sensitive to and more neglectful of their children putting the children at risk of maltreatment. For example, mothers with a high number of depressive symptoms (e.g., difficulty concentrating, fatigue, loss of interest) show less maternal sensitivity, engagement, and affection with their children (Albright & Tamis-LeMonda, 2002). Ill mothers may not recognize symptoms early, may be inconsistent in children's preventive or timely medical care, and/or may not supervise children closely resulting in more injuries and accidents (Propper, Riggs, & Burgess, 2007). This lack of proactive involvement may partially explain a link between poor maternal health and poor child behavioral, physical, and mental health because these children's difficulties may be left untreated by medical doctors and/or mental health professionals. Additionally, from a developmental psychopathology framework (Cicchetti & Toth, 1995), parentification (not measured in this study), which occurs frequently for children whose caretakers are physically and/or mentally ill or have substance abuse problems (Chase et al., 1998; Jones & Wells, 1996; Mayseless, Bartholomew, Henderson, & Trinke, 2004; Tompkins, 2007), may either interfere with or promote youth adjustment (Fitzgerald et al., 2008). Children who are parentified often serve as caretakers for their parent(s) giving them a more adult-like role in the family which may protect some children from developing certain types of problem behaviors (internalizing or externalizing) and social issues with peers yet may leave them at risk for later difficulties in other areas (Hooper, Marotta, & Lanthier, 2008; Mayseless et al., 2004).

Cumulative effects on children's well-being have been documented. For example, children of depressed parents not only experience the negative expression of parental depressive symptoms but also other stressful conditions (e.g., low-income, poor family functioning) that often accompany parental depression (Riley et al., 2009). Adverse environmental risks such as low-income in addition to maternal depression may also exacerbate negative child outcomes. For example, high-risk children of low-income

mothers with depression have more behavioral and emotional problems than children of socio-demographically similar mothers without depression (Riley et al., 2009). Single mothers are more likely to have mental health issues than other women (Cooper et al., 2008). More parental mental health symptomatology or diagnoses may have a cumulative effect on children and put them at greater risk for difficulties. Women's depression is often comorbid with anxiety symptoms and other mental health disorders (Goodman & Tully, 2006; Kessler, 2006) leaving children at risk of being exposed to multiple maternal mental health issues early in life. Additionally, a reciprocal nature between maternal depression and child behavior problems exists—as maternal depressive symptoms become more or less severe, children's behavior problems increase or decrease accordingly (Nicholson, Deboeck, Farris, Boker, & Borkowsk, 2011). Turney (2011) suggests that socioeconomic status, maternal health, and maternal health behaviors account for a large portion of the association between maternal depression and children's health and that the effects of maternal depression may be worse for children of unwed mothers. These associations highlight the usefulness of studying the differential effects of maternal physical and mental health, taken together, on children (both non-maltreated and maltreated) in a sample of high-risk youth who, on average, are from low-income, multi-child, single-mother led families.

Child Maltreatment Effects

Child maltreatment (abuse and/or neglect) is one of the most severe and adverse risks that children may experience. Multiple studies indicate maltreated children have worse outcomes in several domains (e.g., behavioral, physical, and mental) than their non-maltreated counterparts. If parents are unable to protect their children from or personally inflict abuse and/or neglect on their children, the children may suffer to an even greater degree. According to the U.S. Department of Health and Human Services, 82% of maltreatment victims were maltreated by one or both parents in 2012 with 37% by mothers alone, 19% by both parents, and 19% by fathers alone (HHS, 2014). Parental poverty, low educational achievement, alcohol misuse, and mental health problems are risks for parents abusing their own children (Norman et al., 2012). Children from families with these adverse risks are at greater risk for both maltreatment and negative outcomes than those from families with fewer adverse risks. Family

characteristics such as overt family conflict (i.e., angry and aggressive behavior) and deficient nurturing (i.e., neglect) are associated with poor physical and mental health outcomes for offspring (Repetti, Taylor, & Seeman, 2002).

Maltreated children are at an increased risk for a variety of behavioral and social problems (Kim & Cicchetti, 2010). Cross-sectional studies consistently show maltreated children as more aggressive, more withdrawn, and/or less cooperative than non-maltreated children (Alink et al., 2012). School-age abused children are more likely to display social skill problems (Blanchard-Dallaire & Hébert, 2014) and abused adolescents may suffer from social withdrawal (Odhayani, Watson, & Watson, 2013). Physical abuse, in particular, is most frequently found to be associated with children's aggressive behaviors (Gilbert et al., 2009; Teisl & Cicchetti, 2008).

Maltreatment victims report more impairment due to physical health and mental health problems during childhood, adolescence, and adulthood (Flaherty et al., 2006, 2009; Herrenkohl et al., 2012). Adult women with a maltreatment history report lower physical health status than women with no maltreatment history (Bonomi et al., 2008). Children who experience abuse and/or neglect engage in more risky health behaviors and experience more physical health problems (both medically explained and unexplained) during adulthood than those who were not maltreated (Arnow, 2004). An accumulation of multiple adverse childhood exposures, including child abuse and caregivers' problem drinking and depression, are associated with increased risks for poor physical health and/or physical health complaints during ages 6 and 12 (Flaherty et al., 2006, 2009). Additionally, an elevated risk exists between child maltreatment, especially childhood sexual abuse, and obesity across the lifespan (Danese & Tan, 2014; Gilbert et al., 2009; Irish, Kobayashi, & Delahanty, 2010). A known additive effect for children who experience multiple types of maltreatment exists with children who experience both physical abuse and neglect showing higher levels of BMI, even when taking into account several demographic and psychosocial characteristics (Shin & Miller, 2012). Obesity is associated with its own physical health problems including poor self-reported health status (Swallen et al., 2005).

In regards to mental health outcomes, children who are physically abused, physically neglected, or who experience multiple types of abuse have an increased risk of depression (Fergusson et al., 2008). More childhood adversities indicate a greater risk of adult depression (Felitti et al., 1998). Abused children often also suffer from anxiety and other psychiatric disorders (Gilbert et al., 2009; Lansford et al., 2002) and adult women with a maltreatment history have more diagnoses and/or symptoms of mental health disorders than those without this history (Bonomi et al., 2008). Maltreatment is also associated with general psychological problems, specific phobias or panic attacks, and body dissatisfaction (Cogle, Timpano, Sachs-Ericsson, Keough, & Riccardi, 2010; Dunkley et al., 2010). Sexual abuse is associated with an increase in eating disorders (Brewerton, 2007; Irish et al., 2010) but much less is known about associations between other maltreatment types and unhealthy weight loss methods (Gilbert et al., 2009).

The accumulation of multiple early adversities elevates the risk for negative juvenile outcomes and makes it difficult to determine the exact relationship between certain risks and outcomes. The prevalence of child problems (e.g., aggression, anxiety, depression) increases with the number of maternal adverse conditions (e.g., physical health problems—binge drinking; mental health problems—depression, anxiety) (Whitaker et al., 2006). For LONGSCAN children, one adverse trauma exposure nearly doubles the risk of overall poor physical health while four exposures nearly triples the risk of illness requiring medical attention (Flaherty et al., 2006). Less is known about the possible interactive effects between maternal health and maltreatment status on later behavior problems and adolescent physical and mental health outcomes. Maternal health may have different effects for non-maltreated and maltreated children (Arnold, 2004; Bonomi et al., 2008). Maternal general health scores have been found to be higher for mothers of abused children than for mothers of non-abused children with an association between mothers' general health and children's behavior problems for abused children but not non-abused children (Takei, Yamashita, & Yoshida, 2006). Maltreatment type (based on maltreatment severity) is the most consistent predictor of child behavioral and emotional outcomes and different maltreatment types predict different child outcomes (e.g., physical abuse predicting depression; English et al., 2005). Additionally, physical neglect has been found to have behavioral and emotional effects that are unique from physical abuse,

especially during childhood and early adolescence (Hildyard & Wolfe, 2002). The extensive findings regarding the elevated risk of maltreated children to experience behavior problems (Alink et al., 2012; Blanchard-Dallaire & Hébert, 2014) and physical and mental health problems (Bonomi et al., 2008; Fergusson et al., 2008; Flaherty et al., 2006; Gilbert et al., 2009) compared to non-maltreated children lead us to posit that maltreatment status may have differential influences on these childhood and adolescent outcomes. Our current study aims to elucidate some of these additive and/or interactive relationships through mediation and moderation testing.

Current Study

It is useful to consider the developmental pathways leading to adolescent physical and mental health since these problems develop over time. High-risk children with mothers who have physical and mental health problems have shown a tendency to have their own behavioral, physical, and mental health problems. We hypothesize that maternal physical and mental health problems in early childhood affect adolescent physical and mental health outcomes (e.g., overall health, BMI, depression) through the development of children's aggression, withdrawal, and social problems. In other words, perhaps the effect of mothers' difficulties on later adolescent outcomes is through the effects of the mothers' difficulties on the children's development of behavioral difficulties such as social problems, withdrawing behaviors, and aggression. In short, we posit that the development of problem behaviors during school years is the mechanism by which mothers' initial mental and physical health difficulties (such as poor physical health status, depression, general mental health problems, and problem drinking) during children's early years has its effects on later adolescent general mental and physical health, depression, and BMI. In addition, previous research on the harmful effects of maltreatment suggests that if these effects exist then they are most likely different for children who have been maltreated versus children who have not been maltreated; thus, differences in developmental pathways by maltreatment status will be examined.

Methods

Study Design

This secondary prospective analysis uses data collected as part of the Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) project, a consortium of five U.S. longitudinal studies of the antecedents and consequences of child abuse and neglect. Common measurement and data collection procedures were used to assess children from zero to 18 years old at age-specific data collection points (see Runyan et al. 1998). All children were identified in the first years of life as either being maltreated or at high risk for maltreatment. Three sites included children based on Child Protective Service (CPS) referral and matched comparison groups (Northwest, NW; Midwest, MW; South, SO). The East site (EA) included children based on a child risk factor (inadequate growth), a parent risk factor (HIV infection or drug use), or low income status risk alone. The Southwest site (SW) included maltreated, CPS-removed and foster-care placed children.

Sample. The sample includes 1,209 of the LONGSCAN project children, including only those with female primary caregivers. The majority are from low-income families with 53% making less than \$15,000 per year, 63% receiving public assistance, and having an average of over four children. Families are from the five collection sites: 24% SW, 18% EA, 20% NW, 20% MW, and 18% SO. Approximately half of the children are female (51%) and half are male (49%) with the majority African-American (53%) followed by 28% European-American and 19% other races. By assessment at age 6, 58% experienced at least one maltreatment allegation and 42% had experienced none. Most female primary caregivers are biologically-related to the child (77% mothers; 7% grandmothers; 4% relatives; the remainder are foster, adoptive, stepmothers) and are high school graduates (57%) who are unemployed (56%) and unmarried (67%).

Measures

Demographics. Basic child and caregiver information was collected at child age 4 during face-to-face primary caregiver interviews.

Early maltreatment status (age 6). Trained LONGSCAN coders coded official Child Protective Services (CPS) records using the Maltreatment Classification System (MMCS; Barnett, Manly, & Cicchetti, 1993). We use maltreatment allegations, rather than substantiations, as recommended by LONGSCAN researchers (Litrownik, 2009) who claim child maltreatment experience is better indicated by allegations (e.g., English et al., 2005). We define early maltreatment as any CPS allegations of sexual abuse, physical abuse, and/or physical neglect prior to or at assessment age 6. We created a dichotomous maltreatment status variable: non-maltreated (0) or maltreated (1).

Poor maternal physical and mental health (age 4). The poor maternal health latent construct consists of four caregiver-report observed variables assessed at child age 4. One global health item assesses *physical health status* by caregivers rating their health compared to others their age on a Likert scale ranging from 1 (*Excellent*) to 4 (*Poor*) (defines the study metric). *Problem drinking* for mothers who reported ever having an alcoholic beverage is assessed using the CAGE Questionnaire (Ewing, 1984) where caregivers rated experience of four items (e.g., felt need to cut down, felt annoyed by people's criticism, felt guilty, drank first thing in the morning) as 1 (*yes*) or 0 (*no*). Total scores range from 0 to 4 with higher scores indicating more problematic drinking and greater risk for alcoholism ($\alpha=.79$). The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) measures 20 *depressive symptoms* on a Likert scale based on frequency of occurrence within the past week ranging from 0 (*rarely or none of the time*) to 3 (*most or all of the time*) (ranges from 0-60; $\alpha=.90$). The Health Opinion Survey (HOS; MacMillan, 1957), developed as a CES-D supplement, assesses *general mental health* in response to temporary stressors and consists of 20 physical symptom items (e.g., "Are you bothered by your heart beating hard?") rated on a Likert scale ranging from 1 (*hardly ever*) to 3 (*often*) ($\alpha=.84$). Scores range from 20 to 60 with higher scores indicating more neurotic or *psychosomatic symptoms* (Murphy, 1990).

Aggression, withdrawal, and social problems (age 8, 10, 12, and 14). Maternal caregivers completed the Child Behavior Checklist (CBCL; Achenbach, 1991), indicating if 112 problem behaviors are 0 (*not true*), 1 (*somewhat true*), or 2 (*very true or often true*) for their child. The aggression (ranges from 0-40; $\alpha=.97$), withdrawal (ranges from 0-18; $\alpha=.90$), and social problem (ranges from 0-16; $\alpha=.90$)

subscales across four assessment ages (age 8, 10, 12, and 14) are utilized. Examples of subscale items include: aggression—threatening others, physically attacking others, screaming, having a “hot temper,” and sudden mood changes; withdrawal—preferring to be alone over being with others, avoiding getting involved with others, refusing to talk, and being secretive; and social problems—difficulty getting along with and being liked by other children. Higher scores, respectively, indicate more of the given problem behavior.

Body Mass Index (BMI) (age 18). The standard adult weight (lbs.) and height (inches) formula is used to calculate Body Mass Index (BMI) because participants were 18 years old. Standard BMI-associated weight status categories interpret BMI for both sexes: Below 18.5 is underweight, 18.5-24.9 is normal, 25.0-29.9 is overweight, and 30.0 and higher is obese. BMI calculation is one of the best methods for population overweight and obesity assessment and is considered a fairly reliable indicator of body fatness (CDC, 2014a).

Depression (age 16). The CES-D (Radloff, 1977) also assesses adolescent self-report of depressive symptoms ($\alpha=.90$).

Poor adolescent physical and mental health (age 16; age 18). The overall adolescent health latent construct consists of three adolescent self-report observed variables. *Adolescent poor physical health status* (age 18; defines the metric) is also assessed by the global health item. We used the Young Adult Health Status (AHSB) LONGSCAN-developed measure to create a 3-item composite score where adolescents rated experience of anxiety, depression, major fear, phobia, and panic attack within the past year as 1 (*yes*) or 0 (*no*) to assess *general mental health problems* (age 16). Scores range from 0 to 3 with higher scores indicating more problems ($\alpha=.63$). We used the Young Adult Health Risk Behaviors (HRBA) LONGSCAN-developed measure to create a 4-item composite score assessing *unhealthy weight loss methods* (age 18) in the last year including skipping at least one meal, not eating for several meals in a row, vomiting, or taking diet pills or laxatives. Scores range from 0 to 4 with higher scores indicating more unhealthy weight loss methods ($\alpha=.97$).

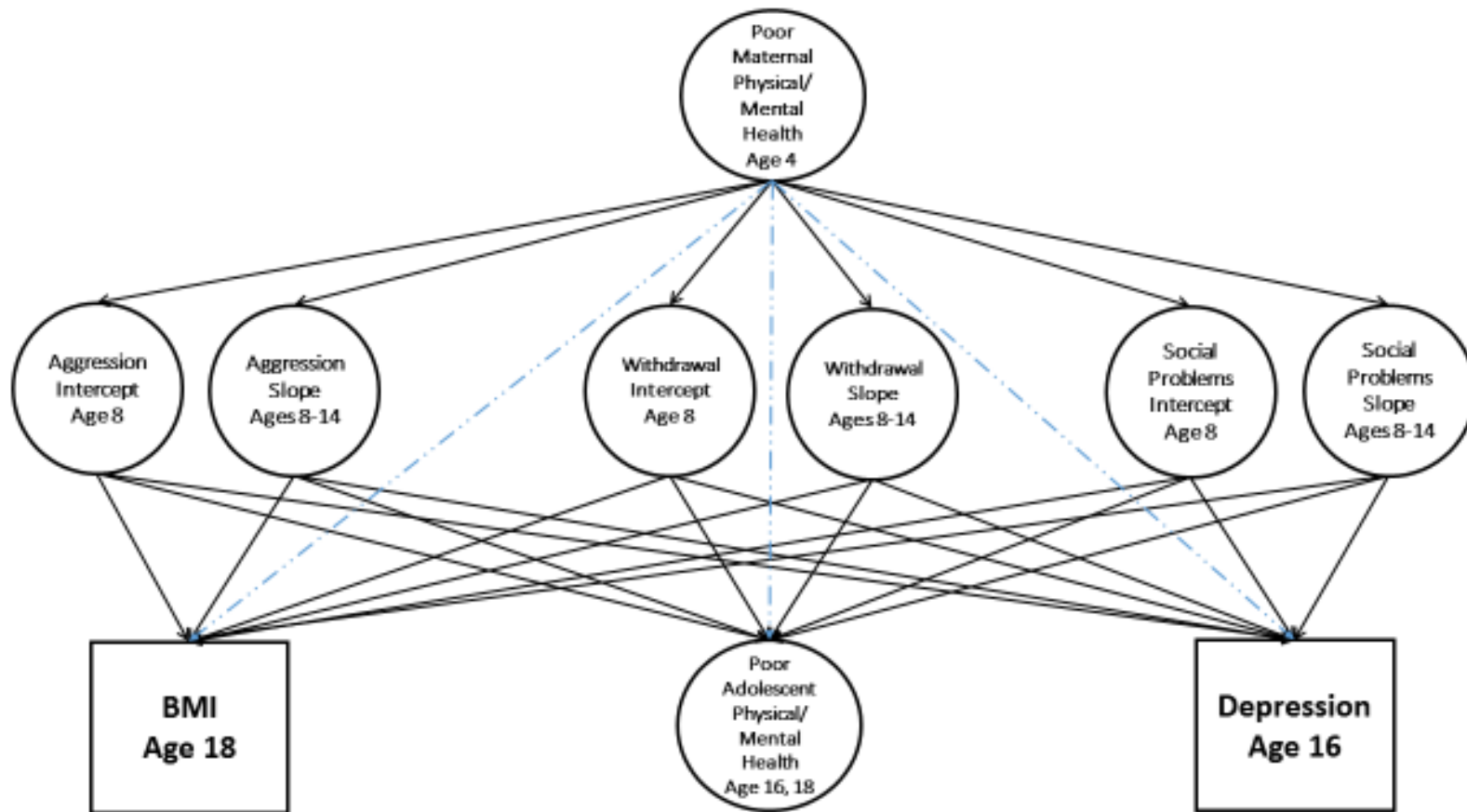
Analysis Plan (Figure 1)

Preliminary univariate and bivariate analyses were conducted using SAS 9.3 (SAS Institute Inc., Cary, NC) (see Appendix A for means, SDs, and correlations). The following were logged due to skew: maternal problem drinking, depression, and psychosomatic symptoms; child aggression, withdrawal, and social problems at each age; adolescent physical health status, general mental health problems, unhealthy weight loss methods, and depression. All multi-domain growth modeling and Structural Equation Modeling (SEM) models are fit using MPlus 7 (Muthén & Muthén, 1998-2010) to take advantage of Full Information Maximum Likelihood (FIML) which allows for the inclusion of participants with missing data. Our main goal is to determine if early maternal physical and mental health predicts later adolescent physical and mental health and whether these effects of early maternal health on later adolescent health are mediated by the development of withdrawal, aggression, and social problems and which, if any, of these effects are moderated by maltreatment status (see Figure 1 for hypothesized model).

Since our main focus is on the differences *between maltreated and non-maltreated youth*, moderation by maltreatment status was tested for each model that was fit before fitting the next model. First, we fit a multi-group main effects SEM model, following established guidelines, to test if maternal physical and mental health (age 4) (controlled for child sex) predicts adolescent physical and mental health (age 16, 18), BMI (age 18), and depression (age 16) (blue lines in the hypothesized model Figure 1) and to determine if the estimates differed for maltreated and non-maltreated children. Secondly, we fit a multi-domain growth model of middle childhood aggression, withdrawal, and social problems to assess if significant change and predictable variance existed in the slopes and intercepts of these behaviors so that we could predict these slopes and intercepts as well as use them as predictors of the outcomes at ages 16 and 18. We added the three growth models to model 1 above fitting a multi-group model that included early maternal health to change in middle childhood behaviors to adolescent health outcomes to assess for differences across maltreatment status. In addition we tested for mediation, according to established guidelines (Baron & Kenny, 1986), by adding the paths from maternal health to adolescent outcomes to

the multi-group, multi-domain conditional growth model to determine if these paths are mediated by middle childhood behavior growth.

Figure 1. Hypothesized path diagram of the fitted structural equation (SEM) model including the conditional multi-domain growth model of aggression, withdrawal, and social problems (age 8-age 14) mediating the relationships between the maternal health latent construct and the overall adolescent health latent construct, adolescent BMI, and adolescent depression in a high-risk youth sample. Note: Blue dashed arrows represent hypothesized non-significant paths after mediation testing. Hypothesized maltreatment status (nonmaltreated (NM) versus maltreated (Mal)) moderation.



Results

Preliminary Models

Early poor maternal health as a predictor of adolescent health outcomes. Multi-group analysis is a common method of moderation testing (Singer & Willett, 2003). A multi-group model of early poor maternal health predicting adolescent health outcomes was fit ($\chi^2/df=2.03$, RMSEA=0.04) (Figure 2). For fitted models, adequate fit is often indicated by a χ^2/df ratio of less than 5 and Root Mean Square Error of Approximate (RMSEA) less than .10 (Wheaton, Muthén, Alwin, & Summers, 1977). Poor maternal health predicts the poor adolescent physical and mental health construct for non-maltreated children ($\beta=0.09$, $p<.05$) but has no effect for maltreated children ($\beta= -1.02$, $p=0.55$). Poor maternal health predicts poor adolescent health and better maternal health predicts better adolescent health for non-maltreated youth, controlling for child sex. Poor maternal health predicts more adolescent depression symptoms for all children ($\beta=0.93$, $p<.001$) indicating that poor maternal health predicts greater adolescent depression for both groups. However, poor maternal health does not predict BMI for either group ($\beta=0.51$, $p=0.47$) (see Figure 2). In this model, poor maternal health predicts some variance: 3.9% of the adolescent health construct, 9.5% of depression, and 0.1% of BMI for non-maltreated children but only 0.1% of overall adolescent health, 11.2% of depression, and 0.1% of BMI for maltreated children.

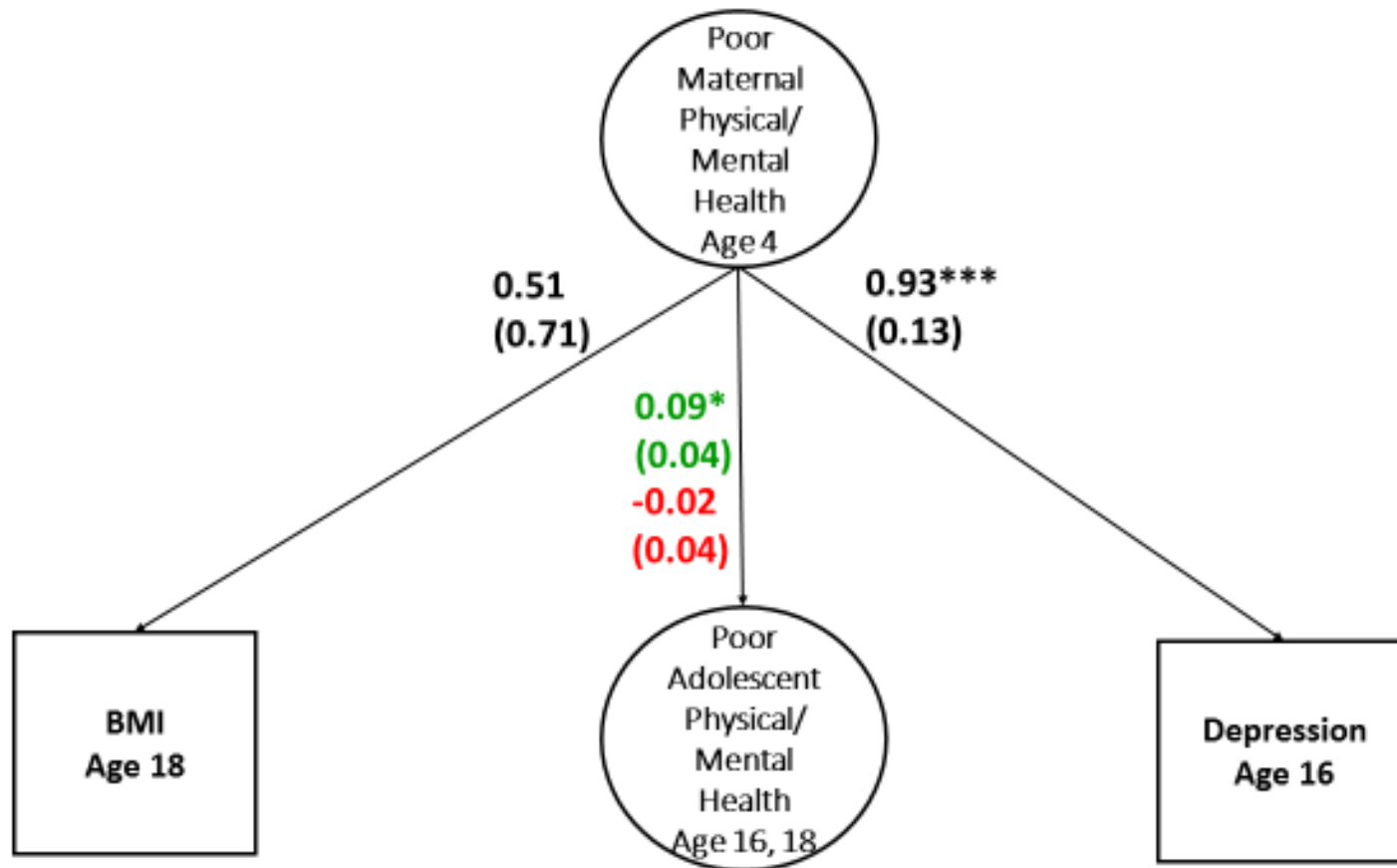


Figure 2. Fitted multi-group path diagram of the structural equation model (SEM) of poor maternal health predicting poor adolescent health, adolescent BMI, and adolescent depression in a high-risk youth sample ($N=1,209$). Note: Multi-group of non-maltreated (NM) $n=503$ versus maltreated (Mal) $n=706$ youth. If significant differences exist, non-maltreated estimates are presented in green and maltreated estimates are presented in red.

Multi-group, multi-domain linear growth modeling. The unconditional multi-group, multi-domain linear growth model of three caregiver-reported behaviors (aggression, withdrawal, and social problems) from 8 to 14 years old was fit ($\chi^2/df=7.80$, RMSEA=0.11). In multi-domain growth modeling, change in each behavior domain controls for change in the other domains. Significant variance in child behaviors exists in all intercepts (NM: $\sigma^2_{\text{Agg}}=0.52$, $\sigma^2_{\text{WD}}=0.23$, $\sigma^2_{\text{SP}}=0.24$, $p<.001$; Mal: $\sigma^2_{\text{Agg}}=0.50$, $\sigma^2_{\text{WD}}=0.30$, $\sigma^2_{\text{SP}}=0.31$, $p<.001$) and all slopes (NM: $\sigma^2_{\text{Agg}}=0.01$, $\sigma^2_{\text{WD}}=0.01$, $\sigma^2_{\text{SP}}=0.00$, $p<.001$; Mal: $\sigma^2_{\text{Agg, WD \& SP}}=0.01$, $p<.001$) which allows for these growth models to be predicted and be used as predictors of later outcomes. The full model of age 4 poor maternal health predicting ages 8-14 behavioral growth models, that in turn, predicting the three final adolescent outcomes (age 16, age 18) was fit across the maltreated and non-maltreated groups. Following multi-group analysis guidelines (Singer & Willett, 2003), each path was constrained one at a time to be equal across non-maltreated and maltreated groups; then, delta chi-square tests were conducted to determine if paths were, in fact, equal. The equality constraint was retained if the delta chi-square test indicated an equal path for the groups. First, the paths from poor maternal health to the intercepts and slopes of aggression, withdrawal, and social problems were tested. Next, the paths from the intercepts and slopes of these behaviors to BMI, adolescent health construct, and depression were tested. Paths that were determined as non-significant for both groups were removed from the model. Next, the means of poor maternal health, behavioral growth variables, BMI, poor adolescent health, and depression were tested for group differences. Further description of preliminary models are available upon request.

Mediation

The rules for mediation hypothesis testing (Baron & Kenny, 1986) were followed and the early maternal health predicting multi-domain behavioral growth predicting adolescent health outcomes model was used to add and test the direct paths from early maternal health to adolescent health outcomes. Since we determined from the first model that early maternal health did not predict adolescent BMI for either group ($\beta_{\text{NM=Mal}}=0.51$, $p=0.47$), we were unable to test for mediation of this path. Since early maternal health had a significant effect on adolescent depression ($\beta_{\text{NM=Mal}}=0.93$, $p<.001$) and poor adolescent health

in the first model ($\beta_{NM}=0.09, p<.05; \beta_{Mal}= -1.02, p=.55$) (Figure 2), we conducted two separate delta chi-square tests to determine if mediation of either path by behavior growth exists. Multi-domain behavior growth during middle childhood did not mediate the relationship between early maternal health and adolescent depression ($\Delta\chi^2=18.21, \Delta df=2; p<.001$). Controlling for all else in the model, early maternal health still significantly predicts adolescent depression; therefore, this path is retained and tested for equality between groups. Early maternal health has the same effect on adolescent depression for both groups ($\Delta\chi^2=1.59, \Delta df=1; 1.59 < \chi^2_{\text{Crit } \alpha=.05} = 3.84$) and is kept constrained ($\beta_{NM=Mal}=5.47, p<.001$). On the other hand, multi-domain behavior growth during middle childhood mediates the relationship between poor maternal health and poor adolescent health ($\Delta\chi^2=0.65, \Delta df=2; p=0.70$) since this previously significant path becomes zero when middle childhood behavior growth is included in the multi-group model. In other words, the direct association between maternal health and adolescent health no longer exists when children's aggression, withdrawal, and social problem development are included. Therefore, this path is not retained in the final model.

Final fitted model. The final fitted conditional multi-domain growth model, proving partial mediation, fit the data adequately ($\chi^2/df=5.59, RMSEA=0.09$). Figure 3 illustrates the final fitted model paths and Table 1 provides final model means and R^2 statistics. All variables that were logged for the analyses have been anti-logged and are presented in their usual metrics. Non-maltreated and maltreated children have significantly different levels of their mothers' maternal health ($M_{NM}=1.00, p<.001, SD_{NM}=1.00; M_{Mal}=1.06, p<.10, SD_{Mal}=1.04$), controlling for all else in the model. Although both groups, on average, have mothers who report excellent health at child age 4, non-maltreated children have mothers who report significantly better health. Maltreated children, on average, display more aggression at 8 (intercept) ($\Delta\chi^2=8.25, \Delta df=1; \beta_{Mal}=8.49, p<.001; \beta_{NM}=7.02, p<.001$) and more social problems at 8 (intercept) ($\Delta\chi^2=10.22, \Delta df=1; \beta_{Mal}=3.06, p<.001; \beta_{NM}=2.66, p<.001$) than non-maltreated children. However, both groups, on average, display the same amount of withdrawal behaviors at 8 ($\chi^2=2.45, \Delta df=1; \beta_{NM=Mal}=2.52, p<.001$) but have different average rates of withdrawal development ($\Delta\chi^2=11.37, \Delta df=1; \beta_{Mal}=1.04, p<.001; \beta_{NM}=1.01, p=0.21$). On average, maltreated children increase in withdrawal

behavior during middle childhood ($M_{WD\ Mal}=1.04$, $p<.001$, $SD_{Mal}=1.01$) while non-maltreated children display no change ($M_{WD\ NM}=1.01$, $p=0.19$, $SD_{NM}=1.01$). Both groups show the same average decrease in aggression ($\Delta\chi^2=1.76$, $\Delta df=1$; $\beta_{NM=Mal}= -1.02$, $p<.001$) and social problem behaviors over time ($\Delta\chi^2=0$, $\Delta df=1$; $\beta_{NM=Mal}= -1.02$, $p<.001$). Poor maternal health has a significant positive effect on all behavioral intercepts, indicating that very poor maternal health predicts greater aggression, withdrawal, and social problems at child age 8 for both groups. Additionally, very poor maternal health has a greater effect on social problems at 8 for maltreated children than non-maltreated children ($\Delta\chi^2=5.25$, $\Delta df=1$; $\beta_{NM}=2.41$, $p<.001$; $\beta_{Mal}=2.67$, $p<.001$). All poor maternal health effects on slopes are significantly different for groups (Agg: $\Delta\chi^2=4.08$, $\Delta df=1$; WD: $\Delta\chi^2=8.25$, $\Delta df=1$; SP: $\Delta\chi^2=3.86$, $\Delta df=1$). No significant effect of poor maternal health on any behavioral slope exists for non-maltreated children ($\beta_{Agg}= -0.02$, $p=0.73$; $\beta_{WD}=0.04$, $p=0.32$; $\beta_{SP}= -0.01$, $p=0.76$). However, poor maternal health has significant negative effects on all behavioral slopes for maltreated children ($\beta_{Agg}= -0.17$, $p<.001$; $\beta_{WD}= -0.08$, $p<.05$; $\beta_{SP}= -0.13$, $p<.001$). On average, very poor maternal health predicts greater decreases in aggression and social problems and a decrease in withdrawal behavior during middle childhood for maltreated children. Possible explanations for this counterintuitive finding are posited in the discussion section. Early poor maternal health at age 4 predicts a large majority of the variance in the behavior growth intercepts. For non-maltreated children's behavior at 8: 66.4% of aggression, 83.6% of withdrawal, and 71.6% of social problems are predicted. For maltreated children's behavior at 8, 74.6% of aggression, 72.8% of withdrawal, and 82.0% of social problems are predicted.

Non-maltreated and maltreated adolescents have the same average BMI at age 18 years old ($M_{NM=Mal}=24.29$, $SD_{NM=Mal}=0.54$). Regardless of maltreatment status, on average, all of these high-risk adolescents are at the high-end of the normal weight status category. Of the adolescents assessed at age 18, 49% were normal weight, 26% were overweight, 21% were obese, and 4% were underweight. Non-maltreated and maltreated adolescents also have the same average depression score at 16 years old ($M_{NM=Mal}=29.24$, $p<.001$, $SD_{NM=Mal}=1.36$). The CES-D scale ranges from 0-60 with 16 as the common cut-off for depressive symptoms (Radloff, 1977); therefore, regardless of maltreatment status, these high-risk

adolescents have clinically relevant levels of depression at 16 years old, on average. The adolescent poor physical and poor mental health construct is significantly different across groups with non-maltreated youth reporting excellent overall health ($M_{NM}=1.00$, $p<.001$, $SD_{NM}=1.00$) compared to maltreated youth ($M_{Mal}=1.01$, $p=0.99$, $SD_{Mal}=1.05$).

Children's social problems at 8 years old predict adolescent BMI with no maltreatment status differences, controlling for all else in the model ($\Delta\chi^2=0.35$, $\Delta df=1$; $\beta_{NM=Mal}=1.24$, $p<.01$). Findings indicate children with greater social problems at age 8 typically have higher BMI at age 18, regardless of maltreatment status. Depression at 16 years old is predicted by children's aggression at age 8 for maltreated children but no such effect exists at 8 for non-maltreated children. Greater aggression at age 8 predicts less depression at age 16 and less aggression predicts greater depression for maltreated youth, controlling for all else in the model. This finding indicates that, in some way, less aggression at age 8 may leave maltreated children at risk for more depressive symptoms during adolescence. On the other hand, children's withdrawal at age 8 predicts adolescent depression for non-maltreated youth but has no effect for maltreated youth ($\Delta\chi^2=3.53$, $\Delta df=1$; $\beta_{NM}= -1.52$, $p<.01$; $\beta_{Mal}= -0.54$, $p=0.15$). For non-maltreated youth, greater withdrawal behavior at 8 predicts fewer depressive symptoms at 16, controlling for other middle childhood behavior change and early maternal health. This finding may indicate that less withdrawal behavior at age 8 may be an indicator of later depression for non-maltreated youth. Interestingly, the withdrawal slope has the same effect on adolescent depression for both groups ($\Delta\chi^2=1.14$, $\Delta df=1$; $\beta_{NM=Mal}=5.41$, $p<.001$). Youth, regardless of maltreatment status, who increase in withdrawal symptoms during middle childhood, on average, have greater levels of adolescent depression; however, youth who decrease in withdrawal behavior show less adolescent depression symptoms.

The slope of withdrawal and the intercept of social problems significantly predict the adolescent poor physical and poor mental health construct, as indicated by adolescent poor health status, general mental health problems, and unhealthy weight loss methods. As previously mentioned, the relationship between poor maternal health and poor adolescent health is the one path that is mediated through multi-domain behavior growth during middle childhood. This relationship is better explained through the social

problem intercept for both groups. For both non-maltreated and maltreated children, poor maternal health predicts greater social problems at 8 ($\Delta\chi^2=5.25$, $\Delta df=1$; $\beta_{NM}=2.41$, $p<.001$; $\beta_{Mal}=2.67$, $p<.001$) which then predicts worse adolescent health ($\Delta\chi^2=0.31$, $\Delta df=1$; $\beta_{NM=Mal}=0.08$, $p<.001$). Additionally, for maltreated children, poor maternal health predicts a decrease in withdrawal behavior during middle childhood ($\Delta\chi^2=3.55$, $\Delta df=1$; $\beta_{Mal}= -0.08$, $p<.05$) which then, unexpectedly, predicts worse adolescent health ($\Delta\chi^2=1.12$, $\Delta df=1$; $\beta_{NM=Mal}=0.90$, $p<.01$). No mediation effect exists for non-maltreated children by this path because maternal health does not predict non-maltreated children's withdrawal slope ($\beta_{NM}=0.04$, $p=0.32$), although the withdrawal slope does significantly predict poor adolescent health for these children. In this final model, little variance is explained in adolescent BMI. Poor maternal health and the social problems intercept, controlling for other behavioral growth, explain 0.8% for non-maltreated and 1.4% for maltreated youth's BMI. For non-maltreated youth, 11.1% of depression is explained by growth in withdrawal behavior (intercept and slope) whereas for maltreated youth, 11.9% of depression is explained by poor maternal health, the aggression intercept, and withdrawal slope. The withdrawal slope and social problem intercept predict 19.6% of the poor adolescent health construct for non-maltreated youth and 10.8% for maltreated youth.

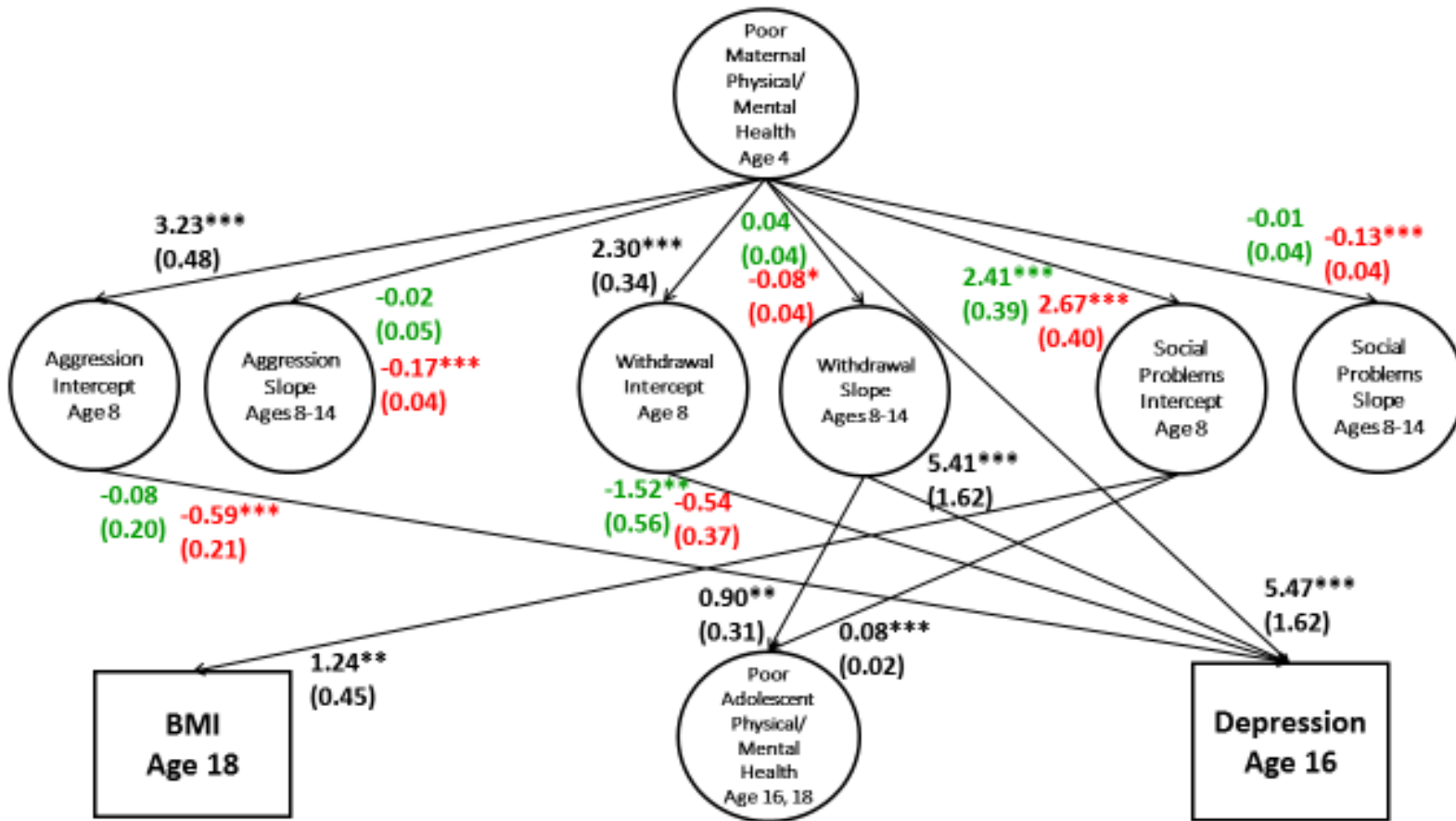


Figure 3. Fitted path diagram of the final structural equation model (SEM) including the conditional multi-domain growth model of aggression, withdrawal, and social problems (age 8-age 14) predicted by the poor maternal health latent construct and predicting the poor adolescent health latent construct, adolescent BMI, and adolescent depression in a high-risk youth sample (N=1,209). Note: Multi-group of non-maltreated (NM) n=503 versus maltreated (Mal) n=706 youth. If significant differences exist, non-maltreated estimates are presented in green and maltreated estimates are presented in red.

Table 1.

Unstandardized parameter estimates and standard errors (in parentheses) from the final structural equation model (SEM) including the conditional multi-domain, multi-group (non-maltreated (NM) and maltreated (MAL)) growth model of aggression, withdrawal, and social problems from 8 to 14 years old in a high-risk youth sample (N=1,209).

	Poor Maternal Health (Age 4)	Aggression Intercept (Age 8)	Aggression Slope (Age 8-14)	Withdrawal Intercept (Age 8)	Withdrawal Slope (Age 8-14)	Social Problems Intercept (Age 8)	Social Problems Slope (Age 8-14)	Adolescent BMI (Age 18)	Poor Adolescent Health (Age 16, 18)	Adolescent Depression (Age 16)
Non-maltreated (NM)										
Mean	1.00*** (1.00)	7.02*** (1.04)	-1.02*** (1.01)	2.52*** (1.03)	1.01 (1.01)	2.66*** (1.03)	-1.02*** (1.00)	24.29*** (0.54)	1.00*** (1.00)	29.24*** (1.36)
R ²	--	66.4%	0.5%	83.6%	0.6%	71.6%	0.9%	0.8%	19.6%	11.1%
Maltreated (MAL)										
Mean	1.06~ (1.04)	8.49*** (1.05)	-1.02*** (1.01)	2.52*** (1.03)	1.04*** (1.01)	3.06*** (1.04)	-1.02*** (1.00)	24.29*** (0.54)	1.01 (1.05)	29.24*** (1.36)
R ²	--	74.6%	12.4%	72.8%	4.1%	82.0%	8.8%	1.4%	10.8%	11.9%

~ < .10, *** $p < .001$

Note: Equal means are indicated in bold.

Fitted trajectories of behavior over ages 8-14 from the final fitted model. The effects of poor maternal health on middle childhood behavior growth parameters for aggression (Figure 4a), withdrawal (Figure 4b), and social problems (Figure 4c) from 8 to 14 years old can best be illustrated by “identifying a prototypical individual distinguished by particular predictor values” (Singer & Willett, 2003, p. 60). We achieved this by selecting meaningful values of the maternal health predictor (2 standard deviations above and below mean) to substitute into the final fitted model equation for non-maltreated and maltreated youth, obtaining the estimated value for the intercepts and slopes of change in behaviors, and plotting these trajectories. This process provides trajectories that would be typical for children in the population with these characteristics.

As expected, overall, all maltreated youth have greater aggression behavior at 8 years old compared to non-maltreated youth, but have the same decrease in aggression over time as the non-maltreated youth. The worst time for maltreated children’s aggressive behavior appears to be early on (closer to their initial early maltreatment experience) and then their aggressive behavior typically becomes less over time, similar to the experience of non-maltreated high-risk children. Our plot illustrates the sharper decrease in prototypical maltreated children’s aggression over time, compared to prototypical non-maltreated children’s aggression, when taking into account the effect of early poor maternal health (at age 4) on aggression development (see Figure 4a). The prototypical maltreated children whose mothers have very poor maternal health decrease to aggression levels less than prototypical non-maltreated children by age 14. Most notably, prototypical maltreated children whose mothers have better maternal health fare better than the other prototypical maltreated and non-maltreated children and decrease to the lowest in aggression by age 14. These trajectories indicate, on average, fairly low caregiver-reported aggression over time for all children (scale of 0-40) since none of these prototypical groups have an estimated aggression level greater than 16 during middle childhood.

Children display the same average level of withdrawal at 8 years old, regardless of maltreatment status, but only maltreated children experience a significant increase in withdrawal behavior over time. However, these effects look different when taking into account early maternal health (see Figure 4b). All

prototypical children whose mothers have very poor health are more withdrawn at 8 years old than those whose mothers have better health. Although maltreated children, on average, significantly increase in withdrawal behavior over time, poor maternal health has a negative effect on maltreated youth's withdrawal behavior. In other words, although these maltreated children are still becoming more withdrawn, poor maternal health predicts less of an increase for them over time. A non-significant positive effect of poor maternal health on non-maltreated youth's withdrawal behavior exists and prototypical non-maltreated children have the highest average levels of withdrawal behavior at age 14 while prototypical maltreated children have the lowest average levels of withdrawal behavior at age 14 when accounting for the effect of early maternal health. Interestingly, prototypical non-maltreated children whose mothers have very poor maternal health fare the worst and are the most withdrawn at age 14. Our plot illustrates the important influence of early poor maternal health in withdrawal behavior development for high-risk children. These trajectories indicate, on average, fairly high caregiver-reported withdrawal by 14 years old (scale of 0-18, where larger numbers indicate more withdrawal) with non-maltreated children having an estimated withdrawal level of almost 14.

Although maltreated children, on average, begin higher on social problems at age 8, both non-maltreated and maltreated children decrease at the same rate over time (see Figure 4c). When taking into account maternal health levels, prototypical maltreated children whose mothers have very poor health have the greatest levels of social problems at age 8 but decrease to average levels of social problems lower than prototypical non-maltreated children. Most notably, prototypical maltreated children whose mothers have better health fare the best compared to all other prototypical groups and are lowest in social problems at age 14. Interestingly, prototypical non-maltreated children whose mothers have very poor health have the highest average social problems at 14 years old. These trajectories indicate, on average, fairly low caregiver-reported social problems (scale of 0-16) with no prototypical group having an estimated social problem level greater than 9 during middle childhood.

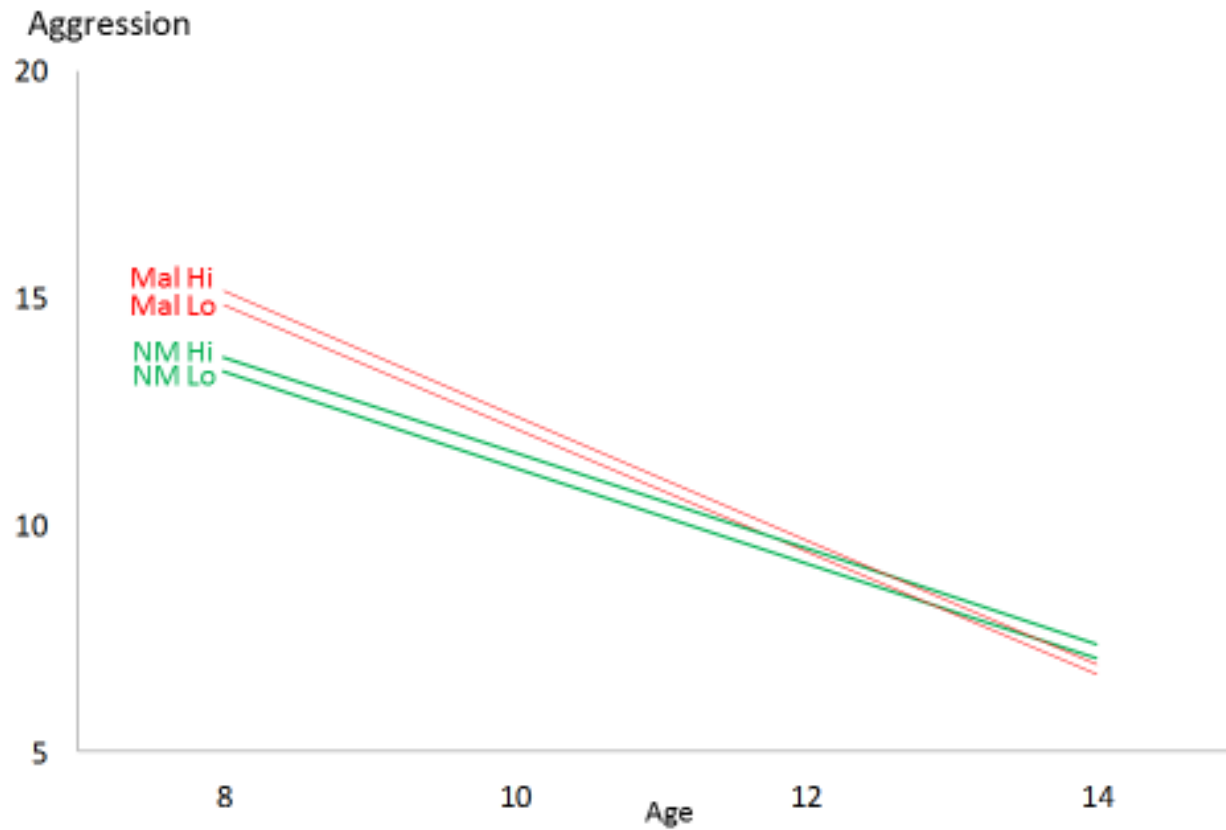


Figure 4a. Fitted true growth trajectories in conditional multi-domain, multi-group (NM, non-maltreated; Mal, maltreated) aggression change during middle childhood (age 8-age14) as predicted by high and low levels of poor maternal health at child age 4 (Lo=2 SD below mean; Hi=2 SD above the mean of metric of mom health latent variable) ($N=1,209$).

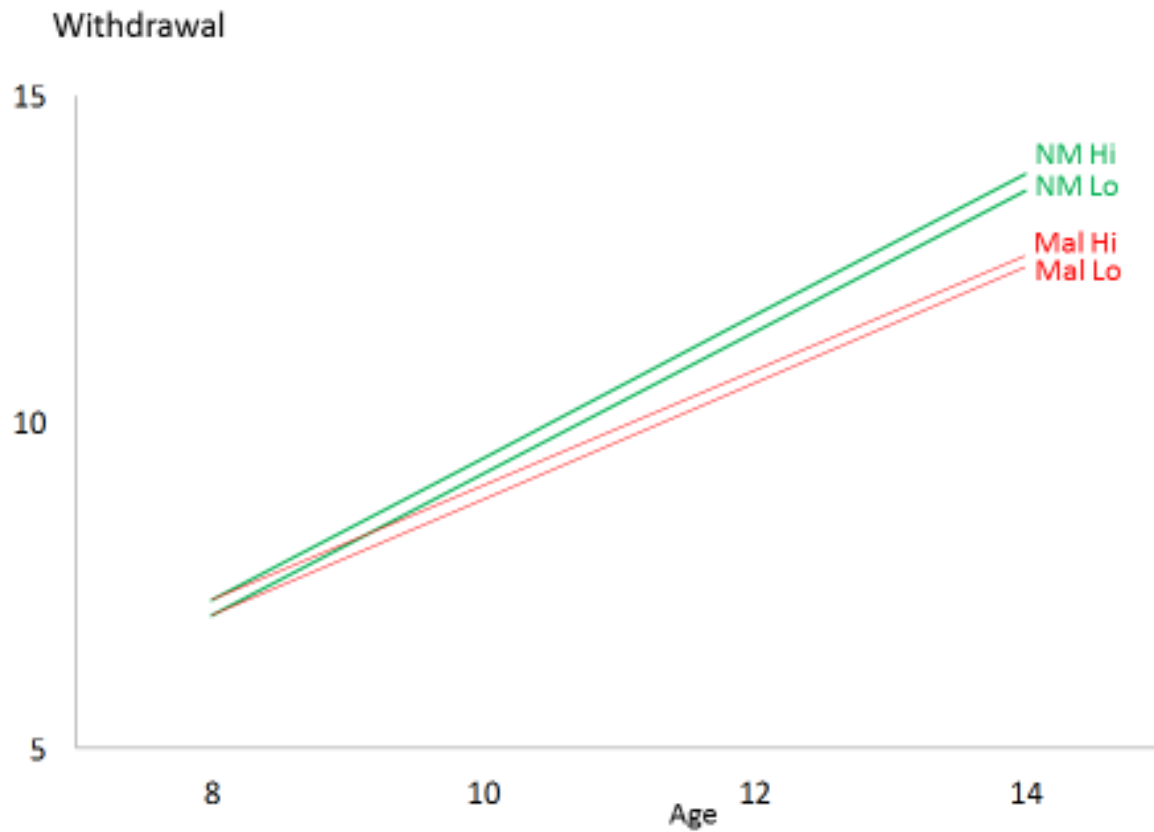


Figure 4b. Fitted true growth trajectories in conditional multi-domain, multi-group (NM, non-maltreated; Mal, maltreated) withdrawal change during middle childhood (age 8-age14) as predicted by high and low levels of poor maternal health at child age 4 (Lo=2 SD below mean; Hi=2 SD above the mean of metric of mom health latent variable) ($N=1,209$).

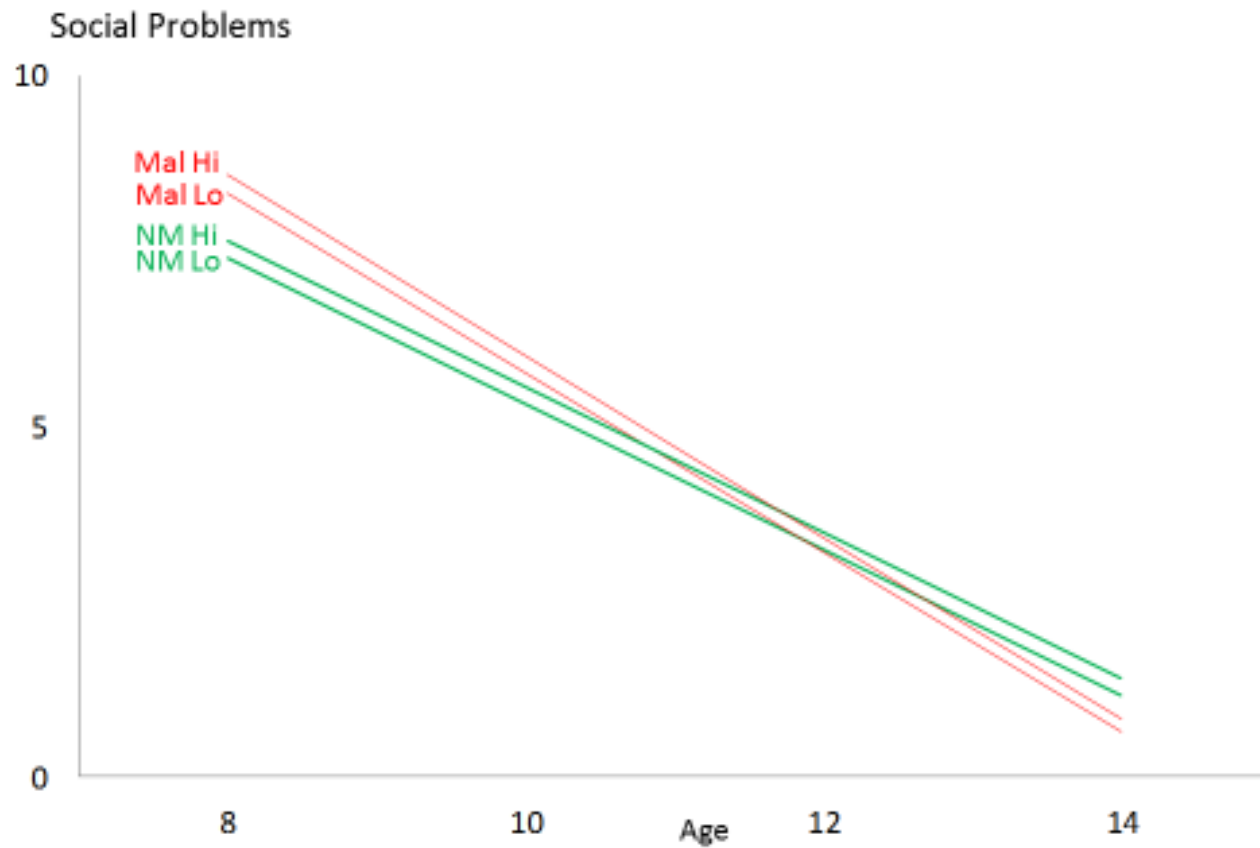


Figure 4c. Fitted true growth trajectories in conditional multi-domain, multi-group (NM, non-maltreated; Mal, maltreated) social problem change during middle childhood (age 8-age14) as predicted by high and low levels of poor maternal health at child age 4 (Lo=2 SD below mean; Hi=2 SD above the mean of metric of mom health latent variable) ($N=1,209$).

Discussion

Overall, maltreated children in our study increase in withdrawal behavior (while non-maltreated children show no significant change) and decrease in aggression and social problems at the same rate as non-maltreated children. It is expected that, overall, maltreated children become more withdrawn over time but is somewhat surprising maltreated children show the same developmental change in aggression and social problems during middle childhood as non-maltreated children. However, it is not so surprising when considering that physical aggression is known to typically be most prominent early in life and decreases as children age, especially into adolescence (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; 2007). When considering maternal health, if mothers have very poor mental and physical health, their children tend to have greater levels of aggression, withdrawal, and social problems at age 8. Not surprisingly, the children who are maltreated have more initial aggression and social problems (Alink et al., 2012). What is striking, however, is that the maltreated children whose mothers had poor health have an additional significant reduction in aggression and social problems from 8 to 14 years old, while the non-maltreated children do not have any additional significant change. As evidenced by the estimates, overall, both groups are still decreasing their aggressive and socially problematic behaviors during middle childhood. This finding supports previous work that indicates high-risk non-maltreated youth sometimes fare worse than maltreated youth (MacKenzie et al., 2011) and the well-documented resiliency of some maltreated children (Cicchetti & Rogosch, 1997; Jaffee et al., 2007). Resiliency definitions vary but maltreated children who are able to master normative developmental tasks despite their experiences of adversity are often referred to as resilient (Luthar, Cicchetti, & Becker, 2000). These maltreated children, especially those who have additional adversity—maternal figures who are physically and/or mentally ill—show resiliency partly because they are able to display normative development in aggression and social problem behaviors, controlling for their withdrawal development. It may be difficult to find practical significance for this finding but this knowledge can help inform clinical practice for both groups of high-risk youth.

Consistent with a developmental psychopathology perspective (Cicchetti & Toth, 1995), parentification may interfere with or promote adjustment in offspring (Fitzgerald et al., 2008) and may provide a possible conceptual explanation for our findings. Research suggests that children whose caretaker(s) are physically and/or mentally ill or who experience personal maltreatment often become parentified, in other words, they become emotional or instrumental care-takers of their ill parent(s) and/or other family members including siblings (Fitzgerald et al., 2008; Mayseless et al., 2004). Parentification of children whose mothers have substance abuse problems (Chase et al., 1998) and serious mental illness or psychopathology (Jones & Wells, 1996) has been well-documented. Attachment and family systems theories posit that maltreated children are particularly susceptible to parentification (sometimes considered another form of neglectful or abusive parental behavior over non-maltreated children because associated features of abuse and neglect often co-occur (Hooper, 2007; Jurkovic, 2014). Parentification has more recently been associated with aspects of youth's resiliency (Hooper et al., 2008). Flexibility, a component of resiliency, may occur for some parentified children who successfully adapt to their environments in order to support impaired parents.

In our study, maltreated children, on average, have mothers with moderately poorer early health. These children may need to and be making more behavioral accommodations during their youth. Maltreated children in our study appear to show resilient change in middle childhood behaviors by decreasing in aggression and social behavior problems. However, these maltreated children may be showing difficulties in other domains (not examined in this study) that are also affecting later physical and mental health. Posttraumatic growth is defined as the assumption that those who experience adversity, stressful events/environments, or trauma may benefit from the experience and apply that benefit to later experiences (Hooper et al., 2008). The more time that has elapsed since the adverse event(s), the greater potential for posttraumatic growth (Morris, Shakespeare-Finch, Rieck, & Newberry, 2005). Previous research has found that parentification sometimes promotes resiliency to adversity and strengthens the parent-child relationship, child adjustment, and/or offspring's interpersonal competence in families dealing with a serious parental medical condition (Tompkins, 2007). Maltreated youth may be more

inclined to demonstrate posttraumatic growth in the face of *additional* adversity than non-maltreated youth because they may further crave a positive connection with others and may find this by relying more heavily on social relationships. Our application of this reasoning to our study is speculative and further examination of this area would be necessary for better understanding of these complicated findings.

The most important findings from our study are the mediation results. To our knowledge, this is the first study of its kind to examine (and find) partial behavioral growth mediation of the maternal and adolescent physical and mental health relationship. Our findings highlight how certain aspects of childhood behavior development are better predictors of overall adolescent health than the direct link between maternal health and adolescent health. Social problems at age 8 mediate this relationship for both non-maltreated and maltreated youth. All youth who have mothers with very poor health, on average, have even greater social problems at 8 years old than those who have mothers with better health. Then, in turn, their greater levels of social problems predict poorer adolescent physical and mental health. Associations between maternal health problems and children's social problems and adolescent health problems have previously been identified (Luoma et al., 2001; Weissman et al., 2006; Whitaker et al., 2006). However, our finding reveals a developmental pathway leading to poorer adolescent overall health that can be a possible point of intervention for all high-risk youth.

Additionally, testing revealed some different developmental pathways for non-maltreated and maltreated children. The slope of withdrawal behavior from 8-14 years old only mediates the relationship between maternal health and adolescent health for maltreated children. Maltreated youth who have mothers with very poor health, on average, show a decrease in withdrawal behavior during middle childhood. These maltreated children, on average, are still becoming more withdrawn during middle childhood but to a lesser extent than maltreated children with mothers who have better health. This finding may seem counterintuitive at first; however, it should be considered in potential contexts. If maltreated children are overcompensating for maternal health problems, they may become less withdrawn and more proactive in a variety of situations due to necessity. Our interpretation is speculative but

deserves further empirical consideration and should be a clinical consideration of mental health professionals.

However, maltreated children who still increase in withdrawal during middle childhood on average, regardless of maternal health, have poorer adolescent physical and mental health. The pathway from the slope of withdrawal to poor adolescent health reveals that a decrease in withdrawal behavior during middle childhood predicts better adolescent health for all high-risk children. This developmental pathway finding may reveal a useful point of intervention for all high-risk children. Obviously, early detection of adverse risks (e.g., maternal physical health, alcohol abuse, depressive and other mental health symptoms) would be the ideal area for assessment, prevention, and intervention efforts to help alleviate youth's later physical and mental health issues; however, it is not always possible to intervene in children's early home environments. Therefore, our mediation findings are promising because they indicate that for children with certain risk factors who display some behavioral concerns in middle childhood, an opportunity may exist to positively affect change in later health by improving certain aspects of their middle childhood social problems and withdrawal behavior.

Some additional interesting non-mediated but moderated pathways existed. Maltreated youth, on average, have greater aggression at 8 years old than non-maltreated children. This supports previous research that finds maltreated children to be more aggressive than non-maltreated children (Alink et al., 2012). If these maltreated youth show even greater aggression at 8 years old than other maltreated youth, they actually show fewer adolescent depressive symptoms. Previous studies lead researchers to believe that there is an association between children's aggression and later depressive symptoms (Loth, Drabick, Leibenluft & Hulvershorn, 2014); however, many studies include/focus on full-blown externalizing behavior disorders in their analyses. A recent meta-analysis finds childhood externalizing behaviors (e.g., oppositional defiant disorder, conduct disorder, aggressive behavior) are associated with adult depressive disorders (e.g., major depressive disorder, depressive disorder NOS, dysthymic disorder) (Loth et al., 2014). In our study, average levels of primary caregiver-reported aggressive behaviors during middle childhood were below the typical problematic aggression cut-off score on the Child Behavior Checklist

(CBCL) and this may influence our results. In addition, youth who display greater externalizing symptoms such as aggression are often associated with greater delinquency and criminal outcomes (Vazsonyi & Chen, 2010) and may not be as susceptible to depression as youth who display greater internalizing symptoms.

We posit that children who have experienced a form of maltreatment as well as maternal health issues have learned to adapt in an aggressive manner. Their additional increase in aggressive behavior at age 8 predicted by poor maternal health may indicate these youth show more externalizing behavior issues (not assessed in this study) that are often found incompatible with depressive symptoms. Additionally, in our study, children's aggressive behaviors are also being controlled for by their withdrawal and social behavior problems, which may influence our unexpected results. In a sense, our finding is important because elevated levels of middle childhood aggression do not negatively affect later depressive symptoms for this high-risk maltreated population; however, these findings suggest that more complicated developmental pathways (involving other influential factors) for maltreated youth may exist which warrants further investigation.

Non-maltreated and maltreated youth display the same level of withdrawal behavior at 8 years old, on average. Broader research in this area often finds an association between childhood anxious/withdrawn behavior and later internalizing disorders, such as depression and anxiety, in childhood, adolescence, and/or young adulthood (e.g., Biederman et al., 2001; Goodwin, Fergusson, & Horwood, 2004; Prior, Smart, Sanson, & Oberklaid, 2000). Our study, however, did not fully support previous findings. We did determine that youth who, regardless of maltreatment status, increase in withdrawal behavior during middle childhood have greater adolescent depressive symptoms as would be expected. However, we determine that if non-maltreated youth display greater withdrawal behavior at 8, they display fewer adolescent depressive symptoms. These withdrawal symptoms (often considered a form of internalizing problems) do not appear to place high-risk non-maltreated youth at a greater risk for adolescent depression. Different findings may exist in our study due to our methods of data collection, measurement, and analyses. It is possible that withdrawal at 8 years old does not have a long-term effect

on depressive symptoms that lasts until 16 years old for these children. Goodwin et al. (2004) statistically controlled for adverse risks such as abuse and still found an association between early anxious/withdrawn behavior and later internalizing disorders using different methods. They used retrospective self-report of physical and sexual abuse (which is susceptible to bias) as opposed to allegations of maltreatment (including abuse and neglect) collected directly from CPS reports closer to the alleged incidents (as our study did). Their study examined anxious/withdrawn behavior at 8 years old alone while our study utilized multi-domain growth modeling where *change* in one form of early childhood behavior problems (e.g., withdrawal) controlled for *change* in the other two behavior problems (e.g., aggression and social problems). A meta-analysis on the relationship between maternal depression and child psychopathology found that the relationship between maternal depression and later internalizing problems (such as depression) was not stronger than the relationship between maternal depression and later externalizing problems (Goodman et al., 2011). The inclusion of aggression, withdrawal, and social problems in the same model may influence these relationships. Our study may also be elucidating differences among non-maltreated and maltreated children due to our use of moderation testing instead of statistical control alone. Similarly to the unexpected findings about aggression and depression for high-risk maltreated children above, more complicated developmental pathways that warrant investigation may be involved in the relationship between withdrawal behavior at 8 and later depression for high-risk non-maltreated children.

Early poor maternal health does predict depression for both non-maltreated and maltreated children supporting evidence of a strong long-term relationship between maternal health and depression (Timko et al., 2008) even when considering several other adolescent physical and mental health outcomes and middle childhood behaviors. It is important to note that when considering all constructs in our final model, adolescent BMI is only significantly predicted by youth's social problems at age 8, which is consistent with previous findings on the association between overweight/obesity and social problems (Strauss & Pollack, 2003). However, our study identifies that these middle childhood social problems have the same significant effect on adolescent BMI for both non-maltreated and maltreated youth. This lack of maltreatment status group difference may be due to the fact that our study sample includes few

sexually abused children and the majority of research on maltreatment and obesity involves the association between childhood sexual abuse and obesity (Irish et al., 2010). Counter to previous findings on the link between child maltreatment and obesity (Shin & Miller, 2012), our findings suggest adolescent BMI was not predicted by poor maternal health for either group; however, different aspects of maternal health may be better predictors of adolescent BMI than those used in our study.

Some limitations exist in our study. A major study limitation is a fairly high attrition rate in the sample and/or later adolescent outcomes only being measured at certain collection sites. For example, unhealthy weight loss methods were only available for 17% of the sample. These types of issues and high attrition rates can be expected in longitudinal studies of this length and nature. This measure was strengthened through using it as part of a latent construct and we were able to address this limitation by utilizing FIML, which allows reliable estimation of models even with large amounts of missing data. All study variables exceeded the recommended amount of data coverage for FIML (Muthén & Muthén, 2003). Some measurement limitations exist because all measures were either caregiver- or self-report; therefore, reporting bias or other factors may influence these measures. For example, it is possible that mothers who had poorer health rated their children's behavior problems as higher than their children's displayed behavior problems. In addition, some of the LONGSCAN-developed or modified health measures had low reliabilities. However, these measures were used to create *latent* constructs that are error free, therefore reliable constructs of maternal and adolescent health. In addition, our inclusion of depressive symptoms (which is most commonly studied) with other variables with which depression is commonly associated (e.g., physical health, problem drinking, and other mental health problems) in our maternal health construct can be considered a strength of our study. Another possible limitation is that we did not examine these relationships for specific maltreatment types but only for the dichotomous variable of maltreatment status (non-maltreated versus maltreated). Future studies may examine these or similar developmental paths for differences by specific maltreatment types.

A major benefit of this study is the LONGSCAN high-risk sample that we used. The majority of our sample consists of youth who are from low-income, mostly single-parent headed households from

five different sites across the United States who were assessed from early childhood to late adolescence. The biggest strength of our study is our analyses. The prospective longitudinal design allows us to examine long-term effects of early maternal health problems and change in middle childhood aggression, withdrawal, and social problems. Through the utilization of mediation and moderation, we were able to identify unique findings. Another major strength of our study is the large amount of variance that early poor maternal health predicts in our final model, especially in the intercepts of aggression, withdrawal, and social problems for both maltreatment groups. These variances indicate that mother-reported early physical health status, problem drinking, depressive symptoms, and general mental health are very good predictors of children's aggression, withdrawal, and social problems at the beginning of middle childhood for both non-maltreated and maltreated children. Additionally, the mediation paths account for a good amount of variance in the overall adolescent health construct (adolescent physical health status, general mental health problems, and unhealthy weight loss methods) which may indicate that the mediation paths are a useful way to conceptualize the development of poor adolescent physical and mental health for a high-risk youth population. Our findings should prove useful when planning prevention and intervention services for high-risk youth from low-income, single-mother headed families who may have mothers with poor physical health status, problem drinking, depression, and psychosomatic symptoms and/or personal maltreatment experiences.

III. Study 2 – Survival Analysis to Time of First Arrest:

Interaction Effects of Juveniles' Sex and Maltreatment Type

Juvenile arrest refers to an arrest for a criminal act (status or non-status offenses) committed by youth under the age of 18. U.S. law enforcement agencies made 1.47 million arrests of youth under the age of 18 in 2011. In that year, 4,367 arrests occurred for every 100,000 youths between 10 and 17 years old (4.37%). First juvenile arrest is a rare event in the juvenile population, especially considering many of these arrests are attributable to repeat offenders (Office of Juvenile Justice and Delinquency Prevention [OJJDP], 2013); however, the individual and societal consequences and economic burden per juvenile arrest remain high (Fang et al., 2012; Gilbert et al., 2009). We investigate how child and environmental factors such as age, sex, race, and maltreatment experience predict first juvenile arrest.

Age, Sex, Race, and Maltreatment

Older youth have a greater risk of juvenile arrest (Chiu, Ryan, & Herz, 2011). In 2011, 73% of juvenile arrests involved youth 15 years old or older (OJJDP, 2013). In terms of *first* juvenile arrest risk, previous survival analyses determine the riskiest age period as age 14 (Vazsonyi & Chen, 2010) and age 15 (Keiley & Martin, 2005) in separate juvenile populations. Of all juvenile arrests in 2011, 71% were males (OJJDP, 2013). In the general population, male youth commit more crime and are more likely to be arrested as a juvenile than female youth (Chiu et al., 2011; Currie & Tekin, 2006). Overall, males are at greater risk for entry into the juvenile justice system than females (Vazsonyi & Chen, 2010). The chance of juvenile arrest, on average, is twice as high for males as females at every age, controlling for race and an interaction of sex with race (Keiley & Martin, 2005). African-American youth are more likely than European-American youth to experience a juvenile arrest (Chiu et al., 2011). Disproportionate minority representation among youth (especially African-American youth) exists in the juvenile justice system

(OJJDP, 2013). African-American youth are at greater risk of arrest for a juvenile offense at every age than European-American youth, controlling for sex and maltreatment (Keiley & Martin, 2005). However, one survival analysis finds Hispanic youth are at the greatest risk for juvenile justice system entry compared to African-American, American-Indian, Asian-American, and European-American youth, who show no differences (Vazsonyi & Chen, 2010).

Child maltreatment, including both child abuse and neglect, is associated with juvenile criminal behavior and arrest (Chiu et al., 2011; Currie & Tekin, 2006; Gilbert et al., 2009; Keiley & Martin, 2005). A large national youth survey found child maltreatment approximately doubles the probability of juvenile crime engagement (Currie & Tekin, 2006) and approximately 27% of maltreated children have a juvenile arrest compared to 17% of non-maltreated children (Widom & Maxfield, 2001). Very little information exists about how maltreatment of children predicts how old they are at their *first arrest*. One such study found that maltreated youth have a greater risk of first juvenile arrest than non-maltreated youth across all juvenile ages; in addition, approximately 1% to 2% of the abused children had been arrested by the age of 9 (Keiley & Martin, 2005). Additionally, physical and sexual abuse are among risk factors associated with *age* of first juvenile arrest specifically for female juvenile offenders (Leve & Chamberlain, 2004). Studies indicate a relationship between child maltreatment and age(s) of arrest but most empirical research on juvenile arrest age examines age of arrest in terms of “early” versus “late” onset of juvenile delinquency. Overall, abused and neglected children tend to be younger at first arrest than non-maltreated children (Keiley & Martin, 2005; Widom & Maxfield, 2001). Early onset of juvenile delinquency is often defined as crime initiation at 13 years old or younger. Compared to later onset delinquents, child delinquents (onset before age 13) more frequently come from dysfunctional families that may include child abuse and/or neglect experiences, as well as a succession of different caretakers, parental substance use, and maternal depression (Hennepin County Attorney’s Office, 1995; Loeber & Farrington, 2000). Out-of-home placement is a potential explanation for the early onset of delinquency. Compared to youth with no foster care experience, youth with foster care experience have been found four times more likely to have early onset delinquency (Alltucker, Bullis, Close, & Yovanoff, 2006). Since one of the major reasons for

out-of-home placement are experiences of child abuse and neglect, it is logical that maltreated youth, in general, are at an increased risk for earlier arrest. However, to our knowledge, no study has examined differing effects of maltreatment *type* on *age of first juvenile arrest* despite conceptual reasons (posited below) existing to expect differences among maltreatment groups.

The majority of empirical evidence regarding differential influences of child maltreatment type focuses on the relationship between maltreatment type and certain types of arrest offenses and/or later aggression or violence. Certain maltreatment experiences are more frequently associated with certain offense arrests (e.g., physical abuse with violent crime; physical neglect with drug/alcohol offenses) (Chen et al., 2011; Gilbert et al., 2009); however, scant information exists about which maltreatment *types* predict *earlier ages* of first juvenile arrest. Compounded maltreatment (experiences of multiple types of maltreatment) increases the probability of juvenile crime (Currie & Tekin, 2006) and violent juvenile delinquency (Maas, Herrenkohl, & Sousa, 2008) compared to one maltreatment type alone. Physical abuse is considered the most consistent predictor of youth violence (Maas et al., 2008) which might be associated with the likelihood that their behavior comes to the attention of law enforcement more frequently or earlier than non-status offenses. When examining violent juvenile delinquency outcome alone (as opposed to overall juvenile arrest risk for any type of crime), some studies find comparable effects of different maltreatment types (e.g., physical neglect vs. physical abuse) for low-income minority youth (Mersky & Reynolds, 2007). However, other studies find differences in arrest experience by maltreatment *type*. Grogan-Kaylor and Otis (2003) find that age, race, sex, and experiences of physical neglect influence subsequent adult arrest experience while physical and sexual abuse do not show statistically significant effects on adult arrest experience. Childhood neglect is often associated with effects that are unique from childhood abuse but often equally as severe as the effects of physical and sexual abuse (Dubowitz, 2007); therefore, there is a need to conduct research that can distinguish potential differential effects of child abuse and neglect experiences. Physically neglected children frequently display more internalizing behavior problems than externalizing behavior problems when compared to physically abused children (Hildyard & Wolfe, 2002). This likely influences the types of

offense(s) for which they are arrested. Physical neglect during childhood is associated with arrest for drug/alcohol offenses (Chen, Propp, deLara, & Corvo, 2011). Neglected children may be at risk of being arrested at earlier ages due to lack of adequate monitoring by an adult caregiver (e.g., drug/alcohol experimentation, truancy, etc.) or an attempt to “fend for themselves” (e.g., robbery, burglary, etc.). These discrepancies in whether maltreatment *type* influences different effects on juvenile delinquency and later arrest experience, as well as conceptual reasons posited that one maltreatment group may be at greater risk for earlier arrest than another, warrant further empirical investigation. Since true interaction effects are rarely tested, it remains unclear if one maltreatment type predicts earlier first juvenile arrest above others.

Many preliminary analyses find that male juveniles are more likely to experience property, felony, or violent offense arrests than female juveniles or find no sex differences in overall juvenile court experiences; however, some sex differences are revealed when maltreatment histories and juvenile sex are taken into account in the analyses. Child maltreatment increases the likelihood of lifetime (juvenile or adult) violence for both sexes but moderation testing indicates a greater effect for females (Makarios, 2007). Overall, in a retrospective study of adjudicated delinquents, female adjudicated youth have significantly higher rates of maltreatment history (including greater incidences of physical neglect and physical, emotional, and sexual abuse) than male adjudicated youth (McCabe, Lansing, Garland, & Hough, 2002). Some types of maltreatment appear to have a stronger effect on females’ aggression, delinquency, and/or arrest than on males’. A greater effect of physical abuse on aggression exists for females over males (Lansford et al., 2002). Physically abused female youth are arrested for violent offenses more than physically abused male youth. Both sexes share similar family risk factors for delinquency but girls show an increased risk for violent arrest (especially in domestic violence situations) after physical abuse experience over boys which may suggest that maltreatment experiences (such as physical abuse) are especially influential in explaining violent offending for girls (Herrera & McCloskey, 2001). In fact, sometimes child abuse and neglect are found to be risk factors for violent crime arrests for females but not for males (Widom & White, 1997). The rate of juvenile incarceration for maltreated

females significantly increases as level of child welfare services increases with those females who experience an out-of-home placement (e.g., foster or group care) having the highest risk of incarceration. However, juvenile incarceration risk for maltreated boys is similar or increases only slightly as level of child welfare services increases (Johnson-Reid & Barth, 2000). Theoretically, multiple types of maltreatment may be involved with more child welfare service involvement. Although not explicitly examined in this study, maltreated females experiencing an increased risk for violence may be associated with early onset of delinquency and/or arrest since violent acts may more easily draw attention of law enforcement than status offenses. These types of findings lead us to test true interaction effects among the time-varying effects of maltreatment type and sex.

Some research exists on the relationships among race, maltreatment history, and arrest experience. Early physical abuse is more strongly related to court records for offenses and self-reported arrests for African-Americans than for European-Americans (Lansford et al., 2007). When considering juveniles' sex and race in a sample of African- and European-American youth, African-American males have the greatest risk while European-American females have the lowest risk of first juvenile arrest, on average, regardless of maltreatment status. Although child maltreatment elevates the risk of being arrested for both European- and African-American youth, an interaction effect between race and maltreatment status has been found. On average, maltreated African-American youth are more at risk of first juvenile arrest than non-maltreated African-American and maltreated European-American youth at all ages (Keiley & Martin, 2005). We do have evidence that early child maltreatment affects the age of first juvenile arrest compared to juveniles with no maltreatment history. But we know much less about the risk of first juvenile arrest as related to the effects of child maltreatment type, child sex, and race taken together. In addition, very little is known about the time-varying effects of these variables. For example, is the effect of physical abuse (or physical neglect) on the risk for arrest more prominent at one age versus another? Is the effect of sex or race on the risk of arrest greater at particular ages (e.g., early, middle, or late adolescence)?

Noteworthy methodological limitations in this research area exist. Many studies examine juvenile arrests retrospectively in terms of “early” versus “late” onset of criminal behavior with an “early” onset of criminal offending reflecting a greater risk for serious and/or chronic offending (Keenan et al., 2003). Some adolescents continue to offend criminally after their initial arrest, subsequently acquiring more juvenile arrests and biasing some arrest examinations since the same youth may be overrepresented in the analysis. This approach may be useful for differentiating categories of juvenile delinquents who may be chronic offenders but is unable to identify juveniles’ specific vulnerabilities or susceptible time periods. Arrest research often uses retrospectively reported maltreatment experiences; however, retrospective study results may be affected by participants’ current psychosocial functioning, which bias the recall of prior maltreatment (Widom, Raphael, & DuMont, 2004), and incorrectly influence results. Cross-sectional design studies on the relationship between child maltreatment and juvenile offending exist; however, these may be unable to identify if maltreatment precedes delinquency and arrests. Additionally, studies in this area often rely on clinical samples, which may artificially inflate the effects of maltreatment by limiting the sample to people who require later clinical treatment (Lansford et al., 2007) or those who become involved in the justice system. Juvenile arrest is quite a rare event in the general population and thus it is important to analyze differences between juveniles who are arrested and the majority who are never arrested. Additionally, studies that have examined sex differences typically examine the consequences for males and females separately comparing magnitudes of associations across sex but rarely test for true interactions between sex and maltreatment (or maltreatment type) (Thompson, Kingree, & Desai, 2004). Our study addresses several of these limitations by using a prospective design with a national high-risk youth sample, assessing actual *age of first* arrest, and implementing a sound methodological approach.

Current Study

Survival analysis has been used to determine when individuals are most likely to experience a particular event (e.g., initiation of sexual intercourse, alcohol use) and is the best methodology for accurately examining time of first juvenile arrest; however, to our knowledge, only two previously

mentioned survival analyses on risk of first juvenile arrest exist (e.g., Keiley & Martin, 2005; Vazsonyi & Chen, 2010). We explore in greater depth questions first posed by Keiley and Martin (2005) regarding whether and when youth are most at risk for juvenile arrest and whether that risk is related to his/her previous maltreatment status, his or her sex or race, or the interactions between maltreatment, race, and sex. Keiley and Martin (2005) tested the dichotomous effects of abuse (non-abused vs. abused) but not the effects of different maltreatment types (e.g., physical abuse, neglect, compounded). Our major aim is to examine the effects of early maltreatment type (allegations before age 8) on risk of first arrest in the context of juveniles' age, sex, and race in a nationally representative high-risk sample of youth from childhood to late adolescence. We explicitly model developmental risk of first arrest over the course of nine years (age 9-age 17) and across sex, four maltreatment groups (non-maltreated (NM) vs. physically abused (PA) vs. physically neglected (PN) vs. both physically abused and neglected (PAPN)), and race. We also examine whether sex, maltreatment type, and race have time-varying effects on this risk. Additionally, for a more complete understanding of how juveniles' risk is related to maltreatment, we examine interactions of maltreatment type with both sex and race. We aim to overcome past methodological shortcomings, reproduce findings on risk of first arrest in a high-risk youth sample, and add to the literature by more thoroughly examining time-varying effects and interaction terms among maltreatment type, sex, and race.

Methods

Study Design

This secondary prospective analysis uses data collected as part of the Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) project, a consortium of five U.S. longitudinal studies of the antecedents and consequences of child abuse and neglect. Common measurement and data collection procedures were used to assess children from zero to 18 years old at age-specific data collection points (see Runyan et al. 1998). All children were identified in the first years of life as either being maltreated or at high risk for maltreatment. Three sites included children based on Child Protective Service (CPS) referral and matched comparison groups (Northwest, NW; Midwest, MW; South, SO). The East site (EA)

included children based on a child factor (inadequate growth), a parent factor (HIV infection or drug use), or low-income status alone. The Southwest site (SW) included maltreated, CPS-removed and foster-care placed children.

Sample. This sample includes 1,255 of the LONGSCAN project children, including only those whose caregiver *ever* responded to the arrest question, regardless of their response. The majority are from low-income families with 53% making less than \$15,000 per year, 66% receiving some form of public assistance, and having an average of over four children. Families are from the five collection sites: 25% SW, 21% EA, 19% NW, 18% MW, and 17% SO. Approximately half of the children are female (52%) and half are male (48%) with the majority African-American (56%) followed by 26% European-American and 18% other races. By assessment age 8, 61% experienced at least one maltreatment allegation and 39% had experienced none. Approximately nine percent experienced at least one primary-caregiver reported arrest by age 17. Most primary caregivers are biologically-related females (73.9% biological mothers; 6.8% grandmothers; 3.4% female relatives) with few biologically-related males (2.6% biological fathers; 0.2% grandfathers; 0.1% male relatives), foster mothers or fathers (5.8%; 0.3%), adoptive mothers or fathers (4.4%, 0.2%), step-mothers (0.3%), other female caregivers (1.5%), and other non-related caregivers (0.5%). The majority of primary caregivers are high school graduates (55%) who are unemployed (56%) and many have never been married (42%).

Measures

Demographics. Basic child and caregiver information was collected at child age 4 during face-to-face primary caregiver interviews.

Early maltreatment groups. Trained LONGSCAN coders coded official Child Protective Services (CPS) records using the Maltreatment Classification System (MMCS; Barnett et al., 1993). We use maltreatment allegations, rather than substantiations, as recommended by LONGSCAN researchers (Litrownik, 2009) who claim child maltreatment experience is better indicated by allegations (e.g., English et al., 2005). We define early maltreatment as any CPS allegations of the respective maltreatment type prior to assessment age 8. We initially used three general indicators of maltreatment type allegations:

sexual abuse (SA)—any sexual contact occurring between an individual and a child, for purposes of perpetrators sexual gratification or financial benefit; physical abuse (PA)—any blows or injury to the head, torso, buttocks, limbs; violent handling, choking, burning, shaking, or nondescript injury; and physical neglect (PN)—failure to provide for a child’s physical needs or lack of adequate supervision to ensure a child’s safety. These allegations were used to create groups based on maltreatment type; each group was dichotomized as children fitting into the group (1) or not (0). Five main groups were initially created (non-maltreated (NM), SA, PA, PN, and both PA and PN); however, only four groups were used in the final analysis due to the small percentage of children in the SA group ($n=15$, 1% of sample) compared to the other groups. A variable for SA experience (regardless of other maltreatment type experience) was also created, tested, and determined to not be a significant predictor of risk of first juvenile arrest for the sample; therefore, SA juveniles were left in the analytic sample but SA was not used as a group.

First arrest. Our key outcome, age of first juvenile arrest, was created using one primary caregiver-report item on a LONGSCAN-developed instrument called Child Life Events (LONGSCAN, 1992), modified from the Life Event Records (Coddington, 1972). Life events were assessed at every study wave from age 6 to 18; the primary caregiver responded either “yes” (1) or “no” (0) to whether the life event of interest (someone in family arrested) had occurred during the previous year. If yes, primary caregivers reported who had been arrested. We created an age of first arrest variable identifying the first time/youngest age (corresponding with assessment age) that the *target child* experienced an arrest.

Analysis Plan

We conducted a survival analysis of the LONGSCAN data to determine whether and when these juveniles are most at risk of experiencing their first juvenile arrest (defined as occurring before age 18) and what predicts that risk. We examine main effects and time-varying effects of static child characteristics (sex, race, and early maltreatment type), as well as, interaction effects among these characteristics themselves on risk of first arrest. Our main interest is whether risk for first arrest is related to juveniles’ early maltreatment type and the potential interactions of this maltreatment type with time

(over ages 9 to 17), sex, and/or race. We conducted preliminary univariate and bivariate analyses using SAS 9.3 (SAS Institute Inc., Cary, NC) (see Table 1 for means, SDs, and correlations). Table 2 presents descriptive statistics for age of first juvenile arrest by sex, maltreatment type, and race. We created a person-period data set and an indicator to denote event occurrence in order to use the logistic regression procedure to fit the hazard models (Keiley, Kirkland, Zaremba, & Jackson, 2011).

We fit a taxonomy of nested models following survival analysis guidelines (Keiley & Martin, 2005). We first constructed a life table, then fit a baseline model with only the variables representing time (Keiley et al., 2011). The life table and the first model answered the major question: 1) When are high-risk youth over the ages 9 to 17 most likely to be arrested? Then, we entered substantive predictors to determine if risk of arrest was related to 2) main effects of sex; 3) time-varying effects of sex; 4) main effects of maltreatment group (MG; PA, PN, PAPN); 5) time-varying effects of maltreatment group; 6) interaction effects among sex and maltreatment group; 7) main effects of race (European-American, African-American); 8) time-varying effects of race; and 9) interaction effects among race and maltreatment group. As is essential in model building, we only retained the variables or interaction terms that significantly predicted risk of first arrest. Each time a variable was added, we conducted a delta deviance statistic (-2 log likelihood) test to determine significance, controlling for all else in the model. If a variable was not significant, we removed it from the model and moved on to the next possible predictor (Keiley & Martin, 2005). We fit these discrete-time models to data using the PROC LOGISTIC procedure within SAS 9.3 (SAS Institute Inc., Cary, NC) and then we created plots to illustrate findings.

Table 1

Means, standard deviations, and correlations among survival analysis variables (N=1,255)

	1	2	3	4	5	6	7	8	9	10
1. Sex	--									
2. European-Americans	-0.01	--								
3. African-Americans	0.01	-0.67***	--							
4. Other Races	-0.01	-0.28***	-0.53***	--						
5. NM	-0.02	-0.13***	0.24***	-0.16***	--					
6. SA Only	0.09***	0.02	-0.02	0.01	-0.09***	--				
7. PA	-0.02	-0.00	-0.09***	0.12***	-0.18***	-0.03	--			
8. PN	0.04	-0.02	0.03	-0.01	-0.55***	-0.08**	-0.16***	--		
9. PAPN	-0.04	0.17***	-0.25***	0.13***	-0.43***	-0.06*	-0.12***	-0.38***	--	
10. Age First Arrest	-0.13	-0.05	-0.01	0.05	0.10	0.06	-0.01	-0.28***	0.18-	--
<i>M</i>	0.52	0.26	0.56	0.18	0.39	0.01	0.05	0.32	0.23	14.88
<i>SD</i>	0.50	0.44	0.50	0.38	0.49	0.11	0.22	0.47	0.42	1.73

Note: All maltreatment groups (MGs) refer to experience prior to age 8 assessment.

Sex, 1=female, 0=male. NM, non-maltreated; SA, sexually abused; PA, physically abused; PN, physically neglected; PAPN, both physically abused and physically neglected.

~ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 2.

Descriptive statistics for age of first juvenile arrest by sex, maltreatment type, and race.

	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15	Age 16	Age 17	Total
Sample (N=1,255)	0	3	1	2	6	7	21	27	33	12	112
Males (n=608)	0	0	1	2	4	3	16	16	24	9	75
Females (n=647)	0	3	0	0	2	4	5	11	9	3	37
Non-Maltreated (n=488)	0	0	0	0	2	4	8	9	8	4	35
Sexually Abused (n=15)	0	0	0	0	0	0	0	1	0	0	1
Physically Abused (n=62)	0	0	0	0	0	1	1	1	3	0	6
Physically Neglected (n=403)	0	2	1	2	4	0	6	12	8	2	37
Physically Abused & Neglected (n=287)	0	1	0	0	0	2	6	4	14	6	33
African-American (N=701)	0	1	1	0	3	4	11	15	15	6	56
European-American (N=329)	0	1	0	2	1	1	5	6	10	1	27
Other Race (N=225)	0	1	0	0	2	2	5	6	8	5	29

Censoring. Having “censored cases” is common in the study of event occurrence, especially when examining an uncommon event (Keiley et al., 2011). Since our target event (first juvenile arrest) is rare, many juveniles do not experience the event during the study and must be appropriately addressed. Censored cases, in our study, exist for one of three main reasons: some may *never* experience an arrest, some may experience an arrest but only *after* data collection ends, or some may *drop out* of the study prior to the end of data collection. The “*CENSOR*” variable equals 0 if the juvenile is arrested during one of the age periods but equals 1 if he/she is censored at any age period. Those who do not experience the event before the end of the study are censored at the last study age. In this data set, 893 juveniles were censored at the final data point (age 17) of data collection because they did not experience a known arrest. Juveniles who drop out of the data set, or attrite, before the end of data collection are censored at their age of last study participation/last available target event data (before age 17). This loss of participants is common in prospective studies and these individuals must be censored since they are no longer in the data set and it cannot be determined whether or not they have experienced the target event. Survival analysis is an especially important methodology for studies that incur loss of participants during the time frame of study (such as this). A major advantage of survival analysis over previous strategies for analyzing event data is that, regardless of whether they do (not censored) or do *not* experience an arrest (censored), all participants are included in the analyses. These censored individuals are *not* a random subgroup of the sample so it is valuable to incorporate data from censored and non-censored individuals simultaneously in the analyses for the most accurate representation of event occurrence and non-occurrence. Censored individuals are the ones who are the “longest lived” in the sample, the *least likely* to experience the event, and provide substantial information about the potential rarity of target event occurrence. Thus, survival analysis and censoring provide a reasonable and sound statistical basis for exploring “whether” and “when” certain events occur in these types of samples (Keiley et al., 2011).

Results

Life Table

The construction of a life table summarizes the distribution of event occurrence in the sample; constructing a life table is the first step in a survival analysis (Keiley et al., 2011). Table 3 presents the life table for the LONGSCAN data on first juvenile arrest. Discrete time periods and their associated metric, age in years for our study, are indicated in the first column. Juveniles who have reached a particular time period without already experiencing an arrest or being censored are still eligible to experience their first arrest during that time period/age are referred to as the “risk set” and included in the second column. Juveniles who were arrested for the first time during each age/time period (who experienced the event during that age) are indicated in the third column. Those who were censored (who attrited or did not experience the event during data collection) are included in the fourth column. Because juveniles are censored throughout this period of data collection, the proportion surviving at any point in time displayed in the life table is different from the estimated survival function in the survival analysis and this creates especially pronounced analysis benefits (Keiley et al., 2011; Keiley & Martin, 2005).

Three necessary statistical summaries for a survival analysis can be determined from the life table: hazard function, survival function, and median life time. The discrete-time hazard function ($h(t_j)$; Table 3, column 5) is the *conditional probability* that a juvenile will experience their first arrest during a certain time period (time period, j), given that he/she had not been arrested during a previous time period. In other words, hazard functions represent the proportion of children in each age period’s risk set who experienced the event during that age period (who had not been arrested at the beginning of the age period but who had been arrested by the end of the age period). Juveniles who experience an arrest or are censored (drop out of the study) within the current period are removed from the risk set for the following time period and are therefore not included in the estimation of the hazard probability for that subsequent period. Hazard functions are calculated by dividing the number of target events at a certain age by the risk set for that age. For example for age 16, the number of first juvenile arrests during age 16 (33) is divided by the risk set (1,008), giving a hazard function of .0327. Higher hazard functions indicate higher risk of

first juvenile arrest during a given age period and vice versa. In our study, the riskiest time period, the time period when first juvenile arrest is most likely to occur, is age 16. Thus, the answer to the first research question of “when are adolescents most at risk of first juvenile arrest?” is 16 years old. The hazard function displays the *unique* risk associated with each age period so the shape of the hazard function can be determined (Keiley et al., 2011; Keiley & Martin, 2005). For these juveniles, the risk of first juvenile arrest mostly increases until age 16 and then subsequently decreases. This pattern may not necessarily be due to the decline in juvenile arrests in general (just *first* juvenile arrest) because some of these juveniles may experience multiple arrests during and/or after the study.

The discrete-time survival function accumulates the period-by-period risks of *event nonoccurrence* over all time periods. The survival function ($\hat{S}(t_j)$; Table 3, column 6) is the complement of the hazard function and indicates the probability that a randomly selected juvenile will “survive” or *not* experience the event during that time period (given that he/she had not experienced an arrest during a previous time period). In other words, for any given discrete time period, it represents the probability that juvenile, *i*, will “survive” past time period, *j*, given previous survival. At the beginning of data collection, all are *survivors*. Thus, the value for any age prior to 9 years is 1.00 (100% of the sample are survivors). The survival function is calculated across all individuals using this formula: $\hat{S}(t_j) = \hat{S}(t_{j-1})[1-h(t_j)]$ and decreases toward zero over time and never increases (Keiley et al., 2011; Keiley & Martin, 2005). For example, in age period 17, the survival function is the estimated survival for age period 16 (0.9106) multiplied by 1 minus the estimated hazard in age period 17 (1-.0133), or .8985. This survival function indicates that, through age 17, 90% of the juveniles in the sample are still “surviving” because they have not experienced an arrest. Conversely, around 10% have experienced a juvenile arrest through age 17. The median life time, indicated by a survival function that is .50, is the time period by which half of the sample has experienced the event and half has not. In the LONGSCAN data, no median life time or “average” time to first juvenile arrest can be estimated because around 90% of the sample has *not* experienced the event by age 17. Median life times often cannot be estimated for target events that are rare; however, hazard functions, survival functions, and median life times can be estimated for subgroups

within a sample in order to provide useful information about these groups (Keiley et al., 2011; Keiley & Martin, 2005). Appendix A provides this life table information of age of first juvenile arrest by sex, maltreatment type, and race.

Table 3.

Life table describing the age at which children/adolescents were first arrested for a juvenile crime (N = 1,255)

Age in years	Number			Proportion	
	Participants at the beginning of the age period who had not been arrested (risk set)	Participants who were arrested for the first time during this age period	Censored at the end of the age period	Participants at the beginning of the age period who were arrested for the first time during this year (hazard function)	All respondents who still had not been arrested for the first time at the end of the age period (survival function)
Less than 9	1,255	--	--	--	1.0000
9	1,255	3	55	0.0024	0.9976
10	1,197	1	0	0.0008	0.9968
11	1,196	2	10	0.0017	0.9951
12	1,184	6	30	0.0051	0.9900
13	1,148	7	15	0.0061	0.9840
14	1,126	21	28	0.0187	0.9656
15	1,077	27	42	0.0251	0.9414
16	1,008	33	70	0.0327	0.9106
17	905	12	893	0.0133	0.8985

Discrete-Time Survival Analysis

Whether and when individuals are likely to experience a target event, and differences between groups, can be examined by estimating sample and hazard functions for subgroups denoted by potential predictors (in our study: sex, maltreatment type, race, and interactions). However, these descriptive comparisons are not as credible as formal statistical tests, making it difficult to account for the influence of sampling idiosyncrasy and generalize back to the population. Therefore, a formal statistical model of the discrete time hazard probability must be specified and then fit to the data (Keiley et al., 2011).

Creating a person-period data set. The first step in this process is to create a “person-period data set,” in which each person has one record for every time period *in which he/she is at risk of the event* (first arrest). These indicators (dummy variables, A_9-A_{17}) designate each of the nine ages (age 9 to age 17) at which a participant could be arrested for the first time. Each of these time indicators is set to 1 in the time period it represents and 0 in all other time periods. Additionally, an “*EVENT*” indicator, denoting event occurrence, was also created from the person-level “*CENSOR*” variable and the age of first arrest variable to serve as the *outcome* variable in the discrete time survival analysis. “*EVENT*” is coded 1 at the age in which an arrest occurred and 0 at each age in which an arrest did *not* occur. Once “*EVENT*” has been coded 1 (indicating an arrest), no additional records are included for that participant in the person-period data set. This juvenile who experiences his/her first arrest is, by definition, no longer at risk of subsequent first arrest and, therefore, drops out of the risk set for this event and out of the person-period data set (Keiley et al., 2011; Keiley & Martin, 2005). The set of time dummies (9 dichotomous variables representing ages 9-17) are used as initial predictors of the timing of event occurrence (“*EVENT*”) in discrete time hazard modeling. Appendix B illustrates the creation of the person-period data set from the person-level data set for selected participants. In the person-level data set, participant MW02784, an African-American male who experienced early compounded abuse and neglect, was arrested at 10 and thus not censored; therefore, in the person-period data set, his event variable is 0 in each of the age periods prior to age 10 but 1 at age 10. Then, after he experienced his first arrest, he is no longer at risk of first arrest ever again; therefore, he contributes no further records to the person-period data set. Similarly,

participant NW32556 was arrested at age 15 and not censored; therefore, in the person-period data set, her event variable is 0 in each of the age periods prior to age 15 but 1 at age 15 with no further records. For participant EA40015, who never experienced a juvenile arrest and thus was censored at age 17, the event variable is 0 in each age period from age 9 to age 17. In the case of participant MW01254, who attrited from the study, his last age of study participation was 12 and thus he was censored at age 12; therefore, in the person-period data set, the event variable is coded 0 but only for the age periods in which he was assessed and then no further records are included for him after age 12. Interactions of substantive predictors (e.g., sex, maltreatment type) with time and interactions of predictors with each other (e.g., sex and maltreatment type) are also included in our person-period data set. The hazard model then can be fit to the person-period data set using the logistic regression procedures starting with the baseline model and adding potential predictors one at a time: sex, sex*time, maltreatment type, maltreatment type*time, sex*maltreatment type, race, race*time, and race*maltreatment type.

Model specification assumptions. Based on previous findings and the rarity of first juvenile arrest, some juveniles in this high-risk population may not be at risk for the event, making survival analysis especially suitable because of the assumption that the population is composed of latent (unobserved) classes that differ in their hazard profiles, including latent classes that are not at risk at all for the event. The hypothesized statistical model for a discrete-time survival analysis describes the functional form, or shape, of the entire discrete hazard function over time, not just its value at any one time period alone. Since the hazard is a conditional probability, the value of the discrete time hazard must be between 0 and 1. A transformation of the hazard function is necessary in order to address the hazard's upper and lower limits of 0 and 1 (Keiley et al., 2011). Most often a logit transformation is suggested which prevents the possibility of implausible predicted values, as well as, makes comparable the distances between the hazard functions represented by different predictors (Cox, 1972). The *proportionality assumption* assumes that the distance between each of the logit hazard functions (expressed on a logit scale) for each value of the predictors will be identical within each time period, claiming that the logit hazard function itself would simply be shifted lower or higher for the predictor of interest, depending on

the values of the logit hazard estimates for that predictor (Singer & Willett, 2003). The *linear additivity assumption* assumes that, in the absence of an interaction with time itself, the shape of the logit hazard function is identical at all levels of each predictor (Keiley et al., 2011; Keiley & Martin, 2005). However, the *proportionality assumption* and *linear additivity assumption* were expected to be violated in this event history analysis since we hypothesized that the effects of certain predictors (i.e., sex, maltreatment type, and race) on risk of first juvenile arrest will vary across time/be different at different ages and have significant interactions with one another. If predictors significantly interact with time, this assumption should be relaxed to allow differently shaped discrete-time hazard functions to be estimated for different subgroups (Keiley et al., 2011). Violations of these assumptions often render interesting and useful findings that greatly add to the understanding of the profile of risk across time.

Model specification. The first model fit to the data, or “baseline model,” represents the logit hazard function when all of the predictors are set to zero and, ideally, does not impose any particular form on the shape of the baseline logit hazard function. Therefore, we quantify the size of the additive shift between the chosen baseline and the other function obtained with a one-unit increment in the predictor (a shift in the baseline). “A” is used to denote time dummies because, in our study, time is juveniles’ age. The set of dummy time indicators (A_9 - A_{17} ; age 9-age17) are used to designate each of the j discrete time periods wherein the event of interest can occur and this allows the baseline model to be flexible in shape. The statistical model to answer our main research question, “What is the relationship between the risk of first juvenile arrest in each time period (at each age) in which a juvenile could be arrested and the predictors in which we are interested?,” was specified. The representative equation is: $\text{logit } h(t_j) = (\alpha_1 A_1 + \alpha_2 A_2 + \dots + \alpha_j A_j) + (\beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p)$, where j is 1 to 9 signifying time periods and p is equal to the number of predictors in this analyses (sex, race, maltreatment). The initial time variable indicators (dummy variables; A_9 to A_{17}) can be thought of as a set of multiple intercepts, one per time period, that represent the baseline logit hazard function (the *baseline logit hazard profile*) when all the other predictors are zero. Our baseline model signifies a non-maltreated, male, European-American child with no maltreatment. The intercept parameter estimates, α_j , represent the log odds of event occurrence during

each separate time period, given that the event has not previously occurred. The part of the equation that includes the predictors other than time represents the shift in the baseline logit hazard function associated with the differences in corresponding predictors. The slope parameter estimates, β_p , define the effect of a one-unit difference in the specific predictor, controlling for the influence of all other predictors in the model. The population values of the outcome (now the logit-transformed hazard probability) in each discrete-time period are represented by the slope parameters associated with each of the dichotomous time predictors. Unit differences are interpreted within the scale of the predictor, same as in regression (Keiley et al., 2011; Keiley & Martin, 2005). In the case of dichotomous variables, a one unit difference is a “state” difference, such as the difference between males and females or differences among the four different maltreatment groups. The intercept parameter estimate during the first time period, α_0 , is the unconditional log odds of event occurrence in the first time period and α_{10} , the intercept parameter estimate during the second time period, represents the conditional log odds of event occurrence in the second time period, and so on (Keiley et al., 2011).

Fitting the logit hazard model. As previously described, the person-period data set was created featuring the appropriate “EVENT” indicator and our possible predictors. We use logistic regression with the person-period data set to regress the “censor indicator” on the multiple time indicators and the predictors. Predictors of interest are added one at a time. The results of fitting the taxonomy of survival models are included in Table 4. Our final equation included age, the interaction of sex and time (age), the interaction of maltreatment group and time (age), and the interaction of sex and maltreatment group.

Interpreting the Results

Comparison of models. In logistic regression, “good model fit” is indicated by a deviance statistic (-2 log likelihood) that is small with a non-significant p value. However, with large sample sizes, the deviance statistic is often significant and “good fit” can be difficult to establish because the null hypothesis of the deviance statistic model fit will likely be rejected. The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) can also be used to assess model fit and they correct the deviance statistic for the number of parameters (AIC) or for the sample size (AIC and BIC). These

criteria can be compared across models that are fit to the same data, even if they are not nested. Better model fit is indicated by smaller absolute values of these criteria (Keiley & Martin, 2005). Our predictors are added one at a time and the deviance statistics of two nested models are compared to determine whether their addition improves the model fit. Time-varying effects on risk are included by creating the interaction terms between the predictor of interest and time dummies (juveniles' age) in the fitted models and testing whether adding these effects improves prediction of risk. The effects of an interaction between variables (i.e., sex and maltreatment type) are tested in the same manner.

Table 4 includes the fit statistics and change-in-deviance statistics hypothesis tests that determine whether each addition improves the fit of the previous comparison model. Model 1 has no predictors other than time so it is the baseline group and represents all children (in high-risk U.S. communities). Each additional model was fit by adding one of the predictors or one of the interactions of the predictor with time; in each step the null hypothesis of 'the prediction of the likelihood of arrest by this/these variable(s) is (are) *not* zero in the population' was tested each time. If the delta deviance test was significant, the fitted results are true in the population across all time periods from nine to seventeen years old. As evident in Table 4, only predictors that make a moderately or greater significant contribution are retained in the model. Through our nested models, it was determined that any sexual abuse (SA) experience (M2) was not a significant predictor of risk of first juvenile arrest (Δ Deviance=1.81, $df=1$); thus, as expected, the SA group was not included in the analyses as one of the maltreatment groups (due to small SA group size and non-significance), but they remained in the data set. The interaction between sex and time is determined as a better fit (more accurate representation of risk) than sex alone (Δ Deviance=32.15, $df=9$, $p<.001$) which indicates that juveniles' sex has a different effect on risk at different ages. Similarly, the interaction among maltreatment group and time is determined as a better fit and better representation of risk than maltreatment group alone, when controlling for the effects of sex over time (Δ Deviance=38.05, $df=27$, $p<.10$). Thus, early maltreatment type has a different effect on juveniles' arrest risk at different ages. Due to our interest in how maltreatment experience may affect

certain juveniles differently, we tested for a significant interaction between juveniles' sex and maltreatment type. Results indicate that maltreatment group affects male and female juveniles differently ($\Delta\text{Deviance}=7.33$, $df=3$, $p<.10$). Next, we tested juveniles' race (M8); however, race was not a significant predictor of risk when taking into account previous interactions ($\Delta\text{Deviance}=3.43$, $df=2$). Neither the interaction between race and time (M9) ($\Delta\text{Deviance}=15.33$, $df=18$) nor the interaction between race and maltreatment type (M10) ($\Delta\text{Deviance}=9.68$, $df=6$) were significant contributions when controlling for all else in the previous model (M7). From this series of tests, Model 7 that includes the interaction between juveniles' sex and age, the interaction among maltreatment types and age, and the interaction among sex and maltreatment types was determined to be the best-fitting model because each of our predictors, added one at a time, are statistically significant predictors (based on the deviance-based hypothesis tests) and it has the lowest deviance statistic (1,050.55). Appendix C presents part of the parameter estimates for this final fitted model.

Table 4.

Results of fitting discrete-time hazard models to age of first juvenile arrest (N=10,096 Events)

	Model 1 (Baseline)	Model 2 (SA)	Model 3 (Sex)	Model 4 (Sex*Time)	Model 5 (Mal)	Model 6 (Mal*Time)	Model 7 (Sex*Mal)	Model 8 (Race)	Model 9 (Race*Time)	Model 10 (Race*Mal)
Goodness of Fit										
Deviance (-2LL)	1,128.08	1,126.27	1,109.83	1,095.93	1,091.94	1,057.88	1,050.55	1,047.12	1,035.22	1,040.87
<i>n</i> parameters	9	10	10	18	21	45	48	50	66	54
AIC	1,146.08	1,146.27	1,129.83	1,131.93	1,133.94	1,147.88	1,146.55	1,147.12	1,167.22	1,148.87
SC	1,211.06	1,218.47	1,202.03	1,261.89	1,285.56	1,472.78	1,493.10	1,508.11	1,643.73	1,538.74
Deviance-based hypothesis test (<i>df</i>)										
H ₀ : β _{SA} =0		1.81 (1)								
H ₀ : β _{Fem} =0			18.25*** (1)							
H ₀ : β _{Fem*Time} =0				32.15*** (9)						
H ₀ : β _{Mal} =0					3.99 (3)					
H ₀ : β _{Mal*Time} =0						38.05~ (27)				
H ₀ : β _{Fem*Mal} =0							7.33~ (3)			
H ₀ : β _R =0								3.43 (2)		
H ₀ : β _{R*Time} =0									15.33 (18)	
H ₀ : β _{R*Mal} =0										9.68 (6)

Note: All maltreatment is experienced prior to Age 8 assessment period. Baseline: A₉-A₁₇; SA, Sexual Abuse experience regardless of maltreatment group; Sex: Fem, Female=1, Male=0; Sex*Time: ft₉-ft₁₇; Mal, Maltreatment: PA, Physical Abuse group, PN, Physical Neglect group, AN, both PA and PN group; Mal*Time: pat₉-pat₁₇, pnt₉-pnt₁₇, ant₉-ant₁₇; Sex*Mal: F*PA, F*PN, F*AN; Race, R: AA, African-American; EA, European-American; Race*Time: aat₉-aat₁₇, eat₉-eat₁₇; Race*Mal: AA*PA, EA*PA, AA*PN, EA*PN, AA*PAPN, EA*PAPN.

Fit Statistics: -2LL, Deviance Statistic -2 Log Likelihood; AIC, Akaike Information Criterion; SC, Schwarz Criterion; ~ *p* < .10, *** *p* < .001

Fitted hazard and survival functions. Presenting plots of the fitted hazard and survival functions for prototypical juveniles is one of the most useful ways to interpret the effects of the predictors and the results of a fitted model. The hazard plot is constructed by substituting particular predictor values into the fitted model, calculating the predicted values of the logit hazard, and then transforming these into hazard values. Next, the fitted survival values are calculated from these hazard values in the same manner as building of the life table. Figure 1 presents a plot for the fitted survival and hazard functions from the baseline model fit to the LONGSCAN data. The downward slope of the estimated survival function plot in Figure 1 (upper panel) indicates, an increasing number of juveniles experience their first arrest over time (i.e., the function declines as fewer juveniles “survive,” or avoid arrest, over time). The fitted survival plot also makes it evident that an estimated median life time cannot be estimated since at no age point do more than half of the juveniles experience their first juvenile arrest. In fact, by age 17, barely more than one-tenth (10%) of the sample have been arrested. The fitted hazard plot in Figure 1 (lower panel) illustrates the answer to our first research question about the “riskiest” time for first arrest among juveniles in general. Overall, adolescents are most at risk for juvenile arrest at age 16, given they had not been arrested prior to that age. At age 16, more than 3% of the juveniles who had not yet been arrested were arrested. The risk for juvenile arrest increases from age 9 until age 16 then subsequently declines but not back to the original level—another 1.33% of those previously not arrested were arrested at age 17.

In answer to the second half of our research questions regarding the effects of the interactions of sex with age, maltreatment group with age, and sex with maltreatment group, we plotted the fitted survival and hazard values for our eight subgroups of interest from the final fitted model (Model 7, Table 4). It is important to note that these plots represent fitted functions, *not* sample estimates from an analysis of a subgroup of the sample since the sample was not divided into subgroups. The parameter estimates from a model fit to the entire sample in which constraints were imposed on the effects of particular predictors were used to create the plots for various subgroups which allows our survival analysis to be generalizable to the population (Keiley & Martin, 2005). Our main interest is male and female juveniles who experienced either no maltreatment, physical abuse, physical neglect, or compounded physical abuse

and neglect. Therefore, the two panels of Figure 2 (upper panel, males; lower panel, females) are the final fitted hazard plots that provide a graphical summary of the estimates from this final fitted model. It should be noted that these hazards are plotted on a smaller scale in order to highlight the differences among groups. Figure 3 presents these findings from the “survival” perspective. These two panels (upper panel, males; lower panel, females) indicate how long subgroups of children “survive” childhood/adolescence without experiencing an arrest.

What is most noticeable in these fitted plots are the time-varying and interaction effects of juveniles’ sex and maltreatment type. Although these juveniles, in general, are most at risk for first arrest at age 16 (Figure 1, lower panel); as seen in Figure 2, different subgroups of juveniles have significantly different “riskiest” ages for first arrest. The differential in times of greatest risk for different subgroups is the result of the interactions of sex with time and maltreatment type with time. On average, physically neglected males, as well as physically abused males, are more at risk than their female counterparts at every age. Males who experience early physical neglect have the earliest “riskiest” age at 15 years old, compared to all other males who are most at risk at 16 years old. Around 5% of physically neglected males who had not previously been arrested will be arrested during their 15th year. In addition, non-maltreated and physically neglected females have the earliest “riskiest” age at 15 years old, compared to females who have been physically abused and females who have experienced co-occurring abuse and neglect who are most at risk at 16 years old. Almost 2% of non-maltreated females and more than 2% of physically neglected females who had not previously been arrested will be arrested during their 15th year. A comparison of the male hazard functions (top) with the female hazard functions (bottom) illustrates that male juveniles are always at the greater risk compared to female juveniles at each age period. Even for juveniles who have not experienced maltreatment, more than 3% of non-maltreated males who had not been arrested prior to age 16 will be arrested during their 16th year compared to less than 1% of non-maltreated females who had not been arrested prior, controlling for all else in the model. The sex and maltreatment type interaction effect is also quite noticeable in the fitted hazard and survival plots. The most noteworthy risk exists for physically abused males during their 16th year with almost 10% of these

adolescents being arrested, given no previous arrest. For females, the most noteworthy risk exists during the 16th year for females who were both physically abused and neglected with around 5% of these adolescents being arrested, given no previous arrest.

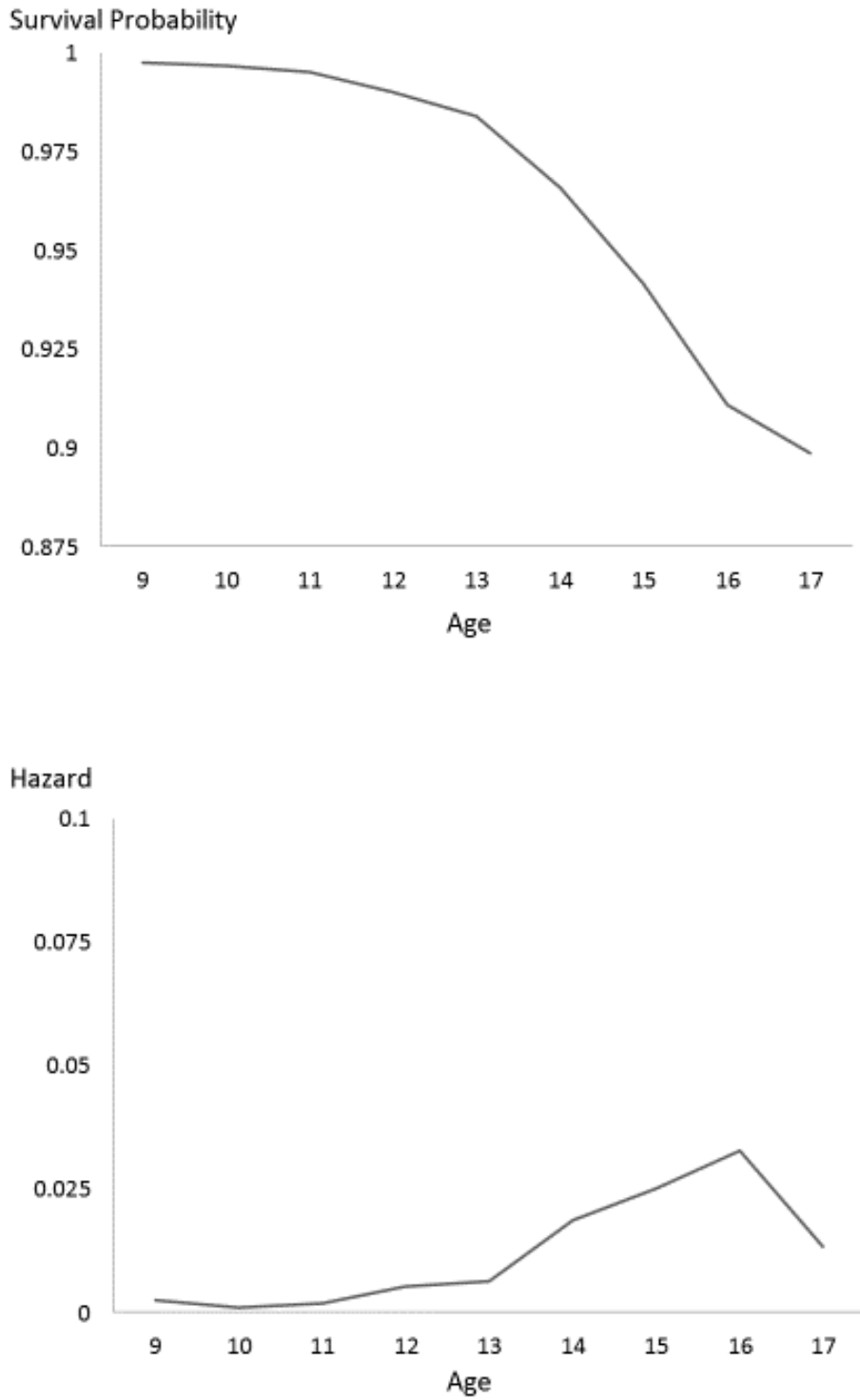


Figure 1. Fitted baseline survival (top) and hazard (bottom) functions for the discrete-time survival analysis with a general specification of time (9 age dummies; $N = 1,255$).

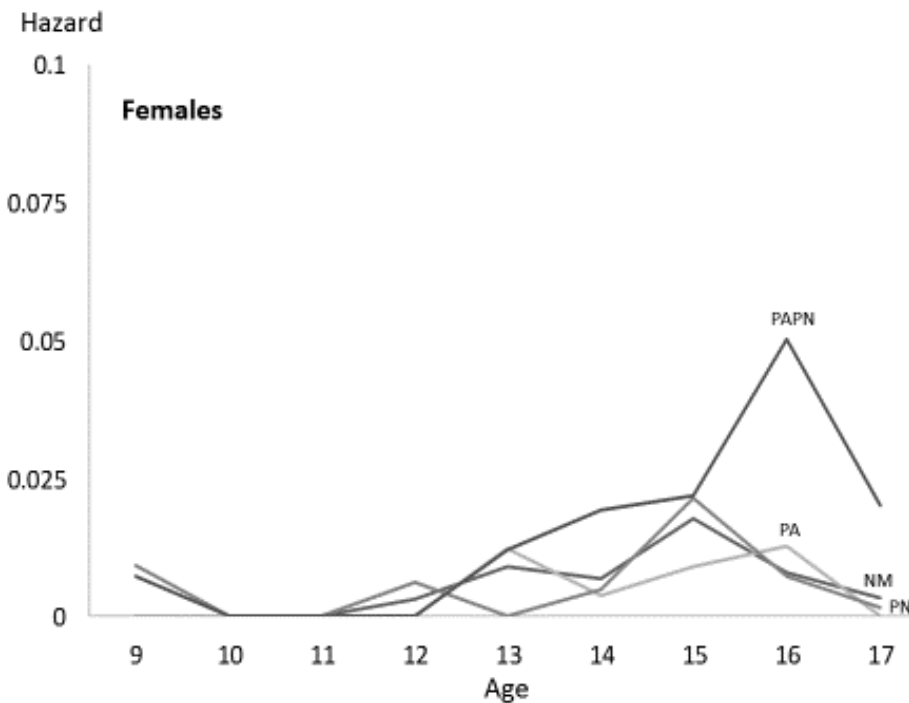
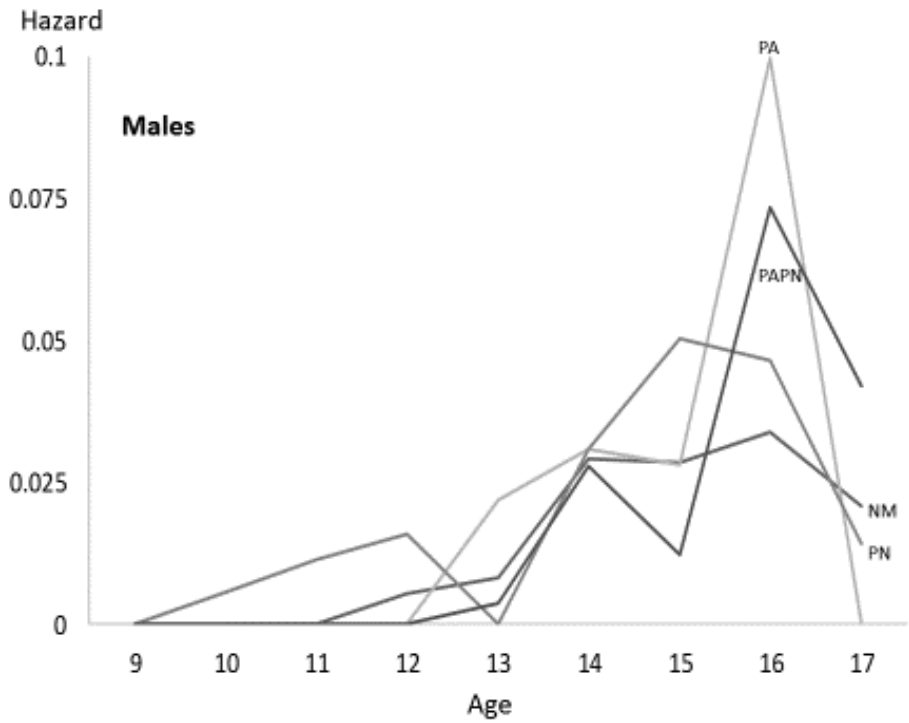


Figure 2. Fitted hazard functions for the final fitted model predicting risk of first juvenile arrest by the interaction of juvenile's sex with age, juvenile's maltreatment type (NM, PA, PN, PAPAN) with age, and juvenile's sex with maltreatment type in subgroups of juveniles [males (top) and females (bottom)] ($N = 1,255$).

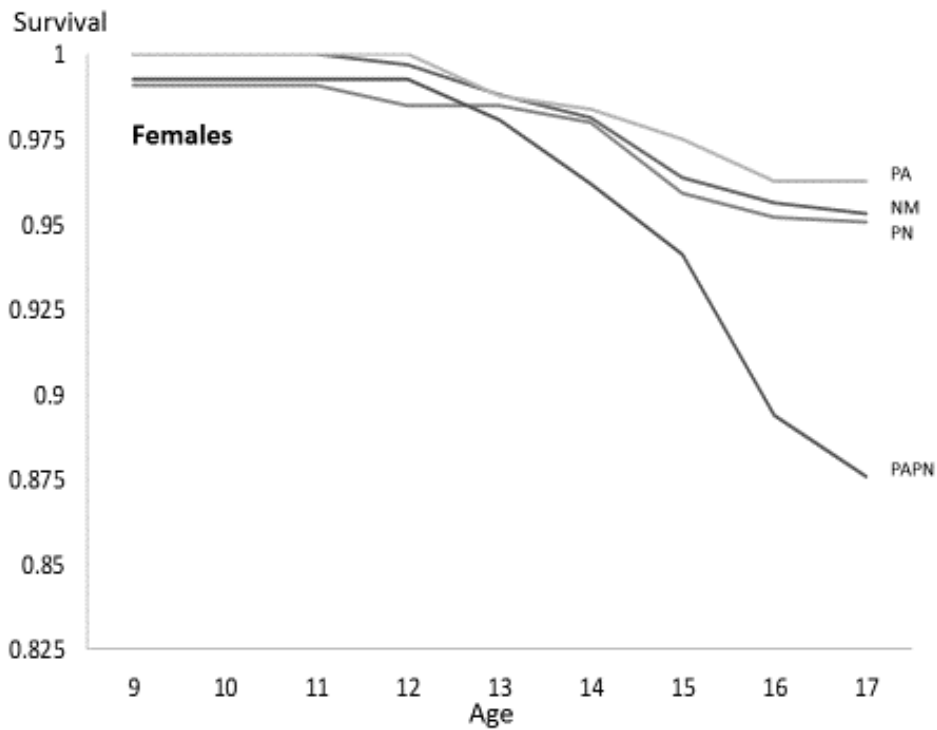
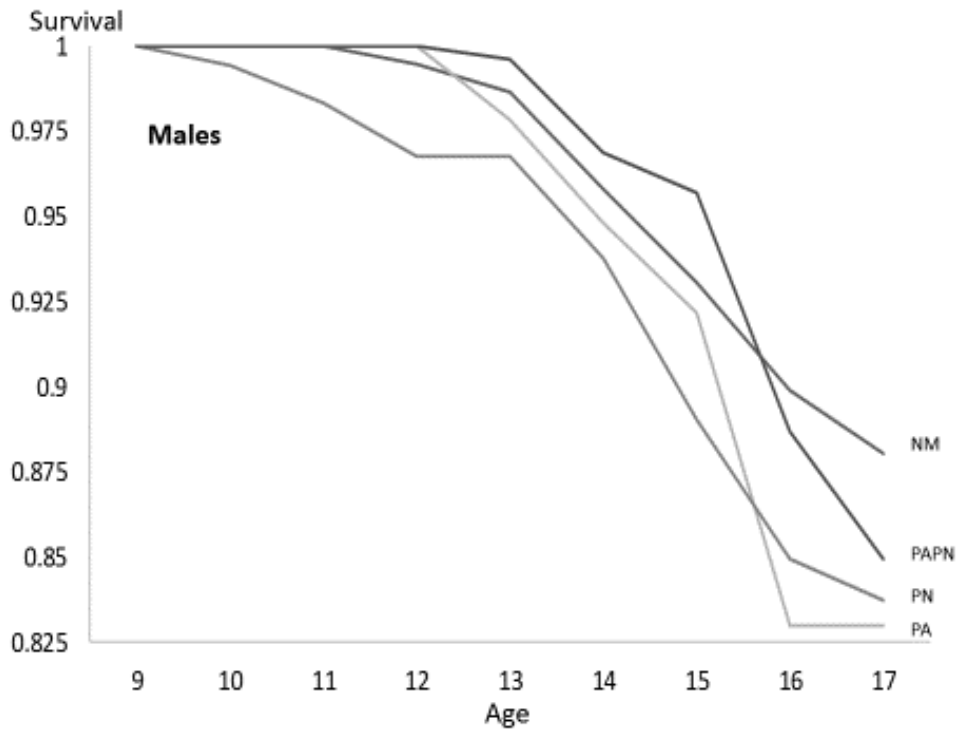


Figure 3. Fitted survival functions for the final fitted model predicting risk of first juvenile arrest by the interaction of juvenile's sex with age, juvenile's maltreatment type (NM, PA, PN, PAPAN) with age, and juvenile's sex with maltreatment type in subgroups of juveniles [males (top) and females (bottom)] ($N = 1,255$).

Discussion

The survival analysis of the LONGSCAN data in which the effects of the interaction between juveniles' sex and maltreatment type were estimated while controlling for the interaction between sex and age and the interaction between maltreatment type and age, produced interesting findings, several of which greatly extend previous research in this area. First, we aimed to reproduce main effects findings from two previous survival analyses using a different sample of at-risk youth. Using the high-risk LONGSCAN sample, we found the *riskiest* age of *first* juvenile arrest is age 16 as opposed to younger previous findings of age 14 (Vazsonyi & Chen, 2010) or age 15 (Keiley & Martin, 2005).

Overall, our findings supported previous research that indicates that male youth are more likely to be associated with juvenile arrest than female youth (Chiu et al., 2011; Currie & Tekin, 2006) because we found that males, on average, were at greater risk of arrest compared to females at every age. We also found that, overall, maltreated children have a greater average risk of arrest compared to non-maltreated children which also supports previous findings. Our results indicate the earliest risk of arrest for maltreated children are at ages 9 and 10. This finding replicates what Keiley and Martin (2005) found in re-analyzing the Widom and White (1997) data as well as the Vazsonyi and Chen (2010) results where they determined that the risk of arrest at age 9 and 10 was approximately 1%. A major innovation of our study is that we examine the effects of maltreatment type in the context of age, sex, and race. We extend previous work by testing the effects of specific maltreatment types, testing time-varying effects of the predictors, and testing the possible interactions among these predictors. The effects of juveniles' sex, as well as maltreatment type, are significantly different at different ages. Overall, physically neglected males are most at risk of arrest for the first time at 15 years old compared to all other males (who are most at risk at age 16) but physically abused 16 year-old males have the highest risk of all juveniles. Our finding fits with previous research that indicates that males are at the greatest risk of juvenile arrest (Vazsonyi & Chen, 2010) and that maltreatment (abuse and/or neglect) elevates risk (Keiley & Martin, 2005). Most noteworthy, the effects of physical abuse, physical neglect, and compounded abuse and neglect on males and females are significantly different from one another.

We added to the literature because our findings went beyond these previously identified main effects results by testing and finding a true interaction effect among juveniles' sex and maltreatment type on risk of first juvenile arrest. There have been indications in the literature that females may be more vulnerable than males to negative effects of maltreatment experience (e.g., greater effect of physical abuse on aggression and/or violent crime arrests; Herrera & McCloskey, 2001; Lansford et al., 2002); however, our study is the first to identify this sex with maltreatment type interaction effect. Females who have experienced compounded physical abuse and neglect experience the greatest risk, especially pronounced at 16 years old, compared to females who have experienced only one early maltreatment type or no maltreatment at all. Our findings fit with previous research that indicates more detrimental effects of abuse and/or neglect on females' delinquency and arrest experience (e.g., greater effect of physical abuse on aggression and/or violent crime arrests for females, Herrera & McCloskey, 2001; Lansford et al., 2002; abuse and neglect on violent crime arrest, Makarios, 2007; Widom & White, 1997) and more female youth with significantly higher rates of abuse and neglect experiences than male youth in the juvenile justice system (McCabe et al., 2002). Since previous research has identified more harmful maltreatment effects on violent arrest history for females, it is logical that compounded maltreatment has a stronger effect on females' first arrest than on males' and that compounded maltreatment has a greater effect than abuse or neglect alone. There are many potential explanations for these findings. Some researchers have speculated that males and females have different reactions to stress that may influence their criminal behavior (Thompson et al., 2004). In terms of physical abuse, some researchers have speculated that abuse may be more tolerated by males than females (Widom & White, 1997) which may influence how boys and girls adjust to abuse. As previously indicated, females who experience an out-of-home placement have the highest risk of incarceration compared to male counterparts (Johnson-Reid & Barth, 2000). Theoretically, compounded maltreatment is more likely due to child welfare service involvement and out-of-home placement (although this was not explicitly measured in our study). This may be one of the potential explanations for females in our sample who experience compounded maltreatment appearing to have the highest risk of first juvenile arrest compared to other high-risk

females. Although our study does not directly address reasons for these sex differences, our findings suggest the importance of further examination of the interaction among youth's sex and specific maltreatment type.

Another major finding is actually a non-significant finding. Despite the plethora of information on juveniles' race and arrest history, these findings are not replicated in our study. A well-documented disproportionate minority representation among African-American youth exists in the juvenile justice system (OJJDP, 2013) and many studies indicate African-American youth are more likely than European-American youth to experience a juvenile arrest (Chiu et al., 2011). In fact, two previous survival analyses also found race to be a significant predictor of first juvenile arrest/entry into the juvenile justice system with Hispanic youth at an elevated risk (Vazsonyi & Chen, 2010) or African-American youth at a greater risk than European-American youth at every age, even when controlling for sex and maltreatment status alone (non-abused vs. abused) (Keiley & Martin, 2005). However, in our study, juveniles' race was not a significant predictor of first juvenile arrest when taking into account the interaction effects of juveniles' sex with age, maltreatment type with age, and sex with maltreatment type. In fact, even when an interaction effect of race with age and race with maltreatment type were tested in this model, juveniles' race still had no significant effect on risk of first juvenile arrest for this high-risk sample. Our study does support previous findings that identified no racial differences in the effects of child abuse on females' criminal arrest when examining interactions among child abuse, race, and violent criminal arrest in females (Makarios, 2007). We believe this is indicative of the need to study the effects of race in the context of other factors that are known to influence juvenile arrest, including but not limited to age, sex, and maltreatment experience(s). This is especially relevant since African-American youth have been shown to display and experience more risk factors across several domains (as opposed to race alone) that exacerbate the negative effects of maltreatment on delinquency and crime for them (Fite, Wynn, & Pardini, 2009). The method of assessment of delinquency also may influence study results.

Due to our method of analysis, our results are generalizable to a U.S. population of high-risk youth from low-income, mostly single-mother headed families who receive some form of public

assistance. Survival analysis is the best method of analyzing rare event occurrence in a population (Keiley et al., 2011; Singer & Willett, 2003). Another study limitation is a high attrition rate of the juvenile sample. However, censoring of these juveniles provides an appropriate way to handle attrition in analyses. Another study limitation is that juvenile arrest is assessed by primary caregiver-report as opposed to juvenile justice records; however, primary caregivers should be accurate reporters of their children's arrest history since guardians are notified of juvenile crimes. Additionally, we were unable to include sexual abuse as a maltreatment group due to the few number who experienced sexual abuse. In one way, that is good, but in many communities large numbers of sexually abused children exist and it would be important to examine what the risk of arrest is for those children. Widom and Massey (2015) empirically investigated later sexual offending of maltreated children and found the hypothesis of childhood sexual abuse predicting sexual offense perpetration was not supported. Perhaps the same is true for other offenses and more empirical studies should be conducted examining risk development of sexually abused youth compared to other types of maltreated youth. Additionally, there are likely other childhood factors or experiences that were unexamined in this study (e.g., domestic violence exposure, parental alcohol/substance use) that may influence juvenile arrest experience or partially account for maltreatment type and sex differences. Despite these limitations, our study contributes to this research area and findings because it is the first to address how developmental risk of first juvenile arrest changes between 9 and 17, how juveniles' sex, as well as, maltreatment group have time-varying effects during these years, and how male and female juveniles' risk is affected differently by their type of maltreatment experience.

The major strength of our study is our methodological approach. As previously mentioned, a major advantage of survival analysis over previous strategies for analyzing event data is that, regardless of whether they do (not censored) or do *not* experience an arrest (censored), all participants are included in the analyses which is very useful for rare events. Questions regarding juvenile justice involvement have most often been addressed using familiar methods of investigation such as multiple regression, analysis of variance, or structural equation modeling. However, none of these methods indicate when children are most at risk for juvenile arrest or the unique contributions of certain factors to the risk of an earlier arrest

age. These methods are problematic and ill-fitting for certain event occurrence questions like “When are juveniles first arrested?” Survival analysis is best used to answer questions about whether and when events are likely to occur and what predicts those occurrences; thus, is the best analysis method for our research questions.

Our study replicates scant research on this topic of first juvenile arrest risk (e.g., Keiley & Martin, 2005). Our examination of the interactions of child and environmental characteristics with age provides a clearer picture of high-risk American youth and helps identify juvenile subgroups most at risk for the earliest arrests and in need of the earliest preventions. In order to develop effective prevention and intervention strategies, this better understanding of the differential influence of abuse and neglect on juvenile arrest for males and females at different ages may be useful. Our findings indicate youth of all races are at risk for juvenile arrest and that their age, sex, and maltreatment type are characteristics that most influence their risk. A great focus on race and arrest has existed in the literature; however, our focus may need to shift to the effects of sex and maltreatment differences in the context of race. We encourage future studies to conduct a survival analysis to time of first juvenile arrest in a different population and examine whether race has a significant effect when controlling for the time-varying effects of juveniles’ sex, maltreatment experience, and their interaction. Future directions may also include a “multiple spells” survival analysis (see Willett & Singer, 1995) to model time to subsequent arrest for juveniles (e.g., time to second or third arrest). A “multiple spells” survival analysis should be especially useful to identify arrest patterns for the children arrested at the youngest ages because they may experience multiple arrests during their youth.

General Conclusion

Numerous studies have found associations among early adverse risks such as child maltreatment and/or poor maternal health and behavioral, physical and mental health, and/or criminal outcomes (Gilbert et al., 2009; Lansford et al., 2002); however, these relationships are not always examined in the same studies or samples and less is known about the potential underlying processes by which maternal health affects juveniles' later physical and mental health. Even fewer studies have investigated how paths among these constructs may be different based on juveniles' maltreatment status. Additionally, many methodological limitations in studies addressing the effects of early child maltreatment on risk of juvenile arrest exist (Keiley & Martin, 2005). Our studies substantially contribute to this research on the long-term effects of child maltreatment in these two separate but related areas (health and criminal outcomes). Study one utilized SEM and multi-domain growth modeling to test the potential mediation of the relationship between early poor maternal health and poor adolescent physical and mental health outcomes by changes in aggression, withdrawal, and social problems during middle childhood. Study two was the first survival analysis that found time-varying effects of youths' sex, time-varying effects of specific maltreatment type (physical abuse, physical neglect, and compounded physical abuse and neglect), and effects of the interaction between sex and maltreatment type on first juvenile arrest. Both studies examined complex longitudinal models in a population of typically understudied high-risk youth from mainly low-income, single-parent families across the United States.

Taken together, findings from both studies assist in providing a more thorough understanding of the developmental pathways for maltreated children compared to non-maltreated children. These studies shed light on the influence of child maltreatment on major behavioral, physical and mental health, and criminal outcomes for different subgroups of juveniles. When considering the findings from study one separately from the findings from study two, it appears that children's sex has no effect on the

relationships between early maternal health and children's behavioral development or adolescent physical and mental health outcomes. However, study two indicates important time-varying sex differences in the prediction of juvenile arrest experience. Juveniles' sex may be a more important indicator for risk of criminal outcomes than risk of poor physical and mental health during adolescence. Both studies also revealed different developmental pathways for certain non-maltreated and maltreated children. Study one indicates many life course similarities but a few developmental pathway differences between non-maltreated and maltreated children especially regarding how early maternal health influences middle childhood behavioral growth and, in turn, influences adolescent physical and mental health outcomes. Study two identified major differences by specific maltreatment types (non-maltreated, physically abused, physically neglected, and both physically abused and neglected) and cumulative risks that put certain juvenile subgroups at greater risk for the earliest arrests based on their sex and maltreatment type.

In summary, we use sound methodologies to further elucidate the complex relationships among child maltreatment, early maternal health, child characteristics, and mental and physical health and criminal outcomes. Collectively, the studies demonstrate that early adverse risks have important implications for behavioral, physical and mental health, and criminal outcomes for both non-maltreated and maltreated juveniles. Our elucidation of a potential mechanism affecting adolescent physical and mental health, as well as, true interaction effects that predict age of first arrest may prove useful in improving services that high-risk children receive to combat the deleterious effects of early adverse experiences. The current dissertation sheds light on the complex manner by which child characteristics and environmental risk factors have a long-term influence on youth outcomes in separate but related domains. We believe this information can help inform developmental models of risk leading to health problems and criminal outcomes and help influence interventions by our elucidation of potential mechanisms or subgroups of juveniles as targets for interventions. Maternal caregiver health-focused and child behavior-focused prevention and intervention services may be useful to ameliorate youth's behavior and health problems during childhood, adolescence, and early adulthood. Additionally, young females who have experienced compounded physical abuse and neglect appear to experience a cumulative effect

on their risk of first arrest making them a very important subgroup for prevention efforts to reduce criminal outcomes.

References

- Achenbach, T.M. (1991). *Manual for Child Behavior Checklist/4-18 and 1991 Profile*. Burlington, VT: University of Vermont Department of Psychiatry.
- Albright, M.B., & Tamis-LeMonda, C.S. (2002). Maternal depressive symptoms in relation to dimensions of parenting in low-income mothers. *Applied Developmental Science, 6*, 24-34. 11111
- Alink, L.R.A., Cicchetti, D., Kim, J., & Rogosch, F.A. (2009). Mediating and moderating processes in the relation between maltreatment and psychopathology: Mother-child relationship quality and emotion regulation. *Journal of Abnormal Child Psychology, 37*, 831-843. doi: 10.1007/s10802-009-9314-4
- Alltucker, K.W., Bullis, M., Close, D., & Yovanoff, P. (2006). Different pathways to juvenile delinquency: Characteristics of early and later starters in a sample of previously incarcerated youth. *Journal of Child and Family Studies, 15*, 475-488.
- Arnow, B.A. (2004). Relationships between childhood maltreatment, adult health and psychiatric outcomes, and medical utilization. *Journal of Clinical Psychiatry, 65*, 10-15.
- Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.
- Barnett, D., Manly, J.T., & Cicchetti, D. (1993). Defining child maltreatment: The interface between policy and research. *Child abuse, child development, and social policy, 8*, 7-73.
- Baron, R.M., & Kenny, D.A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.
- Biederman, J., Faraone, S.V., Hirshfeld-Becker, D.R., Friedman, D., Robin, J.A., & Rosenbaum, J.F. (2001). Patterns of psychopathology and dysfunction in high-risk children of parents with panic disorder and major depression. *The American Journal of Psychiatry, 158*, 49-57.

- Blanchard-Dallaire, C., & Hébert, M. (2014). Social relationships in sexually abused children: Self-reports and teachers' evaluation. *Journal of Child Sexual Abuse, 23*, 326-344.
- Bonomi, A.E., Cannon, E.A., Anderson, M.L., Rivara, F.P., & Thompson, R.S. (2008). Association between self-reported health and physical and/or sexual abuse experienced before age 18. *Child Abuse & Neglect, 32*, 693-701.
- Brewerton, T.D. (2007). Eating disorders, trauma, and comorbidity: Focus on PTSD. *Eating Disorders, 15*, 285-304.
- Centers for Disease Control and Prevention (CDC). (2014a). About BMI for adults. Available from: http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html
- Centers for Disease Control and Prevention (CDC). (2014b). Youth Risk Behavior Surveillance—United States, 2013. Available from: <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6304a1.htm>
- Chase, N.D., Deming, M.P., & Wells, M.C. (2007). Parentification, parental alcoholism, and academic status among young adults. *The American Journal of Family Therapy, 26*, 105-114.
- Chen, W., Propp, J., deLara, E., & Corvo, K. (2011). Child neglect and its association with subsequent juvenile drug and alcohol offense. *Child and Adolescent Social Work Journal, 28*, 273-290.
- Chiu, Y.L., Ryan, J.P., & Herz, D.C. (2011). Allegations of maltreatment and delinquency: Does risk of juvenile arrest vary substantiation status? *Children and Youth Services Review, 33*, 855-860.
- Cicchetti, D. (2013). Annual research review: Resilient functioning in maltreated children—Past, present, and future perspectives. *Journal of Child Psychology and Psychiatry, 54*, 402-422.
- Cicchetti, D., & Rogosch, F.A. (1997). The role of self-organization in the promotion of resilience in maltreated children. *Development and psychopathology, 9*, 797-815.
- Cicchetti, D., & Toth, S.L. (2005). A developmental psychopathology perspective on child abuse and neglect. *Journal of the American Academy of Child & Adolescent Psychiatry, 34*, 541-565.
- Cicchetti, D., & Toth, S.L. (2009). The past achievements and future promises of developmental psychopathology: The coming of age of a discipline. *Journal of Child Psychology and Psychiatry, 50*, 16-25.

- Coddington, R.D. (1972). The significance of live events as etiologic factors in the diseases of children—
II: A study of normal population. *Journal of Psychosomatic Research*, 16, 205-213.
- Cooper, C., Bebbington, P.E., Meltzer, H., Bhurgra, D., Brugha, T., Jenkins, R., Farrell, M., & King, M. (2008). Depression and common mental disorders in lone parents: Results of the 2000 National Psychiatric Morbidity Survey. *Psychological Medicine*, 38, 335-342.
- Côté, S.M., Vaillancourt, T., LeBlanc, J.C., Nagin, D.S., & Tremblay, R.E. (2006). The development of physical aggression from toddlerhood to pre-adolescence: A nation wide longitudinal study of Canadian children. *Journal of Abnormal Child Psychology*, 34, 71-85.
- Cogle, J.R., Timpano, K.R., Sachs-Ericsson, N., Keough, M.E., & Riccardi, C.J. (2010). Examining the unique relationships between anxiety disorders and childhood physical and sexual abuse in the National Comorbidity Survey-Replication. *Psychiatry Research*, 177, 150-155.
- Cox, D.R. (1972). Regression models and life tables. *Journal of the Royal Statistical Society*, B34, 187-220.
- Cox, M.J., Mills-Koonce, R., Propper, C., & Gariépy, J.L. (2010). Systems theory and cascades in developmental psychopathology. *Development and Psychopathology*, 22, 497-506.
- Cummings, E.M., Keller, P.S., & Davies, P.T. (2005). Towards a family process model of maternal and paternal depressive symptoms: Exploring multiple relations with child and family functioning. *Journal of Child Psychology and Psychiatry*, 46, 479-489.
- Currie, J., & Tekin, E. (2006). Does child abuse cause crime? National Bureau of Economic Research, Working Paper No. 12171. Retrieved from <http://www.nber.org/papers/w12171>
- Danese, A., & Tan, M. (2014). Childhood maltreatment and obesity: Systematic review and meta-analysis. *Molecular Psychiatry*, 19, 544-554. doi: 10.1038/mp.2013.54
- Dubowitz, H. (2007). Understanding and addressing the “neglect of neglect:” Digging into the molehill. *Child Abuse and Neglect*, 31, 603-606.

- Dunkley, D.M., Masheb, R.M., & Grilo, C.M. (2010). Childhood maltreatment, depressive symptoms, and body dissatisfaction in patients with Binge Eating Disorder: The mediating role of self-criticism. *International Journal of Eating Disorders, 43*, 274-281. doi: 10.1002/eat.20796
- English, D.J., Upadhyaya, M.P., Litrownik, A.J., Marshall, J.M., Runyan, D.K., Graham, J.C., & Dubowitz, H. (2005). Maltreatment's wake: The relationship of maltreatment dimensions to child outcomes. *Child Abuse & Neglect, 29*, 597-619.
- Ewing, J.A. (1984). Detecting alcoholism: The CAGE Questionnaire. *The Journal of the American Medical Association, 252*, 1905-1907.
- Fang, X., Brown, D.S., Florence, C.S., & Mercy, J.A. (2012). The economic burden of child maltreatment in the United States and implications for prevention. *Child Abuse & Neglect, 36*, 156-165.
- Felitti, V.J., Anda, R.F., Nordenberg, D., Williamson, D.F., Spitz, A.M., Edwards, V., Koss, M.P., & Marks, J.S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventative Medicine, 14*, 245-258.
- Fergusson, D.M., Boden, J.M., & Horwood, L.J. (2008). Exposure to childhood sexual and physical abuse and adjustment in early adulthood. *Child Abuse & Neglect, 32*, 607-619.
- Fite, P.J., Wynn, P., & Pardini, D.A. (2009). Explaining discrepancies in arrest rates between black and white male juveniles. *Journal of Consulting and Clinical Psychology, 77*, 916-927.
- Fitzgerald, M.M., Schneider, R.A., Salstrom, S., Zinzow, H.M., Jackson, J., & Fossel, R.V. (2008). Child sexual abuse, early family risk, and childhood parentification: Pathways to current psychosocial adjustment. *Journal of Family Psychology, 22*, 320-324.
- Flaherty, E.G., Thompson, R., Litrownik, A.J., Theodore, A., English, D.J., Black, M.M., ...Dubowitz, H. (2006). Effect of early childhood adversity on child health. *Archives of Pediatrics and Adolescent Medicine, 160*, 1232-1238.

- Flaherty, E.G., Thompson, R., Litrownik, A.J., Zolotor, A.J., Dubowitz, H., Runyan, D.K., English, D.J., & Everson, M.D. (2009). Adverse childhood exposures and reported child health at age 12. *Child Mental Health, 9*, 150-156. doi: 10.1016/j.acap.2008.11.003
- Ghate, D., & Hazel, N. (2002). *Parenting in poor environments: Stress, support and coping*. London: Jessica Kingsley Publishers.
- Gilbert, R., Widom, C.S., Browne, K., Fergusson, D., Webb, E., & Janson, S. (2009). Burden and consequences of child maltreatment in high-income countries. *Lancet, 373*, 68-81.
- Goodman, S.H., Rouse, M.H., Connell, A.M., Broth, M., Hall, C.M., & Heyward, D. (2011). Maternal depression and child psychopathology: A meta-analytic review. *Clinical Child and Family Psychology Review, 14*, 1-27. doi: 10.1007/s10567-010-0080-1
- Goodman, S.H., & Tully, E. (2006). Depression in women who are mothers. In C.L.M. Keyes & S.H. Goodman (Eds.), *Women and depression: A handbook for the social, behavioral, and biomedical sciences* (pp. 241-280). New York, NY: Cambridge University Press.
- Goodman, S.H., & Tully, E. (2008). Children of depressed mothers: Implications for the etiology, treatment, and prevention of depression in children and adolescents. In J.R.Z. Abela & B.L. Hankin (Eds.), *Handbook of depression in children and adolescents* (pp. 415-440). New York, NY: Guilford Press.
- Goodwin, R.D., Fergusson, D.M., & Horwood, L.J. (2004). Early anxious/withdrawn behaviours predict later internalizing disorders. *The Journal of Child Psychology and Psychiatry, 45*, 874-883.
- Grogan-Kaylor, A., & Otis, M.D. (2003). Adult criminality: A tobit regression analysis. *Child Maltreatment, 8*, 129-137.
- Hammen, C., & Brennan, P.A. (2003). Severity, chronicity, and timing of maternal depression and risk for adolescent offspring diagnoses in a community sample. *Archives of General Psychiatry, 60*, 253-258.

- Hennepin County Attorney's Office. (1995). Delinquents under 10 in Hennepin County: A statistical analysis and practices and experiences of police jurisdiction. Minneapolis, MN: Hennepin County Attorney's Office.
- Herrera, V.M., & McCloskey, L.A. (2001). Gender differences in the risk for delinquency among youth exposed to family violence. *Child Abuse & Neglect*, 25, 1037-1051.
- Herrenkohl, T.I., Hong, S., Klika, J.B., Herrenkohl, R.C., & Russo, M.J. (2012). Developmental impacts of child abuse and neglect related to adult mental health, substance use, and physical health. *Journal of Family Violence*, 28, 191-199.
- HHS [U.S. Department of Health and Human Services], Administration for Children and Families, Administration on Children, Youth and Families, Children's Bureau (2014). *Child maltreatment 2012*. Available from <http://www.acf.hhs.gov/sites/default/files/cb/cm2012.pdf>
- Hildyard, K.L., & Wolfe, D.A. (2002). Child neglect: Developmental issues and outcomes. *Child Abuse and Neglect*, 26, 679-695.
- Hooper, L.M. (2007). The application of attachment theory and family systems theory to the phenomena of parentification. *The Family Journal: Counseling and Therapy for Couples and Families*, 15, 217-223.
- Hooper, L.M., Marotta, S.A., & Lanthier, R.P. (2008). Predictors of growth and distress following childhood parentification: A retrospective exploratory study. *Journal of Child and Family Studies*, 17, 693-705.
- Irish, L., Kobayashi, I., & Delahanty, D.L. (2010). Long-term physical health consequences of childhood sexual abuse: A meta-analytic review. *Journal of Pediatric Psychology*, 35, 450-461.
- Jaffee, S.R. (2005). Family violence and parent psychopathology: Implications for children's socioemotional development and resilience. In S. Goldstein & R. Brooks (Eds.), *Handbook of resilience in children* (pp. 149-163). New York: Kluwer.

- Jaffee, S.R., Caspi, A., Moffitt, T.E., Polo-Tomas, M., & Taylor, A. (2007). Individual, family, and neighborhood factors distinguish resilient from non-resilient maltreated children: A cumulative stressors model. *Child Abuse & Neglect, 31*, 231-253. doi: 10.1016/j.chiabu.2006.03.011
- Johnson-Reid, M., & Barth, R.P. (2000). From maltreatment report to juvenile incarceration: The role of child welfare services. *Child Abuse & Neglect, 4*, 505-520.
- Jones, R.A., & Wells, M. (1996). An empirical study of parentification and personality. *American Journal of Family Therapy, 24*, 145-152.
- Jurkovic, G.J. (2007). *Lost childhoods: The plight of the parentified child*. Routledge.
- Kahn, R.S., Zuckerman, B., Bauchner, H., Homer, C.J., & Wise, P.H. (2002). Women's health after pregnancy and child outcomes at age 3 years: A prospective cohort study. *American Journal of Public Health, 92*, 1312-1318.
- Keenan, K., Tremblay, R.E., Coie, J.D., Herrenkohl, T.I., Loeber, R., & Petechuk, D. (2003). *Risk and protective factors of child delinquency*. Washington: US Department of Justice, Office of Justice Programs, Office of Juvenile Justice and Delinquency Prevention.
- Keiley, M.K., Kirkland, C., Zaremba, A., & Jackson, A.A. (2011). Hazard, event history, and survival modeling. In B. Laursen, T.D. Little, & N.A. Card, (Eds.), *Handbook of Developmental Research Methods* (pp. 364-382). New York: Guilford Publications.
- Keiley, M.K., & Martin, N.C. (2005). Survival analysis in family research. *Journal of Family Psychology, 19*, 142-156.
- Keller, P.S., Cummings, E.M., Davies, P.T., & Mitchell, P.M. (2008). Longitudinal relations between parental drinking problems, family functioning, and child adjustment. *Development and Psychopathology, 20*, 195-212.
- Kessler, R.C. (2006). The epidemiology of depression among women. In C.L.M. Keyes & S.H. Goodman (Eds.), *Women and depression: A handbook for the social, behavioral, and biomedical sciences* (pp. 22-37). New York, NY: Cambridge University Press.

- Kessler, R.C., Chiu, W.T., Demler, O., & Walters, E.E. (2010). Prevalence, severity, and comorbidity of twelve-month DSM-IV disorders in the National Comorbidity Survey Replication (NCS-R). *Archives of General Psychiatry*, *62*, 617-627.
- Kim, J., & Cicchetti, D. (2010). Longitudinal pathways linking child maltreatment, emotion regulation, peer relations, and psychopathology. *Journal of Child Psychology and Psychiatry*, *51*, 706-716.
- Lansford, J.E., Dodge, K.A., Pettit, G.S., Bates, J.E., Crozier, J., & Kaplow, J. (2002). A 12-year prospective study of the long-term effects of early child physical maltreatment on psychological, behavioral, and academic problems in adolescence. *Archives of Pediatrics and Adolescent Medicine*, *156*, 824-830. doi: 10.1001/archpedi.156.8.824
- Lansford, J.E., Miller-Johnson, S., Berlin, L.J., Dodge, K.A., Bates, J.E., & Pettit, G.S. (2007). Early physical abuse and later violent delinquency: A prospective longitudinal study. *Child Maltreatment*, *12*, 233-245.
- Leve, L.D., & Chamberlain, P. (2004). Female juvenile offenders: Defining an early-onset pathway for delinquency. *Journal of Child and Family Studies*, *13*, 439-452.
- Litrownik, A. (2009). LONGSCAN measures selection, construction, and use presentation [PowerPoint Slides]. Retrieved from National Data Archive on Child Abuse and Neglect:
http://www.ndacan.cornell.edu/ndacan/User_Support/LONGSCAN_Support.html
- Loeber, R., & Farrington, D.P. (2000). Young children who commit crime: Epidemiology, developmental origins, risk factors, early interventions, and policy implications. *Development and Psychopathology*, *4*, 737-762.
- Loth, A.K., Drabick, D.A.G., Leibenluft, E., & Hulvershorn, L.A. (2014). Do childhood externalizing disorders predict adult depression? A meta-analysis. *Journal of Abnormal Child Psychology*, *42*, 1103-1113.
- Luoma, I., Tamminen, T., Kaukonen, P., Laippala, P., Puura, K., Salmelin, R., & Almqvist, F. (2001). Longitudinal study of maternal depressive symptoms and child well-being. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*, 1367-1374.

- Luthar, S.S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development, 71*, 543-562.
- Maas, C., Herrenkohl, T.I., & Sousa, C. (2008). Review of research on child maltreatment and violence in youth. *Trauma, Violence, & Abuse, 9*, 56-67.
- MacKenzie, M.J., Kotch, J.B., Lee, L. Augsberger, A., & Hutto, N. (2011). A cumulative ecological-transactional risk model of child maltreatment and behavioral outcomes: Reconceptualizing early maltreatment report as risk factor. *Children and Youth Services Review, 33*, 2392-2398.
- MacMillan, A.M. (1957). The Health Opinion Survey: Technique for estimating the prevalence of psychoneurotic and related types of disorder in communities. *Psychological Reports, 3*, 325-339.
- Makarios, M.D. (2007). Race, abuse, and female criminal violence. *Feminist Criminology, 2*, 100-116.
- Masten, A.S., & Cicchetti, D. (2010). Developmental cascades. *Development and Psychopathology, 22*, 491-495. doi: 10.1017/S0954579410000222
- Maysless, O., Bartholomew, K., Henderson, A., & Trinke, S. (2004). "I was more her mom than she was mine:" Role reversal in a community sample. *Family Relations, 53*, 78-86.
- McCabe, K.M., Lansing, A.E., Garland, A., & Hough, R. (2002). Gender differences in psychopathology, functional impairment, and familial risk factors among adjudicated adolescents. *Child & Adolescent Psychiatry, 41*, 860-867.
- Mensah, F.K., & Kiernan, K.E. (2011). Maternal general health and children's cognitive development and behaviour in the early years: Findings from the Millennium Cohort Study. *Child: Care, Health and Development, 37*, 44-54. doi: 10.1111/j.1365-2214.2010.01150.x
- Merikangas, K.R., He, J., Burstein, M., Swanson, S.A., Avenevoli, S., Cui, L., ...Swendsen, J. (2010). Lifetime prevalence of mental disorders in U.S. adolescents: Results from the National comorbidity Survey Replication—Adolescent Supplement (NCS-A). *Journal of the American Academy of Child & Adolescent Psychiatry, 49*, 980-989.
- Mersky, J.P., & Reynolds, A.J. (2007). Child maltreatment and violent delinquency: Disentangling main effects and subgroup effects. *Child Maltreatment, 12*, 246-258.

- Morris, B.A., Shakespeare-Finch, J., Rieck, M., & Newberry, J. (2005). Multidimensional nature of posttraumatic growth in an Australian population. *Journal of Traumatic Stress, 18*, 575-585.
- Murphy, J.M. (1990). Depression screening instruments: History and issues. In C.C. Attkisson & J.M. Zich (Eds.), *Depression in primary care: Screening and detection* (pp. 65-83). New York, NY: Routledge.
- Muthén, L.K., & Muthén, B.O. (1998-2010). *MPlus User's Guide. Sixth Edition*. Los Angeles, CA: Muthén & Muthén.
- Muthén, L.K., & Muthén, B.O. (2003). *Mplus short courses: Growth modeling with latent variables using Mplus*. Handout.
- Nicholson, J., Biebel, K., Kinden, B., Henry, A., & Stier, L. (2001). Critical issues for parents with mental illness and their families. Available from:
http://www.uwgb.edu/bhttp/tools/critical_issues.pdf
- Nicholson, J.S., Deboeck, P.R., Farris, J.R., Boker, S.M., & Borkowski, J.G. (2011). Maternal depressive symptomatology and child behavior: Transactional relationship with simultaneous bidirectional coupling. *Developmental Psychology, 47*, 1312.
- Norman, R.E., Munkhtsetseg, B., De, R., Butchart, A., Scott, J., & Vos, T. (2012). The long-term health consequences of child physical abuse, emotional abuse, and neglect: A systematic review and meta-analysis. *PLOS Medicine, 9*: e1001349. doi: 10.1371/journal.pmed.1001349
- Odhayani, A.A., Watson, W.J., & Watson, L. (2013). Behavioural consequences of child abuse. *Canadian Family Physician, 59*, 831-836.
- Office of Juvenile Justice and Delinquency Prevention (OJJDP). (2013). *Juvenile Arrests 2011*. Available from <http://www.ojjdp.gov/pubs/244476.pdf>
- Ogden, C.L., Carroll, M.D., Curtin, L.R., Lamb, M.M., & Flegal, K.M. (2010). Prevalence of high Body Mass Index in US children and adolescents, 2007-2008. *Journal of the American Medical Association, 303*, 242-249.

- Pastor, P.N., & Reuben, C.A. (2011). Maternal reports of child health status and health conditions: The influence of self-reported maternal health status. *Academic Pediatrics, 11*, 311-317.
- Prior, M., Smart, D., Sanson, A., & Oberklaid, F. (2000). Does shy-inhibited temperament in childhood lead to anxiety problems in adolescence? *Child & Adolescent Psychiatry, 39*, 461-468.
- Propper, C., Riggs, J., & Burgess, S. (2007). Child health: Evidence on the roles of family income and maternal mental health from a UK birth cohort. *Health Economics, 16*, 1245-1269.
- Radloff, L.S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*, 385-401.
- Repetti, R.L., Taylor, S.E., & Seeman, T.E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*, 330-366.
- Riley, A.W., Coiro, M.J., Broitman, M., Colantuoni, E., Hurley, K.M., Bandeen-Roche, K., & Miranda, J. (2009). Mental health of children of low-income depressed mothers: Influences of parenting, family environment, and raters. *Psychiatric Services, 60*, 329-336.
- Runyan, D.K., Curtis, P.A., Hunter, W.M., Black, M.M., Kotch, J.B., Bangdiwala, S., Dubowitz, H., English, D., Everson, M.D., & Landsverk, J. (1998). LONGSCAN: A consortium for longitudinal studies of maltreatment and the life course of children. *Aggression and Violent Behavior, 3*, 275-285.
- Runyan, D.K., Dubowitz, H., English, D.J., Kotch, J., Litrownik, A., & Thompson, R. (2014). *Longitudinal Studies on Child Abuse and Neglect (LONGSCAN) ages 0-18* [Data file]. Available from National Data Archive on Child Abuse and Neglect (NDACAN), <http://www.ndacan.cornell.edu>
- SAS Institute Inc. (2009). *SAS® 9.3 Output Delivery System: User's Guide*. Cary, NC: SAS Institute Inc.
- Sedlak, A.J., Mettenburg, J., Basena, M., Petta, I., McPherson, K., Green, A., & Li, S. (2010). Fourth national incidence study of child abuse and neglect (NIS-4): Report to congress. *Washington, DC: U.S. Department of Health and Human Services, Administration for Children and Families*. Retrieved from http://www.acf.hhs.gov/sites/default/files/opre/nis4_report_congress_full_pdf_jan2010.pdf.

- Shin, S.H., & Miller, D.P. (2012). A longitudinal examination of childhood maltreatment and adolescent obesity: Results from the National Longitudinal Study of Adolescent Health (AddHealth) Study. *Child Abuse & Neglect, 36*, 84-94.
- Singer, J.D., & Willett, J.B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York: Oxford University Press.
- Strauss, R.S., & Pollack, H.A. (2003). Social marginalization of overweight children. *Archives of Pediatrics and Adolescent Medicine, 157*, 746-752.
- Swallen, K.C., Reither, E.N., Haas, S.A., & Meier, A.M. (2005). Overweight, obesity, and health-related quality of life among adolescents: The National Longitudinal Study of Adolescent Health. *Pediatrics, 115*, 340-347.
- Takei, T., Yamashita, H., & Yoshida, K. (2006). The mental health of mothers of physically abused children: The relationship with children's behavioural problems—reports from Japan. *Child Abuse Review, 15*, 204-218.
- Teisl, M., & Cicchetti, D. (2008). Physical abuse, cognitive and emotional processes, and aggressive/disruptive behavior problems. *Social Development, 17*, 1-23.
- Thompson, M.P., Kingree, J.B., & Desai, S. (2004). Gender differences in long-term consequences of physical abuse of children: Data from a nationally representative sample. *American Journal of Public Health, 94*, 599-604.
- Timko, C.C., Cronkite, R.C., Swindle, R.R., Robinson, R.L., Turrubiartes, P.P., & Moos, R.H. (2008). Functioning status of adult children of depressed parents: A 23-year follow-up. *Psychological Medicine, 38*, 343-353.
- Tompkins, T.L. (2007). Parentification and maternal HIV infection: Beneficial role or pathological burden? *Journal of Child and Family Studies, 16*, 108-118.
- Tompson, M.C., Pierre, C.B., Boger, K.D., McKowen, J.W., Chan, P.T., & Freed, R.D. (2010). Maternal depression, maternal expressed emotion, and youth psychopathology. *Journal of Abnormal Child Psychology, 38*, 105-117.

- Toth, S.L., & Cicchetti, D. (2013). A developmental psychopathology perspective on child maltreatment. *Child Maltreatment, 18*, 135-139.
- Turney, K. (2011). Maternal depression and childhood health inequalities. *Journal of Health and Social Behavior, 52*, 314-332.
- Vazsonyi, A.T., & Chen, P. (2010). Entry risk into the juvenile justice system: African American, American Indian, Asian American, European American, and Hispanic children and adolescents. *Journal of Child Psychology & Psychiatry, 51*, 668-678.
- Weissman, M.M., Wickramaratne, P., Nomura, Y., Warner, V., Pilowsky, D., & Verdeli, H. (2006). Offspring of depressed parents: 20 years later. *The American Journal of Psychiatry, 163*, 1001-1008.
- Wheaton, B., Muthén, B., Alwin, D., & Summers, G. (1977). Assessing reliability and stability in panel models. In D. Heise (Ed.), *Sociological methodology* (pp. 84-136). San Francisco: Jossey-Bass.
- Whitaker, R.C., Orzol, S.M., & Kahn, R.S. (2006). Maternal mental health, substance use, and domestic violence in the year after delivery and subsequent behavior problems in children at age 3 years. *Archives of General Psychiatry, 63*, 551-560.
- Widom, C.S., DuMont, K., & Czaja, S.J. (2007). A prospective investigation of major depressive disorder and comorbidity in abused and neglected children growing up. *Archives of General Psychiatry, 64*, 49-56.
- Widom, C.S., & Massey, C. (2015). A prospective examination of whether childhood sexual abuse predicts subsequent sexual offending. *JAMA Pediatrics, 169*, e143357. doi: 10.1001/jamapediatrics.2014.3357.
- Widom, C.S., & Maxfield, M.G. (2001). An update on the “cycle of violence.” National institute of justice research in brief. Retrieved from <http://files.eric.ed.gov/fulltext/ED451313.pdf>
- Widom, C.S., Raphael, K.G., & DuMont, K.A. (2004). The case for prospective longitudinal studies in child maltreatment research: Commentary on Dube, Williamson, Thompson, Felitti, and Anda (2004). *Child Abuse & Neglect, 28*, 715-722.

Widom, C.S., & White, H.R. (1997). Problem behaviours in abused and neglected children grown up: Prevalence and co-occurrence of substance abuse, crime and violence. *Criminal Behaviour and Mental Health*, 7, 287-310.

Willett, J.B., & Singer, J.D. (1995). It's déjà vu all over again: Using multiple spell discrete-time survival analysis. *Journal of Educational and Behavioral Statistics*, 20, 41-67.

Zubaran, C., Foresti, K., Schumacher, M.V., Amoretti, A.L., Thorell, M.R., & Müller, L.C. (2010). The correlation between postpartum depression and health status. *Maternal and Child Health Journal*, 14, 751-757.

Appendix A

Means, standard deviations, and correlations among study variables (N=1,209)

	1	2	3	4	5	6	7	8	9	10	11
1. Mal Status	--										
2. Mom Physical Hth	0.03	--									
3. Mom Drinking	0.07~	0.09*	--								
4. Mom Mental Hth	0.04	0.42***	0.28***	--							
5. Mom Depression	-0.06~	0.25***	0.22***	0.59***	--						
6. Aggression at 8	0.15***	0.07*	0.10*	0.22***	0.12***	--					
7. Aggression at 10	0.16***	0.11**	0.09*	0.21***	0.12***	0.67***	--				
8. Aggression at 12	0.17***	0.09**	0.09*	0.21***	0.12***	0.64***	0.68***	--			
9. Aggression at 14	0.20***	0.10**	0.13**	0.23***	0.17***	0.54***	0.58***	0.69***	--		
10. Withdrawal at 8	0.05~	0.12***	0.14***	0.20***	0.14***	0.48***	0.29***	0.31***	0.23***	--	
11. Withdrawal at 10	0.13***	0.11**	0.11**	0.20***	0.12***	0.34***	0.51***	0.37***	0.35***	0.48***	--
12. Withdrawal at 12	0.12***	0.11**	0.12***	0.20***	0.15***	0.39***	0.38***	0.55***	0.38***	0.46***	0.52***
13. Withdrawal at 14	0.16***	0.09**	0.16***	0.20***	0.14***	0.33***	0.38***	0.45***	0.58***	0.36***	0.50***
14. Social Pbs at 8	0.14***	0.12***	0.09*	0.22***	0.14***	0.59***	0.44***	0.40***	0.37***	0.49***	0.34***
15. Social Pbs at 10	0.18***	0.15***	0.09*	0.20***	0.09**	0.47***	0.61***	0.46***	0.42***	0.33***	0.52***
16. Social Pbs at 12	0.14***	0.15***	0.05	0.20***	0.09**	0.42***	0.46***	0.58***	0.43***	0.28***	0.36***
17. Social Pbs at 14	0.17***	0.08*	0.08~	0.18***	0.09**	0.37***	0.42***	0.45***	0.57***	0.27***	0.37***
18. Adol BMI	-0.10**	0.06~	-0.07	0.03	0.08*	0.02	0.06	0.08~	0.07~	-0.02	0.05
19. Adol Phys Hth	0.02	0.11***	0.01	0.02	-0.04	0.06	0.11***	0.08*	0.04	0.05	0.08*
20. Adol Depression	0.01	0.16***	0.13**	0.27***	0.27***	0.19***	0.21***	0.24***	0.24***	0.15***	0.16***
21. Adol Mental Hth	0.08*	0.08*	0.05	0.03	0.01	0.09**	0.09**	0.15***	0.10**	0.07~	0.08*
22. Adol Wt Loss	0.16*	0.03	0.03	0.04	-0.05	0.10	0.09	0.09	-0.05	0.12~	0.15*
<i>N</i>	1,209	1,117	737	1,123	1,101	1,012	932	858	837	1,012	932
<i>M</i>	0.58	2.03	0.40	3.33	2.22	2.13	2.01	2.06	1.98	1.00	0.91
<i>SD</i>	0.49	0.76	0.56	0.20	0.98	0.83	0.87	0.87	0.91	0.70	0.72

Note. Mal Status, Maltreatment Status, 1 = maltreated prior to age 6 assessment, 0 = non-maltreated prior to age 6 assessment; Mom, maternal; Adol, adolescent; Hth, health; Pbs, problems; Phys, physical; Wt Loss, unhealthy weight loss methods.

~ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Appendix A (Continued)

Means, standard deviations, and correlations among study variables (N=1,209)

	12	13	14	15	16	17	18	19	20	21	22
1. Mal Status											
2. Mom Physical Hth											
3. Mom Drinking											
4. Mom Mental Hth											
5. Mom Depression											
6. Aggression at 8											
7. Aggression at 10											
8. Aggression at 12											
9. Aggression at 14											
10. Withdrawal at 8											
11. Withdrawal at 10											
12. Withdrawal at 12	--										
13. Withdrawal at 14	0.57***	--									
14. Social Pbs at 8	0.35***	0.33***	--								
15. Social Pbs at 10	0.37***	0.40***	0.57***	--							
16. Social Pbs at 12	0.51***	0.42***	0.54***	0.61***	--						
17. Social Pbs at 14	0.36***	0.54***	0.49***	0.54***	0.62***	--					
18. Adol BMI	0.09*	0.06	0.12***	0.18***	0.20***	0.20***	--				
19. Adol Phys Hth	0.10**	0.15***	0.13***	0.15***	0.16***	0.15***	0.27***	--			
20. Adol Depression	0.27***	0.25***	0.19***	0.18***	0.17***	0.20***	0.11**	0.03	--		
21. Adol Mental Hth	0.12***	0.14***	0.12***	0.11**	0.09*	0.07~	0.02	0.29***	0.05	--	
22. Adol Wt Loss	0.17*	0.02	0.09	0.13~	0.12	0.03	0.00	0.24***	-0.04	0.37***	--
<i>N</i>	858	837	1,012	932	858	837	692	813	749	813	206
<i>M</i>	1.09	1.10	1.11	1.04	1.06	0.99	25.75	1.05	2.23	0.33	0.78
<i>SD</i>	0.71	0.77	0.67	0.73	0.74	0.73	6.00	0.27	0.96	0.46	0.34

Note. Mal Status, Maltreatment Status, 1 = maltreated prior to age 6 assessment, 0 = non-maltreated prior to age 6 assessment; Mom, maternal; Adol, adolescent; Hth, health; Pbs, problems; Phys, physical; Wt Loss, unhealthy weight loss methods.

~ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Appendix A.

Life table describing the age at which children/adolescents were first arrested for a juvenile crime by sex, maltreatment type, and race (N = 1,255)

Age in years	Numbe			Proportion	
	Participants at the beginning of the age period who had not been arrested (risk set)	Participants who were arrested for the first time during this age period	Censored at the end of the age period	Participants at the beginning of the age period who were arrested for the first time during this year (hazard function)	All respondents who still had not been arrested for the first time at the end of the age period (survival function)
Overall, Regardless of Sex, Maltreatment Type, or Race					
Less than 9	1,255	--	--	--	1.0000
9	1,255	3	55	0.0024	0.9976
10	1,197	1	0	0.0008	0.9968
11	1,196	2	10	0.0017	0.9951
12	1,184	6	30	0.0051	0.9900
13	1,148	7	15	0.0061	0.9840
14	1,126	21	28	0.0187	0.9656
15	1,077	27	42	0.0251	0.9414
16	1,008	33	70	0.0327	0.9106
17	905	12	893	0.0133	0.8985
Males (F=0)					
Less than 9	608	--	--	--	1.0000
9	608	0	27	0.0000	1.0000
10	581	1	0	0.0017	0.9983
11	580	2	4	0.0035	0.9948
12	574	4	15	0.0070	0.9878
13	555	3	8	0.0054	0.9825
14	544	16	17	0.0294	0.9536
15	511	16	25	0.0313	0.9238
16	470	24	49	0.0511	0.8766
17	397	9	388	0.0227	0.8567
Females (F=1)					
Less than 9	647	--	--	--	1.0000
9	647	3	28	0.0046	0.9954
10	616	0	0	0.0000	0.9954
11	616	0	6	0.0000	0.9954
12	610	2	15	0.0033	0.9921

13	593	4	7	0.0068	0.9854
14	582	5	11	0.0086	0.9769
15	566	11	17	0.0194	0.9579
16	538	9	21	0.0167	0.9419
17	508	3	505	0.0059	0.9363

Non-Maltreated (*Maltreatment Type=0*)

Less than 9	488	--	--	--	1.0000
9	488	0	19	0.0000	1.0000
10	469	0	0	0.0000	1.0000
11	469	0	3	0.0000	1.0000
12	466	2	10	0.0043	0.9957
13	454	4	8	0.0088	0.9869
14	442	8	11	0.0181	0.9690
15	423	9	25	0.0213	0.9484
16	389	8	30	0.0206	0.9289
17	351	4	347	0.0114	0.9183

Sexually Abused (*Maltreatment Type=4*)

Less than 9	15	--	--	--	1.0000
9	15	0	1	0.0000	1.0000
10	14	0	0	0.0000	1.0000
11	14	0	0	0.0000	1.0000
12	14	0	1	0.0000	1.0000
13	13	0	0	0.0000	1.0000
14	13	0	0	0.0000	1.0000
15	13	1	0	0.0769	0.9231
16	13	0	0	0.0000	0.9231
17	13	0	12	0.0000	0.9231

Physically Abused (*Maltreatment Type=1*)

Less than 9	62	--	--	--	1.0000
9	62	0	3	0.0000	1.0000
10	59	0	0	0.0000	1.0000
11	59	0	1	0.0000	1.0000
12	58	0	0	0.0000	1.0000
13	58	1	0	0.0172	0.9828
14	57	1	2	0.0175	0.9656
15	54	1	2	0.0185	0.9477
16	51	3	4	0.0588	0.8920

17	44	0	44	0.0000	0.8920
Physically Neglected (<i>Maltreatment Type=2</i>)					
Less than 9	403	--	--	--	1.0000
9	403	2	16	0.0050	0.9950
10	385	1	0	0.0026	0.9924
11	384	2	4	0.0052	0.9872
12	378	4	8	0.0106	0.9767
13	366	0	5	0.0000	0.9767
14	361	6	5	0.0166	0.9605
15	350	12	8	0.0343	0.9276
16	330	8	20	0.0242	0.9052
17	302	2	300	0.0066	0.8992
Physically Abused and Neglected (<i>Maltreatment Type=3</i>)					
Less than 9	287	--	--	--	1.0000
9	287	1	16	0.0035	0.9965
10	270	0	0	0.0000	0.9965
11	270	0	2	0.0000	0.9965
12	268	0	11	0.0000	0.9965
13	257	2	2	0.0078	0.9887
14	253	6	10	0.0237	0.9653
15	237	4	7	0.0169	0.9490
16	226	14	16	0.0620	0.8902
17	196	6	190	0.0306	0.8630
African-Americans (<i>Race=0</i>)					
Less than 9	701	--	--	--	1.0000
9	701	1	21	0.0014	0.9986
10	679	1	0	0.0015	0.9971
11	678	0	2	0.0000	0.9971
12	676	3	19	0.0044	0.9927
13	654	4	14	0.0061	0.9866
14	636	11	12	0.0173	0.9695
15	613	15	29	0.0245	0.9457
16	569	15	43	0.0264	0.9207
17	511	6	505	0.0117	0.9099
European-Americans (<i>Race=1</i>)					
Less than 9	329	--	--	--	1.0000

9	329	1	18	0.0030	0.9970
10	310	0	0	0.0000	0.9970
11	310	2	6	0.0065	0.9905
12	302	1	8	0.0033	0.9872
13	293	1	1	0.0034	0.9838
14	291	5	12	0.0172	0.9669
15	274	6	9	0.0219	0.9457
16	259	10	12	0.0386	0.9092
17	237	1	236	0.0042	0.9054

Other Races (*Race=2*)

Less than 9	225	--	--	--	1.0000
9	225	1	16	0.0044	0.9956
10	208	0	0	0.0000	0.9956
11	208	0	2	0.0000	0.9956
12	206	2	3	0.0097	0.9859
13	201	2	0	0.0100	0.9760
14	199	5	4	0.0251	0.9515
15	190	6	4	0.0316	0.9214
16	180	8	15	0.0444	0.8805
17	157	5	152	0.0763	0.8133

Appendix B.

Creation of a Person-Period Data Set from the Original Person-Level Data Set

Person-level data set																		
Identification Number	Age of First Arrest							Censor	Sex			Race			MG			
MW02784	10							0	0			0			2			
EA40015	-							1	1			0			0			
MW01254	12							1	0			1			3			
NW32556	15							0	1			2			1			

Person-period data set																		
	Age	A ₉	A ₁₀	A ₁₁	A ₁₂	A ₁₃	A ₁₄	A ₁₅	A ₁₆	A ₁₇	ft _{9...}	pat _{9...}	pnt _{9...}	papnt _{9...}	Event	Sex	Race	MG
MW02784	9	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
MW02784	10	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
EA40015	9	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
EA40015	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
EA40015	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
EA40015	12	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
EA40015	13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
EA40015	14	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
EA40015	15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
EA40015	16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
EA40015	17	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
MW01254	9	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
MW01254	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
MW01254	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
MW01254	12	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3
NW32556	9	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	2	1
NW32556	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
NW32556	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1
NW32556	12	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2	1
NW32556	13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	1
NW32556	14	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	1
NW32556	15	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	2	1

Note. Censor value of 1 indicates that the juvenile was censored or did not experience the event (juvenile arrest) during his/her study participation (i.e., attrited prior to end of study or no known arrest before end of study). Event value of 1 indicates that the juvenile did experience the event during that age time period. A dash indicates that the juvenile was not arrested as a juvenile prior to age 17. Other codes: Sex=0, male; Sex=1, female; Race=0, African-American; Race=1, European-American; Race=2, other races; MG, Maltreatment Group; MG=0, non-maltreated; MG=1, physically abused; MG=2, physically neglected; MG=3, both physically abused and neglected.

Appendix C.

Parameter Estimates and Standard Errors (in Parentheses) from the Final Discrete Time Hazard Model Representing the Risk of First Juvenile Arrest as a Function of Age, Sex, and Maltreatment Type (NM, PA, PN, PAPN)

Predictor	Model 7
A ₉	-28.03 (298.30)
...	...
A ₁₇	-3.85 (0.52)
ft ₉	11.66 (199.20)
...	...
ft ₁₇	-1.84 (0.79)
pat ₉	0.78 (660.00)
...	...
pat ₁₇	-12.57 (772.40)
pnt ₉	12.09 (222.10)
...	...
pnt ₁₇	-0.39 (0.88)
ant ₉	10.38 (222.10)
...	...
ant ₁₇	0.73 (0.68)
f*pa	-0.67 (1.22)
f*pn	-0.40 (0.59)
f*papn	1.08 (0.57)
Deviance (-2LL) Statistic	1,050.55
<i>n</i> parameters	48
AIC	1,146.55
SC	1,493.10

Note. *N* = 1,255. *N* events = 10,096.

A₉-A₁₇, age dummy variables; ft, Female*Time; PA, Physical Abuse; PN, Physical Neglect; PAPN, both PA and PN; pat, PA*Time; pnt, PN*Time; ant, PA&PN*Time; f*pa, Female*PA; f*pn, Female*PN; f*papn, Female*PAPN.

Deviance Statistic, -2LL, -2 Log Likelihood; AIC, Akaike Information Criterion; SC, Schwarz Criterion.