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DEVELOPMENTAL PATHWAYS BETWEEN LOW BIRTH WEIGHT STATUS AND CHILDREN'S ACADEMIC AND SOCIOEMOTIONAL COMPETENCE: THE ROLE OF PARENTING PROCESSES AS A MODERATOR

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ABSTRACT

The present study examined the longitudinal associations among moderate low birth weight (MLBW), parenting factors, and children's developmental outcomes within an at-risk sample (N= 1,809), using secondary data from Fragile Families and Child Wellbeing (FFCW) study. Of particular interest was whether parenting factors moderate the associations between MLBW and indicators of both socioemotional and cognitive/academic competence. Birth weight and prenatal data were taken from medical records. Parenting factors were assessed during in-home assessments at ages 3 and 5. Mothers and teachers reported on externalizing behaviors and teachers reported on social skills at age 9. In addition, cognitive/academic outcomes were assessed using teacher reports and standardized assessments at age 9. Overall, findings suggest that MLBW was significantly associated with teacher reports of children's socioemotional competence as well as cognitive/academic outcomes including receptive vocabulary, reading, and math achievement at age 9. These associations remained significant after accounting for a large battery of control variables; the exception was the link between MLBW status and parent's report of externalizing behavior at age 9. Results also indicated that maternal warmth, but not parenting stress, moderated the longitudinal associations between MLBW and cognitive/academic outcomes and teacher-reported socioemotional competence. To conclude, these results highlight the significance of MLBW and positive parenting processes across diverse child outcomes. The implications of these findings are discussed for interventions targeting MLBW children within at-risk populations.

Keywords

Academic/Cognitive outcomes, Externalizing behaviors, Low birth weight, Maternal warmth, Parenting stress, Social competence.

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Table of Contents

List of Figures

List of Tables

Chapter 1. Introduction

Low birth weight (LBW; birth weight below 2,500 grams) is considered an important public health problem that may have significant implications across multiple dimensions of child functioning. The percentage of children born LBW has remained roughly constant, around 8%, in the U.S. over the last few decades (Ballot, Potterton, Chirwa, Hilburn, Cooper, 2012; Hamilton, Hoyert, Martin, Strobino, & Guyer, 2013; Martin, Hamilton, Osterman, Curtin, & Mathews, 2015; Mastuo, 2005). With the advancements in Neonatal Intensive Care Unit (NICU) for LBW and preterm (PT; born before 37 completed weeks of gestation) infants, the survival rate of LBW children has increased, particularly among very low birth weight (VLBW; birth weight between 1,000-1,499 grams) and extremely low birth weight (ELBW; birth weight <1,000 grams) children. Beyond the initial issues of infant survival, LBW children are at increased risk for an ongoing vulnerability in different domains, in particular, health and developmental outcomes.

While the majority of research linking LBW to child outcomes focuses on immediate and long-term health consequences (Joyce, Goodman-Bryan, & Hardin, 2012; Matsuo, 2005; Nepomnyaschy & Reichman, 2006) and neurosensory outcomes (Hack, Friedman, Fanaroff, 1996), a substantial amount of literature also highlights the long-term socioemotional and cognitive/academic outcomes among these children. More specifically, the extant studies examining these links demonstrate that LBW is associated with increased socioemotional and behavioral problems (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Hille et al., 2001; Horwood, Mogridge, & Darlow, 1998; McCarton, 1998; McCormick, Workman-Daniels, & Brooks-Gunn, 1996; Tayler, Klein, Minich, & Hack, 2001; Vaske, Newsome, & Boisvert, 2013),

and decreased cognitive/academic outcomes (Bhutta et al., 2002; Hack et al., 1991; Hack, Klein, & Taylor, 1995; Vaske et al., 2013; Weisglas-Kuperus, Baerts, Smrkovsky, & Sauer, 1993).

A growing body of literature also indicates that children with early life vulnerabilities will be at increased risk for behavioral maladjustment and psychopathology in later life (Räikkönen & Pesonen, 2009). More specifically, LBW/PT gestation suggests a suboptimal prenatal environment and serves as a marker for inadequate postnatal growth and long-term medical and developmental consequences (Barker 2007; Godfrey & Barker, 2001). These vulnerabilities may be due to the programming of prenatal development, whereby the lack of adequate growth during a critical period of development leads to subsequent impairment in structure, function, and mechanism of different bodily organs (Barker, 1998; Godfrey and Barker, 2001), such as, a smaller brain volume and a reduced cortical thickness (De Bie, Oostrom, & Delemarre-Van de Waal, 2010; Tolsa et al., 2004). As a result, both preterm and/full-term (i.e., babies born after 37 completed weeks of gestation) LBW babies are at increased risk for poor health and developmental outcomes. Nevertheless, not all LBW children have poor developmental outcomes. LBW children as a group, however, are more likely than normal birth weight children to suffer from immediate and long-term medical complications and developmental disorders, such as learning and behavioral problems (Child Health USA, 2013; March of Dimes, 2014).

While extant studies indicate that late preterm (i.e., babies born between 34-36 weeks gestation) (Shah, Robbins, Coelho, & Poehlmann, 2013), and moderate low birth weight (MLBW; birth weight between 1,500 - 2,499 grams) (Stein, Siegel, & Bauman; 2006) children are more likely to experience medical and developmental vulnerabilities than normal birth weight (NBW; birth weight more than 2,500 grams at birth) children, limited research has

examined the effects of MLBW on developmental outcomes in middle childhood. Recent studies

linking LBW and socioemotional development, however, have focused mainly on select

subpopulations of LBW children, such as VLBW (Arpi & Ferrari, 2013; Hack et al., 1991; Hack

et al., 2004; Hill et al., 2001; Horwood et al., 1998; Rickards, Kelly, Doyle, Callanan, 2001) and

ELBW (Anderson et al., 2003; Hille et al., 2001) categories. Thus, little is known about the

developmental trajectories of LBW children in less extreme categories, particularly the MLBW

group.

Because of their exclusive focus on extreme birth weight categories of LBW/preterm

gestation, earlier studies are also limited in the generalization of their findings across all children

with LBW status, particularly those in the MLBW group. MLBW infants account for the

majority of infants born LBW, as over 85% of LBW children have born birth weight 1,500-2,499

grams (Hamilton et al., 2013; Martin et al., 2015). Although the degree of vulnerability differs

across different birth weight groups, it is of utmost importance to examine the long-term

consequences of MLBW on socioemotional outcomes among children. Notably, only a few

studies have examined these relationships among samples of LBW children using a comparison

group of NBW children, multiple reporters of socioemotional outcomes, and multiple

dimensions of socioemotional and academic outcomes. On such a backdrop, the present study

examines the independent longitudinal associations among the most common group of LBW

children (i.e., MLBW) and multiple dimensions of child's socioemotional competence, including

externalizing behaviors, and social skills at age 9.

Studies examining the associations between LBW and cognitive outcomes also indicate

that LBW is associated with decreased cognitive functioning that may have significant

implications for long-term cognitive/academic achievement in middle childhood (Bhutta et al.,

2002; De Bie et al., 2010; Vaske et al., 2013). More specifically, children with LBW are at increased risk for inadequate brain growth, which has adverse effects on multiple dimensions of cognitive outcomes including receptive vocabulary, IQ, visual, and motor function (Anderson et al., 2003; Bhutta et al., 2002; Hack et al., 1991; Rickards et al., 2001), and academic achievement (e.g., reading, mathematics, and learning) (Anderson et al., 2003; Boardman, Powers, Padilla, & Hummer, 2002; Hack et al., 1991; Horwood et al., 1998; McCormick, Gortmaker, & Sobol, 1990; Shiono & Behrman, 1995). Because the majority of prior studies examined these outcomes among more at-risk LBW sub-groups, particularly VLBW and ELBW with preterm birth, little is known about the developmental trajectories between MLBW status and cognitive outcomes across different developmental ages. Thus, the present study also examines the independent effects of MLBW status on cognitive/academic competence at age 9 among at-risk children with a comparison group of NBW children.

In addition, while existing studies have examined the independent associations among these constructs, little is known about the mechanisms through which MLBW status relates to short and long-term developmental outcomes among children. Interestingly, research examining these links indicates that multiple parenting variables, including maternal warmth and maternal psychological wellbeing, in the early years may have important implications for diverse child outcomes (Broekman, 2011; IHDP, 1990; McCormick et al., 1996; Nordhov, Rønning, Ulvund, Dahl, & Kaaresen, 2012; Tully, Arseneault, Caspi, Moffitt, & Morgan, 2004). In particular, data from the Infant Health and Development Program (IHDP) indicate that preterm LBW children with more responsive and stimulating home environments had high, stable cognitive performance from birth to age 3 years (Liaw & Brooks-Gunn, 1993). Further, data from the IHDP suggested that a preschool intervention program for LBW preterm children improved their

cognitive and academic performance including receptive vocabulary and mathematics scores across school ages (McCarton et al., 1997) and during adolescence (McCormick et al., 2006). Interestingly, these persistent benefits of the intervention during early childhood were greater across the subset of higher low birth weight preterm groups (HLBW; birth weight between 2,001 to 2,499 grams) as compared to lower low birth weight preterm groups (LLBW: weighing ≤ 2,000 grams) and control groups of children (Liaw & Brooks-Gunn, 1993; McCarton et al., 1997; McCormick et al., 2006; Ramey et al., 1992). Similarly, findings of other intervention studies targeting key parenting constructs (e.g., enrichment of the home environment and increased warmth, stimulation, and positive responsiveness) also indicate that intervention groups of LBW children had significantly lower perceived difficulties, lower total problem behavior (IHDP, 1990; McCarton, 1998; Nordov et al., 2012; Spiker, Ferguson, & Brooks-Gunn; 1993) and higher cognitive outcomes (Landry, Smith, & Swank, 2006; Landry, Smith, Swank, Assel, & Vellet, 2001; Rauh, Achenbach, Nurcombe, Howell, & Teti, 1988) as compared to the control/follow-up group of LBW children. Thus, positive family environment and positive parenting during the early years may have significant implications for children's long-term development (Bronfenbrenner, 1986).

The extant literature on LBW and VLBW children indicates that these children are highly susceptible to the poor academic achievement at age 8 through the negative effects of low maternal sensitivity at kindergarten (Jaekel, Pluess, Belsky, & Wolke, 2015). Although LBW children had significantly higher academic functioning when exposed to high-sensitive parenting, they still underperformed their NBW peers under these positive environments. Another study including LBW twins suggests that higher levels of maternal warmth protect LBW children from poor behavioral outcomes (e.g., ADHD; Attention Deficit Hyperactivity

Disorders), whereas lower levels of maternal warmth result in more negative behavioral outcomes (Tully et al., 2004). Similarly, LBW singleton children who had high-responsive mothers during infancy experienced fewer ADHD-type symptoms and total problem behaviors across preschool and school ages (Laucht, Esser, & Schmidt, 2001) as compared to LBW children of low-responsive mothers. This evidence collectively suggests that MLBW children may require more positive parenting environments during early years of development to achieve favorable developmental outcomes in school ages because of their increased susceptibility to poor environmental conditions (Jaekel et al., 2015; Poehlmann et al., 2011; Shah, et al., 2013). These findings support the developmental vulnerability perspective, also known as the diathesis-stress model, that posits that some children are more susceptible to the adverse effects of negative environmental contexts due to their biological, temperamental or behavioral characteristics than others (Monroe & Simons, 1991; Zuckerman, 1999), thus needing higher levels of sensitivity to achieve positive outcomes (Jaekel et al., 2015; Shah et al., 2013). As indicated earlier, LBW/preterm children are also more responsive to parenting intervention such that LBW children who received intervention during early childhood years had significantly better outcomes across behavioral and cognitive/academic domains (Landry, Smith, Miller-Loncar, & Swank, 1997; Landry et al., 2001; Liaw & Brooks-Gunn, 1993; McCarton et al., 1997; McCormick et al., 2006; Ramey et al., 1992; Rauh et al., 1988). For that reason, early positive parenting may have significant implications for positive outcomes among at-risk MLBW children.

On the other hand, prior research also suggests that during infancy, LBW and pre-term children are more likely to exhibit increased sensory thresholds and may be easily distractible in nature and slower to adapt to the environmental changes than their NBW and full-term peers

(Weiss, St. Jonn-Seed & Wilson, 2004). Due to their difficulties with behavioral regulation (Landry, Smith, Swank, & Miller-Loncar, 2000), these children are also more difficult to manage, more prone to difficult temperament, and fussier than their normal birth weight counterparts. Because of these temperamental vulnerabilities and increased medical risks at early ages, mothers of LBW preterm infants show significantly higher levels of parenting stress during infancy than mothers of their NBW peers which can impact long-term development (Halpern, Brand, & Malone, 2001; Howe, Sheu, Wang, & Hsu, 2014; Robson, 1997; Whiteside-Mansell, Bradley, Casey, Fussell, & Conners-Burrow, 2009). Since maternal psychological wellbeing (e.g., low levels of parenting stress) has important implications for children's long-term behavioral adjustment and academic outcomes (McCormick et al., 1996; Monti et al., 2013; Patel, Rahman, Jacob, & Hughes, 2004), it is important to examine how birth weight and parenting processes interact to influence child development.

While scholars posit that low levels of maternal warmth, stimulation, and maternal mental health/stress are risks for developing poor socioemotional competence and academic functioning in childhood (McCarton, 1998; McCormick et al., 1996; Nordov et al., 2012; Rauh et al., 1988; Tully et al., 2004), the cross-sectional design of these studies cannot establish the directionality of the effect among these constructs. In addition, although prior research highlights the importance of parenting on child outcomes across different developmental ages, to date, none of the studies have examined these constructs in a single model or /using a moderational framework. Thus, consistent with the vulnerability perspective (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Zuckerman, 1999) and prior research on twins and singleton LBW children (Jaykel et al., 2015; Laucht et al., 2001; Tully et al., 2004), the present study examines

the role of maternal warmth and parenting stress as moderators in the link among these constructs.

In summary, the primary goal of this dissertation is to explore the processes through which MLBW influences cognitive/academic and socioemotional competence among at-risk children. In particular, this study extends previous findings by testing the independent effects of MLBW and parenting factors (e.g., maternal warmth and parenting stress) in predicting children's academic and socioemotional competence. In addition, the present study focuses on specifying the parenting processes that promote positive outcomes for MLBW infants as well as the processes that are particularly detrimental to their academic and socioemotional trajectories. This includes examining parenting processes as moderators of the link between MLBW and child outcomes. In order to examine the complex associations among these variables with longitudinal data, the present study utilized data from Fragile Families and Child Wellbeing (FFCW) study. In particular, the FFCW study includes key medical and demographic variables that can be accounted for in the models. This dataset also allows for the analysis of the developmental trajectories and processes from birth to age 9 using multiple indicators of children's socioemotional and cognitive/academic outcomes.

Given the higher incidence of low birth weight across disadvantaged families (Child Health USA, 2013; Dombrowski, Noonan, & Martin, 2007; March of Dimes, 2014; Reichman, 2005; Reichman, Hamilton, Hummer, & Padilla,2008) and the effectiveness of parenting intervention for MLBW preterm children from families with low income and lower education level (Brooks-Gunn, Gross, Kraemer, Spiker, & Shapiro, 1992; Brooks-Gunn, Klebanov, Liaw, & Spiker; 1993; IHDP, 1990; Liaw & Brooks-Gunn, 1993), it is also important to examine these links across heterogeneous sample of at-risk families. Thus, FFCW data are particularly relevant

due to the inclusion of diverse groups of families based on different race and ethnicity, poverty status, education, income, and family structure..

In general, LBW infants may exhibit mild problems in cognition, attention, and behavior domains; the exception would be LBW infants with severe developmental delays and cerebral palsy (Hack et al., 1991; Horwood et al., 1998; Weisglas-Kuperus et al., 1993). Although the effect size of the impact of MLBW on socioemotional and academic outcomes may be smaller in magnitude compared to the extreme low birth weight categories (Jaykel et al., 2015; Laucht et al., 2001; Stein et al., 2006), it is important to examine and understand the effects of MLBW for different dimensions of child outcomes across multiple developmental ages. Findings of such studies can help to clarify the picture of prenatal and postnatal influences on long-term developmental outcomes and the need for parenting intervention.

Findings of this study also have several important methodological and practical implications. First, using a multiple informants approach and tapping multiple dimensions of socioemotional and cognitive/academic competence across different developmental ages, the present study provides a complex picture of how birth weight status and parenting processes impact multiple dimensions of child outcomes. Second, the present study has important public health implications, given the potential differences in the outcomes across MLBW and NBW children. Specifically, public health workers may utilize these findings to increase awareness regarding the consequences of premature birth/MLBW in long-term developmental outcomes and may strengthen their parenting education/intervention programs to increase birth outcomes. Third, it will also have important implications for interventions targeting positive parenting and socioemotional/academic competence among MLBW children. Thus, clinicians and researchers may utilize these findings in improving the long-term developmental outcomes of MLBW

children through appropriate parenting interventions during different stages of development

including prenatal, postnatal and childhood years (Hack et al., 1995).

Chapter 2. Literature Review

Low Birth Weight and Developmental Vulnerability

Low birth weight (LBW) is defined as an infant with a birth weight of less than 2,500 grams (5 pounds and 8 ounces) (Kiely, Brett, Yu, & Rowley, 1994; WHO, 2011). It can be a consequence of preterm birth (i.e., babies born before 37 completed weeks of gestation) or full-term birth caused by intrauterine growth restriction (IUGR) and several other conditions (De Bie et al., 2010; WHO, 2004). The term IUGR refers to the slower than the normal growth and development of fetus in mother's uterus and is primarily responsible for small for gestational age (SGA; defined as an infant whose birth weight is smaller than the 10th percentile of his/her gestational age) (WHO, 2011). Thus, LBW consists of a heterogeneous group of infants including preterm, full-term SGA, or both preterm and SGA infants (Goldenberg & Culhane, 2007; WHO, 2011).

The development of the fetal brain begins in the first few weeks after conception. In particular, the prenatal period and the first years of life are considered the critical stages of brain development that provide the foundation for long-term achievement, adaptability, and resilience among children (Hack et al., 1991; Webb, Monk, & Nelson, 2001). Although 37 completed weeks of gestation is considered a full-term birth, research has consistently highlighted that infants born at 39 weeks or later have an advantage in terms of their brain development due to the rapid brain growth that occurs during the final weeks of gestation. Specifically, during these last couple of weeks, fetal brain volume continues to grow and boost the maturation of neural structures including gray matter and white matter of the brain (De Bie et al., 2010; Park, 2012). The formation, reorganization, and maturation of neural structures have identified important aspects of neurological development (Kesssenich, 2003; Webb et al., 2001), which is influenced

by many factors including genetic and epigenetic mechanisms and the external environmental contexts. The positive experiences during the critical period of development provide great potential for healthy growth and development of the human brain, whereas premature exposure to the extrauterine environment may adversely affect the proliferation, organization and selective pairing of neurons (Hack & Taylor, 2000; Moster et al., 2008; Perlman, 2001; Petrini et al., 2009). These adversities also lead to a smaller brain volume and a reduced cortical thickness (De Bie et al., 2010; Tolsa et al., 2004).

Children born full-term/NBW, who are neurologically mature at birth, are also better able to organize and regulate external and internal sensory input and more able to adapt to the external world (Kessenich, 2003). Although preterm/LBW infants can take information through their sensory systems, they lack proficiency in the integration, organization, and regulation of the sensory inputs, which may result in deficits in various learning and cognitive skills, and socioemotional outcomes (Hack et al., 1995; Kessenich, 2003; Landry et al., 2000; Poehlmann et al., 2011). Children born preterm include average for gestational age (AGA; defined as a birth weight at or above the 10th percentile for gestational age) and SGA are both at increased risk for poor health and developmental outcomes. For instance, prior research found increased neonatal morbidity and mortality across SGA children, and decreased cognitive functions across both AGA/SGA groups (Bhutta et al., 2002; De Bie et al., 2010). Thus, being born LBW or preterm places a child at increased risk of cognitive deficits. Virtually all of the VLBWs/ELBWs are born premature, whereas the MLBW babies are a mix of preterm/full-term, and or IUGR/SGA, that may be a consequence of several intrauterine (e.g., smoking, substance use, inadequate maternal nutrition, and low weight gain during pregnancy) and extrauterine/environmental (e.g., sociodemographic factors, home and social environment, quality of parenting/parenting

behaviors, and postnatal growth pattern) factors (Child Health USA, 2013; De Bie et al., 2010; Roberts et al., 2007). Thus, these infants share some common risk factors that contribute to adverse birth outcomes and have long-term developmental consequences.

With advancements in technological interventions and perinatal medicine, the outcomes for LBW children have been improved in recent decades, particularly the rates of survival of very small and premature infants (Ballot et al., 2012; Hack et al., 1995; Hack et al., 2004). LBW infants, however, face significantly higher rates of morbidity and subsequent impairments in functioning across multiple domains of development compared with their normal birth weight peers (Ballot et al., 2012; Bhutta et al., 2002). In particular, the proportion of children surviving with severe mental health and behavioral difficulties has grown (Ballot et al., 2012; McCormick et al., 1990; McCormick et al., 1996). Thus, practitioners need to take a closer look not only at short-term neonatal survival and health-outcomes, but also consider the reduction of long-term developmental outcomes among this population (Horwood et al., 1998).

Low Birth Weight and Socioemotional Competence

The importance of birth weight for children's socioemotional trajectories has become a topic of growing interest for researchers, as an increasing number of studies highlights that LBW is associated with long-term social and behavioral outcomes. The development of socioemotional competence is a key challenge for these at-risk children as they enter the social context of school and enter complex interactions with teachers and peers in middle childhood. Prior research suggests that socioemotionally competent children are more likely to possess the ability to develop better relationships with peers and teachers in school (Anthony et al., 2005). Although the effects of LBW on socioemotional and behavioral domain begin in infancy, (Bhutta et al., 2002; Hille et al., 2001; McCarton, 1998; McCormick et al., 1996), they can persist through

childhood and adolescence and into adulthood (Hack et al., 2004; Kelly, Nazroo, McMunn, Boreham, & Marmot, 2001; Rickards et al., 2001). Thus, it is important to examine the effects of LBW on behavioral outcomes beyond the early childhood years. The socioemotional outcomes in the present study include externalizing behavior and social skills among children at age 9.

The construct of externalizing behavior problems consists of a grouping of problematic behaviors that are manifested in children's outward behavior and are directed negatively towards the external environments (Campbell, Shaw & Gilliom, 2000; Liu, 2004). Although the magnitude of the impairment varies across studies and across subgroups of LBW children, the extant studies suggest that LBW children are at increased risk for behavioral and social adjustment across childhood years (Anderson et al., 2003; McCarton, 1998; McCormick et al., 1996; Stein et al., 2006). For instance, LBW children have higher rates of total problem behaviors measured by strengths and difficulties questionnaire (SDQ) (Kelly et al., 2001) and Child Behavior Checklist (CBCL) (McCarton, 1998). Children with LBW are also more likely to experience behavioral problems (measured by BPI, Behavior Problem Index) and are less likely to be socially competent as compared to their NBW peers during school years (McCormick et al., 1996). Additional studies examining these links across LBW preterm children who were born in 1990s suggest that LBW status was associated with higher behavioral difficulties and lower adaptive functioning among children during their school years (Anderson et al., 2003; Bhutta et al., 2002). Prior intervention research also indicates that the odds of having clinically evident behavior problems were 1.8 times higher among the control groups of LBW children as compared to the intervention groups (i.e, parenting interventions and developmental evaluation of children) of LBW children at preschool ages (McCarton, 1998).

The empirical literature examining the link between LBW and problem behavior suggests that LBW children also have an increased risk of developing externalizing difficulties including aggression, delinquency, hyperactivity, and conduct problems (Bhutta et al., 2002; Hack et al., 1991; Horwood et al., 1998; Vaske et al., 2013). For example, using data from FFCW study, LBW status (weighting less than 2,500 grams) was significantly associated with specific facets of aggressive behaviors (i.e., serious aggression and destructive behavior) at age 5 among at-risk children (Vaske et al., 2013). Additional research suggests that the sub-normal brain growth during perinatal period or lack of adequate catch-up growth during infancy was significantly associated with higher behavioral difficulties in middle childhood (Hack et al., 1991). VLBW children who had a subnormal head growth at 8 months of age (measured by head circumference) also had higher levels of hyperactive behaviors in middle-childhood (Hack et al., 1991), particularly the boys (Kelly et al., 2001). However, other research examining the long-term behavioral implications of LBW failed to find these associations among multiple sub-groups of LBW children during their school years (Anderson et al., 2003; Hille et al., 2001) and in adulthood (Hack et al., 2004). For example, birth weight status was not associated with externalizing problem behaviors among ELBW children (Anderson et al., 2003), or among VLBW adults (Hack et al., 2004). Similarly, the mean scores of externalizing problems were not significantly different across ages 8-10 years between LBW and NBW groups across four countries namely, Netherlands, Germany, Canada, and the United States (Hille et al., 2001). Thus, prior findings examining the link between LBW and externalizing outcomes are inconsistent and inconclusive.

Although the majority of the above studies have focused their attention towards socioemotional processes in middle childhood, they were limited to the more at-risk subgroups

of LBW children, primarily the VLBW (Horwood et al., 1998; Hack et al., 2004; McCormick et al., 1990) and ELBW groups (Anderson et al., 2003; Hack et al., 2009; Hille et al., 2001). As a result, existing findings are not generalizable across all children with LBW status or across children with MLBW, even across the school years. Although a prior study using FFCW data examined the link between low birth weight (i.e., all children with birth weight less than 2,500 grams) and mother-reports of aggressive behavior at age 5 (Vaske et al., 2013), little is known about these associations across school ages or among MLBW children. In addition, even though Vaske et al. (2013) found the significant link between LBW and specific facets of aggression (i.e., serious aggression), they failed to account for many factors that influence the outcomes among these at-risk children (e.g., multiple births, infants with neurological impairment). The inconsistency of prior findings may also be due to different methodological limitations, such as small or unrepresentative sample sizes, inappropriate control groups, and high sample attrition (Hack et al., 1995). Although a few extant studies examining these constructs used multiple informants for behavior problems, including teacher report (Anderson et al., 2003; Hack et al., 2004), the majority examined child behavior outcomes through maternal report (Brennan et al., 2000; Hille et al., 2001; Kelly et al., 2001; Kiernan & Huerta, 2008; McCormick et al., 1996, Vaske et al., 2013), which may lead to underestimates or overestimates of behavior problems. The multiple informants approach including mothers and teachers reports used in this study may provide a more accurate picture in examining these outcomes.

The cross-sectional or correlational design of many previous studies does not address the developmental sequences of these processes among the constructs (Arnold, 1997; Stein et al., 2006). As a result, the extant research is unable to ascertain the processes or casual mechanisms among these constructs. For instance, high levels of negative parenting, low sensitivity and

warmth, and family stress/maternal emotional distress during early childhood may be crucial factors for later behavioral difficulties (Campbell et al., 2000; Laucht et al., 2001; Linver, Brooks-Gunn, & Kohen, 2002). Acknowledging these limitations in the existing literature, the present study examines the longitudinal associations among MLBW status and socioemotional competence including externalizing behaviors and social competence at age 9. In the previous literature, externalizing problems consist of disruptive, hyperactive, delinquent, and aggressive behaviors (Arnold, 1997; Bhutta et al., 2002; Liu, 2004; Vaske et al., 2013). The present study combines two key behavior problems, aggression and delinquent behavior, to make a construct of externalizing behavior. Social competence was conceptualized as children's ability to positively interact with peers and teachers within the school environment. These findings are relevant for intervention programs that aim to ameliorate both short-term and long-term negative developmental outcomes among MLBW children.

Low Birth Weight and Cognitive/Academic Outcomes

A growing body of literature suggests that LBW also contributes to cognitive and academic outcomes among children. These associations begin in early childhood (Hack et al., 1995; Weisglas-Kuperus et al., 1993), and may extend into middle childhood and adolescence (Anderson et al., 2003; Bhutta et al., 2002; Boardman et al., 2002; Rickards et al., 2001). Specifically, school-aged children are at increased risk for academic and learning problems due to the exposure to multiple environmental contexts, such as with peers and teachers, and the increased demand of complex social interactions and educational requirements (Fan, Portuguez, & Nunes, 2013). Indeed, these problems are more evident across pre-term LBW children as compared to full-term and NBW children (Anderson et al., 2003; Hack et al., 1995; Kessenich, 2003). Although the mechanisms underlying these vulnerabilities are not clear in the existing

literature, LBW and preterm children are at increased risk for sub-normal brain development after birth due to the failure of brain growth during pregnancy or lack of catch-up growth during critical periods of infant development (Hack et al., 1991; Joyce et al., 2012). These early life vulnerabilities have important implications for long-term cognitive and academic development. In addition, medical complications associated with prematurity and low birth weight (e.g., brain hemorrhage, hypoglycemia, and chronic lung disease) have been identified as risk factors for cognitive and motor deficits among these children (Kessenich, 2003; March of Dimes, 2014; Moster, Lie, & Markestad, 2008).

Similarly, a large body of literature has found that LBW children scored significantly lower on intelligence tests and exhibited higher rates of learning difficulties in reading, spelling, and mathematics in which the risks of abnormal outcomes increase as birth weight decreases (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Boardman et al., 2002; Hack et al., 1995; Kessenich, 2003). For example, ELBW/very preterm children exhibited lower levels of cognitive functioning across different domains including processing speed, full scale IQ, verbal and visual-spatial reasoning ability, and attention and working memory at age 8 as compared to NBW children (Anderson et al., 2003). In addition, preterm ELBWs were at significantly higher risk for mild to severe intellectual impairment and were more likely to display learning disabilities in reading, spelling, and arithmetic domains than their NBW counterparts (Anderson et al., 2003; Horwood et al., 1998). A study examining these outcomes also suggests that VLBW children were at higher risk for poor academic outcomes (e.g., reading and mathematics) as compared to MLBW and NBW children (Boardman et al., 2002). A meta-analytical study examining these links also suggests that LBW and preterm gestation were significantly correlated with decreased cognitive scores in middle childhood (Bhutta et al.,

2002). Collectively, these findings highlight the importance of birth weight and gestational age such that preterm LBW children are higher risks for developmental vulnerability because of their poor brain growth.

From a developmental perspective, the prenatal period and the first year of child life are the most crucial time for higher brain growth and development among children. In particular, LBW children are at increased risk for sub-normal brain development, which can lead to their poor socioemotional and intellectual functioning, and higher levels of neurologic impairment in childhood (Hack et al., 1991; Joyce et al., 2012). For example, controlling for key socioeconomic and neonatal risk factors, Hack et al. (1991) found that VLBW children who exhibit inadequate growth of the brain, evidenced by subnormal head circumference at 8 months of age, had long-term impact on various dimensions of cognitive functioning including lower IQ scores and receptive vocabulary as well as poor academic outcomes in reading, spelling, and mathematics at age 8. Although the adverse outcomes of LBW were significantly more prominent among extreme categories (e.g., VLBW/ELBW), the extant studies indicate that MLBW children are also at higher risk for poor cognitive outcomes (Boardman et al., 2002; Johnson & Breslau, 2000; Stein et al., 2006). Cognitive functioning is a multidimensional construct that consists of a wide range of cognitive abilities (e.g., receptive and expressive language skills, memory, visual-motor and visual-spatial skills) that can be represented by scores on their individual subtests level or as a global intelligence score, such as full-scale IQ (Bhutta et al., 2002; Kessenich, 2003). These abilities have been examined largely in the literature across different low birth weight categories at various developmental ages, with a particular focus on the preterm VLBW and ELBW group as compared to the MLBW group. Interestingly, however, results of a few studies with MLBW samples indicate that while the differences were small, MLBW children had

significantly lower IQ scores and cognitive test scores and higher learning problems as compared to their NBW peers in middle childhood (Boardman et al., 2002; Stein et al., 2006; Wolke, 1998).

Although the extant studies examined these links across the childhood years, as previously mentioned, most of prior studies are limited to higher-risk LBW subgroups (e.g., VLBW, ELBW, and LBW with preterm gestation) (Anderson et al., 2003; Horwood et al., 1998; Roberts, Bellinger, & McCormick, 2007; Wolke, 1998). Moreover, the meta-analysis examining the impact of LBW on cognitive outcomes in school age children reflected studies drawn exclusively from case control studies and established the direct proportionality of preterm gestational age with cognitive outcomes (Bhutta et al., 2002). Thus, little is known about the effects of this biological risk factor on cognitive/academic outcomes across children within the normative LBW group (i.e, MLBW) during middle childhood.

There is also limited research on the longitudinal associations among these constructs using multiple methods of cognitive/academic competence. Children are more likely to get exposure to and are influenced by multiple environmental contexts outside their family during the kindergarten and school years. Data from informants outside the family, such as teacher's reports of academic and socioemotional competence at school, provide the critical information on child outcomes (Anderson et al., 2003; Eisenberg et al., 2001; Nordov et al., 2012). Academic competence is a multidimensional construct comprised of the skills, attitudes, and behaviors of children that support school achievement (DiPerna, & Elliott, 2002). Although a significant body of evidence examined the effects of preterm/LBW status for diverse academic outcomes, including academic skills (related to mathematics, spelling, and reading achievement) and learning behaviors across childhood years (Aarnoudse-Moens et al., 2009; Anderson et al., 2003;

Landry et al., 1997), these associations are not clear for MLBW children in middle childhood. Thus, despite a large volume of LBW literature on cognitive/academic outcomes, there is a significant need for research focusing on MLBW outcomes, particularly using a longitudinal design with a large sample of at-risk children. Consequently, the present study examines the impacts of MLBW status on cognitive and academic achievement at age 9 using multiple methods including teacher reports of learning outcomes as well as direct assessments of cognitive and academic competence.

The Association between Parenting and Children's Socioemotional and Cognitive/Academic Outcomes

The quality of early parenting plays an important role in child development, as it can promote positive outcomes or contribute to adverse effects. Positive parenting behaviors (e.g., maternal sensitivity and responsivity, positive warmth and interaction) have been shown to promote cognitive functioning (Poehlmann & Fiese, 2001) and socioemotional competence (Altschul, Lee, & Gershoff, 2016; Spiker et al., 1993; Treyvaud et al., 2009) among children. In contrast, higher levels of parenting stress, depression, and more intrusive parenting behavior have increased the risk for poor socioemotional development (Altschul et al., 2016; Anthony et al., 2005; Huhtala et al., 2012) and cognitive deficits (Treyvaud et al., 2009) among children. Thus, maternal warmth and parenting stress are identified as two key constructs in the present study that have important implications for child functioning.

Maternal warmth consists of behaviors such as the demonstration of positive affection, love, and verbal responsiveness, the expression of enthusiasm and praise for children's accomplishments, and interest in children's activities (Amato, 1990; Rohner, 2004). Positive parenting behaviors, such as warmth and responsiveness, increase trust and reciprocity among

parents and children (Maccoby & Martin, 1983), which in turn promote reciprocity and children's apposite behaviors with their parents. Prior research also suggests that higher levels of warmth and contingent responsiveness are important factors for children's socioemotional and cognitive development. More specifically, higher levels of warmth and responsive parenting have been positively linked with higher social competence and fewer externalizing behaviors (Altschul et al., 2016; Landry et al., 2006; Lee et al., 2013; Spiker et al., 1993; Steelman, Assel, Swank, Smith, & Landry, 2002) and increased cognitive outcomes (Landry et al., 2006; Treyvaud et al., 2009) among preschool children. Whereas low levels of warmth (characterized by lack of nurturing behavior and negative affective behavior) and harsh parenting behavior have been linked to decreased social competence and increased externalizing difficulties among preschool (Altschul et al., 2016), and pre-adolescent (Alegre, Benson, & Pérez-Escoda, 2014) children.

Similarly, the recent literature examining child's socioemotional and academic outcomes highlights the importance of positive parenting interventions within these domains of child development. Prior intervention studies on this topic, such as, IHDP, suggest that responsive parenting (i.e., contingent responsiveness, warmth, and decreased negativity) facilitates positive developmental outcomes. IHDP is a multisite randomized clinical trial of preterm LBW infants for the first 3 years to test the effectiveness of educational intervention, parenting support services, and pediatric follow-up programs in facilitating child's social, health, physical, and cognitive/intellectual development (Ramey et al., 1992). Stratification was made by two birth weight groups (i.e., HLBW and LLBW; in which 2/3rd of the sample were under LLBW strata) and divided into intervention and follow-up only groups (McCarton et al., 1997; Ramey et al., 1992). Findings from this study indicate that the positive effects of advantageous learning

experiences and access to more positive and supportive parenting environment during early childhood are important processes for long-term neurodevelopmental outcomes among at-risk children (Bradley et al., 1994; Linver et al., 2002). For example, children in the intervention group had increased cognitive performance and decreased behavior problems during preschool (Brooks-Gunn et al., 1993; Liaw & Brooks-Gunn, 1993), and school ages (McCarton et al., 1997). Thus, positive parenting practices, including higher levels of warmth and stimulation, and developmental follow-up are important for preterm LBW infants in predicting increased behavioral and cognitive/academic outcomes during their childhood years (Brooks-Gunn et al., 1993; McCarton, 1998; McCormick et al., 1997; McCormick et al., 2006).

Consistent with the findings of the IHDP study, additional research on these links suggest that higher levels of responsiveness, sensitivity, and positive maternal warmth during early years were positively and significantly associated with increased social skills, and emotional and cognitive functioning among preterm LBW children at age 2 (Treyvaud et al., 2009), and during the preschool years (Landry et al., 2006; Landry, Smith, Swank, & Guttentag, 2008). On the other hand, lower levels of maternal warmth were significantly associated with higher levels of teacher's reported ADHD (attention deficit/hyperactivity disorder) symptoms among LBW twins at age 5 (Tully et al., 2004). Although prior studies have examined these links across early childhood years and in adolescence, little is known about the associations among these constructs in middle childhood. Indeed, the present study examines the independent effects of maternal warmth at ages 3 and 5 on socioemotional and cognitive/academic outcomes among children at age 9.

Furthermore, parenting stress during the early childhood years may have important implications for cognitive and socioemotional competence among children at different ages

(Anthony et al., 2005; Kiernan, & Huerta, 2008; Maughan, Cicchetti, Toth, & Rogosch, 2007; Monti et al., 2013; Satyanarayana, Lukose, & Srinivasan, 2011; Singer et al., 1999). Parenting stress is a multifactorial construct, involving characteristics of the child and parents, as well as the context (Abidin, 1995). In general, parents who characterize their children as difficult and demanding and label their interactions with their children as lacking pleasure and encouragement, report greater levels of parenting stress (Anthony et al., 2005; Robson, 1996). Parenting stress has been conceptualized as difficulties that begin from the demands of being a parent. Higher levels of maternal parenting stress may negatively influence maternal parenting behavior (Abidin, 1995) such that parents usually provide less warmth and responsive care for their children. In addition, higher levels of parenting stress were directly linked to higher levels of child's externalizing problems and lower levels of social competence during preschool period (Anthony et al., 2005). Whereas, children with low levels of parenting stress and positive parenting behaviors during the preschool period build confidence to interact positively in group situations and enhance positive social skills and behaviors (Anthony et al., 2005; Denham, Mitchell-Copeland, Strandberg, Auerbach, & Blair, 1997).

The extant studies examining these links also suggest that poor psychological health, including increased parenting stress and depression among mothers, has a crucial impact on children's growth and development among low-income and at-risk children (Kiernan, & Huerta, 2008; Monti et al., 2013; Muzik & Borovska, 2010; Patel et al., 2004), specifically in their social and behavioral outcomes (McCormick et al., 1996) and cognitive functioning (Brennan et al., 2000). Due to the exposure to negative maternal cognitions, behaviors, and affect, children of depressed mothers are at higher risk for developing subsequent behavioral difficulties (Brennan et al., 2000; Goodman & Gotlib, 1999; Turney, 2012), and exhibiting lower social competence

(Maughan et al., 2007) and poor receptive vocabulary (Brennan et al., 2000) at kindergarten. While existing studies have examined the independent associations among these constructs, additional research is needed to examine the developmental trajectories and processes on how parenting stress is linked to various domains of cognitive and behavior outcomes among at-risk children across the school years.

Also, extant studies are limited in terms of their study measures and statistical analyses. Although a few studies have examined the impacts of maternal psychological wellbeing in multiple dimensions of child functioning, the majority are focused on infancy (Halpern et al., 2001; Monti et al., 2013), and the early childhood period (Anthony et al., 2005; Brennan et al., 2000; Kiernana & Huerta, 2006; Singer et al., 1999) or at kindergarten (Brennan et al., 2000; Maughan et al., 2007; Turney, 2012). Thus, the impacts of maternal parenting stress on child's socioemotional competence and cognitive/academic outcomes at school are not clear. Acknowledging these limitations in the literature, the present study also examines the independent effects of maternal parenting stress at ages 3 and 5 on child's socioemotional and cognitive/academic outcomes at age 9.

Low Birth Weight, Parenting, and Child Outcomes: The Role of Parenting as a Moderator

Based on the findings of extant studies, low birth weight and parenting factors have important implications for developmental outcomes among children. Beyond the initial issues of the infant's survival, children's developmental status may be strongly influenced by the contextual environment, primarily parenting factors. For instance, studies demonstrate that increased maternal responsiveness and positive parenting behaviors were significantly associated with increased cognitive and language skills during infancy (Smith et al., 1996), and socioemotional and cognitive outcomes during early childhood years (Landry et al., 2006; Tully

et al., 2004) among at-risk (LBW/preterm) children. Whereas negative parenting contexts (e.g., higher levels of intrusiveness, low maternal warmth/sensitivity, and increased parenting stress) are linked to decreased child outcomes among LBW preterm children (Jaekel et al., 2015; Joyce et al., 2012; Linver et al., 2002; Poehlmann et al., 2012; Shah et al. 2013; Treyvaud et al, 2009). Due to the reason that LBW children are more prone to poor environmental conditions, they require high sensitive/positive parenting to achieve favorable developmental outcomes as compared to their NBW peers (Jaekel et al., 2015; Shah et al., 2013). Although an extensive body of literature provides support for a vulnerability perspective, the moderating role of parenting processes with respect to MLBW and child outcomes are not clear in the literature.

More importantly, positive parenting behaviors (such as maternal warmth and sensitivity) increased trust and reciprocity among parents and children (Maccoby & Martin, 1983) that led to increased cognitive and socioemotional competence among children (Landry et al., 2006; Laucht et al., 2001; Tully et al., 2004). Interestingly, these positive parenting interactions and behaviors are crucial for LBW and preterm children to have more favorable developmental outcomes. Consistent with the differential effects of caregiving context, prior research also suggests that LBW and VLBW children with low sensitive parenting had a worse cognitive/academic performance (Jaekel et al., 2015, Poehlmann et al., 2012; Shah et al. 2013; Treyvaud et al, 2009); whereas more optimal parenting and increased maternal sensitivity resulted in better behavioral and cognitive outcomes (Landry et al., 1997; Shah et al., 2013), and academic achievement (Jaekel et al., 2015) among these children. Additional studies suggest that maternal warmth moderates the effects of birth weight on ADHD among LBW twins at age 5 (Tully et al., 2004), such that LBW twins who received low maternal warmth had more teacher- and parent-reported ADHD problems at age 5 than their NBW peers. Similarly, maternal

responsivity at age 1 moderated the link between LBW and inattention and hyperactivity problems at age 8 (Laucht et al., 2001), such that the effect of LBW on attention problems were greater for children whose mothers were less responsive as compared to highly responsive mothers. More importantly, the demonstration of high levels of warmth and responsivity with their children during early ages may serve as a protective factor for behavioral difficulties in early childhood. Although previous research examining these links suggests the importance of positive parenting factors (i.e, maternal warmth and maternal responsivity) for the behavioral outcomes among LBW children (Laucht et al, 2001), and particularly among LBW twins (Tully et al., 2004), no study to date examines the role of maternal warmth as a moderator in the link among these constructs across MLBW singleton children.

Data from the IHDP study also suggest that parenting intervention programs have positive outcomes on different dimensions of cognitive and socioemotional functioning among LBW preterm children. In particular, as compared to control groups, the intervention group of LBW preterm children had higher scores on cognitive and achievement outcomes, such as IQ and math scores, during the preschool and school years (Brooks-Gunn et al., 1993; Liaw & Brooks-Gunn, 1993; McCarton et al., 1997; McCormick et al., 2006; McCormick et al., 1996) and had lower levels of behavioral difficulties in preschool years (McCarton, 1998). More interestingly, persistent benefits of the intervention were particularly more effective for children of less educated mothers (Brooks-Gunn et al., 1992; Brooks-Gunn et al., 1993; IHDP, 1990; Liaw & Brooks-Gunn, 1993) and across the subset of HLBW groups (conceptualized as MLBW in the present study) as compared to LLBW intervention groups and control groups of children (McCarton et al., 1997; McCormick et al., 2006).

Similar to the findings of IHDP studies, the results of a few other experimental/ intervention studies also suggest that parenting interventions during infancy may improve the behavioral and cognitive outcomes among preterm LBW children across early childhood years (Landsem et al., 2015; Nordhov et al., 2010; Nordhov et al., 2012; Rauh et al., 1988). For instance, a parenting intervention program in Norway (i.e., mother infant transaction program: MITP, to improve parental self-confidence and contingent responsiveness) among mothers of LBW preterm children (i.e., birth weight <2,000g) had significant positive effects on behavioral outcomes at age 5, whereas an increased number of LBW control children showed clinical level of behavioral symptoms measured by both the CBCL and the SDQ (Nordhov et al., 2012). These studies collectively highlight the importance of early parenting practices in child outcomes among preterm LBW children. Although prior intervention and experimental studies examining the impacts of parenting intervention on child developmental outcomes had positive effects across children with LBW and preterm status, the moderating role of parenting factors in these developmental processes among MLBW children in the absence of intervention remains unclear.

Research examining these links also suggests that maternal parenting stress is another important risk factor for child 's socioemotional and cognitive/academic competence during the childhood years (Brennan et al., 2000; Goodman & Gotlib, 1998; McCormick et al., 1996; Patel et al., 2004; Singer et al., 1999). Specifically, parenting stress may increase after the birth of an LBW infant due to the increased medical risks and decreased regulation abilities associated with LBW status (Robson, 1997; Singer et al., 1999). Research also suggests that LBW and preterm infants are more difficult to manage for the first few months of infancy due to their reduced ability to adapt to environmental changes, increased distractibility, and irregularities in their biological rhythms compared to their NBW/full term peers (Weiss et al., 2004). These children

also demonstrate less regularity in bodily functions (such as feeding, sleeping, and elimination) and higher intensity of crying, less soothability during distress and more withdrawal in reaction to new routines, places, or stimuli (Hughes, Shults, Mcgrath, & Medoff-Cooper, 2002). Thus, increased medical risks and immature behavioral organization associated with premature/LBW infants may increase the psychological distress among mothers that interfere with their interaction patterns (Robson 1997; Singer et al., 2003). As a result, these children are at increased risk for higher levels of developmental delay, cognitive, behavioral, and learning problems (Arpi & Ferrari, 2012; Bhutta et al., 2002).

Consistently, studies examining these links across LBW subgroups also suggest that parenting stress and depressive symptoms are particularly higher among mothers of preterm and VLBW children (Halpern et al., 2001; Monti et al., 2013; Singer et al., 1999). In particular, due to the increased burden from medical and other complications including developmental delay among LBW and preterm children, parents often experience higher levels of parenting stress and maternal depression (Howe et al., 2014; Monti et al., 2013; Singer et al., 1999; Tayler, Klein, Schatschneider, & Hack, 1998). Therefore, it could be possible that lower levels of maternal psychological wellbeing/mental health may predict higher levels of behavioral and academic difficulties among children with MLBW status. In contrast, mothers with less parenting stress engage in positive interaction and are more sensitive to their child's needs, which may positively impact behavioral and cognitive outcomes among children (Singer et al., 2003). The lower levels of parenting stress and the higher levels of positive maternal behaviors during early childhood years may also enhance children's ability to practice positive social skills in group situations that may link to long-term socioemotional and cognitive/academic outcomes (Anthony et al., 2005; Denham et al., 1997). Although, the extant studies highlight the importance of maternal mental

health on child outcomes, the role of parenting stress as a moderator in the link between MLBW and child developmental outcomes remains unclear. To date, none of the prior studies have examined these constructs in a single model or using a moderational framework. In addition, given that the majority of prior studies examining these links focused on higher risk LBW sub-groups, primarily preterm birth/VLBW categories, the role of parenting stress as a moderator in the link between MLBW and multiple domains of child outcomes is still unknown.

In sum, consistent with developmental vulnerability perspective and using the findings of prior intervention and empirical research in the field, the present study examines the role of parenting processes during early childhood in the link between MLBW and child outcomes in middle childhood. The objective of the present study is to explore whether parenting processes have differential impacts in the associations among MLBW and socioemotional and cognitive/academic outcomes. In particular, the present study examines the moderating effects of positive parenting processes (i.e., maternal warmth at ages 3 and 5) and psychological wellbeing (i.e., parenting stress at ages 3 and 5) in the link between MLBW and socioemotional including externalizing behaviors and social skills and cognitive/academic competence at age 9 among at-risk children. Findings from this study may be helpful to design intervention and enrichment programs supporting parents during the first few years of life, which help to provide long-term protection against biological disadvantages and increase positive developmental outcomes among LBW children (McCarton, 1998).

Middle Childhood and Developmental Outcomes

Middle childhood is an important developmental period that consists of children between the ages of 6 and 12 years. This period is considered a distinctive phase of the major developmental transition because children are entered in the formal education system and are

required to have complex social interactions with both adults and children (Coll & Szalacha, 2004; Fan et al., 2013). From the psychosocial perspective, school age is considered a critical period for the development of the sense of industry (by Erik Erikson) and the importance of interpersonal relationships/social relations with peers in the elementary years (by Harry Stack Sullivan) (Fischer & Bullock, 1984). In particular, children have complex interactions with peers and teachers in a wider variety of settings and have to accept universal standards and apply sophisticated socialization skills, such as the social norms, emotional expressiveness, and role-taking skills, to successfully navigate peer relationships (Fischer & Bullock, 1984; Ladd, 1999). The widening social world and the pressure that present them with the unique developmental challenges have significant implications to the developmental outcomes among children.

Not only to the socioemotional aspects of development, but cognitive functioning in middle childhood has also been a central focus in the developmental literature. From a cognitive standpoint (by Jean Piaget), school age children are competent of logical and systematic ways of thinking, problem solving, and reasoning skills in a wide range of tasks (Fischer & Bullock, 1984). Children also acquire a broad array of competencies in reading, writing, and math skills and develop the capability to solve the complex problems at school (Coll & Szalacha, 2004; Epps & Smith, 1984; Fan et al., 2013). In a broader framework, family socialization practices and parenting during earlier ages are crucial for the acquisition of positive social skills and the development academic and cognitive functioning at school. Thus, it becomes more critical to identify with the nature of the cognitive/academic development and socioemotional development during school ages.

Children also require participating in state-level testing in different areas, such as reading, math, science, and writing proficiency to measure and improve performance. While the

implementation of standardized tests varies across the fifty states, experts have suggested that it is important to measure children's educational standards in middle childhood (generally beginning at 3rd grade) to determine their mastery in grade-level content and skills (Epps & Smith, 1984; Times4Learning, 2017). Thus, children exhibit remarkable growth in multiple areas of development at school including complex social skills and effective cognitive/academic functioning for school success (Coll & Szalacha, 2004; Fan et al., 2013). Also, beginning at age 9, children will have increased academic demand because they need to participate and compete in standardized assessments. Given that, it is particularly relevant to examine socioemotional and cognitive/academic outcomes at age 9 among these at-risk children.

Theoretical Framework

Low birth weight is considered as an important biological determinant for long-term cognitive/academic and behavioral competence among children. Because brain architecture and brain functions differ markedly among children with NBW and LBW, and particularly among children born SGA, LBW children exhibit decreased cognitive and intellectual abilities across their childhood years (De Bie et al., 2010; Tolsa et al., 2004). Consistent with the developmental vulnerability hypothesis (i.e., vulnerability of the immature brain), the diverse medical situations (e.g., severity of illnesses across LBW children, prolonged hospitalization, the lack of their physiological stability and exposure to adverse medical/social experiences) at an early age may have a persistent and a long-term impact on the developing brain leading to cognitive and behavioral difficulties among children at various ages (Bhutta et al., 2002; McCarton, 1998; Tayler et al., 2001). Extant research also suggests that infants born VLBW and ELBW have a significantly increased risk of medical complications (e.g., hypoxia at birth, immature lungs or respiratory distress syndrome (RDS)), thus requiring resuscitation and prolonged artificial

ventilation support following birth. Also, these children may suffer from difficulty feeding and gaining weight as well as have trouble staying warm (i.e., immature thermoregulation thus requiring to be in an incubator) (Arpi & Ferrari, 2013; Kessenich, 2003; March of Dimes, 2014; Moster et al., 2008). The results from both human and animal experimental studies also suggest that there are structural alterations in the brain and a consistent underdevelopment of the brain among humans and animals born SGA/IUGR (De Bie et al., 2010; Tolsa et al., 2004) that lead to increased susceptibility to cognitive deficits and behavioral problems. In addition, due to a biological/temperamental vulnerability in their make-up, LBW children may be more likely to be affected by adverse effects of negative parenting (Belsky & Pluess, 2009; Jaykel et al., 2015; Whiteside-Mansell et al., 2009; Zuckerman, 1999), which may undermine their wellbeing (Belsky et al., 2007). However, as indicated earlier, the specific outcome for each child with LBW status depends on the complex interaction between several intrauterine and extrauterine factors (De Bie et al., 2010; Roberts et al., 2007). Thus, the accumulation of risk factors impacts developmental outcomes among at-risk children.

Since LBW has been linked to short and long-term health and developmental consequences, it is important to identify key prenatal/biological factors that contribute to the adverse birth outcomes. In particular, nutrition and weight gain during pregnancy, maternal pre-pregnancy body mass index (MBMI), high-risk maternal behaviors, and mental health during pregnancy have important implications for both birth outcomes and later child development. For instance, nutritional deficiency and inadequate weight gain during pregnancy may contribute to IUGR and could have long-term physical and mental health consequences for children (Roseboom, Painter, van Abeelenm Veenendaal, & Rooji, 2011; Scrimshaw, 1991; Torche & Echevarría; 2011). These factors can directly affect the child's birth weight as well as their

prenatal programming. For example, a study in the U.S. found that pregnant women living in proximity to a supermarket with access to fresh foods (e.g., better nutritional values) had significantly lower rates of LBW infants than other pregnant women despite their income level (Lane et al., 2008).

There is also evidence that prenatal undernutrition during wartime famine for an acute period (i.e., Dutch Hunger Winter) had an adverse effect on birth weight and subsequently increased the risk for diabetes and heart disease later in life (Lumey, 1998; Painter, Roseboom, & Bleker, 2005; Roseboom et al., 2011; Susser, Hoek, & Brown, 1998). Additional research suggests that maternal undernutrition during the critical period of fetal development may impose generational-spanning effects, such that maternal famine exposure in utero was associated with increased neonatal adiposity and poor health in later life such as increased risk for obesity, diabetes, and heart diseases for their offspring (Painter et al., 2008). Moreover, nutritional deficiencies, such as iron deficiency, may have significant effects on brain function that result in permanent impairments in learning and behavioral domains among children (Scrimshaw, 1991; Tolsa et al., 2004). Thus, impaired nutrition during pregnancy is a risk factor for poor birth outcomes and later health consequences. In addition, smoking, substance use, and maternal psychological distress during pregnancy are positively linked to IUGR and prematurity (Child Health USA, 2013; Lobel et al., 2008; Reichman, 2005; Satyanarayana et al., 2011), which, have negative long-term effects on behavioral and cognitive outcomes (Gray, Indurkhya, & McCormick, 2004; Lobel et al., 2008; Satyanarayana et al., 2011).

The extant literature also indicates that gestational age and child's weight at birth are both important predictors of short-term and long-term developmental outcomes among children. More particularly, LBW children who were born preterm exhibited higher levels of behavioral

difficulties and lower levels of cognitive test scores in their preschool (Arpi & Ferrari, 2013) and

school years (Bhutta et al., 2002) such that these children subsequently had a higher risk of poor

developmental outcomes. Recent studies examining these outcomes within the MLBW group

also suggest that children with MLBW are at increased risk for poor learning, higher behavioral

difficulties, and poor health outcomes (i.e., identified as having a special health care

needs/chronic health condition) as compared to NBW children (Stein et al., 2006). Although, less

is known about the effects of full-term LBW on these outcomes, studies have consistently

indicated that children born with IUGR/SGA are at increased risk for impaired brain

development (De Bie et al., 2010; Tolsa et al., 2004), which leads to long-term negative

consequences across multiple domains of child development.

A developmental perspective also suggests that the perinatal period (primarily mid-

gestation to late infancy) is considered as a critical period for growth and development of the

human brain (Hack et al., 1991). While an increased number of children with LBW, particularly

VLBW, are more susceptible to perinatal failure of brain growth, they also fail to have normal

catch-up growth in their subsequent period of development during infancy and early childhood

(Hack et al., 1991; Horwood et al., 1998). As a result, these children are unable to achieve

normal growth and development during the critical age that leads to poor emotional and

intellectual functioning (Hack et al., 1991; Joyce et al., 2012). As LBW children are also at

higher risk for medical complications, for growth retardation, and developmental delay, being

LBW itself is a biological disadvantage for them (WHO, 2011). Thus, although many LBW

babies are healthy and have normal outcomes, as a group, LBW babies are more likely than

NBW babies to suffer from immediate life threatening health situations (e.g., respiratory distress

syndrome, heart problems, neonatal infection), long-term health complications (e.g., failure to

thrive, diabetes, heart disease, metabolic disorder etc.) and developmental disorders (e.g., learning and behavioral problems) (Child Health USA 2013; March of Dimes, 2014). As a result, these children are increased risk for medical and developmental consequences.

According to the Fetal Programming Hypothesis (FPH), also known as the Developmental Origins of Health and Disease (DOHaD) Hypothesis (Barker, 1998; Barker 2007), LBW and preterm gestation may represent a suboptimal prenatal environment that provides a cue for their postnatal growth and long-term development. More specifically, this prenatal programming can serve as a stimulus or insult at a critical period of fetal development that may permanently modify the structure and function of the various organs, thereby enhancing the risk of disease (e.g., coronary heart disease, stroke and type-2 diabetes) in later life (Godfrey & Barker, 2001; Räikkönen & Pesonen,2009). Consistent with the DOHaD hypothesis, research suggests that early growth and development have a crucial effect on individual differences in cognition, psychological development, and mental health among children (Räikkönen & Pesonen, 2009). Thus, these early life vulnerabilities may result in an increased risk for behavioral maladjustment and psychopathology in later life (Barker, 1998; Godfrey and Barker, 2001). Although, the recent literature has examined the associations between low birth weight and its long-term health implications (Räikkönen & Pesonen, 2009), the effects of prenatal programming for long-term developmental outcomes, particularly across socioemotional and cognitive/academic domains, are not clear in the literature.

Research also suggests that MLBW children are more likely to suffer from chronic health conditions, special health care needs, and or learning difficulties as compared to NBW children (Stein et al., 2006). Learning difficulties may apparent among these groups due to their neurophysiological impairments. For instance, the deviation in attentional control, working

memory and mental flexibility may have a significant impact on learning among LBW children (Anderson et al., 2003). Similarly, a small number of these children, particularly the VLBW group, may also suffer from neurological deficits (Ballot et al., 2012), thus leading to an increased risk of adverse behavioral and cognitive outcomes (Horwood et al., 1998).

Similarly, a developmental approach further suggests that environmental factors and positive parenting during early childhood would have significant implications for positive developmental outcomes and later school success among children (Broekman, 2011). In particular, early maternal sensitivity and responsivity during parent-child interactions have been linked to enhanced cognitive outcomes and self-regulation skills (Jaekel et al., 2015; Landry et al., 2000; Poehlmann & Fiese, 2001). Attachment frameworks also suggest that positive parenting interactions during early years help infants to develop secure attachment relationships with parents/caregivers (Ainsworth, 1989; De Wolff & Van Ijzendoorn,1997) result in an enhanced brain activity and positive socioemotional outcomes during school ages (Fox & Rutter, 2010). A growing body of research also suggests that secure parent-child attachment and positive bonding contribute to long-term child outcomes through the formation of internal working models of the self as worthy of affection and care and of others as trusting and responsive (Bowlby, 1982, Kenny & Sirin, 2006). Findings of the Harlow's experimental studies on infant monkey's also suggest that warmth, nurturance, and affection are more vital for children than is the provision of physical needs in developing better self-regulatory capacities and better adaptation in fearful situations (Harlow, 1961; Harlow & Zimmermann, 1958). Consistently, earlier research in Romanian orphanages indicates that psychological care, love, and affection during critical years of development have a positive effect on children's brain development and long-term child outcomes (Fox, Leavitt & Warhol, 1999 Fox & Rutter, 2010). Perhaps children

may experience a marked deprivation in developmental stimulation and social interaction when they are exposed to adverse caregiving environments, such as child neglect and institutional rearing (McLaughlin, Fox, Zeanah, & Nelson, 2011; Zeanah et al., 2009), thus have increased the risk of poor brain development and the higher level of cognitive and behavioral difficulties.

Regardless of their medical and developmental vulnerabilities at birth, infants require contingent responsiveness and sensitive care from their parental figures for optimal socioemotional competence and cognitive and learning skills (Jaffee, 2007). Due to the complex interaction between social experiences and human brain development, the exposure to positive parenting contexts stimulates the developing brain resulting in increased cognitive and behavioral outcomes. However, the exposure to adverse environmental contexts (e.g., child abuse and neglect, failure to thrive) (Gindis, 2005; Jaffee, 2007; McLaughlin et al., 2011) and less sensitive parenting interactions (Bilgin & Wolke, 2015; Korja et al., 2012; Poehlmann & Fiese, 2001) result in poor cognitive and behavioral outcomes among children due to the lack of sufficient amount of sensory stimulation and nurturing touch. Thus, contingent responsiveness and sensitive parenting during early childhood are crucial in enhancing self-regulatory capacities and positive working models that may link to developing positive socioemotional and cognitive outcomes in middle childhood.

Positive parenting practices (i.e., higher levels of maternal warmth and positive interaction) also stimulate the immature brain of LBW children (Nordhov et al., 2012), thereby facilitating positive long-term developmental outcomes (McCarton, 1998; Rauh et al., 1988). A few experimental studies among LBW children and control groups of NBW children suggest that parenting interventions improve maternal parenting and decrease their reported stress, hence resulting in positive cognitive, socioemotional, and behavioral outcomes for the children

(Nordhov et al., 2010; Nordhov et al., 2012). Indeed, efforts to increase the quality of the home environment (e.g., various categories of social stimulation activities during infancy and toddlerhood) are important to reduce the negative effects of prenatal cerebral damage at an earlier age and to gain the catch up growth and positive cognitive outcomes among VLBW infants, in particular among neurologically at-risk children in their early childhood period (Weisglas-Kuperus et al., 1993).

Furthermore, a stimulating home environment and positive parenting practices may help to overcome the negative effects of biological vulnerability of preterm birth and LBW status, thus improving behavioral and cognitive/academic outcomes. In particular, the greater amount of maternal support and warmth promote positive outcomes among LBW children because these children are able to internalize the positive affect through positive maternal behaviors (Landry et al., 2006). Similarly, prior intervention studies suggest that preterm children with HLBW groups benefitted more than an LLBW intervention group of preterm children from educational stimulation and positive parenting practices (Liaw & Brooks-Gunn, 1993; Brooks-Gunn et al., 1994; McCarton et al., 1997; McCormick et al., 2006; Ramey et al., 1992). In contrast, less stimulating environment/nurturing parenting may further contribute to unfavorable developmental outcomes among LBW children leading to poor intellectual and achievement outcomes during the preschool and late childhood years.

Interestingly, the effect of the intervention was stronger for preterm HLBW group, whose mothers had lower than high school education (Brooks-Gunn et al., 1992; Brooks Gunn et al., 1993; IHDP, 1990; Liaw & Brooks-Gunn, 1993) and children of lower income families (Linver et al., 2015; Roberts et al., 2007) as compared to children of mothers with higher levels of education and higher income families. Using a large sample of Chilean Twins, Torche &

Echevarría (2011) also found that LBW was more strongly associated with lower cognitive scores at grade 4 in children whose mothers had less education as compared to children of well-educated mothers. Thus, due to the increasing susceptibility of LBW children for poor developmental outcomes, particularly in disadvantaged families, positive parenting may be beneficial for these at-risk children to strengthen the impacts of biological vulnerability on cognitive/academic achievement (Torche & Echevarría, 2011) and behavioral competence (Landsem et al., 2015; Räikkönen & Pesonen, 2009).

Given that LBW children are more likely to demonstrate lower levels of cognitive performance and behavioral competence than their NBW peers (Brooks Gunn et al., 1993; IHDP, 1990; Liaw & Brooks-Gunn, 1993), they have more to gain from positive intervention. Although the majority of research has identified the importance of parenting\parenting intervention in these associations, it is important to understand how multiple parenting factors influence and interact for positive cognitive/academic and socioemotional outcomes among MLBW children. While the neonatal outcomes of LBW children have improved in recent years via rapid advances in fetal medicine and perinatology, (Bhutta et al., 2002), little is known about the role of different parenting factors for MLBW children in predicting positive developmental outcomes. Indeed, the present study examines the moderating role of parenting in the link between MLBW and various domains of child outcomes in middle childhood.

Conceptual Model
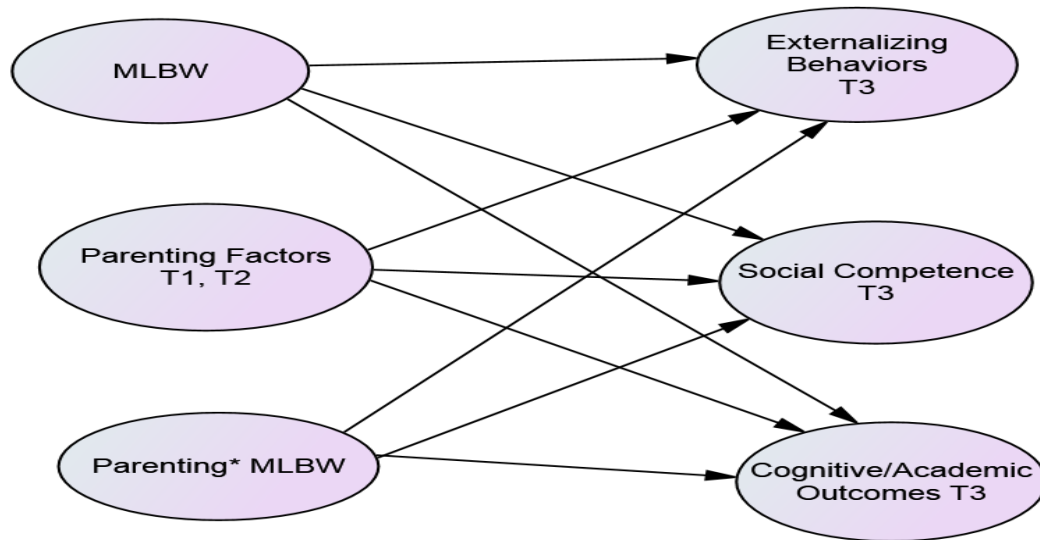
Figure 1. The conceptual model of the relationships between MLBW, parenting processes, and socioemotional & cognitive/academic competence among children. T1 = Time 1 (Year 3), T2 = Time 2 (Year 5), T3 = Time 3 (Year 9).

Figure 1 presents a diagram of the proposed conceptual model for how MLBW, parenting processes, externalizing behaviors, social competence, and cognitive/academic outcomes are linked to each other among at-risk children at various developmental ages. Consistent with prior research and theoretical framework, the present study proposes the following research questions/hypotheses.

Research Questions and Hypotheses

(1) Does MLBW status predict maternal and teacher reports of children's problem behavior and social competence at age 9?

Hypothesis 1 (H1): Based on previous research examining the link between LBW and externalizing problems (Aarnoudse-Moens et al., 2009; Anderson et al., 2003; Bhutta et al., 2002; Hoorwood et al., 1998; Landsem et al., 2015; Vaske et al., 2013) and social competence (Anderson et al., 2013; McCormick et al., 1996; Spiker et al., 1993), the present study proposes that:

H1a. MLBW status will be longitudinally associated with higher levels of mother-reported externalizing behaviors at age 9.

H1b. MLBW status will be longitudinally associated with higher levels of teacher-reported externalizing behaviors and lower levels of social competence at age 9.

(2) Are parenting processes longitudinally associated with socioemotional competence among children?

Hypothesis 2 (H2): There is increasing evidence regarding the importance of early parenting factors on socioemotional and cognitive/academic competence among children. Similar to prior findings regarding the important role of maternal warmth (Altschul et al., 2016; Landry et al., 2006; Spiker et al., 1993) and parenting stress (Anthony et al., 2005; Denham et al., 1997; Halpern et al., 2001; Huhtala et al., 2012; Maughan et al., 2007) in socioemotional competence among children, the present study proposes that:

H2a. Positive maternal warmth and low levels of parenting stress (at ages 3 and 5) will be significantly associated with lower levels of mother-reported externalizing problems at age 9.

H2b. Positive maternal warmth and low levels of parenting stress (at ages 3 and 5) will be significantly associated with lower levels of teacher-reported externalizing problems and higher levels of social competence at age 9.

(3) Does MLBW predict cognitive/academic outcomes at age 9?

Hypothesis 3 (H3): Based on the earlier research findings in the link between LBW and cognitive/academic outcomes (Anderson et al., 2003; Bhutta et al., 2002; Boardman et al., 2002, Dombrowski et al., 2007; Rickards et al., 2001; Shah et al., 2013; Vaske et al., 2013), the present study also hypothesizes that:

H3. MLBW status will be associated with lower levels of cognitive and/ academic functioning at age 9.

(4) Are parenting variables longitudinally associated with cognitive/academic competence among children?

Hypothesis 4 (H4): Increasing evidence also suggests that higher levels of maternal warmth and sensitivity and lower levels of parenting stress and negative parenting behaviors make an important positive contribution to children's cognitive/academic outcomes (Landry et al., 2001; Landry et al., 2000; McCormick et al., 1996; Patel et al., 2004; Poehlmann & Fiese, 2001; Roberts et al., 2007; Treyvaud et al., 2009). Thus, the present study also hypothesized that:

H4a. Higher levels of maternal warmth (at ages 3 and 5) will be associated with higher levels of cognitive/academic competence at age 9 among at-risk children.

 H4b. Lower levels of parenting stress (at ages 3 and 5) will be associated with lower levels of cognitive/academic competence at age 9.

(5) Do parenting processes moderate the strength of the associations between MLBW and child outcomes?

Hypothesis 5 (H5): As positive parenting processes may reduce the negative effects of LBW in predicting child outcomes (Landry et al., 2000; Landry et al., 2001; Landry et al., 2006; McCormick et al., 2006; Nordhov et al., 2012; Tully et al. 2004), the present study also hypothesizes that:

H5a. Maternal warmth (at ages 3 and 5) will moderate the longitudinal association between MLBW and socioemotional outcomes, including externalizing behaviors and social skills at age 9.

H5b. Maternal warmth (at ages 3 and 5) will moderate the longitudinal association between MLBW and cognitive/academic competence at age 9.

H5c. Parenting stress (at ages 3 and 5) will moderate the longitudinal association between MLBW and socioemotional competence including externalizing behaviors and social skills at age 9.

H5d. Parenting stress (at ages 3 and 5) will moderate the longitudinal association between MLBW and cognitive/academic competence at age 9.

Consistent with the theoretical understanding of developmental vulnerability and differential contextual effects on child outcomes (Belsky, 2013; Belsky et al., 2007; Zuckerman, 1999), and prior research on the differential impacts of caregiving contexts (Jaekel et al., 2015; Poehlmann et al., 2011; Laucht et al., 2001; Shah et al., 2013), the present study also proposes that MLBW children with more optimal parenting (i.e., high maternal warmth and low parenting stress) will demonstrate better cognitive/academic and socioemotional outcomes than MLBW children who are exposed to lower levels of warmth and higher levels of stress in early childhood. Although, a few other research examined the moderating role of maternal warmth and maternal responsivity in the link between birth weight and ADHD problems across LBW twins

(Tully et al., 2004), and across LBW preterm children (Laucht et al., 2001) and found the significant interactions, none of the prior studies have examined these effects across MLBW children.

Also, to date, none of the prior studies have examined the moderating role of parenting stress in these links across LBW and or MLBW children. Thus, the examination of parenting processes as moderators of the links between MLBW and child outcomes are notably exploratory. However, given findings of prior research with more extreme categories of LBW and preterm children and differential impacts of parenting context, it is expected that the link between MLBW and child outcomes will be stronger among children with more positive parenting contexts as compared to negative parenting contexts.

Summary

Low birth weight is considered as an important variable for multiple dimensions of children's developmental outcomes, including socioemotional, and cognitive/academic competence. It is also noteworthy that the effects of birth weight are not uniform across LBW groups. In particular, children with lower/extreme birth weight categories have a higher risk of long-term negative effects for their subsequent development. Given that LBW consists of heterogeneous groups of children with different weight categories and gestational ages, it is important to examine these outcomes across heterogeneous groups of LBW sample. While the majority of research in these areas has focused on VLBW and ELBW subgroups, consistent with a few prior studies (Boardman et al., 2002; Stein et al., 2006), the present study conceptualized MLBW as an infant with a birth weight of 1,501-2,499 grams irrespective of their gestational age at the time of birth. Therefore, the present study includes both preterm and full-term MLBW infants with birth weights between 1,501-2,499 grams and a comparison group of NBW children

using data from FFCW study. VLBW and ELBW children were excluded from analyses due to the scope of this study and the limited number of cases.

Prior research examining these links also supports parenting as an important predictor of positive child outcomes at different developmental ages (Altschul et al., 2016; Anthony et al., 2005; Denham et al., 1997; Huhtala et al., 2012; Landry et al., 2006; Landry et al., 2000; Spiker et al., 1993; Treyvaud et al., 2009). The contribution of MLBW status in combination with parenting processes to child developmental outcomes in middle childhood, however, is less established in the literature. While a few experimental/intervention studies highlight the positive effects of parenting on child developmental outcomes among preterm/LBW children (McCarton, 1998; McCarton et al., 1997; McCormick et al., 2006; Nordhov et al., 2012), none of the earlier studies to date examined how parenting processes interact with MLBW in predicting multiple domains of child outcomes. Thus, in addition to the independent effects among these links, the present study will examine the moderating role of maternal parenting processes in the link between MLBW, and socioemotional and cognitive/academic outcomes.

In addition to the parenting influences, multiple sociodemographic variables may also have a greater impact on the outcomes of LBW children. In particular, sociodemographic variables, including maternal age, education, income, and race/ethnicity, are significant predictors of long-term behavioral outcomes across different LBW groups (Gray et al., 2004; Roberts et al., 2007; Taylor et al., 2001). Additional research indicates racial/ethnic disparities in birth weight status and child outcomes. In particular, African-American infants are at an increased risk of being born LBW (Goldenberg & Culhane, 2007; Lane et al., 2008; Reichman et al., 2008), and exhibit poor cognitive and academic outcomes (Roberts et al., 2007). The recent data indicate that African American mothers (13.18 %) are most likely to have a LBW baby,

followed by Asian (8.4%), and Hispanic and White mothers (about 7%) (Child Health USA, 2013; March of Dimes, 2014) with White-Black differentials being particularly large.

It could also be possible that other factors such as differences in socioeconomic conditions, cultural factors, and prenatal health behaviors are important for elucidating differences in birth outcomes across racial/ethnic groups (Landale, Oropesa, & Gorman, 2000; Reichman et al., 2008). For instance, there is a strong positive association between the low socioeconomic condition and poor birth outcomes of infants born to minority families (Reichman et al., 2008; Teitler, Reichman, Nepomnyaschy, & Martinson, 2007). In particular, African American families have three to four times higher rates of poverty as compared to whites and the increased incidence of low birth weight as compared to other race/ethnic groups. The lower incidence of LBW children among Hispanic and White families as compared to African American families may also be linked to their cultural values and behaviors, such as healthy diets and lower rates of substance use during pregnancy despite low socioeconomic status. For instance, Hispanic families often put a high value on motherhood and are more likely to adhere to culturally-informed and less deleterious health behaviors during pregnancy (e.g., decreased rate of drinking, smoking and use of illicit drugs) (Landale et al. 2000; Reichman et al. 2008). Thus, it is important to note that racial/ethnic differentials could be a proxy for other behavioral and sociodemographic factors that may have significant implications for immediate and long-term developmental outcomes.

While birth weight is classified as an important biological parameter that may have a crucial implication in long-term child outcomes, sociodemographic and perinatal factors also have strong negative effects on developmental outcomes across the continuum of low birth weight (Boardman et al., 2002; David & Collins, 1997; Hack et al., 1995; Horwood et al., 1998;

Kelly et al., 2001; Lobel et al., 2008; Torche & Echevarría, 2011). In sum, along with prenatal

risk factors, it is important to examine the impact of sociodemographic risk factors, as these are

often stronger predictors of children's developmental outcomes (Bhutta et al., 2002; Linver et al.,

2002; Poehlmann et al., 2012; Roberts et al., 2007). The present study controls for a number of

potentially key prenatal variables, family and child characteristics, and sociodemographic

variables in the model that impact on child outcomes.

Interestingly, only a few prior studies have examined the associations among these

constructs using multiple reporters of behavioral and academic outcomes (Anderson et al., 2003;

Arnold, 1997; Horwood et al., 1998; Nordov et al., 2012). A few studies examining these

outcomes also combined both mother- and teacher- reported behaviors to create a composite

scale (Horwood et al., 1998); however, averaging scores across multiple reporters may lose some

vital information about child's socioemotional characteristics in different context and bias the

results (Sabatelli & Barltle, 1995). Thus, the present study utilizes data on externalizing

behaviors and social skills (only teacher's report due to data constraints) through multiple

informants including mothers and teachers and examines these links separately for both parents

and teachers. The data on cogntive/academic outcomes are also examined using multiple

methods including teacher reports and direct cognitive assessments. In summary, the present

study will employ a multiple informant perspective and multiple methods to investigate the link

among these constructs using a secondary data from FFCW study. The data from FFCW study

are particularly useful for the present analyses because ethnic minorities (i.e., Hispanics and

African American) are oversampled, allowing for study of these associations among a diverse

sample of U.S. children.

Chapter 3. Methods

Participants

Participants were drawn from the FFCW Study, a national longitudinal study of nearly

5,000 children born between 1998 and 2000 across 20 U.S. cities. The FFCW survey was

conducted by the Center for Research on Child Wellbeing at Princeton University and the Social

Indicators Survey Center at Columbia University. The study was designed to examine the

characteristics of unmarried parents, the relationships between them, and the consequences for

children (Center for Research on Child Wellbeing, 2008). The unmarried parents and their

children are referred to as 'fragile families' because their families were at greater risk of

breaking up and living in poverty than more traditional families (Center for Research on Child

Wellbeing, 2008). The FFCW study follows a birth cohort of children born to unmarried parents

(75% of the sample) with a comparison group of married families using a stratified random

sample of 20 U.S. cities with 200,000 or more people (Reichman, Teitler, Garfinkel, &

McLanahan, 2001). Baseline interviews with mothers and fathers were conducted shortly after

the child's birth at the hospital based on stratified sampling using maternity ward lists.

Stratification was based on policy environments (i.e., welfare policies and child support policies)

and labor market conditions in the different cities (McLanahan & Garfinkel, 2000).

Medical records data for mothers and children (n = 3,684 of those births) were obtained

from the birth hospitalization record. Mothers were interviewed in person in the hospital within

48 hours of the child's birth, and fathers were interviewed in person or by phone as soon as

possible thereafter, either in the hospital or wherever they could be located (Reichman, et al.,

2001). Of the total births, approximately 3600 births were to unmarried mothers; 87% of eligible

mothers completed baseline interviews, and at least 75% of unwed fathers were interviewed at

baseline (Reichman et al., 2001). These initial interviews were followed by telephone interviews with both mothers and fathers when children were ages 1, 3, 5, and 9; families also participated in in-home assessments capturing the home environments and child outcomes at ages 3, 5, and 9 (Reichman et al., 2001).

The analytic sample reflects a subsample of families participating in the FFCW study. Specifically, to be eligible for the analytic sample, families had to have complete medical record data with a singleton birth ($n = 3,619$), and infants with no neurological impairment at birth. First, families who did not have medical record data (n = 1,214) and mothers with multiple pregnancy (n = 65) were excluded from the analytic sample. Second, children had to be born without neurological impairments (Approximately 2.2% of children, $n = 82$; suffered from neurological problems including hydrocephalus, microcephalus, seizures and other central nervous system disorders at birth and were excluded from analyses. Third, children were required to have a birth weight greater than 1,500 grams (VLBW and ELBW children; $n = 80$), and mothers needed to be interviewed in the 3 ($n = 608$) and 5 year ($n = 438$) in-home longitudinal surveys of children and families. These criteria resulted in the exclusion of 3,089 (63.1% of original sample; in which 41%: $N = 2,007$ were missing, and 22%: $N = 1082$ were dropped) families, which brought the final analytic sample to 1,809 (36.9% of original sample) families.

Demographic characteristics of the analytic sample and the original sample are displayed in Table 1. Demographic characteristics of the analytic sample by birth weight status are also presented in Table 2. Among the total sample, 8.0% ($n = 143$) were born MLBW (birth weight 1,501 to 2,499 g) in which about 2/3rd of them ($n = 89$) were preterm LBW. Fifty-one percent of children ($n = 921$) were male. Two items from the mother's questionnaires at baseline (i.e.,

cohabiting status and marital status of mother with baby's father at birth) were used to determine family type, which included married/cohabiting (59.4%, $n = 1075$) and single parent (40.6%, $n = 734$) families. Of the mothers in this analytic sample, 63.5% fell below the poverty threshold at baseline (income < 200% of poverty threshold) and 34.9% did not complete high school. The majority of participants were of ethnic minority, including 51.5% African American, 25.8% Hispanic and 2.9% other race/ethnic category. About 13% of children in the analytic sample were from foreign-born mothers. In addition, 12.4% of mothers had a history of mental health problems, 20.9% of mothers had a history of smoking only, and 26.1% used substances (including tobacco, alcohol, and drugs) during pregnancy. Regarding prenatal care, only about 50.8% ($n = 788$) of mothers started prenatal visits during the first trimester of pregnancy.

Preliminary analyses suggest that the analytic sample did not differ from the original sample on a number of demographic and medical variables. For instance, families were similar in both samples in terms of mother's level of education (i.e., about 30% completed high school education and 35% had some college or more education) and family types (about 40% of single parent families and 60% of married cohabiting families). There were also similar proportions of girls (48.9 vs. 47.8) and boys (51.1% and 52.2%), in the analytic and original samples, respectively. Next, the proportion of MLBW children in the analytic sample did not differ from the original sample (7.9% vs. 8.9%) Similarly, the analytic sample had an equal proportion of families below the poverty line (i.e., below 200% of poverty threshold) as in original sample (63.5% vs. 61.9%).

Nevertheless the analytic sample did differ from the original sample on some key demographic variables. For example, the analytical sample had slightly lower proportions of preterm births (9.8% vs. 12.0%; $\chi^2 = 6.02$, $p < .05$) and higher proportions of children from U.S.-

born mothers (86.7% vs. 83%%, $\chi^2 = 13.47$, $p < .001$) as compared to the original sample.

Similarly, compared to the original sample, the analytic sample also consisted of fewer Hispanic

(25.8% vs. 27.3%) and white (19.8% vs. 21.1%) families, and more African American (51.5%

vs. 47.6 %, $\chi^2 = 10.2$, $p < .05$) families. Despite these differences, the analytic sample was

ethnically and socioeconomically diverse, and was a representative of original sample of mid-

sized U.S. cities on several factors. Furthermore, the mean differences were calculated on key

variables for the analytic sample and for those participants who were dropped out or not retained

in the study. The results suggest no significant differences in mean scores across all measures of

parenting constructs, and socioemotional and cognitive/academic outcomes, except teacher

reports of externalizing problem behaviors at age 9. Specifically, the mean scores for teacher-

reported externalizing behavior problems were higher for participants who were dropped out

compared to those who were retained in this study (mean difference $= .54$ ($SD = .26$), $t = 2.09$

(df = 3034), $p <. 05$).

Table 1

Descriptive Statistics of Original Sample and Analytic Sample for Demographic and Control

Variables

Variable	Original Sample ($N = 4,898$)				Analytic Sample ($N = 1,809$)			
	N	*%*	*M*	*SD*	*N*	*%*	*M*	*SD*
MLBW	326	8.9			143	7.9		
Pre-term birth	442	12			177	9.8		
Child gender (male)	1915	52.2			921	51.1		
Above poor (>200%)	1864	38.1			661	36.5		
Birth weight (in grams)	3651		3217.8	621.9	1809		3270.0	532.9
Infant's length (in cms)	3583		49.9	3.3	1780		50.3	2.8

Variable						
Head circumf. (in cms)	3542	33.7	2.1	1761	33.8	1.8
Gestational age	3677	38.5	2.4	1808	38.8	1.8
Difficult temperament	4316	8.5	3.2	1735	8.6	3.2
Household income	4897	319994.0	31567	1809	31202.5	30615
Maternal age (in years)	4894	25.3	6.1	1809	25.1	6.0
Gravida	3680	2.9	1.9	1809	2.9	1.8
Pre-pregnancy BMI	2999	26.2	6.5	1509	26.7	6.8
Dependent children (> 4 children under the age of 18)	133	2.7		59	3.3	
Parity						
First-born	1342	36.6		644	35.7	
Second/ higher	2323	63.4		1160	64.3	
Family types						
Single Parent	1926	39.3		734	40.6	
Married/Cohabiting	2970	60.7		1075	59.4	
Maternal education						
< High school	1699	34.7		630	34.9	
High school/GED	1480	30.3		546	30.2	
Some college	1189	24.3		456	25.2	
College grad/ more	524	10.7		175	9.7	
Race/ethnicity						
White	1030	21.1		357	19.8	
African American	2326	47.6		930	51.5	
Hispanics	1336	27.3		466	25.8	
Others	194	4.0		53	2.9	
Mother's birth country						

Foreign-born	831	17.0		240	13.3	
US-born	4054	83.0		1564	86.7	
Prenatal care began						
First trimester	1523	49.2		788	50.8	
Second/ higher	1571	50.8		764	49.2	
Wt. gain in pregnancy						
Inadequate	809	28.6		470	28.8	
Adequate/ more	2020	71.4		1031	71.2	
Substance use	980	26.6		473	26.1	
Smoking in pregnancy	767	20.8		376	20.8	
Mental health problems	480	13.0		225	12.4	

Table 2

Descriptive Statistics for Demographic and Control Variables by Birth Weight Status

Variable	MLBW ($N = 143$)				NBW ($N = 1,666$)				χ^2/t-test
	N	*%*	*M*	*SD*	*N*	*%*	*M*	*SD*	
Pre-term birth	89	62.2			88	5.3			483.7***
Child gender (males)	65	45.8			856	51.5			1.72
Above poor (>200%)	48	33.6			613	36.8			.59
Birth weight (grams)	143		2167	262	1666		3365	435	-49.2***
Infant's length (cms)	139		45.4	2.4	1641		50.7	2.4	-24.8***
Head circumf. (cms)	137		30.9	1.7	1624		34.1	1.6	-21.3***
Gestational age	143		35.4	2.5	1665		39.0	1.5	-17.4***
Difficult temperament	138		9.2	3.5	1597		8.5	3.2	2.3*
Maternal age (years)	143		24.9	6.8	1666		25.1	6.0	-.24
Gravida	143		3.2	2.3	1666		2.9	1.8	1.79+

Pre-pregnancy BMI	113		25.0	6.5	1388		26.8	6.8	-2.79**
Parity									.94
First-born	56	39.4			588	35.4			
Second/ higher	86	60.6			1074	64.6			
Family types									2.0
Single Parent	66	46.2			668	40.1			
Married/Cohabiting	77	53.8			998	59.9			
Maternal education									6.55+
< High school	59	41.5			571	34.3			
High school/GED	47	33.1			499	30.0			
Some college	25	17.6			439	25.2			
College grad/ more	11	7.7			164	9.8			
Race/ethnicity									15.2***
White	24	16.8			333	20.0			
African American	95	66.4			835	50.2			
Hispanics	22	15.4			444	26.7			
Others	2	1.4			51	3.1			
Mother's birth country									5.2*
Foreign-born	10	7.0			230	13.8			
US-born	132	93.0			1432	86.2			
Prenatal care began									.44
First trimester	53	47.7			735	51.0			
Second/ higher	58	52.3			706	49.0			
Wt. gain in pregnancy									35.8***
Inadequate	59	53.6			358	26.8			
Adequate more	51	46.4			980	73.2			
Substance use	61	42.7			412	24.7			21.9***

Smoking in pregnancy	52	36.4		324	19.4	22.9***
Mental health problems	34	23.8		191	11.5	18.3***

Note. [+] $p < .10$; [*] $p < .05$; [**] $p < .01$; [***] $p < .001$.

Procedure

Demographic characteristics of the participants were collected at baseline from medical records data and baseline core interview with mothers. Data on birth weight and prenatal history were also collected from medical records data. Data on maternal parenting stress and maternal warmth were collected from age-3 and 5- in-home longitudinal survey. Data on child externalizing behaviors, social skills, and cognitive/academic outcomes at age 9 were collected via the maternal interview and teacher reports. Direct assessments of children's academic outcomes were conducted by trained child interviewers during the in-home visits at age 9.

Measures

Birth weight. The primary independent variable, birth weight, was obtained from the birth hospitalization report from the medical records data. Compared to maternal self-report, this is the most accurate record of birth weight and has been used in numerous studies examining child outcomes (McCarton, 1998; McCormick et al., 1996; Nordhov et al., 2011). For the analyses, birth weight was operationalized into two groups: 1.) MLBW (i.e., birth weight between 1501- 2499 grams at birth), and 2.) Normal birth weight (NBW: birth weight $\geq$ 2500 grams at birth). More extreme categories of LBW children with birth weight less than 1,500 gram (i.e., VLBW and ELBW subgroups) were excluded from the analyses.

Maternal warmth. The measures of maternal warmth were based on the observer ratings from the ages 3 and 5 in-home longitudinal survey of children and families as part of the *Home Observation for Measurement of the Environment (HOME;* Caldwell & Bradley, 1984). The HOME was a semi-structured interview in which the primary caregiver was asked about daily

routines, other activities, and ways that the home environment was structured to accommodate the child's needs. During the in-home assessment at both ages, interviewers were asked to rate maternal warmth based on their observations of mother-child interactions. Data on maternal warmth were collected using dichotomous items at ages 3 and 5 (8 items) indicating whether the interviewer observed the mother's positive responsiveness and affection towards the child during home visit (0 = no, 1 = yes). Example items include *mothers spontaneously praise the child's behavior or qualities at least twice during the visit* and *mother's voice conveys positive feelings when talking to or about child*. Items were summed to create a composite score (α =.80, and .79, at ages 3 and 5, respectively) so that higher scores indicated higher levels of maternal warmth. Prior studies among young children using the HOME maternal warmth subscale indicate predictive and concurrent validity in predicting children's socioemotional and cognitive outcomes (Lee et al., 2013; Leventhal, Martin, & Brooks-Gunn, 2004).

Maternal parenting stress. Parenting stress was measured using items drawn from the Parenting Stress Index (PSI; Abidin, 1995). During the in-home assessments at ages 3 and 5, mothers were asked 11 items describing stress on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree). Sample items include "*you feel trapped by your responsibilities as a parent*" and "*you often have the feeling that you cannot handle things very well*." Items were recoded on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) before creating a composite scale. Then, responses were summed to create a composite scale (α = .87 at both ages) as in other studies (Razza, Martin, & Brooks-Gunn, 2010; Guterman, Lee, Taylor, & Rathouz, 2009), with higher scores on these scales indicating higher levels of parenting stress.

Socioemotional competence. The measures of child's socioemotional competence included parent's reports of externalizing behaviors, and teachers reports of externalizing behaviors and social skills at age 9.

Parent's reports of externalizing behavior outcomes at age 9. Mothers completed the Child Behavior Check List (CBCL; Achenbach's 1991a, 1991b) questionnaire about their child's problem behavior as part of the age 9 primary caregiver survey. The CBCL is a widely used questionnaire composed of 113 items designed to assess multiple dimensions of behaviors among children age 4-18 years with well-established psychometric properties (Achenbach & Edelbrock, 1983). The CBCL has been recognized as a valid measure to examine child behavior problems in families across different cultures (Ivanova et al., 2007). Mothers reported on externalizing behavior at age 9 using the following two subscales of the CBCL: Aggression (20 items; α =.90) and Delinquency (9 items, α =.70). Items were rated on a three-point scale ranging from zero to three (0, *not true*; 1; *sometimes/somewhat true*; and 2, *very true*). Sample items from each sub-scale include "*destroys own things*" and "*physically attacks people*" (for aggressive behavior) and "*steals outside home*" and "*sets fires*" (for delinquent behavior). A total externalizing scale was created by averaging the scores across the two sub-scales; in which higher scores represent higher levels of externalizing problems among children. The total externalizing score was used in the analyses.

Teacher report of externalizing behavior outcomes at age 9. Child's socioemotional outcomes at age 9 were measured via teacher report using the Social Skills Rating System (SSRS; Gresham & Elliott, 2007). The present study used the externalizing subscale to present problem behaviors. The externalizing subscale consisted of 6 items (α =.93) tapping aggressive behaviors; sample items include "*argues with others*", and "*fight with others.*" Items were scored

on a 4-point Likert scale: never (1), sometimes (2), often (3), and very often (4). Items were averaged to create scales in which the higher scores indicated higher levels of externalizing behaviors among children.

   Teacher report of social skills at age 9. Child's social competence at age 9 was also measured from teacher report via a social skill measure adapted from the ECLS-K study which included select items from the SSRS. The relations with peer subscale consisted of 10 items that measure children's ability to cooperate with peers in the classroom; sample items include "*ignores peer distractions when doing class work*" and "*follows the directions*." For each item, teachers rated the frequency of the child's behavior on a 4-point scale ranging from (1) never to (4) very often. Items were averaged to create a scale (α =.95) in which higher scores indicating increased social skills among children. Previous studies using this scale also reported high reliability (Altschul et al., 2016; Razza, Martin, & Brooks-Gunn, 2012).

   Cognitive/academic competence. Data on child's cognitive and academic competence were taken from standardized assessments of cognitive abilities and academic skills, and teacher's reports of learning behaviors at age 9.

   Cognitive ability. Children's cognitive ability was measured via the Peabody Picture Vocabulary Test-Third Edition (PPVT-III; Dunn & Dunn, 1997b). The PPVT-III is a standardized measure to assess children's receptive vocabulary (i.e., ability to recognize a word when child hears it) and is a screen for verbal ability that does not depend on expressive language skills. As part of the in-home interview at age 9, children were administered the full version of PPVT. The PPVT has high internal consistency (α = .93) and test-retest reliability (r = .92) for children (Dunn & Dunn, 1997a). This measure has been used in several other studies to examine the verbal intelligence across early and middle childhood (Brennan's et al., 2000,

Razza et al., 2010; Vaske et al., 2013). Age-standardized scores were created (with a mean of 100 and the standard deviation of 15) from raw scores recorded at test time, with higher scores indicating better cognitive outcomes. The standardized PPVT scores were used in analyses.

Academic Achievement. Child's academic competence at age 9 was measured by Woodcock Johnson III Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). WJ-III provides a norm-referenced measure of academic outcomes. At age 9, academic achievement was measured by using Passage Comprehension and Applied Problems subtests of the WJ-III. The WJ-III has high test-retest reliability for this age group (Woodcock et al, 2001). Passage comprehension measures a child's ability to understand the written text. Children are required to supply a missing key word in the context of sentence and paragraphs, first pictorially and then orally. The Applied Problems subscale measures child's ability to analyze and solve math problems. Children are given simple number concepts orally and visually, and asked to recognize the mathematical procedure and solve the problems with paper and pencil. Each scale was age-standardized (M = 100, SD = 15) from raw scores, with higher scores indicating higher academic achievement.

Approaches to Learning (ATL). Teachers rated children's ATL using a scale derived from the Early Childhood Longitudinal Program- Kindergarten Class of 1998-99 (ECLS-K; see http://nces.ed.gov/ecls/kindergarten.asp) to capture children's behaviors during learning activities. The ATL scale consisted of 7 items capturing the frequency of children's behaviors during learning situations, sample items include, "*pays attention well*" and "*easily adapts to change in routine*." Items were rated using a 4-point scale ranging from 1 *(never)* to 4 *(very often)*. Scores were averaged across items to create a composite scale (α =.93) in which higher scores represent higher learning/academic outcomes.

Control variables. The models used in this study control for key sociodemographic,

child, and perinatal (i.e., related to pregnancy and postnatal period) variables in order to avoid

spurious associations among MLBW, parenting, and child outcomes. Measures of family

sociodemographic background include mothers' age at child's birth, measures of maternal

education, family type, race/ethnicity, poverty status, and family size (number of children in the

household below age 18). Age of mother at birth is a continuous variable tapping mother's age at

the time of birth from medical records data at baseline. The indicator variable adolescent mother

was created from maternal age at birth and coded as 1 = *mothers age 19 or below*, and 0 = *20*

years and above. Maternal education was specified as less than high school, high school diploma

/a GED and some college or above from the baseline survey. Similar to other studies

(McCormick et al., 2006; Poehlmann et al., 2012), an indicator variable of educational

attainment was created as 1 = *less than high school graduate (HSG)* and 0 = *HSG and more than*

HSG. Race/ethnicity includes African American, white, Hispanic, and other. White is considered

as a reference group in analyses. Family types (indicator variable coded 0 = *married and or*

cohabiting with child's biological father, and 1 = *single parent families*) were also recorded at

baseline interview with mothers. Poverty status was coded as 1= *below poverty threshold (poor)*

and 0 = *above poverty threshold (not poor)* at baseline. Family size at baseline was a continuous

variable representing the total number of children below the age of 18 in the household. Similar

to other studies (Shah et al., 2013), an indicator variable was created as 1 = *greater than 4*

dependent children in the household, and 0 = *equal to or less than 4 dependent children*.

Similar to prior studies (Poehlmann et al., 2011; Shah et al., 2013), a socioeconomic

(SES) risk index was created by summing the presence of following risk factors from the

demographic questionnaire: family income below federal poverty guidelines (i.e., poverty status

below 200% of federal poverty threshold), single parent families, adolescent mother, minority race/ethnic groups, less than high school education for the mother, and more than 4 dependent children in the households. Scores ranged from 0 to 6 with higher scores representing more risk factors (α = .53). That SES risk index was entered as a control variable in the SEM models.

Child characteristics included pre-term birth and difficult temperament. Pre-term birth was an indicator variable coded as *yes* (1) and *no* (0) from medical records data at baseline. Difficult temperament in infancy was assessed at 1 year and reflected the average of the following three items (α = .59) drawn from the Emotionality scale of the Emotionality, Adaptability, Sociability (EAS) Temperament Survey for Children (Buss & Plomin, 1984): (1) Reacts strongly when upset, (2) Often fusses and cries, (3) Gets upset easily. The continuous measure of temperament was entered in SEM models.

Similar to prior studies (Hack et al., 1991; Horwood et al., 1998), the present study also included controls for perinatal variables in the models. These variables included maternal pre-pregnancy body mass index (MBMI), prenatal mental health problems, adverse prenatal health behaviors (substance use), and weight gain during pregnancy, all derived from medical records data. MBMI was a continuous variable tapping mother's body mass index (BMI) before the pregnancy and was recorded from medical records data at baseline. The continuous measure of MBMI was entered in SEM models. Prenatal mental health problem was an indicator variable coded as 1 = *yes* (mother had a mental health problem during pregnancy from all possible sources) and 0 = *no*. Substance use during pregnancy was measured by averaging three items from medical records data (i.e., drank during pregnancy, smoked during pregnancy, and drug use during pregnancy; α = .55); response scales included *yes* (1) and *no* (0). Similarly, maternal weight gain during pregnancy was an indicator variable coded as 1 = *inadequate* and 0 =

adequate and more from medical records data. For the purpose of this study, a prenatal risk

index was also created by averaging the presence of following risk factors from perinatal

questionnaire: substance use, maternal mental health problems, and weight gain during

pregnancy. Scores ranged from 0 to 3 with higher scores representing more risk factors ($\alpha = .43$).

The prenatal risk index was entered as a control variable in SEM models.

The present study also controls for maternal depression at ages 1. Maternal depression

was assessed with the Composite International Diagnostic Interview- Short Form (CIDI-SF)

Section A (Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998), which determines the

probability of mothers being diagnosed with major depression. Mothers were asked if, at some

time during the past year, they had feelings of depressive symptoms or were unable to enjoy

normally pleasurable things for most of the day or every day, for at least 2 weeks. Mothers who

experienced those symptoms were asked seven additional questions about symptoms of major

depression (items include: losing interest in things, feeling tired, experiencing a change in weight

of at least 10 pounds, having trouble sleeping, having trouble concentrating, feeling worthless, or

thinking about death). Those who answered affirmatively to having three or more of these

conditions were considered depressed. The constructed measures of depression at age 1 was used

in present analyses denoting whether mother meets the depression criteria (1 = *yes*, 0 = *no*).

Missing data

Among the 1,809 families in the analytic sample, the amount of missing data in

demographic and control variables was relatively small (less than 5%) with the exception of a

few prenatal variables including maternal pre-pregnancy BMI (17%), date when prenatal care

began (14.2%), and weight gain during pregnancy (20%). Similarly, the amount of missing data

on key study variables including parenting factors, socioemotional measures (maternal report),

and academic outcomes (standardized tests) ranged from 5.2% to 14.8% of the children. The exception was maternal warmth, for which the rates of missingness were 35.2% and 25.9% at ages 3 and 5, respectively, due to data collection via observer ratings during in-home assessments. In addition, teacher reports of externalizing problems, social skills, and approaches toward learning were largely missing (between 42.9% - 43.6% of the children) due to limitations in data collection.

The result of Little's MCAR (missing completely at random) test suggests that the data were not missing completely at random (χ^2 (df=3,510) = 4002.8, p <.001), which is quite common in longitudinal studies. Similar to other studies (Altschul et al., 2016; Lee et al., 2013), the present study considered the missing data patterns in analyses through the use of Full Information Maximum Likelihood (FIML) estimation in AMOS (Analysis of moment structures) to avoid missing data bias and maximize the sample size. Structural equation modeling (SEM) with FIML estimation is preferred method of model estimation with missing data (Allison, 2003), because this method automatically utilized all observed information to create the maximum likelihood information and comes up with the estimated value rather than imputing the missing values. This approach also provides less biased estimates as compared to pairwise deletion, listwise deletion, and mean substitution (Acock, 2005) specifically when data do not appear to be missing completely at random (Allison, 2003).

Analytical Strategies

Structural equation modeling (SEM) was conducted to examine the associations among LBW, parenting processes, and children's socioemotional and academic competence. The present study used AMOS 22.0 statistical software (Arbuckle, 2012) to perform SEM with maximum likelihood (ML) estimation to test the hypothesized models. Confirmatory factor analyses (CFA)

were conducted via AMOS in the measurement model to confirm significant item loadings.

These analytic approaches also provided the correlations among variables to examine

multicollinearity and factor loadings of each variable for reliability. The χ^2 statistic, Comparative

Fit Index (CFI; Bentler, 1992; Bolen & Long, 1993), and Root Mean Square of Approximation

(RMSEA; Brown & Cudeck, 1993) were used to examine the fit between the hypothesized

models and the data. Based on the suggestions of evaluating structural equations models by Hu

& Bentler (1999), CFI values greater than .90, and RMSEA values less than or equal to .06

represent a good model fit.

Research Design

  Before examining the full structural equation model, it is critical to test the validity of the

measurement model (Byrne, 2009; Kline, 2011). Thus, based on the recommendations of prior

researchers (Byrne, 2009; Kline, 2011), the analysis involves a two-step process which includes

the examination of a measurement model and a structural model.

  The measurement model. In the first step, a Confirmatory Factor Analysis (CFA) was

performed to test the validity of indicator variables. The measurement model was created with

key study variables including parenting measures (i.e., maternal warmth, and parenting stress)

and child outcomes including socioemotional (externalizing behaviors and social skills) and

academic/cognitive functioning. These analytical techniques provided the factor loadings of each

construct for the reliability test and correlations among the variables to determine

multicolinearity.

  The structural model. In the second step, SEM with latent variables was conducted to

examine the hypothesized links among study variables. The model tested the independent

associations among key variables. A full structural equation model, as shown in Figure 2,

examined the directional links both between observed variables and latent constructs (i.e.

measurement model), and among latent constructs (i.e., structural model) including MLBW,

parenting, externalizing problems, social competence, and cognitive/academic competence. As

noted earlier, all pertinent control variables were included in the models based on the preliminary

findings and were allowed to correlate with each other.

Figure 2. Hypothesized full SEM model linking MLBW, parenting, and socioemotional and

cognitive/academic competence. MBMI = Maternal Pre-Pregnancy Body Mass Index, TR =

Teacher Report, PR = Parent Report.

The moderational model. The SEM with interaction was conducted to examine the potential moderating effects of parenting processes in the link between MLBW and socioemotional and cognitive/academic outcomes. The present study also tested separate structural models for each parenting construct including maternal warmth and parenting stress and with each outcome. The simple moderational model (as depicted in Figure 3; included both parenting constructs and all outcomes in one model) was created to help readers better conceptualize the model. Similar to structural models, all control variables were also included in moderational models and were allowed to correlate with each other.
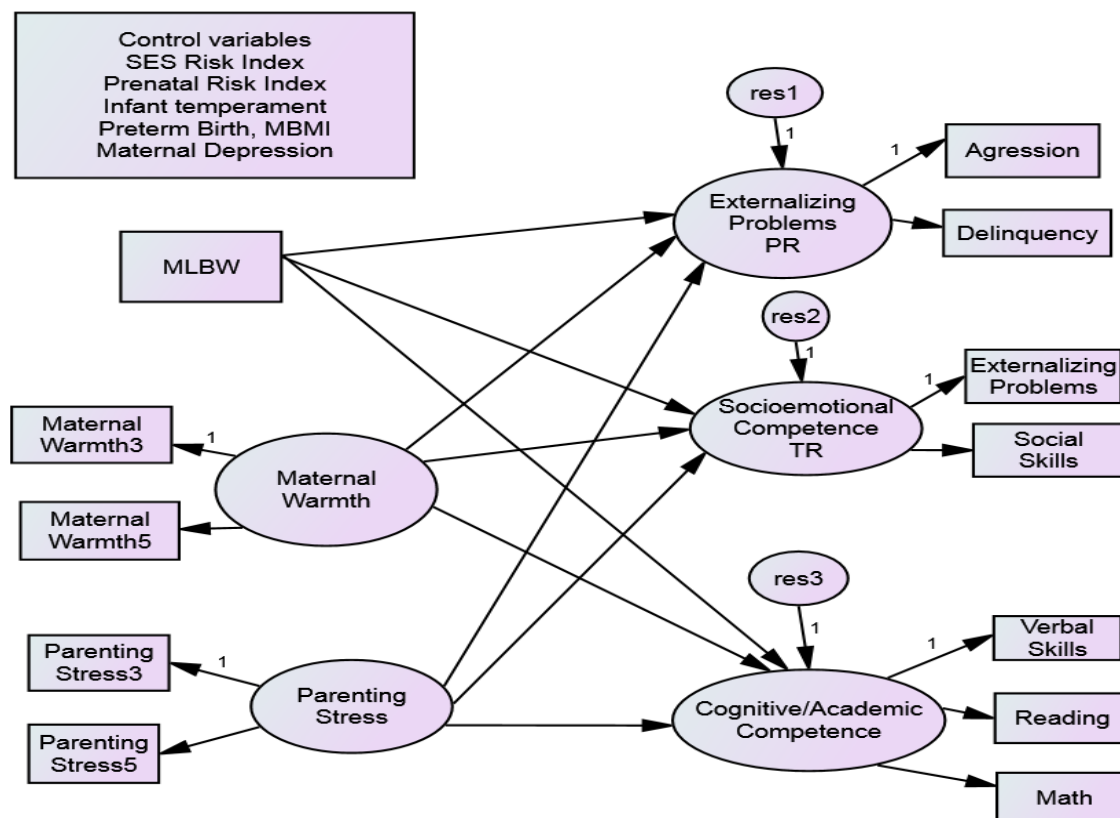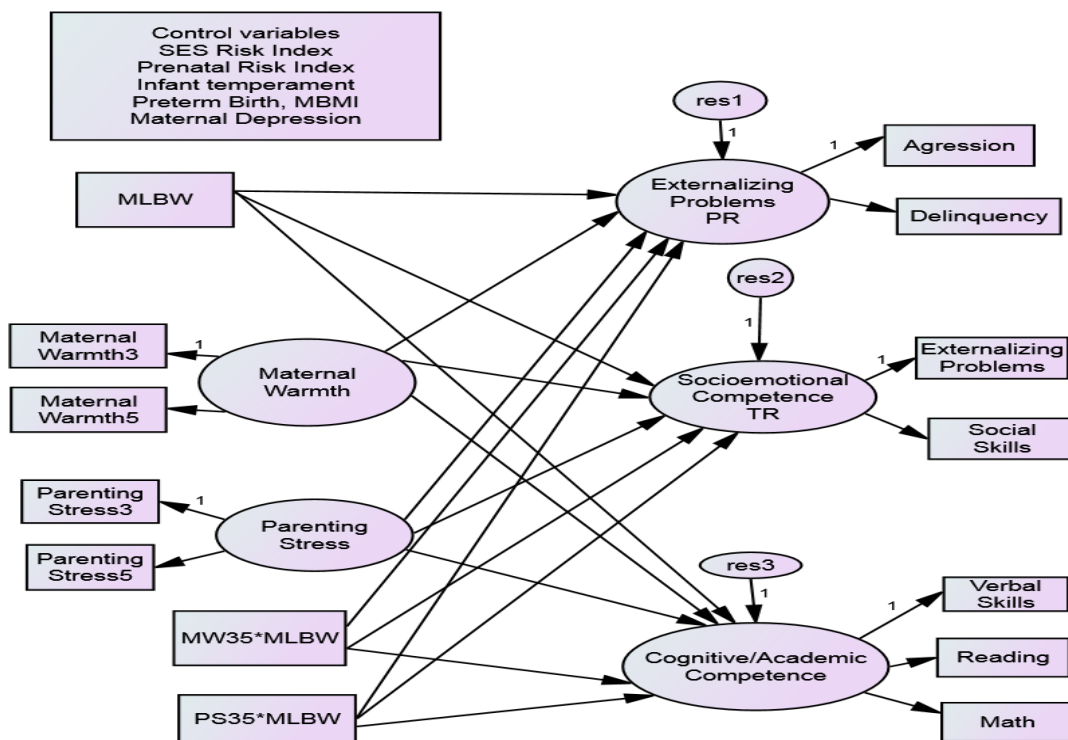

Figure 3. Hypothesized full SEM model linking MLBW, parenting, and socioemotional and cognitive/academic competence moderated by parenting factors. MBMI = Maternal Pre-pregnancy Body Mass Index, TR = Teacher Report, PR = Parent Report.

Chapter 4. Results

Preliminary Analysis

As indicated earlier, Tables 1 and 2 present the percentages or means, standard

deviations, and sample sizes for key demographic and control variables for the original and the

analytic samples and by birth weight status. Similarly, Table 3 presents the means and standard

deviations for predictor and outcome variables. Table 4 includes the bivariate correlations among

key study variables and control variables. As expected, significant bivariate associations were

found between MLBW status and teacher reports of externalizing behaviors ($r = .07$, $p < .05$),

social skills ($r = -.07$, $p < .05$), and approaches towards learning ($r = -.06$, $p < .05$) at age 9.

Similarly, MLBW status was significantly associated with different measures of

cognitive/academic outcomes including receptive vocabulary skills ($r = -.05$, $p < .05$), reading

comprehension ($r = -.06$, $p < .05$), and math achievement ($r = -.10$, $p < .001$) at age 9. However,

the link between MLBW status and parents' reports of externalizing behaviors at age 9 was not

significant.

As noted in Table 4, significant bivariate correlations were also supported between

maternal warmth at ages 3 and 5 and all measures of socioemotional and cognitive/academic

outcomes at age 9. Similarly, parenting stress at ages 3 and 5 was significantly correlated with

cognitive/academic competence and socioemotional outcomes; the exception was a modest

association between parenting stress at age 3 and teacher-reported externalizing behaviors at age

9 ($r = -.06$, $p < .10$). For the sake of clarity, only these correlations are depicted in Table 4.

Pearson correlations were also examined to determine multicolinearity; primarily the variables

whose correlations with the main variables were greater than .70. There was a significant high

correlation between teacher-reported social skills and ATL at age 9 ($r = .94$, $p < .001$). Due to

this multicolinearity, ATL was dropped from the analyses. Covariates of each model were determined based on the significant correlations with key control variables including SES risk index, prenatal risk index, MBMI, infant temperament, preterm birth, and maternal depression.

Table 3

Means for Child Outcomes across the Full Sample, and by Birth Weight Status

Variable	Full Sample $(N = 1{,}809)$		LBW $(N = 143)$		NBW $(N = 1666)$		t-value
	Mean	SD	Mean	SD	Mean	SD	
Maternal warmth-3	6.90	1.71	6.55	2.0	6.93	1.68	-2.09*
Maternal warmth-5	6.12	2.06	5.88	2.12	6.14	2.05	-1.29
Average warmth-35	6.49	1.50	6.10	1.76	6.52	1.47	-2.07*
Parenting stress-3	42.86	8.01	42.41	7.33	42.89	8.07	.73
Parenting stress-5	43.44	7.60	42.39	7.66	43.52	7.59	1.65+
Externalizing-9	7.47	7.27	7.92	6.94	7.43	7.30	.70
Externalizing TR-9	9.47	4.13	10.39	4.42	9.39	4.10	2.14*
Social skills TR-9	28.91	7.34	27.30	7.69	29.06	7.30	-2.11*
Average socioemotional TR-9	49.45	10.26	46.73	11.03	49.69	10.17	-2.50*
Receptive vocabulary-9	92.91	14.42	90.38	13.52	93.12	14.48	-2.01*
Reading -9	93.01	13.62	90.14	13.64	93.26	13.59	-2.44*
Math -9	98.18	15.61	93.07	16.98	98.62	15.42	-3.8***
Average cognitive outcome-9	94.89	12.14	91.37	12.58	95.19	12.06	-3.33**
ATL9	20.31	5.45	19.18	5.83	20.42	5.40	-1.96*

Note. TR = Teacher Reports, ATL = Approaches Toward Learning
+ p < .10, * p < .05, ** p < .01, and *** p <. 001

Chi-square tests of independence were conducted to examine whether prenatal variables were different for MLBW vs. NBW children (see Table 2). The results revealed that there was a

significant association between substance use during pregnancy and birth weight (χ^2 = 21.9 (df = 1), p < .001, effect size = .11), such that substance use during pregnancy had a higher chance of infant born MLBW. In addition, there was a significant association between nutrition (as measured by an adequate weight gain during pregnancy) and birth weight (χ^2 = 35.8 (df = 1), p < .001, effect size = .16), such that inadequate weight gain during pregnancy was associated with increased children being born MLBW. Results also indicate a significant association between race/ethnicity and birth weight in which African American (χ^2 = 13.9 (df = 1), p < .001, effect size = .09) and Hispanic (χ^2 = 8.8 (df = 1), p < .01, effect size = .07) race/ethnic groups were more likely to have MLBW children as compared to white families.

Preliminary analyses also included independent sample t-tests comparing values on externalizing behavior, social skills, and different measures of cognitive/academic outcomes across LBW and NBW children (see Table 3). Results indicated a significant difference in academic outcomes, such that MLBW children scored lower than NBW children in receptive vocabulary (t = -2.01, p < .05; eta squared = .002), reading (t = -2.44, p < .05; eta squared = .004), math (t = -3.8, p < .001; eta squared = .01), and ATL (t = -2.01, p < .05, eta squared = .004) with a small effect size. Similarly, externalizing behavior problems (t = 2.14, p < .05; eta squared = .004) and social skills (t = 2.11, p < .05; eta squared = .004) reported by teachers were significantly higher across MLBW children compared to NBW children. However, maternal report of externalizing behavior at age 9 did not differ significantly between NBW and MLBW children (t = .70, ns) suggesting that the mean scores for externalizing behavior problems were similar across both birth weight groups.

Table 4

Bivariate Correlation Matrix of All study variables ($N = 1,809$)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. MLBW	1											
2. Maternal warmth-3	-.06*	1										
3. Maternal warmth-5	-.04	.20***	1									
4. Parenting stress-3	.02	-.12***	-.15***	1								
5. Parenting stress-5	.04+	-.11***	-.17***	.49***	1							
6. Externalizing problems-9PR	.02	-.08*	-.17***	.20***	.23***	1						
7. Externalizing problems-9TR	.07*	-.20***	-.15***	.06+	.08*	.37***	1					
8. Social skills-9TR	-.07*	.15***	.13***	-.08*	-.14***	-.31***	-.57***	1				
9. Receptive vocabulary-9	-.05*	.20***	.21***	-.14***	-.19***	-.09**	-.15***	.21***	1			
10. Reading achievement-9	-.06*	.22***	.12***	-.13***	-.20***	-.13***	-.20***	.31***	.60***	1		
11. Math achievement-9	-.10***	.17***	.12***	-.10***	-.17***	-.14***	-.16***	.30***	.57***	.64***	1	
12. Approaches to learning-9	-.06*	.13**	.11**	-.08*	-.15***	-.31***	-.55***	.94***	.22***	.31***	.33***	1
13. Poverty	.02	-.12***	-.15***	.19***	.25***	.11***	.13***	-.15***	-.32***	-.22***	-.20***	-.15***

14. Education	-.05*	.21***	.18***	-.19***	-.26***	-.07**	-.10**	.13***	.39***	.27***	.26**	.10**
15. Ethnicity	-.04+	-.03	-.03	.04+	.09***	-.08**	-.03	.03	-.17***	-.11***	-.07**	.03
16. Family types	.03	-.09**	-.10***	.12***	.15***	.09**	.14***	-.15***	-.17***	-.11***	-.15***	-.14***
17. Maternal age	-.01	.12***	.14***	-.07**	-.05*	-.09***	-.13***	.10**	.18***	.12***	.12***	.07*
18. Dependent children	-.02	-.10***	-.07**	.07**	.09***	-.12***	.01	.04	-.02	-.18***	-.12***	-.11***
19. Temperament-1	.06*	.01	-.07**	.15***	.17***	.16***	.13***	-.07+	-.15***	-.08**	-.10***	-.08*
20. Preterm birth	.52***	-.05	-.04	.02	.03	.02	-.02	-.02	-.01	-.01	-.06*	-.03
21. Pre-pregnancy BMI	-.07**	-.05	-.05+	.01	.01	.07*	.08*	-.05	-.06*	-.09**	-.09**	-.07*
22. Smoking	.11***	-.06*	-.02	.13***	.12***	.11***	.08**	-.07*	-.03	-.04	-.05*	-.08**
23. Substance	.11***	-.07*	-.03	.14***	.13***	.13***	.09**	.08**	-.04	-.05*	-.05*	-.08**
24. Prenatal MHP	.10***	-.08**	-.02	.13***	.08**	.06*	.05+	-.03	-.01	-.05+	-.07**	-.01
25. Weight gain	.16***	-.07*	.04	.03	.01	-.04	.03	-.03	-.10**	-.06*	-.03	-.02
26. Maternal depression-1	.02	-.01	-.05+	.16***	.19***	.12***	.07*	-.07*	-.04	-.01	-.04	-.07*

Note. Bivariate correlations among key study variables (#1- #12) are presented above the line and bivariate correlations between control variables and key study variables are shown below the line. PR = Parent Reports, TR = Teacher Reports, BMI = Body Mass Index, MHP = Mental Health Problems.

+ p < .10, * p < .05, ** p < .01, and *** p <. 001.

Measurement Model

First, the measurement model was created for all parenting variables and child outcome variables to check internal consistency among items of respective variables. The measurement model fit the data fairly well, with CFI greater than .90, and RMSEA less than .043. Then, individual mean scores of respective items of each parenting constructs and outcomes of interest were created and entered in SEM models. In particular, a latent construct of maternal warmth was indicated by measures of maternal warmth at age 3 and 5. Similarly, the model also included a latent variable of maternal parenting stress, which was represented by measures of parenting stress at ages 3 and 5.

Two latent variables for socioemotional outcomes were created, one for parent's ratings of problem behaviors and the other for teacher's ratings of problem behaviors and social skills at age 9. The latent variable of parent-reported problem behaviors was comprised of aggression and delinquent behavior at age 9. Items were averaged to create individual scales of parent's reports of aggression (20 items) and delinquent behaviors (9 items, after removing one item with factor loadings below .20 that improves the model fit; item # 4) and included in respective models. The latent variable of teacher reported socioemotional outcomes was indicated by measures of social skills and externalizing behaviors at age 9. The items representing teacher-reported externalizing behaviors were recoded and averaged to create a new scale for SEM models examining socioemotional competence, such that higher scores indicated lower levels of externalizing behaviors among children. These scores were consistently used across structural and moderational models examining socioemotional competence and for testing the interaction effects.

Similarly, the latent variable of cognitive/academic outcomes was estimated by measures of receptive vocabulary, reading comprehension, and math (applied problems) achievement. The loadings of these individual measures with the latent outcome were ranged from .77 to .80 in each model as represented in Figures 6 and 10.

Structural Model

In the first step of analyses, the model was tested to determine the direct effects of birth weight and parenting variables on socioemotional and cognitive/academic outcomes. Three structural models were fitted to the data fairly well with each of the outcomes. In particular, due to the high associations between measures of warmth and latent measures of socioemotional competence (β = .90, p < .001),when examining both parents and teachers reports of socioemotional outcomes in a same structural model (results not shown), two models of socioemotional outcomes were created with each of the outcomes (one for parent report and others for teacher report) as compared to a single model. Separate models also fit the data fairly well as compared to a single model of socioemotional outcomes. Similarly, cognitive/academic outcomes were examined in a separate structural model. Each model included a large battery of control variables, including SES risk index, prenatal risk index, MBMI, infant temperament, preterm birth, and maternal depression at age 1 and were allowed to correlate with each other. Fit indices of each model were also depicted in Table 5, both with and without control variables. Figures 4, 5, and 6 represent the results of the analyses by displaying the standardized path coefficients and loadings. The chi-square tests for these models predicting socioemotional and cognitive/academic outcomes were significant, perhaps as an effect of the large sample size.

Socioemotional outcomes. Model 1 examined the association between birth weight, parenting factors, and parent's reports of externalizing problems at age 9 (see Figure 4). The

model fits the data fairly well ($\chi2$ = 163.09, df = 37, p < .001 CFI = .952, RMSEA = .043), even

after accounting the effects of control variables in the model. As expected, significant

associations were existed from parenting variables to parent's reports of externalizing problems

with and without controls in the model. Specifically, as hypothesized (H2a), the latent measures

of maternal warmth (β = -.26, p < .01) and parenting stress (β = .32, p < .001) were significantly

associated with parent-reported externalizing behavior problems. Thus, higher levels of maternal

warmth and lower perceived stress at ages 3 and 5 significantly predicted lower problem

behaviors among children at age 9. However, contrary to the first hypothesis (H1a), MLBW

status was not associated with parent-reported externalizing behavior outcomes at age 9 (β = .01,

ns). Overall, the model explained 17.2% of the variance in parent-reported externalizing
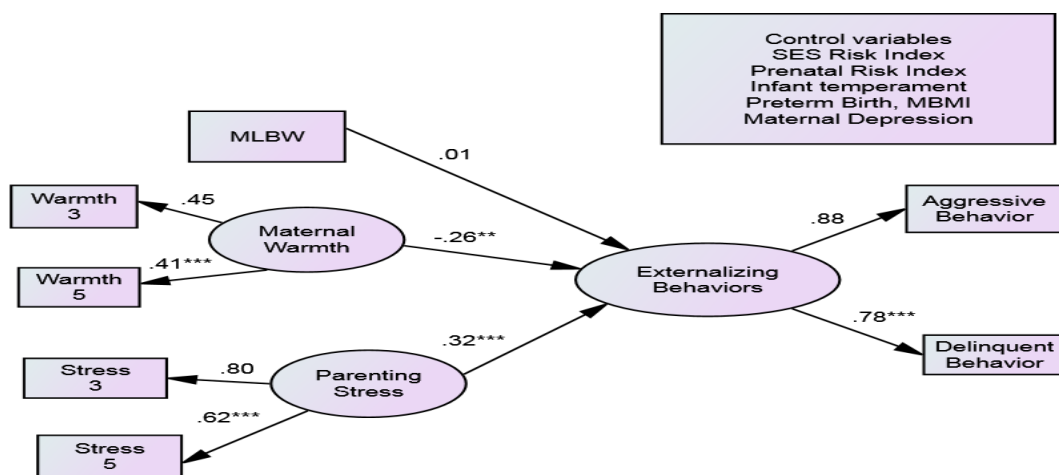
problems.

Figure 4: Model 1. Structural equation model predicting parent reports of externalizing problems at age 9 from MLBW, and parenting factors (*N* = 1,809).

Note. Model fit indices: $\chi2$ = 163.09, df = 37, *p* < .001, CFI = .952, RMSEA = .043

Significant paths are indicated by asterisks: [*] *p* < .05, [**] *p* < .01, & [***] *p* <. 001.

Similarly, model 2 examined the association between birth weight, parenting factors, and teacher's reports of socioemotional competence, including externalizing problems and social skills at age 9. The results of structural models examining these associations are displayed in Figure 5. The model fits the data fairly well with $\chi2$ = 90.68, df = 38, *p* < .001 CFI = .974, RMSEA = .028 even after accounting the effects of large battery of controls in the model. As expected, significant associations were existed from both MLBW and parenting variables to parents and teachers reports of socioemotional competence with and without controls in the model. Specifically, consistent with hypothesis H1b, MLBW status was significantly associated with teacher reports of lower socioemotional competence (β = -.09, *p* < .05). Although, the effect size predicting socioemotional competence from birth weight was relatively small, findings support that MLBW children demonstrated lower socioemotional competence, including higher levels of externalizing problem behaviors and lower levels of social skills at age 9.

Similar to model 1, the results also suggest that parenting processes had a significant influence on child outcomes. In particular, consistent with hypothesis H2b, higher levels of maternal warmth were associated with teacher reports of increased socioemotional competence (i.e., lower levels of teacher-reported externalizing behavior problems and higher social skills) (β = .45, *p* < .01) among children at age 9. Similarly, increased perceived parenting stress at ages 3 and 5 predicted lower levels of teacher-reported socioemotional outcomes at age 9 (β = -.16, *p* <

.05), which provided support for hypothesis H2b. Overall, model 2 explained 21.5% of the variance in teacher-reported socioemotional competence at age 9.
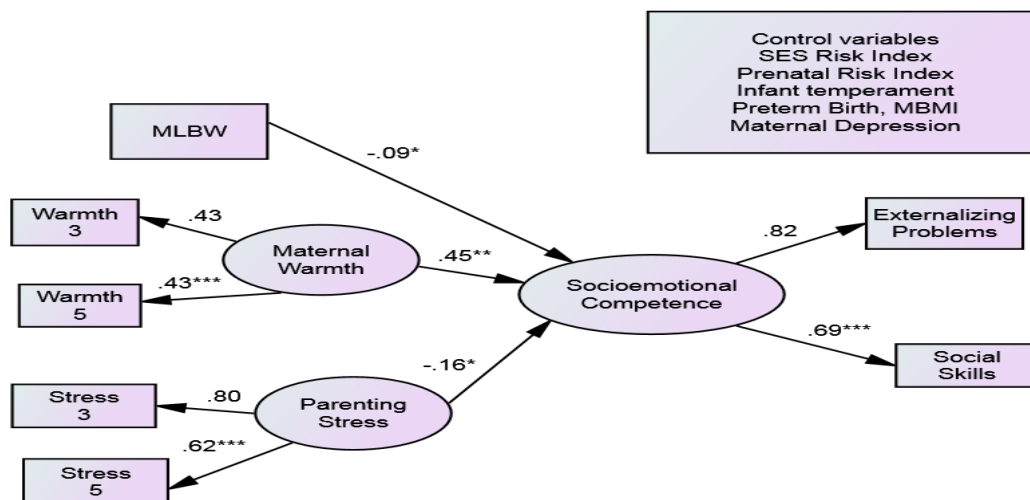
Figure 5: Model 2. Structural equation models predicting teacher's reports of socioemotional competence at age 9 from MLBW, and parenting factors ($N = 1,809$).

Note. Model Fit Indices: $\chi2 = 90.68$, df $= 38$, $p < .001$, CFI $= .974$, RMSEA $= .028$

Significant paths are indicated by asterisks: $^*p < .05$, $^{**}p < .01$, & $^{***}p < .001$.

Cognitive/academic outcomes. As depicted in Figure 6, Model 3 examined the associations among MLBW, parenting factors and cognitive/academic outcomes. This model fits the data fairly well with $\chi2 = 232.24$, df $= 52$, $p < .001$, CFI $= .950$, RMSEA $= .044$. Consistent with the third (H3) and fourth hypotheses (H4a and H4b), both MLBW and measures of

parenting factors predicted cognitive/academic outcomes independent of the effects of the control variables in the model. Results suggest that MLBW was significantly associated with decreased cognitive and academic outcomes ($\beta = -.07$, $p < .05$), including receptive vocabulary, reading, and math achievement at age 9. In addition, higher levels of maternal warmth at ages 3 and 5 were significantly associated with increased cognitive/academic competence across all children ($\beta = .39$, $p < .001$). Similarly (H4b), higher levels of parenting stress at ages 3 and 5 significantly predicted decreased cognitive/academic outcomes ($\beta = -.18$, $p < .001$) at age 9. Although the significant link existed between MLBW and cognitive/academic outcomes, it should be noted that the coefficient was small. Overall, the model 3 explained 29.7% of the variance in cognitive/academic competence.
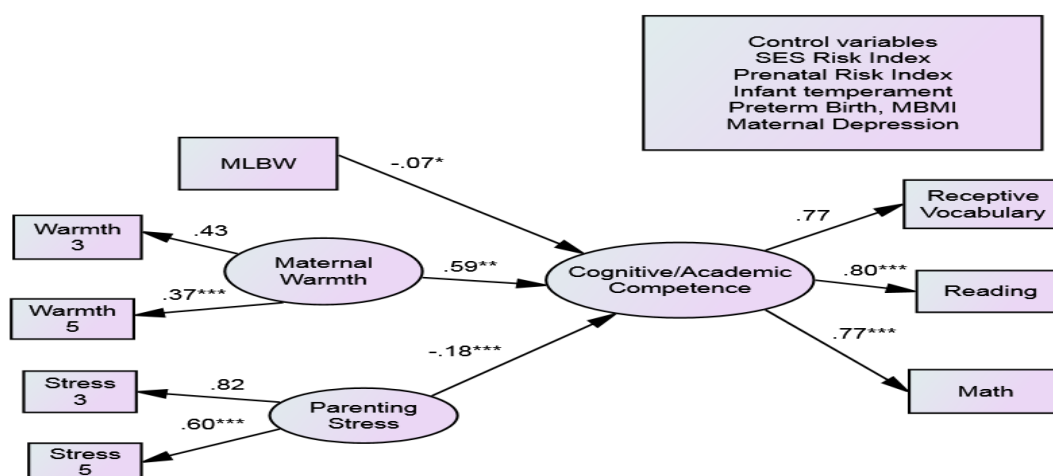
Figure 6. Model 3. Structural equation models predicting cognitive/academic competence at age 9 from MLBW, and parenting factors ($N = 1,809$).

Note. Model fit indices: $\chi2 = 232.24$, df $= 52$, $p < .001$, CFI $= .950$, RMSEA $= .044$

Significant paths are indicated by asterisks: [*] $p < .05$, [**] $p < .01$, & [***] $p <. 001$.

Table 5

Fit Statistics for Models with and without Control Variables

	Baseline Model	Final Model with Controls
Model 1	$\chi2 = 68.39$, df $= 12$, $p < .001$	$\chi2 = 163.09$, df $= 37$, $p < .001$
(Figure 4)	CFI $= .964$, RMSEA $=.051$	CFI $= .952$, RMSEA $= .043$
Model 2	$\chi2 = 16.74$, df $= 22$, $p > .05$	$\chi2 = 90.68$, df $= 38$, $p < .001$
(Figure 5)	CFI $= .994$, RMSEA $=.017$	CFI $= .974$, RMSEA $= .028$
Model 3	$\chi2 = 91.26$, df $= 18$, $p < .001$	$\chi2 = 232.24$, df $= 52$, $p < .001$
(Figure 6)	CFI $= .969$, RMSEA $= .047$	CFI $= .950$, RMSEA $= .044$
Model 4	$\chi2 = 5.28$, df $= 6$, $p > .05$	$\chi2 = 77.52$, df $= 31$, $p < .001$
(Figure 7)	CFI $= 1.000$, RMSEA $= .000$	CFI $= .970$, RMSEA $= .029$
Model 5	$\chi2 = 27.56$, df $= 11$, $p < .01$	$\chi2 = 163.87$, df $= 41$, $p < .001$
(Figure 10)	CFI $= .992$, RMSEA $= .029$	CFI $= .960$, RMSEA $= .041$

Moderational Model: Moderation Analysis by Parenting Factors

Structural equation models were also conducted to test the interaction between MLBW and parenting variables on child outcomes (H5). Since MLBW was not predictive of parent's reports of externalizing problems (in Model 1), the interaction effect of warmth for MLBW children was not tested for parent report of externalizing problems. In particular, tests of moderation by parenting factors were conducted by creating interactions between binary measures of birth weight (1= MLBW) and averaged scores of parenting factors at ages 3 and 5. Specifically, the standardized scores (z-scores) of each parenting construct were created and used consistently in all moderational model. Four models were created to test the interaction effects of

each parenting construct separately with each child outcome. In particular, possible interaction effects of averaged scores of maternal warmth were analyzed in separate models for cognitive/academic outcomes and for teacher reports of socioemotional competence. Similarly, interaction effects of the averaged score of parenting stress were examined in separate models for both outcomes. Only two models examining the interaction effects of maternal warmth on both outcomes were fitted to the data well and reached the level of significant.

Moderating role of maternal warmth on socioemotional competence. The first moderational model (Model 4) was tested to determine whether maternal warmth moderates the associations between birth weight and teacher reports of socioemotional competence (see Figure 7). The model fits the data fairly well ($\chi2 = 77.52$, df $= 31$, $p < .001$, CFI $= .970$, RMSEA $= .029$), even after accounting the effects of control variables in the model. As predicted (H5a), the interaction between maternal warmth and MLBW was significantly and negatively associated with teacher-reported socioemotional competence at age 9 ($\beta = -.24$, $p < .05$) suggesting that the association between birth weight and socioemotional competence was stronger at high levels of maternal warmth than low levels among NBW children. The model explained 26.3% of variance in teacher reports of socioemotional competence at age 9.
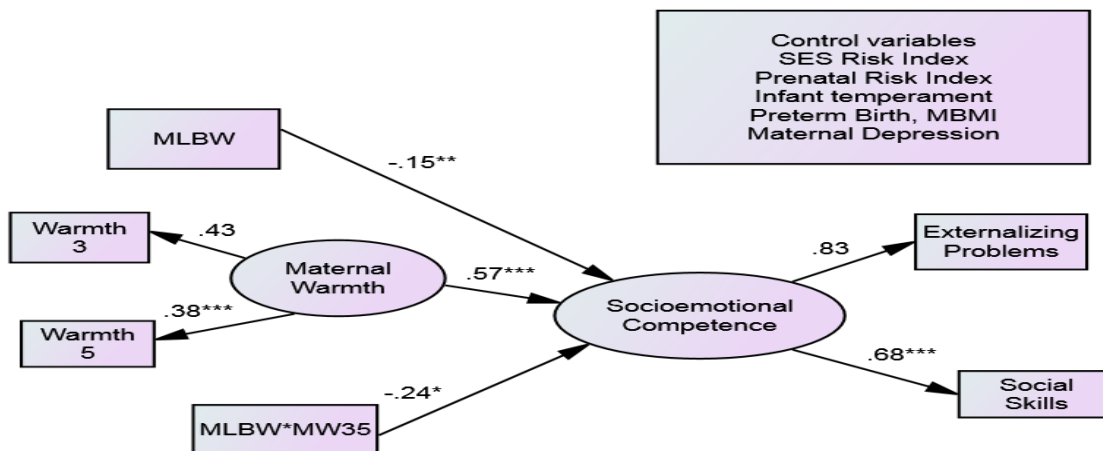
Figure 7. Model 4 explaining the moderating role of maternal warmth in the associations among MLBW and teacher's reports of socioemotional competence at age 9 (*N* = 1809).

Note. Model fit indices: $\chi 2$ = 77.52, df = 31, *p* < .001, CFI = .970, RMSEA = .029

Significant paths are indicated by asterisks: * *p* < .05, ** *p* < .01, & *** *p* <. 001

This interaction was probed by calculating average socioemotional competence from the standard scores of externalizing problems and social skills at selected high warmth (1/2 standard deviation above the mean) and low warmth (1/2 standard deviation below the mean) categories for MLBW and NBW children (Fig. 8). As indicated earlier, average maternal warmth at ages 3 and 5 were used in these analyses. The mean scores of individual sub-scales representing

socioemotional outcomes and mean scores of averaged socioemotional competence by levels of warmth and by birth weight status are displayed in Table 6. Interestingly, as depicted in Figure 8, the differences on mean scores across socioemotional outcomes for high and low warmth groups were significant only for NBW children ($t = -5.37$, $p < .001$) but not for the MLBW group ($t = -1.29$, ns). Thus, the scores of socioemotional outcomes between children with low and high warmth was significant for those who were born greater than 2,500 g (NBW) (Fig. 8), who represented the majority of children in this sample.

However, MLBW children, who scored 1/2 SD below or above the mean on maternal warmth, did not exhibit a statistically significant mean difference in teacher report of socioemotional competence at age 9. Given the similar size of differences in mean socioemotional scores between low and high warmth were obtained for children who were NBW ($N = 347$; mean difference = -6.15, SD difference = 1.14) and MLBW groups ($N = 34$; mean difference = -5.22, SD difference = 3.98) groups, however, it is possible that the small sample size for the MLBW group could contribute to the lack of significance. From the visual inspection of the data, MLBW children had better outcomes when higher levels of warmth were available at both ages 3 and 5 (Fig. 8). Whereas, MLBW children showed lower socioemotional competence when exposed to low levels of maternal warmth across ages 3 and 5 compared with their NBW peers who were exposed to low levels of maternal warmth. These findings support the notion of vulnerability, such that MLBW at-risk children showed worse outcomes on socioemotional competence than NBW children under negative parenting conditions, thus requires higher levels of warmth for favorable developmental outcomes.
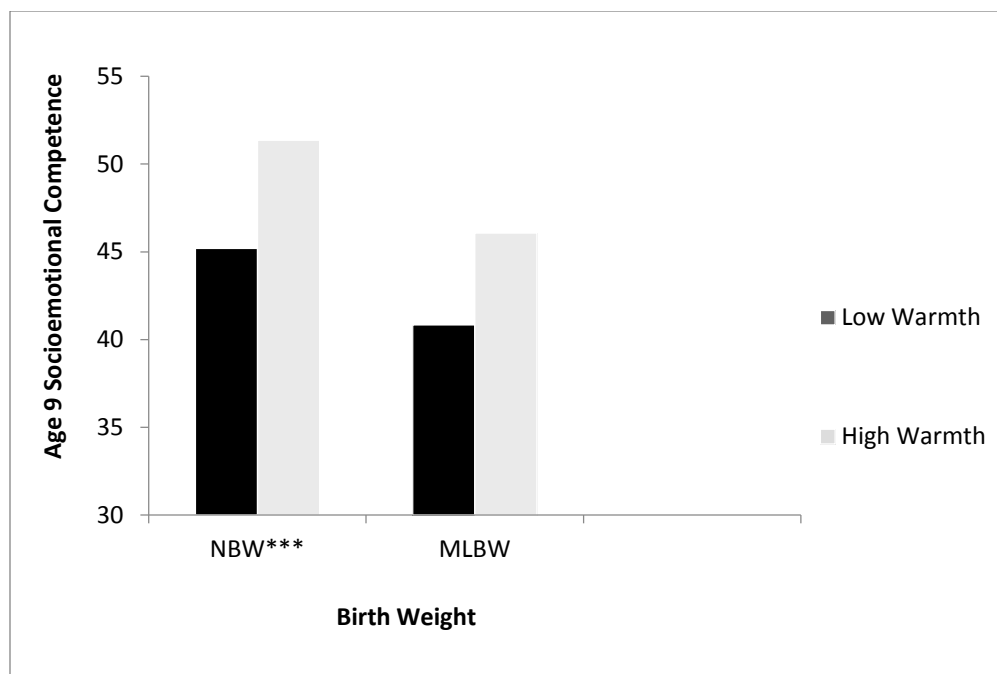
Figure 8. The association between birth weight and teacher-reports of socioemotional competence at age 9 as a function of levels of maternal warmth. A significant (*** *p* <. 001) mean difference between low warmth and high warmth group (1/2 SD below the mean and above the mean, respectively) is represented by an asterisk on the x-axis.

Follow-up analyses of the interaction results were also examined by plotting the fitted regression lines, as suggested by Aiken and West (1991). As shown in Figure 9, the average scores of socioemotional competence (i.e., the combined scores of teacher-reported externalizing problems and social skills at age 9) were regressed onto raw scores of continuous measures of maternal warmth across ages 3 and 5 separately for MLBW and NBW children. The results indicate that the simple slope of the regression was slightly steeper for NBW children as compared to MLBW children. It is important to note, however, that higher levels of maternal warmth are essential for MLBW children to have better socioemotional development at age 9.
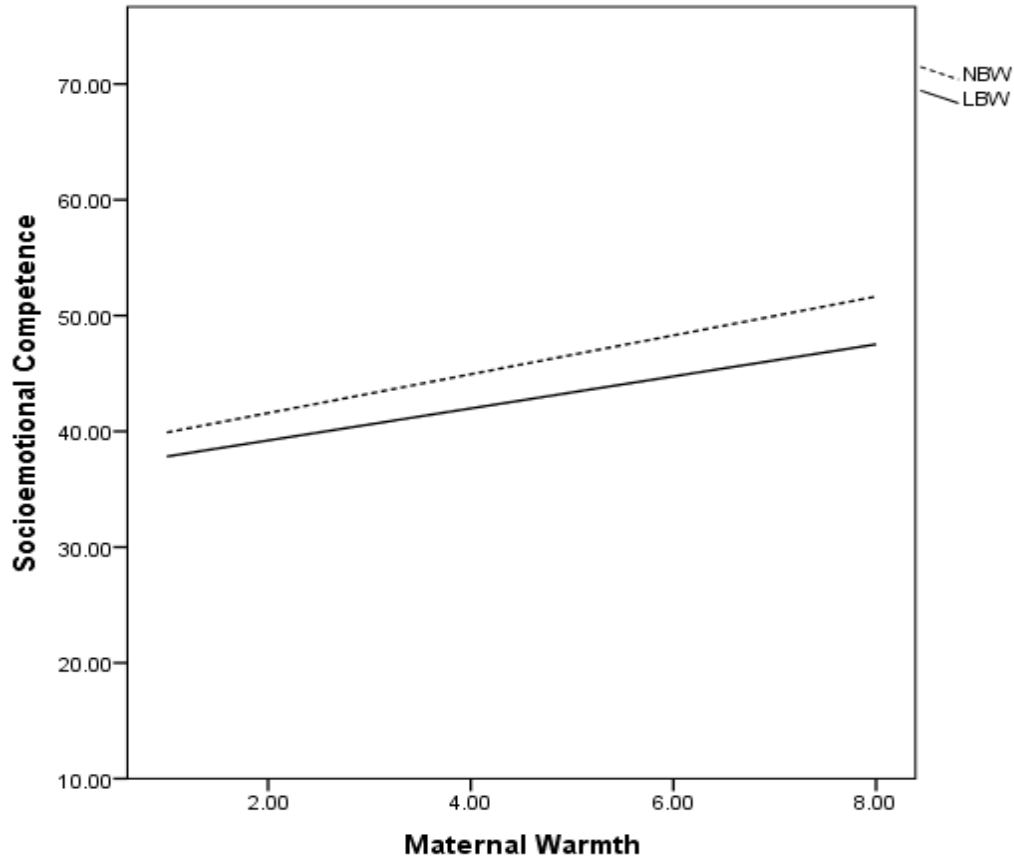
Figure 9. The slope of regression fitted lines in the associations between maternal warmth and teacher reports of socioemotional competence at age 9 across MLBW and NBW group.

Moderating role of maternal warmth on cognitive/academic outcomes. The second moderational model (see Figure 10) was tested to determine whether maternal warmth moderates the associations between birth weight and cognitive/academic competence at age 9. Similar to model 4, the model 5 fits the data well with $\chi2 = 163.87$, df $= 41$, $p < .001$, CFI $= .960$, RMSEA $= .041$. Similar to the effects on socioemotional competence, as expected (H5b), the interaction effect of averaged maternal warmth at ages 3 and 5 were significantly and negatively associated with the latent factor of cognitive/academic outcomes ($\beta = -.22$, $p < .05$) representing receptive vocabulary, reading, and math achievement. Thus, maternal warmth moderated the link between

birth weight and cognitive/academic outcomes at age 9 in which the link was more stronger for

NBW children with higher levels of warmth as compared to MLBW children. The moderational

model explained 36.1% of variance in cognitive/academic outcomes.
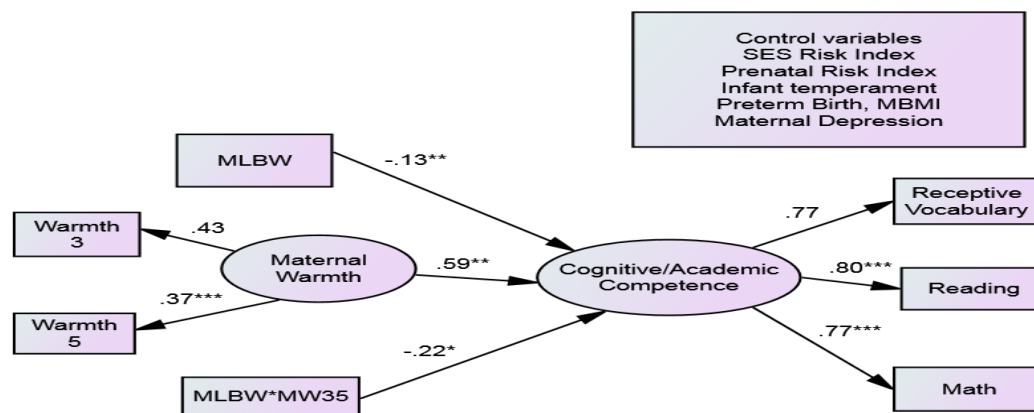
Figure 10. Model 5 explaining the moderating role of maternal warmth in the associations

among MLBW and cognitive/academic outcomes at age 9 (*n* = 1809).

Note. Model fit indices: $\chi2$ = 163.87, df = 41, *p* < .001, CFI = .960, RMSEA = .041

Significant paths are indicated by asterisks: [*] *p* < .05, [**] *p* < .01, & [***] *p* <. 001

The interaction was examined by calculating average cognitive/academic competence

from the standard scores of receptive vocabulary, reading, and math scores at selected high

warmth (1/2 standard deviation above the mean) and low warmth (1/2 standard deviation below

the mean) categories across MLBW and NBW children (Fig. 11). The mean scores of

cognitive/academic outcomes across groups by levels of warmth and by birth weight status are

also displayed in Table 6. Results indicate that the differences between cognitive/academic scores for children with high and low warmth were significant for both MLBW ($t = -3.0$, $p < .01$) and NBW children ($t = 8.13$, $p < .001$). In addition, although, the largest differences in mean cognitive/academic scores between low and high warmth were obtained for children who were MLBW ($N = 48$; mean difference = -10.44, SD difference = .04) than NBW groups ($N = 518$; mean difference = -8.52, SD difference = .40), on average NBW children outperformed their MLBW children under the exposure of positive maternal warmth.

These results indicated that higher levels of maternal warmth during critical developmental ages (i.e., at ages 3 and 5) protect at-risk MLBW children from poor cognitive/academic functioning at age 9. It is also important to note that MLBW children do significantly worse on cognitive/academic functioning when exposed to low levels of warmth. These results support the concept of developmental vulnerability perspective, such that MLBW at-risk children showed even worse outcomes than NBW children under the negative parenting condition, thereby requiring higher levels of warmth for favorable developmental outcomes. Collectively, these results highlight that positive maternal warmth during early years of development is important for at-risk MLBW children for the development of increased socioemotional and cognitive/academic competence during school ages.
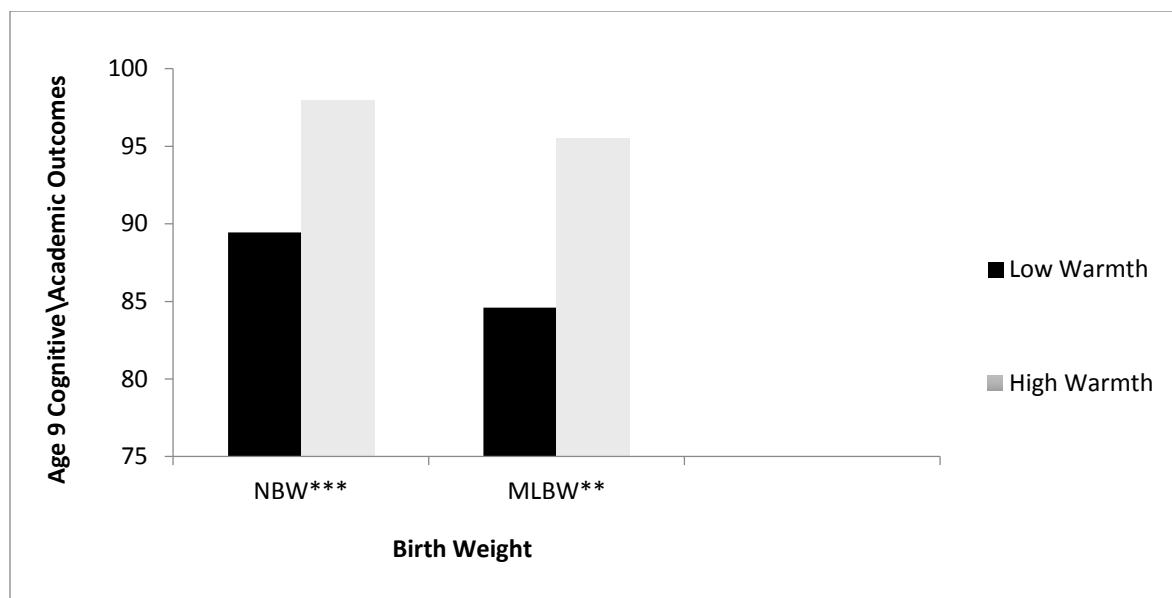
Figure 11. The association between birth weight and cognitive/academic achievement at age 9 as a function of levels of maternal warmth. A significant mean difference (** $p < .01$, *** $p < .001$) between low warmth and high warmth group (1/2 SD below the mean and above the mean, respectively) is represented by asterisks on the X-axis.

Table 6

Means for Child Outcomes across the Warmth Group (Averaged Maternal Warmth at Ages 3 and 5), and by Birth Weight Status

Variable	NBW					MLBW				
	Low MW		High MW		*t*-Value	Low MW		High MW		*t*-Value
	M	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*	
Ext 9-PR	9.99	9.03	6.03	5.99	5.25***	8.83	5.96	5.96	5.68	1.69^{+}
ExtR9-TR	18.80	4.99	21.30	3.74	-5.29***	17.0	4.73	19.12	4.79	-1.32
SK9-TR	26.38	6.88	29.97	7.24	-4.46***	23.84	7.78	27.27	7.23	-1.31
AvSC-TR9	45.20	10.49	51.35	9.88	-5.38***	40.84	11.54	46.07	11.48	-1.31
ZSC-TR9	-.73	1.89	.38	1.67	-5.37***	-1.52	2.02	-.61	2.04	-1.29
RV9	86.53	12.17	96.90	14.21	-8.87***	83.28	11.29	94.74	16.23	-2.86**

Reading-9	88.78	14.82	95.77	11.77	-5.57***	82.12	15.70	93.25	11.19	-2.85**
Math-9	93.15	14.58	101.14	14.57	-6.07***	88.40	18.05	97.83	14.01	-2.04*
AvC/A9	89.45	11.23	97.97	11.64	-8.13***	84.60	12.56	95.54	12.53	-3.02**

Note: Low Warmth = 1/2 SD below Mean; and High Warmth = 1/2 SD above Mean
MW = Maternal Warmth, Ext = Externalizing Behaviors (R= Recoded scores), PR = Parents Reports, SK= Social Skills, TR = Teachers Reports, AvSC = Averaged Scores of Social Skills and Externalizing Problems, ZSC= Standardized Scores of Social Competence, RV = Receptive Vocabulary, AvC/A = Averaged Scores of Cognitive/Academic Competence
[+] $p < .10$, [*] $p < .05$, [**] $p < .01$, and [***] $p < .001$.

Figure 12 also displays the interaction by plotting the regression fitted lines for NBW and MLBW groups. In these analyses, the cognitive/academic competence outcome (i.e., standardized scores of receptive vocabulary, reading, and math scores) was regressed onto the raw scores of continuous measures of maternal warmth (average warmth at ages 3 and 5) separately for children with MLBW and NBW groups. As shown in Figure 12, the slope of the regression line for MLBW children was steeper than the slope of the regression line for NBW children indicating that the association between maternal warmth and cognitive/academic outcomes was stronger for MLBW children as compared to NBW children. Thus, it is important to note that the higher levels of maternal warmth during early years are critical for at-risk MLBW children to have a positive cognitive/academic development at age 9.
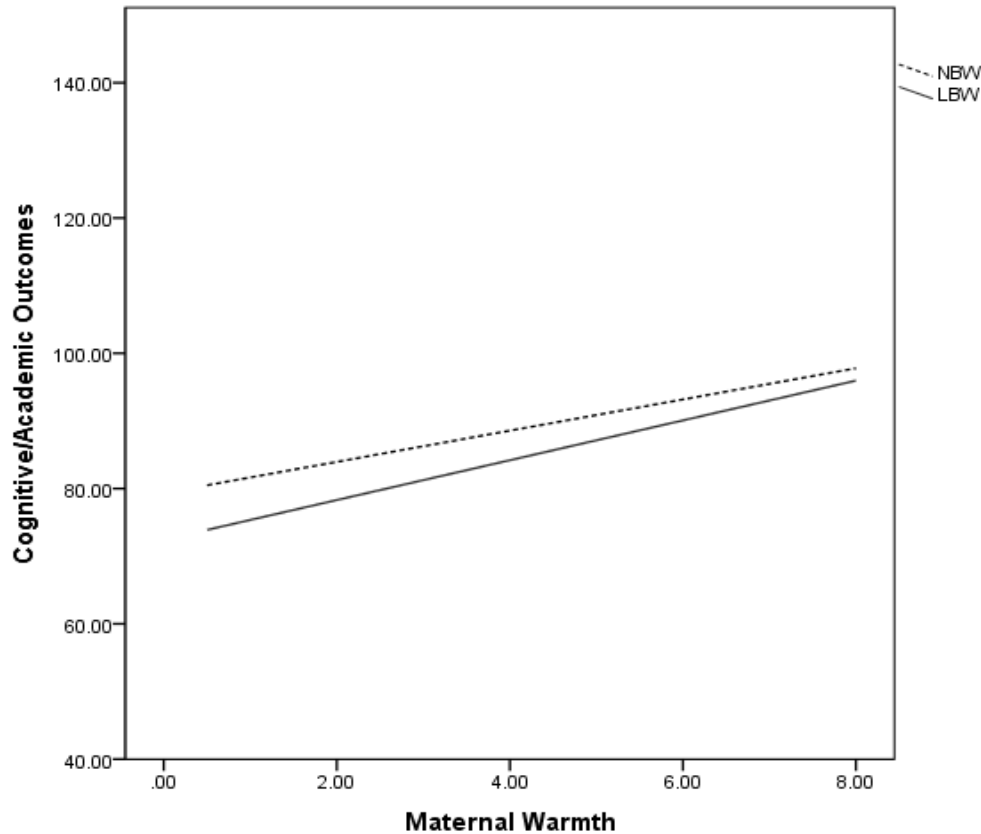
Figure 12. The slopes of regression fitted lines in the associations between maternal warmth and cognitive/academic outcomes at age 9 across MLBW and NBW group.

Moderating role of parenting stress on socioemotional and cognitive/academic outcomes.

As indicated earlier, the interaction effects of combined measures of parenting stress at ages 3 and 5 were analyzed in separate models for teacher-reports of socioemotional competence and cognitive/academic outcomes. None of the interactions terms reached significance in any models. Thus, contrary to the expectations (H5c and H5d), parenting stress did not buffer the strength of the association between moderate low birth weight and measures of socioemotional outcomes and/or cognitive/academic outcomes (results not shown). Therefore, the associations between MLBW and socioemotional and cognitive/academic competence at age 9 did not differ based on the levels of maternal parenting stress at ages 3 and 5.

Effects of Control Variables

At outlined before, each model included a large battery of control variables including socioeconomic and prenatal risk factors, infant temperament, preterm birth, MBMI, and maternal depression at age 1. It is important to note that several control variables made a significant input to the key outcome variables in the model, which is net of all other effects estimated in the model as reviewed here. For all models, infant difficult temperament was associated with decreased socioemotional and cognitive/academic outcomes. For model examining parental reports of externalizing problems (Model 1), SES risk index was associated with higher levels of externalizing problems. For models examining teacher reports of socioemotional outcomes (Model 2 and 4), lower MBMI, prenatal risk index (modest strength), maternal depression (modest for Model 4), and preterm status (modest strength) were associated with decreased socioemotional competence (i.e., increased externalizing problems and decreased social skills). Similarly, for model examining cognitive/academic competence (Model 3 and 5), MBMI and SES risk index (in Model 3 only) were associated with decreased cognitive/academic competence at age 9.

Chapter 5. Discussion

The present study emphasized the importance of low birth weight and the quality of early parenting factors for child outcomes within an at-risk sample. In particular, the findings contribute to the existing literature demonstrating the impacts of moderate low birth weight for different dimensions of cognitive and academic skills (Anderson et al., 2003; Bhutta et al., 2002; Hack et al., 1995; Weisglas-Kuperus et al., 1993) and socioemotional competence (Arnoudse-Moens et al., 2009; Bhutta et al., 2002; Landsem et al., 2015). Specifically, results suggest that MLBW status was significantly associated with lower levels of cognitive/academic outcomes, including receptive vocabulary, math, and reading achievement at age 9. Above and beyond the effects of several demographic and prenatal risk factors, child characteristics, and maternal depression during infancy, MLBW status also significantly predicted lower levels of teacher-reported socioemotional competence, including higher levels of externalizing behaviors and lower levels of social skills at age 9. However, the present study failed to find a significant association in the link between MLBW and parent's reports of externalizing behavior at age 9.

Consistent with extant studies (Alegre et al., 2014; Landry et al. 2008; Landsem et al., 2015; Poehlmann et al., 2012; Treyvaud et al., 2009; Tully et al., 2004), the present study also highlighted the important implications of early parenting factors on children's socioemotional, and cognitive/academic competence in middle childhood. For instance, the present study found direct longitudinal associations between maternal warmth and different measures of socioemotional outcomes and cognitive/academic outcomes among children at age 9. Similarly, higher levels of parenting stress at ages 3 and 5 was associated with lower levels of socioemotional competence and decreased cognitive/academic outcomes at age 9 across all children. Consistent with the developmental vulnerability approach (Monroe & Simons, 1991;

Zuckerman, 1999) and a few prior studies (Jaykel et al., 2014; Laucht et al., 2001; Tully et al., 2004), findings of the present study also suggest that maternal warmth moderated the strength of the association between MLBW, and measures of socioemotional and cognitive/academic outcomes. These associations were stronger even after controlling for key control variables in the model. Thus, positive parenting during early childhood is crucial for MLBW children for their long-term developmental outcomes across middle childhood.

MLBW and Socioemotional Outcomes

School age is a period in which children are exposed to and influenced by multiple attribute environmental contexts (such as, with peers and teachers) outside their family. Complex social abilities and effective functioning in cognitive and behavioral domains are crucial for success in the school setting (Coll & Szalacha, 2004; Fan et al., 2013). For this reason, examining socioemotional outcomes at school context may be of primary importance during middle childhood (Anderson et al., 2003; Eisenberg et al., 2001; Hack et al., 1991; Horwood et al., 1998; Nordov et al., 2012). As hypothesized, MLBW status significantly predicted teacher-reports of decreased socioemotional competence at age 9. In particular, similar to the few prior studies among extreme low birth weight and preterm groups (Anderson et al., 2013; McCormick et al., 1996; Spiker et al., 1993), MLBW children exhibited fewer teacher reported social skills and higher teacher reported externalizing problems at age 9. This finding is also consistent with prior research across VLBW pre-term children in which VLBW status significantly predicted teacher reports of increased externalizing problems in school age children (Aarnoudse-Moens, 2009; Hoorwood et al., 1998; Landsem et al., 2015).

These results are consistent with the notion that MLBW children are at increased risk for socioemotional difficulties at school. Although the mechanisms underlying this negative

association is not well understood in the literature, one explanation is consistent with the developmental vulnerability hypothesis. Specifically, the diverse medical and physiological risks at an early age may have a persistent and long-term impact on the developing brain leading to behavioral difficulties among LBW preterm children (Bhutta et al., 2002; McCarton, 1998; Tayler et al., 2001). In addition to biological vulnerability, externalizing behaviors of MLBW children may be influenced by other factors, such as home and social environment, child characteristics, and the quality of parenting factors (Boardman et al., 2002; Hack et al., 1995; De Bie et al., 2010). Although these factors are included as controls in the present model, the effects of additional factors may be equally important when examining socioemotional outcomes for MLBW children at school. Given the strong associations among these links and the significant mean differences on scores on teacher reported externalizing problems and social skills across MLBW and NBW group, MLBW children were still at increased risk for lower socioemotional competence at school. While there was a statistically significant direct effect between MLBW and teacher's reports of socioemotional competence at age 9, it is also important to note that the associations were small in strength. MLBW only explained approximately 0.3% of the variation on socioemotional competence at age 9. These small effects were not surprising given the previous findings across MLBW and VLBW children (Laucht et al., 2001; Stein et al., 2006; Vaske et al., 2013). For instance, Vaske et al.'s (2013) analysis of LBW children from the FFCW study revealed that LBW explained a small percentage of variation in serious aggression (0.4%) and destructive behaviors (0.3%) at age 5. Albeit MLBW increased the risks of poor socioemotional competence among children, these effects are often small in magnitude.

Contrary to expectations, the results of the present study did not support the association between MLBW status and parent report of externalizing difficulties at age 9. Similar to other

studies (Bhutta et al., 2002; Hille et al., 2001; Landsem et al., 2015), the present study operationalized externalizing behavior as a more global composite including aggressive and delinquent behaviors sub-scales and included a latent construct of parent-reported externalizing behaviors in the model. However, a previous study using data from FFCW examined the associations between LBW and three specific facets of aggression (i.e., destructive behavior, serious aggression, and minor aggression), and found the significant link only for destructive behaviors and serious aggression (Vaske et al., 2013). It could be possible that LBW children may be especially sensitive to parent reports of the particular facets of aggression (i.e. serious aggression) at age 5 (Vaske et al., 2013) as compared to a global composite measure of externalizing behaviors.

On the other hand, the present sample only included MLBW children as a high-risk group and excluded ELBW and VLBW groups due to data constraints. Previous studies examining these links suggest that preterm status in extreme weight groups was predictive of behavior outcomes, with behaviors problems most notable among infants born at lower gestational ages and with more medically vulnerable infants in their early childhood years (Kelly et al., 2001; Shah et al., 2013). There was also moderate stability of parent-reported behavior problems over time with greater prevalence and stability during ages 2 to 3 years (Gray et al., 2004; Landsem et al., 2015) and diminished levels of parent-reported problems of externalizing difficulties across the school ages (Landsem et al., 2015). Thus, it may be possible that infants in more extreme categories may have increased behavioral difficulties at home as compared to the low-risk group of LBW children (i.e., MLBW group) and that these problems may be more evident for parents during early childhood years. Specifically, exposure to positive sociodemographic and parenting environments during early years of development may be positively linked to behavioral

outcomes across the continuum of LBW and appear to have far greater effects on outcomes (Boardman et al., 2002; Hack et al., 1995). In addition, LBW preterm children may have decreased problem behaviors overtime due to the effects of other modifiable environmental factors, such as parenting interventions and developmental follow-up of LBW preterm children during their early years of development (Gray et al., 2004; Landsem et al., 2015).

On the other hand, the disagreement between parent and teacher reports of behavior problems could also be influenced by other environmental contexts and factors, such as the relationships of the child to parents and teachers (Grietens et al., 2004; Landsem et al., 2015). Notably, teachers are considered as important sources/informants for socioemotional outcomes during school ages because they observe children's behaviors closely with peers for a long period and may provide less biased information as compared to parents (Abikoff, Courtney, Pelham, & Koplewicz; 1993). Thus, low agreement between parents and teachers has been found reports of problem behaviors among 5 to 6 years old children (Grietens et al., 2004).

MLBW and Cognitive/Academic Outcomes

The present study also supports the importance of examining the association between MLBW and cognitive/academic outcomes in middle childhood. As expected, MLBW status was significantly associated with lower levels of cognitive and academic competence at age 9, including receptive vocabulary, reading comprehension, and math achievement. Thus, consistent with prior studies across preterm LBW groups (Anderson et al., 2003; Bhutta et al., 2002; Boardman et al., 2001, Rickards et al., 2001; Shah et al., 2013), children from families who were biologically at-risk at birth, like MLBW, demonstrated lower levels of competence across multiple dimensions of cognitive and academic functioning. In addition, there were statistically significant mean differences in scores on different measures of cognitive and academic outcomes

at age 9 (i.e., receptive vocabulary, reading, and math achievement) with the highest difference on math scores across MLBW and NBW children. Thus, MLBW children, who were previously considered to be relatively a low-risk group among LBW infants, may be at increased risk for deficits in cognitive/academic competence compared to their NBW peers.

It may be that due to their increased risk for medical complications, for growth retardation, and developmental delay (WHO, 2011), MLBW status itself becomes an important biological vulnerability for poor verbal ability, reading, and math achievement at age 9. It is also possible that, consistent with developmental perspective, prenatal underdevelopment of the fetal brain or inability to catch up normal growth during a critical period of infant development may have a persistent long-term negative impact on cognitive and intellectual functioning among at-risk LBW children (De Bie et al 2010; Hack et al., 1991; Joyce et al., 2012). In particular, preterm and neurologically intact VLBW children with failure of catch-up growth during infancy (as evidenced by subnormal head circumference at 8 months of age) had significantly high behavior problems, low cognitive outcomes (e.g., receptive and expressive language, IQ scores), as well as poor academic performance (e.g., mathematics, reading, and spelling) (Hack et al., 1991). Although the mechanisms underlying the vulnerability of poor head growth for VLBW children has not been understood in the literature, these children are at increased risk for poor developmental outcomes.

These children may also have limited potential for functional adaptation following a preterm LBW/VLBW birth (Jaekel et al., 2015) due to immature behavioral organization/physiological stability (Bhutta et al., 2002; McCarton, 1998; Robson, 1997; Tayler et al., 2001), and thus are more vulnerable to poor developmental outcomes. Although, being born SGA/ or premature is considered an important risk factor for adverse neurodevelopmental

outcomes (Bhutta et al., 2002; De Bie et al., 2010; Shah et al., 2014; Tolsa et al., 2004), the overall outcome of each LBW child depends on its interaction with several factors. Thus, in addition to the effects of biological adversity, adverse sociodemographic and environmental factors may also negatively influence long-term cognitive/academic outcomes among at-risk children. It is also important that sociodemographic controls made a significant contribution in the model predicting cognitive/academic outcomes. The present study, however, did not explore the mechanisms underlying these adverse outcomes. Perhaps, it is important to consider the effect of sociodemographic and parenting variables in the associations among these constructs. In addition, the enrichment program for MLBW children may be particularly beneficial toward decreasing long-term consequences on multiple domains of child outcomes, specifically among these children from low SES background, less educated mothers (Boardman et al., 2002; Brooks-Gunn et al., 1992; Brooks Gunn et al., 1993; IHDP, 1990; Liaw & Brooks-Gunn, 1993), and children of lower income families (Linver et al., 2015; Roberts et al., 2007).

Although these associations existed in the current data, it is also important to note that the effect sizes were small in magnitude. Specifically, MLBW only explained approximately 1.7% of the variation in cognitive/academic competence. These small effects were not unforeseen given the findings of previous research (Dombrowski et al., 2007; Vaske et al., 2013). For instance, using data from the FFCW study, prior research suggests that LBW only explained about 0.9% of the variation in PPVT-R scores at age 3 (Vaske et al., 2013). Other studies also suggest that VLBW/pre-term groups had a statistically significant, but a small difference in mean scores across cognitive outcomes (Bhutta et al., 2002; Dombrowski et al., 2007), and reading and math achievement (Anderson et al., 2003; Jaykel et al., 2015) as compared to NBW children. It is also noteworthy that the present study excluded children who were neurologically impaired at

birth, and who were born VLBW and ELBW, as preterm and LBW children with extreme weight categories and with neurological deficits often shown more negative cognitive and behavioral outcomes as compared to neurologically stable children across different developmental ages (Ballot et al., 2012; Bhutta et al., 2002; Hack et al., 1995; Horwood et al., 1998; Kessenich, 2003; McCarton et al., 1997; Weisglas-Kuperus et al., 1993). Overall, although there is a small effect size, the finding of the present study highlights that MLBW children were at-risk for poor cognitive/academic functioning, even without obvious neurological deficits. These findings may have significant implications for interventions to promote child outcomes among at-risk MLBW children.

Parenting Factors, Socioemotional, and Cognitive/Academic Outcomes

Findings of the present study also suggest that quality of early parenting factors may have important implications in long-term socioemotional and academic competence among at-risk children. In particular, higher levels of maternal warmth and lower levels of parenting stress made important positive contributions to children's cognitive/academic and socioemotional outcomes. As hypothesized, the present study found that higher levels of maternal warmth and lower levels of parenting stress at ages 3 and 5 were longitudinally associated with higher levels of cognitive/academic outcomes, including receptive vocabulary, reading comprehension, and math achievement at age 9. In addition, higher levels of maternal warmth and lower levels of parenting stress predicted decreased parent-reported externalizing behavior problems and increased teacher-reported socioemotional competence among all children at age 9. Thus, above and beyond the effects of key control variables, the effect of parenting during early childhood was statistically significant with multiple outcomes among at-risk school-aged children.

Specifically, positive warmth and high levels of sensitivity/responsiveness increased trust and reciprocity among parents and children (Maccoby & Martin, 1983), which in turn promotes appropriate behaviors toward children, fosters positive mother-child interaction, and enhances competence among children. Positive maternal behaviors also help to develop parent-child synchrony, the parent and child's capacity to share and match each other's affect and behavior, and is positively linked to cognitive and socioemotional competence, even among developmentally at-risk LBW children (Treyvaud et al., 2009). In addition, higher levels of warmth and positive interaction may stimulate the immature brain of LBW children (Nordhov et al., 2012), thereby facilitating positive long-term developmental outcomes (McCartoon, 1998; Rauh et al., 1988). In sum, similar to prior research demonstrating the importance of early positive parenting behaviors on socioemotional (Altschul et al., 2016; Landry et al., 2006; Lee et al., 2013; Spiker et al., 1993; Steelman et al., 2002) and cognitive outcomes (Landry et al., 2006; Poehlmann & Fiese, 2001; Treyvaud et al., 2009), the present findings underscore the importance of higher levels of warmth at ages 3 and 5 as important factors for developmental outcomes.

In contrast, higher levels of parental stress negatively link to child outcomes as parents who report more stress often provide less warmth and responsive care for their children. In general, higher levels of parenting stress negatively influence maternal parenting behavior (Abidin, 1995) thus mothers show lack of pleasure and encouragement in interacting with their children (Anthony et al., 2005; Robson, 1996). Children who were exposed to negative parenting contexts during early childhood years may, therefore lack the ability to effectively develop skills and competence for their long-term development. Whereas children who are exposed to low levels of parenting stress and positive parenting contexts during preschool build confidence in

the positive interactions with peers/group situations, enhancing positive social skills and behaviors (Anthony et al., 2005; Denham et al., 1997). Thus, similar to other studies examining the role of parenting processes on child outcomes (Anthony et al., 2005; Brennan et al., 2000; Goodman & Gotlib, 1999; Kiernan, & Huerta, 2008; Maughan et al., 2007; Monti et al., 2013; Satyanarayana, et al., 2011; Singer et al., 1999), the present study highlights that higher levels of parenting stress during early childhood made a significant contribution on child's socioemotional and cognitive/academic outcomes.

In addition, parenting stress and depression often co-occur and both have contributed negatively to child outcomes. Due to the exposure to negative maternal cognitions, behaviors, and affect, children of highly stressful/depressed mothers are at higher risk for developing subsequent behavioral difficulties and lower socioemotional and cognitive outcomes in childhood (Brennan et al., 2000; Goodman & Gotlib, 1999). Positive maternal parenting (e.g., warmth, responsiveness, and stimulation) could also be affected by increased parenting stress and depression in early childhood years; thus, mothers may be less competent to provide the appropriate stimulation and care that their infants need (Patel et al., 2004). Although, the present study included maternal depression during infancy as a control, revealing a significant effect on models predicting socioemotional outcomes, the effect of these parenting processes (such as maternal warmth, parenting stress, and maternal depression) in developmental outcomes among at-risk children need further exploration. Overall, the findings collectively suggest that positive parenting quality during early childhood predicts increased cognitive/academic and social competence and decreased problem behaviors in later childhood.

MLBW, Socioemotional, and Cognitive/Academic Outcomes: The Role of Parenting as a Moderator

The recent literature examining child's socioemotional and cognitive/academic outcomes also highlights the importance of positive parenting factors for LBW children within these domains of child development. Findings of the present study also support that positive parenting processes could have a potentially modifiable influence that can promote the positive development of LBW at-risk infants (Hack et al., 1995; Jaekel et al., 2015; Shah et al., 2013; Treyvaud et al., 2009). In particular, the positive effects of parenting contexts during early childhood are important processes for long-term socioemotional and cognitive outcomes among at-risk preterm/LBW children (Bradley et al., 1994; Brooks-Gunn et al., 1993; Linver et al., 2002; McCarton et al., 1997). Thus, increased maternal warmth played a significant role in the positive development of children, even those who were biologically at-risk for vulnerability, like MLBW children. Knowledge of the risk and protective parenting factors are also important in designing interventions to improve outcomes of MLBW children.

Moderating role of maternal warmth. A large body of evidence suggests that parenting processes during the early years may be particularly important for biologically at-risk children regarding their short-term and long-term academic and socioemotional development. In particular, consistent with differential effects of parenting processes, MLBW and VLBW children may be particularly at risk for lower academic achievement (Jaekel et al., 2015; Shah et al., 2013) and socioemotional competence (Poehlmann et al., 2012; Laucht et al., 2001; Tully et al., 2004), when parenting is less optimal. Interestingly, findings of the present study only support a growing body of literature indicating that MLBW children are more vulnerable to the negative parenting influences and that these factors can moderate the effects of low birth weight

on cognitive/academic outcomes (Jaekel et al., 2015; Shah et al., 2013). Specifically, after accounting for the effects of key control variables in the model, averaged maternal warmth at ages 3 and 5 was found to moderate the strength of the associations between birth weight and cognitive/academic competence at age 9. Further results also suggest that the mean scores of cognitive/academic outcomes at the levels of high (1/2 standard deviation above the mean) and low (1/2 standard deviation below the mean) warmth were significantly different for both NBW and MLBW children with the largest differences in mean scores obtained for the MLBW group. As a result, MLBW children significantly predicted catch-up to their NBW peers from more positive parenting contexts during critical ages of development. Thus, enhancing maternal warmth during early years of development is of particular importance to prevent cognitive/academic difficulties among the increasing population of MLBW children.

Although there was a significant interaction effect between maternal warmth and birth weight in predicting socioemotional competence, the link was stronger for NBW children as compared to MLBW children. The follow-up analysis also suggests that the mean scores of socioemotional outcomes between the high (1/2 standard deviation above the mean) and low (1/2 standard deviation below the mean) warmth group were significantly different only for NBW children but not for MLBW children. As discussed in the results, although the difference in mean scores at levels of high and low warmth were similar across the two groups, the small sample size for the MLBW group could have contributed to the lack of significance for this group. In particular, as the sample size proportions vary within two groups, the power to detect the difference will decrease (Frazier et al., 2004). Thus, unequal sample size across groups may be a major issue that needs a further exploration in the future research among LBW groups.

From the visual inspection of the data, however, MLBW children were more susceptible to both lower cognitive/academic outcomes and socioemotional competence at age 9 than their NBW counterparts when they were exposed to low levels of maternal warmth across ages 3 and 5 years. These findings highlight that MLBW children are particularly more susceptible to poor developmental outcomes due to increased developmental vulnerabilities (Zuckerman, 1999). Although the present study did not explicitly test the effects of DST model or the vulnerability model, as indicated in the results and the visual inspection of the data, MLBW children were highly susceptible to low levels of warmth as compared to NBW children, central to a vulnerability framework. Because of their compromised developmental outcomes, MLBW children required a high level of positive parenting environments during early childhood to achieve favorable outcomes in multiple areas of development as compared to their NBW peers.

These findings are consistent with those from an earlier study that found that maternal responsivity during infancy moderated the effects of low birth weight (weight less than 2500 g) on children's inattention and hyperactivity disorders at age 8 (Laucht et al., 2001). Similarly, the moderating effects of maternal warmth on behavior problems were also consistent with another study across LBW twins, such that higher levels of warmth protect LBW children from developing teacher and parent reports of ADHD problems at age 5 (Tully et al., 2004). It is possible that mothers in a high warmth group may provide a more supportive and favorable environment for their MLBW children, which protects them from developing externalizing behaviors and enhances their positive social skills and cognitive/academic performance. Similarly, MLBW children, who were exposed to low maternal warmth during their crucial developmental period, may receive less positive and less sensitive interactions from their mothers, which may increase the chance of development of socioemotional and academic

difficulties. Thus, although MLBW children did not outperform their NBW peers, they benefitted from higher levels of maternal warmth across ages 3 and 5 and demonstrated better outcomes on both socioemotional and cognitive/academic domains under these positive parenting environments.

These findings are also supported by the prior research indicating the positive implications of mother-child interactions and maternal sensitivity in long-term development, particularly among preterm LBW children (Bilgin & Wolke, 2015; Jaekel et al., 2015; Neri, Agostini, Salvatori, Biasini, & Monti, 2015). Findings of the present study are also similar to those from the few intervention studies among pre-term heavier MLBW (weight between 2,001 to 2499 grams) children, which found that mothers in the intervention group were more responsive, stimulating, and attentive and that infants had positive effects in multiple developmental outcomes (Brooks-Gunn et al., 1993; Klebanov et al., 2001; McCormick et al., 2006). Thus, enhancing maternal warmth may prevent socioemotional and academic difficulties among the increasing population of MLBW children.

Despite the lack of research on factors that moderate the negative effects of MLBW on children's long-term developmental outcomes, a large volume of early intervention studies has been conducted across premature LBW children and VLBW/ELBW groups in earlier decades. These intervention studies have mostly focused on interventions to enhance parent's sensitivity, interaction, and responsiveness across at-risk LBW groups (Brooks-Gunn et al., 1992; Rauh et al., 1988; Spiker et al., 1993) to enhance socioemotional and cognitive development across LBW preterm children. The IHDP study also indicated that preterm LBW children born at 2,001 - 2,499 g birth weight (which represents MLBW group in the present analyses), benefitted more from parenting interventions and preschool education programs than children in the lower birth

weight category (<2,000 g birth weight) in their cognitive and academic competence during school ages (McCarton et al., 1997; McCormick et al., 2006).

Thus, persistent positive benefits of early childhood interventions and positive parenting may have stronger effects on MLBW children as compared to VLBW/ELBW children. These children usually have less severe medical complications at birth and are less likely to have neurodevelopmental limitations than their lower birth weight peers (Hack et al., 1995), but still required highly sensitive and positive environments before school entry to catch-up their NBW peers (Jaykel et al., 2014; Landry et al., 2001). In addition, MLBW children may not be equipped with increased capabilities for developmental plasticity to facilitate better adjustment after birth, thus requiring a high level of maternal warmth to achieve favorable outcomes at the same levels as their NBW peers. Due to their increased biological vulnerabilities and risk for poor adjustment, LBW preterm children may need a consistent parenting intervention and additional follow-up throughout the early childhood years for achieving strong positive effects on cognitive and socioemotional outcomes (Brooks-Gunn et al., 1993; Landry et al., 2001; McCarton et al., 1997; McCormick et al., 2006). In addition, due to changes in complexity of these skills across developmental period, consistency in maternal warmth and contingent responsiveness across early childhood years are also important for LBW preterm children to help maintain a positive developmental trajectory for cognitive and social competence (Landry et al. 2001; Landry et al., 2008) than their full-term peers. Hence, positive parenting interventions and developmental follow-up during earlier ages may be particularly important for these MLBW children.

Similar to findings of intervention studies, the present study also supports the notion that the totality of positive maternal warmth at both ages (3 and 5) is very important for better socioemotional and cognitive/academic development at age 9 among MLBW children. To my

knowledge, this is the first study among MLBW children (including a sample of both preterm and full-term gestation) and a comparison group of NBW sample that has identified the important role of maternal warmth in multiple child outcomes using a moderation framework. In particular, the examination of the role of maternal warmth as a moderator in the associations between MLBW and socioemotional and academic competence add further empirical understanding in the literature examining the important implications of parenting factors on child outcomes (Faure et al., 2016; Jaekel et al., 2015; Landry et al., 2006; Landry et al., 2000; Laucht et al., 2001; Poehlmann et al., 2012; Poehlmann et al., 2011; Shah et al., 2013; Tully et al., 2004). Collectively, the present results provide further evidence that positive maternal warmth may serve as a protective factor to overcome the biological vulnerability of MLBW on developmental outcomes among at-risk children.

Moderating Role of Parenting Stress. Contrary to expectations, the present study did not support the moderating effects of maternal parenting stress in the link among MLBW and socioemotional or cognitive/academic outcomes in middle childhood. Thus, it was concluded that MLBW children who exposed to higher levels of maternal stress during the preschool years did not differ from their NBW peers across the socioemotional and academic domains. As compared to the exposure to negative maternal cognitions and stress, MLBW children may have more beneficial impacts through more positive maternal interactions (e.g., more positive affect and warmth, less intrusiveness, and high sensitivity) on cognitive and socioemotional competence (Poehlmann et al., 2012). In addition, similar to previous studies among LBW pre-term children among toddlers and preschool ages (Poehlmann et al., 2012; Whiteside-Mansell et al., 2009), it could be possible that MLBW infants who were not prone to temperamental distress, parenting stress may be unrelated to cognitive/academic and socioemotional outcomes.

On the other hand, parenting stress may relatively increase after a birth of a low birth weight infant due to the increased medical risks and ongoing developmental vulnerability associated with LBW (Singer et al., 1999; Robson, 1997). Specifically, some LBW/preterm children may be difficult to manage, and more likely prone to difficult temperament and fussier than their NBW counterparts (Halpern et al., 2001; Monti et al., 2013; Poehlmann et al., 2012). Others may suffer from increased medical problems and need frequent follow-up with pediatric practitioners (Child Health USA, 2013; Moster et al., 2008; Stein et al., 2005). Thus, due to these ongoing vulnerabilities and temperamental difficulties, mothers of LBW/preterm children often exhibit higher levels of parenting stress and depression during infancy as compared to mothers of term and NBW infants (Monti et al., 2013; Singer et al., 1999). Interestingly, there was no significant link between birth weight and parenting stress at ages 3 and 5 in the present study. It may be possible that parenting stress may be particularly increased during infancy after a birth of MLBW infants. Thus, as compared to examining parenting processes later in the childhood, it may be more relevant to examine the effects of parenting stress during infancy as a mechanism in the link between MLBW and later child outcomes.

Besides, a methodological caution should be considered when interpreting the lack of interaction effects with maternal parenting stress. In particular, several factors may influence the statistical power in determining the moderating effects on outcomes including the reliability of measures, the size of the effect, and unequal sample sizes across groups (Frazier, Tix, & Barron, 2004). As previously noted, the effect sizes between MLBW and outcomes in the present data were small in magnitude. In addition, the sample sizes of MLBW children were very low as compared to the NBW sample. Although it is recommended to use multi-group SEM with categorical variables in SEM (Frazier et al., 2004), the study used SEM interactions due to the

small sample of MLBW children. Thus, multi-group analyses with larger samples may provide a more accurate representation of the strengths of the associations.

Conclusions

Despite the consistent scientific and technological interventions that have contributed to increase infant's survival and decrease morbidity across low birth weight and preterm infants, these biological adversities remain one of the leading causes of a persistent long-term impact in multiple developmental outcomes. The present study provided evidence that socioemotional and cognitive/academic outcomes of MLBW children in middle childhood are significantly influenced by the quality of early parenting factors (Bhutta et al., 2002; Landesm et al., 2015; Shah et al., 2013; Vaske et al., 2013). To my knowledge, this is the first study to examine the link between MLBW and socioemotional and academic outcomes with a particular role of parenting factors across low-income families. Perhaps the most noteworthy finding is that MLBW is a strong predictor of diverse measures of cognitive/academic and teachers reports of socioemotional outcomes. These findings are net of the effects of the key control variables; including different socio-demographic and prenatal factors, child characteristics, and maternal depression in a SEM framework. Thus, the present results raise the possibility that biologically at-risk infants, who were previously thought to be a low-risk group (i.e., MLBW), may benefit from closer developmental and behavioral follow-up and may be uniquely benefitted by interventions focused on enhancing positive parenting (Blair, 2002).

Although, prior studies discussed the importance of positive parenting for pre-term and temperamentally difficult children for behavioral and cognitive outcomes during infancy, toddlerhood (Landry et al., 2006; Poehlmann et al., 2011), and preschool ages (Poehlmann et al., 2012; Shah et al., 2013), this study extends the importance of parenting up to age 5 for child

outcomes at age 9. The results also support the beneficial roles of parenting factors (e.g., maternal warmth and parenting stress) in long-term socioemotional and academic competence among at-risk children. A significant contribution of the present study is to add to the limited literature in which MLBW children, who received high levels of maternal warmth during early ages, did significantly better in their academic and socioemotional functioning at age 9 as compared to their exposure to low levels of warmth. However, MLBW children who were exposed to low levels of warmth underperformed in both cognitive/academic and socioemotional outcomes than their NBW peers. Thus, consistent with developmental vulnerability perspective (Monroe & Simons, 1991; Zuckerman, 1999) and differential effects of parenting (Belsky et al., 2007; Jaekel et al., 2015; Poehlmann et al., 2011), findings underscore the importance of parenting contexts (i.e., the beneficial role of positive parenting as well as adverse effects of negative parenting) at early childhood for developmental outcomes during middle childhood among at-risk children.

Interestingly, a growing body of evidence also suggests that LBW children may be born with an increased capacity for developmental plasticity, such that they are differentially susceptible to the postnatal rearing environments (Belsky et al., 2007; Pluess & Belsky, 2011; Shah et al., 2013). More specifically, consistent with the Differential Susceptibility Theory (DST), children who are more at-risk biologically/temperamentally, like LBW children, may be more vulnerable to the negative effects of unfavorable contextual/parenting environments and conversely, are more positively influenced by the beneficial effects of positive environments (Belsky, 2013; Belsky & Pluess, 2009; Belsky et al., 2007). Thus, not only to the increased vulnerability of poor outcomes but MLBW children may also be equally more susceptible to the advantageous effects of positive environmental contexts. Although the present study did not

empirically test the differential susceptibility model, the future research may look at the effects of parenting processes and other factors at which MLBW children outperform their NBW counterparts. In addition, differential effects of other variables including cognitive stimulation and temperamental characteristics should be examined in further research across all MLBW children and may be particularly critical in designing follow-up programs to provide developmental monitoring for MLBW infants until their school years. Thus, the present study helps further to explain the processes by which MLBW children may be at risk for poor outcomes.

The present study also has several methodological strengths, including the use of a diverse sample of families from large 20 U.S. cities, recognized and standardized measures of key study variables, and multiple informants and methods of data collection. Specifically, although the extensive body of work has examined the relation between LBW and cognitive and socioemotional outcomes across early and middle childhood, the present study's unique aspects include the use of longitudinal design, multiple reporters of child outcomes including parent's and teacher's reports, multiple methods of data collection (e.g., questionnaire, in-home assessment, standardized assessments), and the ability to investigate the links across MLBW children with a comparison of NBW sample for diverse child outcomes.

Although there the effect sizes for the link between LBW and children's socioemotional and cognitive/academic competence were small, it is important to note that these associations were statistically significant after accounting for the effects of a large battery of control variables. MLBW consists of the majority of infants born LBW, as over 85% of LBW children fall in this category (Martin et al., 2015). Even though the degree of vulnerability varies across different birth weight categories, MLBW children are still at increased risk for similar, but

perhaps less severe, outcomes. Due to their greater susceptibility to poor environmental contexts after birth (Monroe & Simons, 1991; Zuckerman, 1999), MLBW children require high sensitive and responsive parenting during the critical stages of their development (Jaekel et al., 2015; Poehlmann et al., 2011; Shah, et al., 2013). It is also noteworthy that prior findings suggest that the MLBW preterm group benefitted more from positive parenting interventions and educational stimulation as compared to infants in the lower birth weight category (Liaw & Brooks-Gunn, 1993; Brooks-Gunn et al., 1994; McCarton et al., 1997; McCormick et al., 2006; Ramey et al., 1992). Thus, investing in programs for these children and their families may have significant implications for long-term child outcomes.

Since birth weight itself is not a proxy for poor outcomes, as less optimal prenatal factors may cluster together, intervention before, during, and after pregnancy are critical for positive outcomes. The preliminary analysis (i.e., chi-square tests of independence) also found differences between the MLBW and NBW groups on several prenatal risk factors. For example, high-risk prenatal behaviors (i.e., substance use and smoking), and inadequate weight gain during pregnancy were significantly associated with higher rates of an infant being born MLBW. These prenatal risk factors may also correlate with parenting processes, such that mothers with substance abuse/smoking during pregnancy may provide less warmth/less synchronous interaction for their infants, which may lead to poor outcomes among children. In sum, identification of risk factors during the perinatal and early childhood years and appropriate interventions for both mothers (e.g., prenatal dietary and lifestyle intervention, education and support services for mothers) and infants (e.g., developmental follow-up and referral, home visits) are necessary to promote birth outcomes and long-term child outcomes. Thus, future

analyses could specify associations among prenatal factors, birth outcomes, and parenting processes and their combined influence on various child outcomes among at-risk children.

Limitations

Although the present study advances our knowledge by examining the links among MLBW, parenting factors, and socioemotional and cognitive/academic outcomes in a single model, it is not without limitations. First, several methodological issues should be considered when interpreting the findings. Due to sampling constraints, this study included all MLBW children including infants born IUGR (i.e., full term SGA infants) and pre-term SGA. Whereas IUGR infants may be more likely to suffer from severe neuro-cognitive outcomes, thus would be excluded from LBW preterm sample and examined separately (Hack, 1998). Next, due to data constraints, VLBW and ELBW groups were excluded from the analyses. However, the inclusion of those extreme weight categories in the model to examine these outcomes across different groups could help to understand if similar or different processes occur across different weight categories of LBW infants.

Another significant limitation of the present study is conceptualizing LBW as a categorical variable rather than on a continuous scale. Similar to the majority of prior research, the present study used the categorical measure of birth weight as an independent predictor of child developmental outcomes. Although there are set criteria for the different birth weight categories, there is a consistent overlap among these groups in the existing research (i.e., LBW includes VLBW and ELBW; while VLBW study included ELBW). Thus, it is difficult to ascertain the qualitative differences in outcomes among these children across different LBW categories. Also, these children may be born at term or pre-term and gestational age may be an important predictor of birth weight and later child outcomes. The present study only included

two categories of birth weight groups (i.e., MLBW group and a comparison of NBW group). Since LBW children are not a homogenous group, these children have a broad range of health and developmental consequences with the risk increases with the birth weight decreases (Hack et al., 1995).

As discussed earlier, LBW/preterm children with extreme weight categories may also be at increased risk for multiple issues (such as microbleeds to the brain, prolonged ventilator support due to immature lungs/RDS) following birth, thus requiring a prolonged hospitalization in the NICU (Arpi & Ferrari, 2013; Hack et al., 1995; Kessenich, 2003; Moster et al., 2008). These adverse medical and social experiences after birth could have differential impacts on long-term developmental outcomes among these children along with the continuum of biological risk factors. On the other hand, adverse prenatal factors are crucial in determining birth outcomes such that they are also linked to long-term outcomes among LBW children. Not only across singleton birth; monozygotic twins, who are genetically identical and share the same prenatal environment from the mother, may have different birth weight and height and are different in susceptibility to diseases (Fraga et al., 2005). Thus, the overall outcome of LBW infants depends on the constellation of many prenatal, sociodemographic, medical, and contextual factors before and after birth and that these factors have a greater impact on long-term developmental outcomes. In sum, it is important to examine the effects of other factors with a continuous measure of birth weight to identify the differences in outcomes. Although the examination of birth weight on a continuous scale may fail to capture the qualitative differences of outcomes across these different weight categories, the continuous measure of birth weight may be important to look at the growth and developmental trajectories among these high-risk children.

Given the large amount of missing data on teacher's reports at age 5, the present study was also unable to incorporate socioemotional and cognitive/academic outcomes at age 5. Thus, while findings modeled the influence of early parenting practices on child outcomes at age 9, it was unable to ascertain the timing of the effect on outcomes at earlier developmental ages. The inclusion of other child characteristics (such as child temperament and growth measures at different developmental ages) and socioemotional and cognitive competence at earlier ages in the model may also help to elucidate the significant implications of birth weight and parenting processes for developmental outcomes across the childhood years among these at-risk children. Thus, it is important to look at the patterns and the longitudinal developmental trajectories of cognitive/academic and socioemotional outcomes among children.

The current study also failed to support parenting stress as a moderator in the link between MLBW and cognitive and socioemotional outcomes. Additionally, while the present study focuses exclusively on parenting processes as a moderator through which MLBW influences socioemotional and academic achievement, previous research indicates that other factors, such as temperament, measures of self-regulation, and cognitive stimulation (Feldman, 2009; Linver et al., 2002; Poehlmann et al., 2012; Poehlmann et al., 2011; Weisglas-Kuperus et al., 1993; Whiteside-Mansell et al., 2009), may be particularly important phenomena that have crucial impact on diverse child outcomes among LBW children. It is possible that other mechanisms may mediate or moderate the associations among these constructs. For example, since LBW infants with more difficult temperament were more susceptible to the effects of early negative parenting (Poehlmann et al., 2011), examining the role of infant temperament in conjunction with parenting processes may be important for MLBW children in predicting their developmental outcomes.

Also, due to data constraints, the report on parenting stress was utilized from ages 3 and 5 in-home assessments. But acknowledging the findings of prior research among VLBW and preterm children (Monti et al., 2013; Singer et al., 1999; Robson, 1997), maternal parenting stress during infancy may serve as a mechanism for long-term outcomes across MLBW children. Thus, it is possible that parenting stress at earlier ages (e.g., birth to 1 year) may have been more important for long-term developmental outcomes across MLBW children. In addition, due to the small sample size of MLBW group, the present study employed interaction techniques rather than testing multi-group moderation in SEM. To examine the differences in the pathways across different birth weight groups and parenting processes, multiple group analyses in SEM may provide more specific information about the pathways and differences across groups.

In addition, the present study only examined externalizing problem behaviors. Low birth weight children are also at increased risk for the development of attention deficit hyperactivity disorders (ADHD) (Laucht et al., 2001; Tully et al., 2004) and internalizing difficulties, specifically to VLBW and ELBW groups (Anderson et al., 2003; Bhutta et al., 2002; Horwood et al., 1998). Since, there is an increasing trend of internalizing problems across LBW children up to school age (Landsem et al., 2015), with higher prevalence of these behaviors across preterm LBW children (Aarnoudse-Moens et al., 2009; Bhutta et al., 2002; Hille et al., 2001; Horwood et al., 1998), the examination of other behavior problems, such as internalizing behaviors and ADHD problems, may explain whether MLBW children are equally susceptible to these vulnerabilities across school years likewise preterm and extreme weight groups. Thus, future studies should include additional facets of problem behavior.

Another important limitation of the present study is that there are limitations to the generalizability of the results due to multiple factors. For example, the sample size of MLBW

children was small compared to their NBW counterparts. Thus, it is possible that the MLBW children in this sample are less diverse than MLBW children in the population. Also, given the significant difference in mean scores on teacher reports of externalizing problems across the participants who were lost to attrition and those who remained in the study, the findings may not generalize to all children regarding externalizing outcomes. Besides, approximately 80% of mothers in the present sample were non-white which resulted in the majority of the sample from minority families with impoverished children. While selecting white families as a reference category is a common practice in research, such a model does not include other salient factors reflecting the potential strengths of minority families. Finally, this study is also limited in generalizability across all race/ethnic groups of at-risk families because of its select sample of urban low-income families in the United States, which is not a nationally representative sample of all births in the US.

Finally, the present study did not focus on the mechanisms linking birth weight to socio-emotional and cognitive/academic outcomes. Consistent with fetal programming hypothesis and few other research, early life vulnerabilities during critical periods of development have a crucial effect on individual differences in cognition, behavior and psychopathology (Räikkönen & Pesonen, 2009), due to the changes in the structure and functions of various organs (Barker, 1998; Godfrey and Barker, 2001), and individual differences in self-regulation (Belsky et al., 2007; Feldman, 2009; Poehlmann et al., 2012; Poehlmann et al., 2011; Whiteside-Mansell et al., 2009). Thus, it is important to include the impacts of neuropsychological processes and measures of self-regulation in the link between LBW and child outcomes (Aarnoudse-Moens et al., 2009; Feldman, 2009; Landesm et al., 2015; Vaske et al., 2013). However, the present study also did not account the effects of neuropsychological processes in the link between MLBW and

cognitive and socioemotional outcomes. Hence, future research may include the effects of neuropsychological processes (e.g., executive functioning and attentional processes) as a mechanism for the link between MLBW and socioemotional and cognitive/academic outcomes.

Future Implications

Overall, the results of the present study have several important implications at the policy level and for practitioners to foster positive parenting interventions and developmental outcomes for MLBW children. Since children's long-term health and development are influenced by early life events, which begin even before birth from prenatal health/behavior, effective program and policies for the health and wellbeing of mothers before, during, and after pregnancy are essential for the optimal maternal and fetal outcomes. Specifically, the importance of positive parenting processes up to age 5 is crucial for MLBW children to achieve favorable developmental outcomes at school. Families with MLBW children whose mothers provide low levels of warmth may benefit from parenting interventions designed to foster positive mother-child interactions, and increase maternal sensitivity and warmth toward their child. The findings of the present study help policymakers and public health professionals to understand better the long-term consequences of being born MLBW and determine the programs and policies to improve the health and wellbeing of at-risk infants. Thus, it is also important to design parenting programs to support the mothers who are at-risk for low warmth and sensitivity and implement the evidence-based intervention programs to promote optimal outcomes for at-risk children and their families. Furthermore, because MLBW children have overall lower academic and socioemotional performance as compared to NBW infants and especially in the context of more sub-optimal parenting, these children may uniquely be benefitted from positive parenting interventions to improve behavioral and academic outcomes.

These findings also demonstrate the importance of neonatal and pediatric providers recognizing the possible cognitive/academic and behavioral risks associated with infants of moderately low birth weight and parenting practices at home such that they may develop and utilize an individualized neurodevelopmental assessment for these infants. Specifically, clinicians may obtain information about birth weight and parenting practices to determine whether a child is at greater risk for adverse outcomes such that they may develop a long-term developmental follow-up and consistent risk assessment for these biologically at risk infants on a regular basis.

Furthermore, the results of such studies should have important theoretical and methodological implications for developmental outcomes of MLBW children with a particular role of early parenting factors. Due to the fact that various intrauterine and extrauterine factors may play a critical role in the developmental outcomes of LBW preterm children (De Bie et al., 2010; Roberts et al., 2007), it is important to examine the impacts of these factors in these associations for MLBW children to identify whether similar or different processes occurs across MLBW preterm and full term IUGR children. In addition, after the origin of Barker's DOHaD framework (Barker, 1998), studies have been posited that adverse prenatal influences (as evidence by birth weight) have a long-term impact on the health and wellbeing of children. Due to data limitations, the present study did not include specific health outcomes in the model. Consistent with DOHaD framework and few other researches (Barker, 1998; Godfrey and Barker, 2001; Moster et al., 2008; Stein et al., 2006), future studies should explore the mechanisms linking MLBW and multiple health and developmental outcomes among at-risk MLBW children with a particular focus on parenting processes and neuropsychological mechanisms.

In addition, due to increasing behavioral challenges (e.g., less active during interaction and show less interpretable behavioral cues) across preterm LBW during infancy (Feldman, 2009; Singer et al., 2003), parents may provide less synchronous interactions and less responsive and sensitive care (Neri et al., 2015; Poehlmann & Fiese, 2001; Korja, Latva, & Lehtonen, 2012) to their preterm LBW children, which may have negative implications for child outcomes (Smith et al., 1996; Treyvaud et al., 2009). Although the present study solely focused on the moderating roles of parenting, future research may examine the role of parenting processes as a mediator in these links (Bilgin & Wolke, 2015; Singer et al., 2003) across MLBW children. Further study is also needed to replicate these findings and to test additional hypotheses about socioemotional and cognitive/academic outcomes across MLBW children. Also, longitudinal studies are needed to better understand the developmental trajectories of socioemotional and cognitive/academic competence across different developmental ages, with a particular focus on the varying influences of key parenting processes and the home environment over time.

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