The Influence of cumulative risk factors on the cognitive abilities of low-income, African-American preschool children

Cassandra L. Esposito

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by

Cassandra Esposito

Thesis

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Thesis Committee:
Heather Janisse, Ph.D., Chair
Alissa Huth-Bocks, Ph.D.
Stephen Jefferson, Ph.D.

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Dedication

This project is dedicated to my mother, who has always believed in me (and in the completion of this thesis). Without her love and endless support, I would not be where I am today.
Abstract

A large number of children are exposed to multiple risk factors within the first 3 years of life, resulting in poorer child developmental outcomes. Additionally, exposure to multiple risks is especially prevalent in low-income populations. Several studies have found that multiple maternal and biological risks such as maternal depression, physical health or illness, other socio-demographic risks, and low birth weight lead to poor child outcomes, such as lower cognitive achievement at preschool age. The current study investigated the influence of both maternal and infant biological risks in a cumulative risk model on predicting preschool children’s cognitive outcomes. Hierarchical multiple regression was implemented through SPSS Statistical Software to test the hypotheses. Preliminary analyses indicated that maternal health risks and an infant biological risk were not risk factors in this study, and were therefore removed from the cumulative risk indices. Results indicated that cumulative maternal risks did have a direct influence on children’s cognitive scores. However, the infant biological risk did not significantly influence children’s cognitive scores. Additionally, results indicated that the effects of the cumulative risks were additive for this sample, not multiplicative.
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Preschool has been referred to as the most important grade by many researchers and educators (Barnett & Hustedt, 2003). In recent years the importance of preschool cognitive achievement and its lasting effects have been further brought to light in research and educational policy. Preschool cognitive achievement is one of the strongest predictors of later cognitive and academic achievement, as well as other social outcomes (Burchinal, Campbell, Brayant, Wasik, & Ramey, 1997; Duncan et al., 2007; McCormick et al., 2006; Reynolds, Temple, & Ou, 2010; Walker, Greenwood, Hart, & Carta, 1994). Some of the outcomes associated with high preschool cognitive achievement include lower remediation rates, increased success in high school completion, higher levels of employment, and decreased juvenile delinquency (Reynolds, Temple, Robertson, & Mann, 2002; Reynolds et al., 2010).

Unfortunately not all children enter preschool at the same cognitive skill level, and many continue to be at risk for lower cognitive achievement scores by the time they reach grade school. In particular, children from low-income and minority backgrounds have been found to be at risk for below-average cognitive achievement in preschool and later school years (Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009; Reynolds et al., 2010; Walker et al., 1994). National studies show that upon entering preschool, primarily minority low-income children score lower than their same-aged peers in all cognitive domains, including language, literacy, and mathematics (Ayoub et al., 2009; Moiduddin, Aikens, Tarullo, West, & Xue, 2012). This early discrepancy in achievement scores is known as the “school entry gap,” and it contributes to an estimated 50% of the test score gap in 12th grade (Jencks & Phillips, 1998). Contributors to this school entry gap include family characteristics, socio-demographic and socio-economic risk
factors, as well as child and maternal health characteristics (Currie, 2005; Duncan & Magnuson, 2005; Janus & Duku, 2007). Though poverty is a significant risk factor for poorer cognitive achievement, not all low-income or minority children experience academic failure, and in fact, many are high academic achievers (Brooks-Gunn & Duncan, 1997; Burchinal et al., 1997). As a result of this, a better understanding of the cognitive processes among this population is needed. The current study will particularly focus on African-American children from a low-income, urban setting.

The exposure to environments with higher levels of psychosocial risks may contribute to low-income African-American children’s susceptibility to poorer cognitive achievement skills (McLoyd, 1990). Literature has shown children’s exposure to biological birth risks factors, such as preterm birth and low birth weight have been found to contribute to later cognitive, motor, and emotional disabilities in childhood (Candelaria, O’Connell, & Teti, 2006; Laucht, Esser, & Schmidt, 1997; Liaw & Brooks-Gunn, 1994; Rouse, Fantuzzo, & LeBoeuf, 2011; Rouse & Fantuzzo, 2009). Additionally, maternal factors such as education level, maternal mental health, single motherhood, maternal unemployment, teenage motherhood, and maternal health/illness have been shown to have significant effects on negative child development outcomes (Ayoub et al., 2009; Berger & Waldfogel, 2010; Candelaria et al., 2006; Liaw & Brooks-Gunn, 1994; Perry & Fantuzzo, 2010; Pike, Iervolino, Eley, Price, & Plomin, 2006; Rouse & Fantuzzo, 2009; Slykerman et al., 2005).

Because there are a number of risk factors that contribute to preschool cognitive achievement, examining these factors in a cumulative risk model may be valuable because cumulative risk may be more influential than any specific risk factor alone in predicting negative child development outcomes (Candelaria et al., 2006; Sameroff, 2000; Sameroff, Seifer, &
Baldwin, 1993; Stevens, 2006). The cumulative risk model posits that negative developmental outcomes in children is a result of an accumulation in the number of risks a child is exposed to, rather than the influence of any one risk factor (Stanton-Chapman et al., 2004). Many research studies have used the cumulative risk model to demonstration that exposure to multiple risks increases the negative effects of these risks on children’s cognitive, motor, and emotional outcomes (Candelaria et al., 2006; Rouse & Fantuzzo, 2009; Sameroff et al., 1993; Stanton-Chapman, Chapman, Kaiser, & Hancock, 2004). The cumulative risk model also helps to explain why not all children in poverty have negative developmental outcomes, possibly due to the presence or absence of a certain number of risks (Liaw & Brooks-Gunn, 1994).

Despite the large body of research examining multiple risk factors and their effects on cognitive outcomes, little is known about the cumulative and interactive effects of infant birth risks and maternal risk factors on children’s cognitive outcomes. Therefore, the purpose of this study is to examine preschool age children’s cognitive outcomes in relation to early cumulative infant birth risk exposure and cumulative maternal health and socio-demographic risk factors in a low-income African-American sample. This study will contribute to the current developmental and clinical literature by examining the individual and joint impact of cumulative infant birth risk and maternal risk factors. Additionally, this study will examine these relationships for urban, low-income, African-American children, which is a higher risk and under-studied population.
Review of the Literature

Cognitive Achievement in Preschool Children

Cognitive achievement domains in preschoolers consist of areas of knowledge such as working memory, verbal comprehension skills, and perceptual reasoning. In preschool, children’s cognitive skills are showcased by the ability to recognize letters and shapes, beginning to count, writing his or her own name, understanding the beginning of sounds of words, and reading or pretending to read (Morrison, 2007). These skills are typically measured by intellectual achievement tests or language assessments. Examining cognitive achievement in preschool children is important because these abilities are found to have lasting effects on children’s academic and social outcomes (Burchinal et al., 1997; McCormick et al., 2006; Reynolds et al., 2010; Walker et al., 1994)

Preschool cognitive functioning has been reported to be a stable predictor of achievement from first grade (McCormick et al., 2006), through children’s grade school years (Burchinal et al., 1997), and later in life. In school, regardless of socioeconomic status, gender, or behavioral issues, cognitive achievement at school entry (measured by math, reading, and attention skills) is the strongest predictor of later cognitive achievement (Duncan et al., 2007). Additionally, participation in quality preschool programs directly impacts children’s intellectual and social development, which is linked to higher cognitive functioning at school entry (Reynolds, Temple, Robertson, & Mann, 2002). These higher cognitive abilities are significantly associated with school achievement later in life, lower rates of school remediation, and success in high school completion (Reynolds et al., 2002). Higher cognitive abilities, mediated by preschool participation, results in children who outperform their non-preschool peers in intellectual and language assessments up to first grade, and in school achievement tests in their middle school
years (Schweinhart, Montie, & Xiang, 2005). Early cognitive achievement and preschool participation also has a critical impact on psychosocial trajectories, such as higher levels of employment, and decreased juvenile delinquency and child maltreatment (Reynolds et al., 2010; Reynolds et al., 2002). In sum, cognitive achievement in preschool is a critical component that directly impacts later cognitive and psychosocial outcomes.

The connection between early cognitive achievement and later outcomes is even more significant for disadvantaged populations because they are at risk for lower cognitive achievement upon school entry (Burchinal et al., 1997; Duncan & Magnuson, 2005; Pungello et al., 2009). More specifically, the typical developmental trajectory for African-American children reared in low-income families shows normal cognitive performance during infancy, which then develops into somewhat below-average cognitive performance during preschool and elementary school years (Burchinal et al., 1997). During infancy and early childhood (7-36 months) low-income children with lower cognitive and language scores have consistently lower receptive and spoken language scores, verbal abilities, and cognitive achievement scores 7 years later (Walker et al., 1994). Furthermore, below-average cognitive performance has effects on low-income African-American children past their grade school years and influences critical factors such as high school completion, highest grades completed, and incarceration by early adulthood (Reynolds et al., 2010). Considering that low-income African-American children are at greater risk for experiencing other negative life outcomes like depression, becoming a teen parent, or participating in criminal activity (Rouse, Brooks-Gunn, & McLanahan, 2005), it is important to look at factors that predispose children for lower cognitive achievement. This may be one avenue for the development of early interventions that can alter trajectories in a positive
way. Finding ways to eliminate the school entry gap offers an early and promising opportunity to improve life outcomes for low-income, African-American children.

**The School Entry Gap**

The substantial gap in children’s cognitive skills and educational achievement is known as the school entry gap. The school entry gap is defined as the disparities in test results between a group of children that are as large or larger than $\frac{1}{2}$ standard deviation from the mean (Rouse, Brooks-Gunn, & McLanahan, 2005). Another study defines the school entry gap as a statistically significant difference in children’s scores of school readiness that is attributed to a specific risk factor (Janus & Duku, 2007). Researchers have found that at 3 years of age, low-income African-American children have lower receptive language skills and cognitive development outcomes on average, than children from higher income families (Pungello et al., 2009). National studies show that upon entering preschool, primarily minority children of low-income status scored lower than their same aged peers in all cognitive domains, including language, literacy, and mathematics (Ayoub et al., 2009; Moiduddin et al., 2012). In some cognitive domains, for example expressive vocabulary, low-income minority children scored more than 1 standard deviation below the mean ($SS = 81$; Moiduddin et al., 2012). These results show that low-income minority children are entering preschool significantly behind their same aged peers. Historically, researchers have reported that, on average, African-American children score 1 standard deviation lower than Caucasian children on standardized intelligence tests at the age of 5 years (Brooks-Gunn, Klebanov, & Duncan, 1996). However, confounds such as socioeconomic status (SES) have been found to significantly contribute to this gap (Duncan & Magnuson, 2005).
Contributions to the school entry gap have been documented in children with different socioeconomic resources (e.g., income, maternal education, family structure, and neighborhood conditions) and were found to account for an 8-point difference in cognitive scores, which is $\frac{1}{2}$ of a standard deviation between the gap (Duncan & Magnuson, 2005). Additional family characteristics such as the number of children’s books in the home, parent involvement in literacy development, age of entry into kindergarten, birth weight, age of mother at time of birth, lone parent status, maternal smoking, and gender, as well as child and maternal health characteristics have been shown to be significant correlates of the school entry gap (Currie, 2005; Duncan & Magnuson, 2005; Janus & Duku, 2007). Children from socioeconomically disadvantaged families tend to enter school at the lower end of the school entry gap, are more likely to have poor academic outcomes (Duncan et al., 2007), and are more likely to experience a decline in academic achievement, compared to national norms (Ayoub et al., 2009; Burchinal, Roberts, Hooper, & Zeisel, 2000; Gutman, Sameroff, & Cole, 2003). Decline does not necessarily imply a loss of skills, but may reflect a slower ability to acquire cognitive skills and transition to learning new cognitive skills, resulting in lower cognitive and achievement scores while increasing the achievement gap (Burchinal et al., 2000).

Furthermore, it has been estimated that about 50% of the test score gap in 12\textsuperscript{th} grade could be attributed to the gaps that were present before children entered 1\textsuperscript{st} grade (Jencks & Phillips, 1998). For example, children who had lower cognitive achievement scores at school entry continued to decline in performance as they proceeded to high school, having lower grades and more absences as they progressed through school (Gutman et al., 2003). The significant lasting effects of the initial school entry gap on later cognitive and psychosocial outcomes is why early intervention programs like Head Start and program trials such as the High/Scope Perry
Preschool project and the Abecedarian project have been created (M. Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Schweinhart et al., 2005; Zill, Resnick, Kim, O’Donnell, & Sorongon, 2003). These programs seek to provide assistance to preschool children who have been identified as being high risk in infancy and early childhood, and therefore warrant researchers to examine what factors are contributing to differences in early cognitive achievement.

**Contributors to the School Entry Gap and Low Cognitive Achievement**

For years now, researchers have concluded that poverty is a risk factor for negative child cognitive development, such as poor cognitive performance and academic failure in children (Brooks-Gunn & Duncan, 1997; M. Burchinal, Campbell, Brayant, et al., 1997; Petterson & Albers, 2001; Pungello, Kupersmidt, Burchinal, & Patterson, 1996; Walker et al., 1994). Additionally, ethnicity and poverty are confounded, where 40% of African-American children currently live in poverty, compared to 14% of Caucasian children (U.S. Bureau of the Census, 2013). African-American children are the most represented group in poverty in the United States. Children who are reared in impoverished families are more likely to experience poor neighborhood conditions, inadequate nutrition, and fewer books and learning experiences in the home, which often leads to lower cognitive performance throughout their entire academic careers (Brooks-Gunn & Duncan, 1997; Burchinal et al., 1997; Janus & Duku, 2007; Walker et al., 1994). Additionally, family income has been found to be a mediator of some parenting behaviors, such as supportive parenting practices and time spent reading to children, and the children’s pre-reading performance (Hill, 2001). For example, stress and other parenting behaviors may be influenced by economic hardship, which in turn may lessen supportive
parenting practices and time allotted for a parent to spend with their child on cognitively stimulating materials or school related activities.

Though low-income African-American children are at risk for compromised cognitive and academic failure, many children are high cognitive and academic achievers (Brooks-Gunn & Duncan, 1997; Burchinal et al., 1997). This suggests that there are important factors of resilience at work. Furthermore, many researchers have argued against using income as a sole predictor of developmental outcomes because it doesn’t account for or explain the proximal differences in family environment and experiences in different socioeconomic groups (Brooks-Gunn & Duncan, 1997; Gershoff, Aber, Raver, & Lennon, 2007; Sameroff et al., 1993). Additional researchers argue that the analysis of family income alone is confounded by unmeasured constructs, such as material hardship (Gershoff et al., 2007), and that it is important to examine other influences besides income. Since it is more than just the low-income risk factor that contributes to poorer developmental outcomes in children, a better understanding of the risk factors that lead to cognitive development processes among low-income African-American children is needed. Additionally, Liaw and Brooks-Gunn (1994) found that multiple risk factors as a whole explained a significant proportion of variance in a child’s IQ score above family poverty. Since the literature indicates that many factors influence low-income African-American children’s cognitive development, it is important to examine how risk factors may combine as predictors of cognitive achievement in preschool aged children. This study aims to add to the current research by examining the influence of multiple risk factors on preschool cognitive outcomes based on a cumulative risk model, specifically in a low-income African-American population.
Another reason that low-income African-American children may be susceptible to poorer school readiness skills, as well as lower cognitive abilities in preschool, may be due to the finding that African America children living in poverty are exposed to environments with higher levels of psychosocial risks (McLoyd, 1990). Risk has been defined broadly as the exposure to biological and environmental conditions that can lead to negative developmental outcomes (Gerard & Buehler, 2004). As a result of poverty, children are exposed to more adversarial psychosocial and physical environmental risks such as chaos in the home, family stress and turmoil, polluted air, dangerous and deteriorated neighborhoods, and loud or crowded living conditions (Evans, 2004). Specifically, one study found that impoverished African-American children had been exposed to more risk factors than children in the overall population, where 94% of African-American children were exposed to at least one risk factor and 39% were exposed to three or more risk factors (Stanton-Chapman et al., 2004). In another study of primarily African-American urban, low-income children, 57% of children had experienced a biological birth risk, and an overwhelming number of children experienced two or more risks (Rouse & Fantuzzo, 2009). As shown, in the context of poverty, African-American children are experiencing a disproportionate number of risks, which may lead to negative developmental outcomes.

As a result of the exposure to multiple risks early in life, significant delays in cognitive performance can develop. The multiple risks associated with poverty have harmful effects on children’s physical, social-emotional, and cognitive development (Evans, 2004). These delays can been seen as early as 3 months of age and continue to increase as the child gets older (Laucht et al., 1997). Typically, children with multiple risks are already susceptible to cognitive deficits by the time they reach preschool age. Multiple socioeconomic, family, and child health variables
have all been found to contribute to cognitive abilities and school readiness by the time children are enrolled in preschool (Janus & Duku, 2007; Whittaker et al., 2011). Exposure to multiple risks contributes to lower cognitive skills, which in turn begins to solidify the gap in school readiness and achievement. Consistent with previous literature, preschool children from low-income backgrounds perform below average on receptive vocabulary tests, like the Peabody Picture Vocabulary Test (PPVT-4; Allison, Robinson, Hennington, & Bettagere, 2011). This is important because receptive vocabulary relates to processing and understanding words, instructions, questions, and concepts. The lower skillset in receptive vocabulary can be seen in the classroom when children show an inability to follow directions, provide accurate or appropriate responses, remember verbal information, or attend to spoken language. Considering the detrimental effect of multiple risks on early child development, it is important to examine how risk factors combine to influence child development, which may be an important method for identifying children in need of intervention services.

**Cumulative Risk**

Researchers report that there are a number of risk factors consistently found to relate to children’s development (e.g., child race/ethnicity, family social class, child health, maternal mental health; Candelaria et al., 2006). One way to study the effects of these multiple risk factors on children’s development is through the use of the cumulative risk model. The basic premise of the cumulative risk model is that negative developmental outcomes are the result of a combination of risks, rather than a single risk factor (Rutter, 1979; Sameroff et al., 1993). In other words, negative developmental outcomes in children are not a function of any one risk factor, but the accumulation or number of risk factors a child is exposed to. The number of risks, regardless of the type of stressor, increases the likelihood of these negative outcomes (Stanton-
Chapman et al., 2004). Therefore, researchers often use the cumulative risk model by combining the absence or presence of multiple risks to create a cumulative risk index, which is used as a single predictor for the outcome measure. A number of cumulative risk factors have been used in previous research such as the presence of maternal mental illness, high levels of maternal distress, large family size, poor family functioning, poor quality of the home environment, minority status, father’s absence in the home, family income at or below poverty, and high school drop-out status (Dickstein et al., 1998; Sameroff et al., 1993).

One of the first studies to apply the cumulative risk model to cognitive outcomes was done by Sameroff et al. (1993). This study examined the relationship between multiple social and family risk factors and child developmental outcomes. Instead of looking at socioeconomic status as a sole predictor of IQ scores, the researchers examined the influence of multiple social and family risk factors on child developmental outcomes. The researchers used 10 risk factors to create their cumulative risk variable (maternal anxiety, maternal mental health, maternal level of education, absence of father, family size, major stressful life events, occupation of head of household, and minority status). With these variables, Sameroff et al. (1993) were able to account for 34% of the variance in children’s IQ at 4 years of age, and 37% of the variance at 13 years of age. Their results found that as children’s number of experienced risks increased, their IQ scores deceased. Additionally, the authors concluded that for children with multiple risks, regardless of race and socioeconomic status, the total amount of risks were more important than any one risk by itself.

Researchers have used the cumulative risk model to measure a number of other outcomes. An early study used the cumulative risk model to examine the effect of multiple family risk factors on child psychiatric disorders (Rutter, 1979). Cumulative risk has also been
used to examine its impact on marital functioning, parent-child levels of family functioning and whole family functioning (Dickstein et al., 1998). In general, researchers have found that cumulative social and family risk factors, measured by items such as maternal mental illness, large family size, poor family functioning, poor quality of the home environment, and low income status were significantly associated with all measures of family functioning (Dickstein et al., 1998). Dickstein et al. also found that the cumulative risk model was more predictive of outcomes than maternal mental illness alone, which is consistent with the idea that cumulative risk is a stronger predictor than any one factor alone (Rutter, 1979; Sameroff et al., 1993).

Cumulative risk models have also been applied longitudinally to measure long-term effects of multiple risks from childhood into adolescence or early adulthood. Appleyard, Egeland, van Dulmen, and Sroufe (2005), for example, examined the effects of cumulative risk over time in a longitudinal study on behavioral outcomes in adolescence. Starting at the child’s birth, the researchers collected surveys and observational data related to child maltreatment, inter-parental violence, family disruption, low socioeconomic status, and high parental stress. Their findings supported the cumulative risk model, showing that the number of risks experienced in early childhood contributed to an increase in reported behavioral problems in adolescence. The cumulative risk model has also been used longitudinally in a population of adolescents into young adulthood, findings indicated that the increase in family risk factors and psychosocial adjustment of the adolescents lead to internalizing and externalizing problems later in early adulthood (Forehand, Biggar, & Kotchick, 1998). This study shows that earlier exposure to cumulative risk can also sometimes have long-term effects on children’s adjustment, even when immediate problems are not apparent.
Some recent empirical studies have also begun to examine cumulative risk factors and their relationship to children’s cognitive, motor, and social-emotional development outcomes (Candelaria, O’Connell, & Teti, 2006; Moiduddin et al., 2012; Rouse, Fantuzzo, & LeBoeuf, 2011; Rouse & Fantuzzo, 2009; Stanton-Chapman et al., 2004). For example, neonatal cumulative psychosocial and medical risks were predictive of infant cognitive and motor development a 4 months of age (Candelaria et al., 2006a). Additionally, early childhood risk factors (birth risk, poverty, maltreatment, homelessness, low-maternal education) were examined in relation to academic and behavioral outcomes in 2nd grade children (Rouse & Fantuzzo, 2009). In accordance with the cumulative risk model, as the number of cumulative risk factors increased, the reading scores at second grade decreased. Rouse and Fantuzzo found that regardless of the type of risk, each additional risk that the child had experienced contributed to a significant increase in the odds of having lower reading achievement scores. Furthermore, in a study with low-income 3rd graders, the authors found that the accumulation of psychosocial and maternal risks increased the likelihood of math and reading deficiencies, as well as poorer classroom conduct and truancy (Rouse et al., 2011). In another study, Pungello et al. (1996) found a relationship between cumulative risk in childhood and math achievement outcomes in school-aged children. Because having one risk factor increases the likelihood that a person is exposed to multiple risks (Stevens, 2006), these studies are able to capture a more realistic picture of many children’s lives. The cumulative risk model also helps to explain why not all children in poverty have negative developmental outcomes, which is possibly due to the presence or absence of a certain number of risks (Liaw & Brooks-Gunn, 1994).

In sum, research demonstrates that cumulative psychosocial and environmental risks have negative effects on children’s development (e.g., Appleyard et al., 2005; Candelaria et al., 2006;
Forehand et al., 1998; Moiduddin et al., 2012). Although the specific cumulative risk variables tend to vary across studies, the general consensus in the literature is that the additive effect of risks is more detrimental than any one factor alone. One limitation in the literature that this study aims to address is that African-American children are underrepresented in most cumulative risk studies. Many studies do not include any, or have minimal, African-American children in their sample (Appleyard et al., 2005; Forehand et al., 1998; Stevens, 2006). Some studies do include African-American children, but they only represent about 50 to 60% of their sample (Liaw & Brooks-Gunn, 1994; Rouse et al., 2011; Rouse & Fantuzzo, 2009). However, even though African-American families are exposed to a significantly higher number of risks (Deater-Deckard, Dodge, Bates, & Pettit, 1998; McLoyd, 1990), no studies have looked at the effects of cumulative risks on just African-American children. Additionally, some researchers report that cumulative risk in African-American children has resulted in different findings than in Caucasian children. In a study by Sameroff et al. (1993), the significant effects of cumulative risk on child’s IQ were seen in both African-American and Caucasian children at 13 years of age, but these effects were only seen in Caucasian children at 4 years of age. In this study, the effects of cumulative risk were not seen in African-American at age 4 because their IQ scores were unilaterally low (Sameroff et al., 1993). Additional studies have also reported differences in cumulative risk outcomes on externalizing behaviors and conduct problems between African-American and Caucasian children and adolescents (Deater-Deckard et al., 1998; Gerard & Buehler, 2004), suggesting that the developmental process through which cumulative psychosocial risks affects externalizing behaviors may be different between the two groups. It is important to examine these processes within a low-income, African-American sample to more fully understand the processes at work within this population.
Categories of Risk in the Cumulative Risk Model

Researchers examining cumulative risks have begun to divide risk factors into specific categories: infant birth risks, family- psychosocial risks, and maternal risks are among these categories. Children who experience both biological risks and exposure to psychosocial risks have greater developmental problems in childhood, and are found to have the strongest developmental delays as compared to children exposed to just one risk category or the other (Laucht et al., 1997; Rouse, Fantuzzo, & LeBoeuf, 2011). Research shows that with combined infant biological and psychosocial risk factors, the developmental lag in IQ is more than 1 standard deviation below the mean at preschool age (Laucht et al., 1997; Liaw & Brooks-Gunn, 1994). This developmental lag in IQ was also found when examining maternal risk factors, such as low maternal education, unemployment, and a less cognitively stimulating environment (Ayoub et al., 2009). In particular, as low-income children experienced more maternal risks, their cognitive performance scores were significantly lower than the average preschooler by 3 years of age (Ayoub et al., 2009). Additionally, when looking at cumulative risks, maternal education and health related risk factors in children made a substantial contribution to lower achievement in reading and mathematics by grade 3 (Rouse, Fantuzzo, & LeBoeuf, 2011).

Though the literature has begun to acknowledge that multiple categories of risk are interrelated, few studies have examined both infant birth risk and maternal risk in relation to preschool cognitive outcomes (Candelaria et al., 2006a; Liaw & Brooks-Gunn, 1994; Perry & Fantuzzo, 2010). Additionally, none of these studies have included maternal physical health variables. Specific infant biological and maternal risks that have been previously found to correlate with preschoolers’ cognitive outcomes will be described in more detail below.
**Child biological birth risk correlates of cognitive outcomes.** Numerous research studies have discovered that infant biological birth risk factors, including prematurity, low birth weight and pre-, peri- and neonatal complications such as chronic illness, cerebral damage, and asphyxia, contribute to cognitive deficits in preschool-age children (Laucht et al., 1997; Liaw & Brooks-Gunn, 1994; Rouse & Fantuzzo, 2009; Rouse et al., 2011). Specifically, in the Head Start population it has been found that children are, on average, exposed to more biological birth risk factors than children in the overall population, with 97% of samples exposed to at least one biological birth risk factor (Janus & Duku, 2007; Whittaker et al., 2011). In several research studies, the most well documented biological birth risks are low birth weight and preterm birth (Laucht et al., 1997; Liaw & Brooks-Gunn, 1994; Rouse & Fantuzzo, 2009; Rouse et al., 2011; Stanton-Chapman et al., 2004). Both will be described separately below.

**Low birth weight.** In 2013, 8.02% of all births nationally were of children born with a low birth weight, defined as at or below 5.5lbs (2500g). In African-American populations, the rate of low birth weight has been reported to be 13.27% (Hamilton, Martin, Osterman, & Curtin, 2014). Low birth weight is a biological birth risk factor that puts children at risk for neurodevelopmental problems and is a significant contributor to lower cognitive outcomes in children (Candelaria, O’Connell, & Teti, 2006). Specifically, low birth weight has been found to correlate with lower language development (Pike, Iervolino, Eley, Price, & Plomin, 2006) and delays in mathematic and reading achievement (McCormick et al., 2006). When combined with multiple risks, low birth weight is also a significant contributor to lower IQ scores in preschool aged children (Liaw & Brooks-Gunn, 1994). Not only is low birth weight considered to be a direct correlate of lower cognitive outcomes, but it may also decrease a child’s resiliency when faced with other risk factors that have been known to contribute to lower cognitive scores. For
example, in a study examining children who had low birth weights, having a stressed mother was found to contribute to lower IQ scores (Stanton-Chapman et al., 2004). Thus, being born with a low birth weight can cause children to be even more susceptible to cognitive delays when faced with additional risks.

**Preterm birth.** Urban, African-American, low-income mothers are the most at risk group for premature birth, defined as a birth that is 21 days (3 weeks) early. In 2013, the national rate for preterm births was 11.38%, where in African-American women it was 16.2% (Hamilton et al., 2014). Preterm birth has been associated with delayed cognitive and motor development in young children (Candelaria et al., 2006; Liaw & Brooks-Gunn, 1994; Rouse et al., 2011; Stanton-Chapman et al., 2004) and disproportionally contributes to the number of children with developmental disabilities (Sesma & Georgieff, 2003). Specifically, preterm infants have been found to have lower IQ’s at preschool age than children who were born full term (Liaw & Brooks-Gunn, 1994). When examining the effects of preterm birth within a cumulative medical and psychosocial risk model, prematurity was found to have a negative effect on mental and motor development in urban, low-income children (Rouse & Fantuzzo, 2009; Rouse et al., 2011). These findings demonstrate that developmental success is compromised at birth and within the context of being born in a high-risk environment, highlighting the need for family intervention services to reduce psychosocial risks early in children’s lives. However, past literature has not looked at child birth risks along with maternal health variables within a cumulative risk model, this study aims to address that gap in the literature.

**Maternal correlates of cognitive outcomes.** Many authors suggest that having a sensitive, warm, responsive parent and a cognitively stimulating home environment is linked positively to children’s cognitive outcomes and school readiness (Ayoub et al., 2009; Downer &
This research demonstrates the significant role that parents play in their child’s development. Additionally, literature has also shown that children growing up with fragile or unstable families, that provide low maternal support, are at risk for poorer academic achievement and mental processing scores (Perry & Fantuzzo, 2010; Waldfogel et al., 2010).

Since children are better able to learn cognitive skills when they feel they are emotionally safe and have stimulating toys and interactions (Ayoub et al., 2009), one could conclude that maternal risk factors would contribute to the amount of safety and stimulation a child is exposed to in their early years of life. Research has also identified a reciprocal relationship to responsiveness, whereby responsiveness provided by early caregivers increases child responsiveness, which in turn, affects caregivers’ reactions to the child. This leads to more adult-child interactions, which has been found to ultimately enrich development (Slykerman et al., 2005). These research studies show that there are many potential obstacles influencing parent-child interactions, which could be detrimental to a child’s development. This highlights the need to understand the extent and nature of family and parental influences on early child cognitive development. Some of the most cited maternal correlates of poorer child outcomes are low maternal education, maternal depression, single motherhood, maternal unemployment, teenage motherhood, and maternal health/illness (Ayoub et al., 2009; Perry & Fantuzzo, 2010; Slykerman et al., 2005; Waldfogel et al., 2010). All six will be described below.

Maternal depression. Maternal depression has been linked to significant negative effects on cognitive and motor development in preschool aged children (Liaw & Brooks-Gunn, 1994; Perry & Fantuzzo, 2010; Petterson & Albers, 2001). Maternal psychological well-being has also frequently been cited as an important predictor of parenting practices, contributing to child
cognitive outcomes (Mistry, Biesanz, Chien, Howes, & Benner, 2008). For example, maternal reports of moderate and severe depressive symptoms have been found to have significant adverse effects on cognitive and motor development in children ages 28 to 50 months (Petterson & Albers, 2001). Mothers with higher levels of depression symptomology have been reported to have more aggravated and less patient and nurturing parenting patterns, which in turn, has led to lower cognitive skills in preschool-age children (Petterson & Albers, 2001). In addition, it has been hypothesized that depressed mothers may be less likely to provide a stimulating environment and the nurturance necessary for positive child development (Ayoub et al., 2009; Stevens, 2006). When looking specifically at a low-income sample, LaForett and Mendez (2010) reported that 40% of mothers reported being sometimes or chronically depressed over the course of the year that their child was enrolled a Head Start program. Similarly, compared to the mothers who did not report feeling depressed, mothers who either sometimes or always felt depressed were found to be less involved with their child pertaining to in-home and school-based activities. These findings highlight the effects of maternal psychological-wellbeing on children’s development, especially in the population of interest in this study, low-income families.

**Maternal health/illness.** Overall, maternal health has been shown to have a larger influence on racial disparities and the gap in child school readiness than most children’s health conditions (Currie, 2005). In a general population of German children and adolescents (ages 4-18 years), having a parent with a physical illness was twice as common as having a parent with a mental illness (Barkmann, Romer, Watson, & Schulte-Markwort, 2007). Mothers with other risk factors, such as being young, unmarried, less educated or of a minority group, reported to have significantly more depressive symptoms and fair or poor health. Additionally, in one study, women who had children and described themselves as low SES had an 80% greater risk of poor
or fair health (Kahn, Wise, Kennedy, & Kawachi, 2000). Maternal illness or health problems have also been shown to have significant negative effects on child development, specifically, cognitive, emotional, and behavioral development (Anderson & Hammen, 1993; Barkmann et al., 2007; Pike et al., 2006). In a study of 4-year-old twins from the Twins Early Development Study (TEDS), a study following all twins born in England and Whales between 1994-1996, including maternal medical problems within a cumulative risk model resulted in significant negative correlations with cognitive outcomes and very strong positive correlations with problem behavior (Pike et al., 2006). Having a parent with a physical illness at 4 years of age and in childhood was also associated with higher levels of psychosocial maladjustment in males, and later in adolescence, psychosocial maladjustment was more commonly seen in females as well (Barkmann et al., 2007). Some of this maladjustment in children is presumed to be a function of secondary illness-related stressors, such as family role changes, financial issues, and fears towards the future and the caregiver (Barkmann et al., 2007). Furthermore, poor academic performance, behavior problems, and issues of social competence are also found in school-aged children of medically ill mothers (Anderson & Hammen, 1993). Maternal health and illness has been shown to have lasting effects on development independently and when examined within a cumulative risk model of family factors. Forehand, Biggar, and Kotchick (1998), for example, found maternal physical health problems to be one of the factors that was associated with lower academic achievement (measured by GPA and highest grade completed) in adolescents and early adulthood, indicating an important influence of maternal health and illness on children’s academic and cognitive performance.

Socio-demographic risk variables. There are a number of variables described in the literature as demographic factors or individual characteristics of the parent. These socio-
demographic risk factors are thought to account for or interact with other risk factors to influence developmental outcomes (Zelazo et al., 2006). Some of the socio-demographic risk factors commonly discussed in the literature that have been noted earlier are described below.

**Low maternal education.** Maternal education has been found to be one of the strongest predictors of cognitive outcomes in children (Laucht et al., 1997; Perry & Fantuzzo, 2010). Specifically, having a mother with a high school, GED, or less than a high school education is one of the risk factors that contributes to a deficit in cognitive skills for children between 14-36 months, resulting in lower cognitive scores at preschool age. Additionally, low maternal education has contributed to poorer school readiness at preschool age, and lower cognitive performance in reading and mathematics achievement outcomes in urban, low-income, 3rd grade students (Connell & Prinz, 2002; Pungello et al., 2009; Rouse et al., 2011). When examined in a cumulative risk model, low maternal education has also been reported to contribute to poorer cognitive outcomes in preschool aged children (Liaw & Brooks-Gunn, 1994). Maternal education has also been reported to be one of the strongest predictors of socioeconomic status, which in turn, has a mediating effect on lower cognitive outcomes in young children (Connell & Prinz, 2002; Pungello et al., 2009; Rouse et al., 2011), possibly resulting in less access to cognitively stimulating and age-appropriate child materials. Overall, maternal education has been found to have direct and indirect effects on children’s cognitive development, highlighting the necessity to examine its influence in research.

**Single motherhood or cohabiting families.** Growing up in a single mother or cohabiting family home has a negative impact on cognitive development, especially in comparison to children from married families (Waldfogel et al., 2010). One of the main reasons for this assertion is that single parent or cohabiting homes have often been associated with less financial
and time resources, as well as instability within the home, which have been found to be essential for child development (Sarsour et al., 2011; Waldfogel et al., 2010). However, single motherhood has been reported to be a stronger predictor of cognitive outcomes than income alone, indicating the importance of family structure on children’s development. For children who are already exposed to other risk factors, the addition of single motherhood or a “broken family,” has been found to increase the likelihood of vulnerability to school readiness problems in young children (Janus & Duku, 2007). Furthermore, infants of non-married and single mothers are more likely to have risk profiles that result in lower executive functioning performance, specifically inhibitory control and cognitive flexibility, by the time they reach school-age (Janus & Duku, 2007). This emphasizes the effects of the family environment, including single motherhood and non-married, cohabiting families, on lasting learning and developmental deficits starting from infancy into elementary school ages.

**Maternal unemployment.** Maternal unemployment is related to a number of negative outcomes in preschool aged children, such as lower scores in cognitive achievement measured by knowledge acquisition and receptive vocabulary, poorer pro-social expressive skills, and an increase in internalizing behaviors (Perry & Fantuzzo, 2010). Unemployment also has been shown to have lasting effects throughout development. Sameroff, Seifer, Baldwin, and Baldwin (1993) reported that parental unemployment was significantly related to lower IQ scores in children when they were 4-years-old and again when they were 13-years-old. Additionally, maternal employment has been found to have positive effects on child development. In a study of low-income African-American and Hispanic families, early maternal employment (employment within the first 2 years following childbirth) was related to enhanced emotional and behavioral
functioning in children at 7 years of age (Coley & Lombardi, 2012). This highlights the effects of maternal unemployment on child developmental outcomes.

**Teenage motherhood.** One in five African-American or Hispanic children are born to a teenage mother, which is reportedly twice the rate of Caucasian children (Duncan & Magnuson, 2005). Lower cognitive scores and poorer pro-social skills in preschool aged children are associated with the mother’s age at birth of her child (Laucht et al., 1997; Perry & Fantuzzo, 2010). Moreover, in comparison to children of adult mothers, children of teenage mothers reportedly have lower cognitive scores, smaller head circumferences, higher body mass indexes (BMI) by age 6 years (Cornelius et al., 2009) and lower math and reading scores at 9 years of age (Rouse et al., 2011). In addition to the direct effects young motherhood has on development, being a teenage mother may contribute to overall quality in parenting, or a type of parenting style that results in poorer overall outcomes for their children (Cornelius et al., 2009; McGroder, 2000). For example, parenting behaviors such as supporting the child during play in early infancy and toddlerhood, are influenced by maternal age, and in turn, affect cognitive and language abilities (Rafferty, Griffin, & Lodise, 2011). Additionally, mothers who were classified as “Aggravated but Nurturant” in their parenting style, meaning that the mothers scored high in aggravation and stress in parenting, but also scored high in maternal warmth and responsiveness, exhibited a profile of risks including an increased external locus of control, more depressive symptoms, having been a teen mother, and having been on welfare for a longer duration (McGroder, 2000). This parenting style resulted in lower scores of cognitive school readiness, verbal ability, and decreased social competence/maturity in their preschool children.
Goals of the Current Study

In sum, the literature clearly shows that cumulative family, psychosocial, and environmental risk factors contribute to an increase in poor outcomes in individuals in early childhood through early adulthood (Appleyard et al., 2005; Connell & Prinz, 2002; Forehand et al., 1998). Some research studies have begun to investigate cumulative risk in relation to poverty (Janus & Duku, 2007), but few studies have examined the variability of risk factors within a low-income, African-American population, especially in relation to variability in infant biological health and maternal risk factors (Ayoub et al., 2009; Candelaria et al., 2006; Liaw & Brooks-Gunn, 1994; Sameroff, 2000; Sameroff et al., 1993; Stevens, 2006). Since past literature has established that low-income, African-American children are at higher risk for lower cognitive achievement scores, and that maternal and infant biological risks also contribute to delays in cognitive development, it is important to examine how multiple risks contribute to lower cognitive scores in this group. Currently, only one known study has looked at the variability of maternal risks and their relationship to cognitive outcomes in preschoolers within a low-income population (Perry & Fantuzzo, 2010). However in this study, infant birth risks were not examined as individual predictors of cognitive outcomes, maternal health risks were not included in the analyses, and the risks were not looked at in the context of a cumulative risk model. Furthermore, this study was not solely conducted with a low-income African-American population.

The proposed research study aims to address these gaps in the literature by examining the effects of cumulative infant biological and cumulative maternal risks on low-income, African-American preschooler’s cognitive outcomes. This study will contribute to the current developmental and early childhood literature by examining the individual and joint impact of
cumulative birth and maternal risk factors on the cognitive development of urban, low-income, African-American children, which is an understudied population. Results from this study will provide additional information about how cumulative risk factors affect cognitive outcomes in this population and may further explain what risk factors contribute to the school achievement gap, which will provide future insight towards intervention programs that aim to address developmental risks.

**Hypotheses**

The current research study examined children’s cognitive outcomes in relation to early cumulative risk exposure in a low-income, African-American preschool population. Specifically, the current study sought to explore the relationship between cumulative infant biological and maternal risks on children’s cognitive outcomes in preschool. There were two primary aims, 1) to examine the impact of infant and maternal risk individually and 2) to examine the interaction between infant and maternal risk. Three major hypotheses are proposed to examine these relationships.

*Hypothesis 1:* Consistent with the cumulative risk model, it is expected that children with a higher number of biological birth risk factors will have poorer overall cognitive scores.

*Hypothesis 2:* It is hypothesized that children with a higher number of maternal health and socio-demographic risk factors will have poorer overall cognitive scores.

*Hypothesis 3:* It is hypothesized that the combined effects of the cumulative infant birth risks and the cumulative maternal risks will be multiplicative rather than additive, such that the impact of each cumulative risk index is worse when the other one is present.
Methods

Participants

The sample for the current study was drawn from a larger dataset of mothers and children enrolled in Head Start. As more fully described below, participants were part of a larger, 2-phase Maternal and Child Health Study. The larger study focused on examining the influence of maternal health related variables on low-income African-American children’s cognitive development. Phase 1 of the larger study included 337 participants and phase 2 consisted of 202 participants. Data from phase 2 will be used for the current study because cognitive assessments were administered at that time. Therefore, the sample will consist of 202 biological mother-child pairs. The sample that was used for the current study consisted of 197 (97%) African-American mothers and children and 5 (3%) mothers and children self-identified as multiracial or Hispanic. The mother’s ages ranged from 18 to 52 years (mean age = 29.1 years, $SD = 6.5$). All children were between the preschool ages of 3-5 years, with a mean age of 45.4 months ($SD = 6.7$ months) and their genders were relatively equal (Male = 50.4%, Female = 49.6%). For the mothers in this sample, 73% reported that they were single, 19% were married, 5% were living with a partner, and 3% were divorced. Additionally, 67% of the population sampled had an annual income of below $15,000 a year, with 31.8% reporting an annual income of less than $5,000.

Procedure

The first phase of the study took place at the beginning of the 2007-2008 school year. During the first phase of the study, mothers filled out a child and family questionnaire that included demographic information, maternal history of smoking and substance use during pregnancy, a measure of depression, and one about general attitudes about parenting.
Additionally, mothers completed a health related questionnaire about their child who was currently enrolled in Head Start. If the mother had more than one child participating in Head Start at that point in time, the mother was asked to choose the older child for this survey. This took approximately 30 minutes to administer, and mothers were paid $10 upon completion of the survey.

In the second phase of the study, both the mother and child participated in data collection. This phase took place towards the end of the 2007-2008 school year. From those who participated in the first phase, 202 mother-child pairs were randomly selected to complete a number of more intensive measures. Individual parent meetings were set up to administer the measures to the mothers, and children were assessed during class time, with the mothers’ permission. During phase 2, mothers completed the same measures as those listed above and additionally completed a screening measure of her own intelligence. The children in this phase completed a cognitive assessment measure. Overall, phase 2 took approximately 45 minutes of the mother’s time and 40 minutes of the child’s time. The specific measures collected relevant to the current study are described below. Participants were paid $40 for the completion of phase-2.

Measures

Cognitive outcome. *Wechsler Preschool and Primary Scale of Intelligence- Third Edition (WPPSI-III).* To assess children’s current cognitive skills, the WPSSI-III was administered. The WPSSI-III is a clinical instrument that assesses intellectual ability in children ages 2 years 6 months, through 7 years 3 months. The scoring of the WPSSI-III yields a composite score that represents a general intelligence quotient (Full Scale IQ), which is further composed of two cognitive domains, Verbal and Performance IQ. The administration of the WPSSI-III has been divided into two age brackets, 2 years 6 months to 3 years 11 months, and 4
years 0 months to 7 years 3 months, with some subtests overlapping between the different age groups. The Full Scale IQ (FSIQ) score is composed of a sum of subtest scaled scores, which are scaled to a mean of 100 and a standard deviation of 15, with a range (99.9% of all children) of scores between 55 and 145 (Wechsler, 2002). A score of 100 indicates an average score whereas scores of 85 and 115 are one standard deviation below and above the mean respectively. For the younger age group, there are 4 core subtests that make up two indices, which contributes to the FSIQ; for the older age group, there are 7 subtests that make up 4 indices, which contributes to the FSIQ. Reliability data on the WPPSI-III (Wechsler, 2002) show the Full Scale to have significant internal consistency (α = .96). In addition, the subtests have all been found to have excellent reliability (Verbal α = .95, Performance α = .93, Processing Speed α = .89). The total scores were found to be stable across a test-retest interval of 26 days (Full r = .92, Verbal r = .91, Performance r = .86, Processing Speed r = .90). In addition, when studied in a population of children with multiple risk factors who were expected to have lower scores than a control group of children, the WPPSI-III successfully discriminated between children with multiple developmental risk factors and the control group, based on subtest and composite scores (Wechsler, 2002).

In this study, a shortened version of the WPPSI-III was used, by administering 4 subtests to all children. Shortened cognitive tests are often used in research to save time in administration while giving a reliable estimate of overall cognitive ability. Literature has found short versions of the WPPSI, as well as other Wechsler cognitive measures such as the Wechsler Adult Intelligence Scale (WAIS), to be a valid measure of overall intelligence, and scores correlate highly with full version scores (Crawford, Allum, & Kinion, 2008; LoBello, 1991; Tellegen & Briggs, 1967; Tsushima, 1994). In a previous version of the test (WPPSI-R), a shortened version
was created using 4 subtests as well. The 4 scales included were the Comprehension and Arithmetic subtests from the Verbal scale and the Block Design and Picture Completion subtests from the Performance scale (LoBello, 1991). LoBello (1991) showed that a 4 subtest short form of the WPPSI-R had consistent reliability, validity, and standard error estimates compared to the full WPPSI-R. An additional study found similar results, suggesting that a shortened version of the WPPSI may be a reliable substitute for the full WPPSI version, especially when there are time constraints or when conducted for research purposes (Tsushima, 1994). Previous research has shown that when using a short form, the FSIQ score is more reliable than the Verbal or Performance scale scores alone (Crawford, Johnson, Mychalkiw, & Moore, 1997).

In this proposed study, the 4 subtests that were given to all children, measured both the Performance IQ (Block Design and Object Assembly) and Verbal IQ (Information and Picture Naming). Picture Naming is a supplemental subtest, however it can reliably replace Receptive Vocabulary in calculating a composite Verbal IQ score (Wechsler, 2002). The choice of these 4 subtests allowed for consistency of subtest inclusion across age groups and a range of verbal and performance tests. Using an abbreviated form of the WPPSI-III cut the administration of the assessment down to approximately 30-45 minutes per child.

Scoring of the Full Scale IQ was calculated from the short form WPPSI-III using Tellegen and Briggs’ (1967) method of linear equating. In this method, the sums of the scaled scores are calculated into standard composite scores. The composite scores are then turned into a Deviation Quotient (DQ), which is a measure of IQ ($M=100$, $SD=15$). The formula for calculating the IQ is: $DQ = \frac{15}{Sc} (X_c - M_c) + 100$. In this equation, $Sc$ is the standard deviation of the composite scores, and $(X_c - M_c)$ is the sum of the subscale scores, minus the mean score for the subtests. This method has successfully been used in other short forms of Wechsler tests.
and is considered the preferred method for scoring short form assessments (Crawford et al., 2008; LoBello, 1991; Tsushima, 1994).

**Risk factors/independent variables. Infant birth risk.** Information for infant birth risks was obtained using the Child and Family Questionnaire, which was developed by the Principal Investigator of the larger study. This questionnaire included demographic information about the mother and child and was administered to the mother. Two questions pertaining to infant biological risk were asked, including what the birth weight of the child was and whether or not the child was born early, on time, or late. Children who weighed less than 5.5lbs at birth (2500g) are considered to have low birth weights, and were therefore, considered to have the presence of a biological birth risk. Children whose mother reported that they were born early were considered at risk. A cumulative risk index was created from these two risk factors resulting in an index that ranged from 0-2.

**Maternal risk.** Maternal risk consisted of multiple risk factors that included socio-demographic risks and mental/physical health risks. The sum of these risks were used to compute the overall cumulative risk index for mothers. The maternal risk index was made up of 7 variables resulting in a possible risk index score that ranged between 0-7.

**Maternal socio-demographic risks.** Information on socio-demographic risks were obtained using the Child and Family Questionnaire created for the larger study. Mothers answered single items pertaining to the following socio-demographic risks: maternal education, single motherhood, maternal unemployment and teenage motherhood. All of the socio-demographic variables were evaluated for absence or presence of risk and dichotomized to scores of 0 or 1, respectively. Based on previous risk literature (Coley & Lombardi, 2012; Cornelius et al., 2009; Duncan & Magnuson, 2005; Janus & Duku, 2007; Laucht et al., 1997;
McGroder, 2000; Perry & Fantuzzo, 2010; Rouse et al., 2011; A. Sameroff et al., 1993; Sarsour et al., 2011; Waldfogel et al., 2010) high school completion or lower, being a single mother or in a cohabiting family, being unemployed and having been a teenage mother were considered for the presence of a risk and scored a “1.”

*Maternal health.* Maternal health risks included a measure of maternal depressive symptomology and physical health. These were added to the above-described socio-demographic risk variables to calculate “maternal cumulative risk.”

*Maternal depression.* Maternal Depression was assessed using the *Centers for Epidemiological Studies Depression Scale (CESD-10, Andresen, Malmgren, Carter, & Patrick, 1994; Radloff, 1977).* The CES-D is a 10-item scale designed to measure self-reported depression symptoms with an emphasis on affect and depressed mood. Specifically, the CESD-10 measures the presence and severity of depression symptoms over the past week. Responses are reported on a 4-point Likert scale (0 = *Rarely or None of the time (Less than 1 day)*, 3 = *Most or all of the time (5-7 days)*). Scores range between 0 and 30 with higher scores indicating more frequent and greater severity of depressive symptoms. The CESD-10 is a validated shortened version of the CES-D (Radloff, 1977), which has also been validated for low-income African-Americans (Nguyen, Kittner-Triolo, Evans, & Zonderman, 2004). Andresen et al. (1994) shortened the validated CES-D into 10 items and found the CESD-10 to have good predictive accuracy in comparison to the full scale (k = .97). Additionally, they found the expected positive correlation between higher CESD-10 scores and poorer health status (r = .37) and a negative correlation between CESD-10 scores and positive affect (r = -.63). Good test-retest reliability was also established with a stable correlation (r = .59) after 12 months between the two testing periods. This scale correlates highly with other depression scales such as the Sung scale (r = .90)
and the Beck Depression Inventory \( r = .81 \); Myers & Weissman, 1980). A score of \( \geq 10 \) is indicative of clinically significant depressive symptoms and was, therefore, used as the risk cut off score, with those scoring at or above 10 on the CES-D receiving a score of “1.”

*Maternal physical health.* Mothers’ physical health was assessed from 2 items administered on the Child and Family Questionnaire. As part of the larger study’s survey assessment, mothers were asked if they had a current illness or medical condition and to rate their overall physical health. The presence of any medical condition was coded with a “1” to indicate presence of a maternal health risk. Overall physical health was rated on a Likert scale including the following points: *excellent* = 1, *good* = 2, *average* = 3, *poor* = 4, *extremely poor* = 5. It is anticipated that a response of “poor” or “extremely poor” will be coded as a “1” and considered to be the presence of risk.

**Data Analyses**

**Preliminary Analyses**

SPSS Statistical Software was used to conduct all analyses for the current study. Prior to the primary hypothesis testing, individual variables were screened for normality using SPSS Frequencies and Explore. Scatterplots were generated between independent and dependent variables to screen for multiple regression assumption of linearity. Cumulative risk index scores were calculated and are described more fully in the results section. Bivariate correlations were run between all individual risk variables and the cognitive outcome, as well as between the risk index scores and the cognitive outcome. The demographic characteristics of family income and child gender were considered as possible covariates. If either were significantly related to the cognitive outcome at a \( p < .02 \) level, it was controlled for in further analyses. Based on this criterion, only child gender was included in further analyses.
Hierarchical Multiple Regression

All of the hypotheses were analyzed using hierarchical multiple regression. Two separate regression analyses were conducted to test the 3 study hypotheses. The first analysis examined the main effects of infant and maternal risks allowing for the evaluation of hypotheses 1 and 2 of the current study, examining the unique contribution of infant risk and maternal risk on the cognitive outcome. A linear and quadratic term was included in this model. The linear variable assessed the additive effect of increased risk, while the quadratic term assessed the potential multiplicative effect.

A second hierarchical multiple regression analysis was conducted to test hypothesis 3 that stated that the combined effects of infant biological risk and maternal risk would be multiplicative. For the purpose of increased interpretability, only the linear effect was examined in this analysis. Child gender was controlled for in this regression analysis. A linear interaction term between infant and maternal risk was entered to assess whether the impact of the presence of both infant and maternal risk was not merely additive, but multiplicative.

Results

Preliminary Analyses

Preliminary analyses revealed that there were missing data for all 9 of the risk variables. Seventeen were missing information on maternal education status, 14 were missing information for maternal marital status, 15 were missing information on maternal illness, 14 people were missing information on maternal overall health, 15 were missing information on maternal employment status, 13 people were missing information on maternal age at child’s birth, and 14 people were missing information on maternal depression. Additionally, 13 people were missing information on the child’s birth weight, and 22 people were missing information on the child’s
delivery time. For 58 people, missing information from phase-1 was pulled from the child and family questionnaire given from the second phase of the study. Although there was an approximate 4 months time difference between phase-1 and phase-2, this was still deemed the best way of imputing missing data for these individuals since the variables being imputed were considered to be temporally stable (e.g., child’s weight at birth). Following that imputation, of the 202 participants, a total of 9 still had missing data. Child’s birth weight was missing for three participants, child’s delivery status was missing for 5 participants, maternal age at child’s birth was missing for 1 participant, and maternal employment status was missing for 1 participant. For the 2 participants that were missing a maternal risk variable, individual variable imputation was not used. Rather, a sum of scores was calculated to create their final risk score by calculating their percent risk out of the number of risk variables they had data for and then multiplying that percent by the actual total possible of seven maternal risks. For the 7 participants who were missing an infant biological risk, listwise deletion was used. Because there was such a small number of missing data that could not be imputed through the mechanisms described above, multiple imputation was not employed.

Univariate outliers were identified on two of the model variables. Maternal depression measured with the CESD-10 had two outliers and maternal age at child’s birth had one outlier. The three outliers were Winsorized. Malhalanobis $D^2$ was used to detect multivariate outliers. A total of three multivariate outliers were detected and removed.

**Bivariate Correlations**

Bivariate correlations were run to examine the patterns of relationships between the independent variables and the dependent variable prior to creating any cumulative risk index scores. These risk variables included maternal risks such as marital status, education level,
employment status, age at child’s birth, depression, overall health, and any significant illnesses. Infant biological variables included birth weight and time of delivery (early/late). Table 1 displays correlations, means and standard deviations for the risk variables and the dependent variable prior to dichotomization. In addition to the demographic variables shown in these tables, which make up the cumulative risk variables, child gender, was also found to be significantly related to the cognitive outcome variable ($r = .20, n= 198, p = .005$); however, income was not significantly related to the cognitive outcome variable ($r = .134, n= 198, p = .06$). Therefore, child’s gender was controlled for in the regression models.

Zero order correlations showed correlations with a few of the individual risk variables and the cognitive outcome variable. Variables that were correlated with cognitive outcomes were maternal employment status, maternal marital status, maternal education level, maternal overall health, and maternal illness. Maternal employment status was negatively related to children’s cognitive scores ($p < .01$). Mothers who reported being unemployed were more likely to have children with lower cognitive scores. Maternal marital status was also negatively correlated with children’s cognitive scores ($p < .05$). Non-married mothers were more likely to have children with lower cognitive scores. Additionally, maternal education level was negatively correlated with children’s cognitive scores ($p < .01$). Mothers who had reported lower levels of education attainment had children with lower cognitive ability scores. Lastly, positive relations were found between maternal overall health, maternal illness and children’s cognitive scores ($p < .05$). This means that the presence of these risk factors were unexpectedly related to higher IQ scores. Since these variables correlated in the opposite direction and are not apparently risk factors in this sample, they were removed from the maternal cumulative risk index. Additionally, though not significantly correlated, child’s delivery time was positively related to IQ ($p = .10$). The results
of this analysis also indicates that the presence of early birth as a risk factor is related to higher IQ scores, indicating that it is also not an apparent risk for this sample and it was therefore removed from the child cumulative risk index.

Follow up analyses were conducted to examine the nature of these unexpected positive relations between maternal health problems, early child delivery time, and child IQ (see Table 1). Bivariate correlations were run to examine the patterns of relationships between these variables and other independent variables. When looking at the presence of a maternal illness, a significant positive correlation was found with maternal age ($r = .23, p < .01$), and a marginal relation was found with mother’s level of education ($r = .13, p < .10$). Mothers who reported having a significant illness reported that they were older and that they had a higher level of education. Additionally, mothers who reported poorer overall health also reported a higher level of education ($r = .15, p < .05$). As a result, this may mean that maternal age and education level were confounded with maternal health status in the current sample and served as protective factors against health related risk factors when examining their impact on children’s cognitive abilities.

The report of the child’s delivery time was also examined because of the unexpected relationship with child IQ. Child’s birth weight was not significantly correlated with any maternal or child demographic information in the current sample. It was significantly negatively correlated with child birth weight in the expected direction ($r = -.32, p < .01$). Children who were born early had lower birth weights. Though birth weight and delivery time were correlated, they did not have the same effect on child’s IQ. This suggests that the measurement of early delivery may not be an accurate measurement because it did not ask specifically if the child was born premature, it just asked if they were “born early.”
Bivariate correlations were also run to examine the patterns of relationships between the dichotomized risk variables and the dependent variable. Table 2 displays the zero order correlations for the dichotomized risk variables, the cumulative risk variables, and the dependent variable.

Using the criterion for defining a risk variable as defined in the methods section, dichotomized risk variables were created for each risk factor (0 = no risk, 1 = presence of a risk). When examining the zero order correlations for the dichotomized risk factors and the overall cumulative risks index, some significant correlations with the cognitive outcome were found. Dichotomized risk variables that were significantly correlated with the cognitive outcome were marital status, maternal employment, and maternal education level. Marital status, maternal employment, and maternal education level were all negatively correlated with child cognitive outcomes. Mothers whose reported marital status was indicated as a risk factor were more likely to have children with lower cognitive scores. Additionally, mothers who were unemployed were more likely to have lower children’s cognitive scores. Furthermore, mothers whose reported education status was considered a risk factor (e.g. high school or less) were also more likely to have lower children’s cognitive scores. The maternal cumulative risk index was negatively correlated with child cognitive scores. This indicates that the higher the number of the maternal cumulative index score, the lower the cognitive score. The infant biological risk variable was not correlated with IQ.

The Maternal Cumulative Risk index was created by summing the 5 dichotomized maternal risks (0 or 1) for each child ranging in total risks between 0 and 5. Therefore, higher cumulative risk index scores indicted the presence of more risks. Additionally, the infant biological cumulative risk index could not be calculated because there was only one risk factor.
Table 1
Zero Order Correlations, Means, and Standard Deviations among Risk Variables and IQ

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IQ</td>
<td>86.74</td>
<td>12.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Child's Gender a</td>
<td>.46</td>
<td>.5</td>
<td>.20**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maternal Marital Status b</td>
<td>.79</td>
<td>.41</td>
<td>-.17*</td>
<td>-.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Maternal Education Level c</td>
<td>1.59</td>
<td>.53</td>
<td>.19**</td>
<td>.03</td>
<td>-.18*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Maternal Employment Status d</td>
<td>2.27</td>
<td>.86</td>
<td>-.22**</td>
<td>-.01</td>
<td>-.09</td>
<td>-.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Maternal Age at Child's Birth</td>
<td>26.03</td>
<td>6.52</td>
<td>.06</td>
<td>.01</td>
<td>-.23**</td>
<td>-.06</td>
<td>-.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Maternal Depression</td>
<td>7.01</td>
<td>4.79</td>
<td>-.12</td>
<td>-.001</td>
<td>.08</td>
<td>.03</td>
<td>.03</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Maternal Overall Health</td>
<td>2.12</td>
<td>.86</td>
<td>.15*</td>
<td>-.01</td>
<td>-.01</td>
<td>.15*</td>
<td>-.13</td>
<td>.02</td>
<td>.26**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Maternal Illness</td>
<td>.22</td>
<td>.42</td>
<td>.16*</td>
<td>-.01</td>
<td>.08</td>
<td>.14</td>
<td>.02</td>
<td>.23**</td>
<td>.30**</td>
<td>-.29**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Child's birth weight</td>
<td>109.20</td>
<td>19.10</td>
<td>-.06</td>
<td>-.02</td>
<td>.05</td>
<td>.03</td>
<td>.02</td>
<td>-.01</td>
<td>-.07</td>
<td>-.10</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Time of Child's Delivery c</td>
<td>.42</td>
<td>.49</td>
<td>.12</td>
<td>.03</td>
<td>.06</td>
<td>.05</td>
<td>-.05</td>
<td>-.05</td>
<td>.02</td>
<td>-.02</td>
<td>-.05</td>
<td>.32**</td>
<td></td>
</tr>
</tbody>
</table>

* p<.05  **p<.01

a 0 = male, 1 = female.  
b 0 = married, 1 = single  
c 1 = elementary school, 2 = middle school, 3 = high school, 4 = college  
d 1 = full-time, 2 = part-time, 3 = do not work.  
e 0 = on time, 1 = early
Table 2
Zero Order Correlations for Dichotomized Risk Factors, Maternal Cumulative Risk, and IQ

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IQ</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Maternal Marital Status</td>
<td>-.17*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maternal Education Level</td>
<td>-.19**</td>
<td>.18*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Maternal Employment Status</td>
<td>-.22**</td>
<td>-.08</td>
<td>.10</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Maternal Age at Child's Birth</td>
<td>.06</td>
<td>.20**</td>
<td>.17*</td>
<td>.004</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Maternal Depression</td>
<td>-.11</td>
<td>.01</td>
<td>-.09</td>
<td>-.03</td>
<td>-.03</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Child's birth weight</td>
<td>-.05</td>
<td>.03</td>
<td>-.02</td>
<td>.03</td>
<td>.01</td>
<td>-.01</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8. Maternal Cumulative Risk Index</td>
<td>-.28**</td>
<td>.50**</td>
<td>.60**</td>
<td>.47**</td>
<td>.50**</td>
<td>.35**</td>
<td>.02**</td>
<td>-</td>
</tr>
</tbody>
</table>

* p<.05  **p<.01
Therefore, a child’s infant biological risk had a potential range from 0 to 1. The average maternal cumulative risk index score was 2.3 \((SD=1.1)\). The average infant biological risk score was .11 \((SD=.32)\). In terms of individual risks, 22 (11.3%) of the 196 participants reported having low birth weight as a risk factor. Additionally, 156 (78.8%) of the participants reported being non-married, 114 (57.6%) had an educational attainment of high school or less, 107 (54.3%) were unemployed, 33 (26.8%) were teenage mothers when their child was born, and 48 (24.2%) met criteria for depression. Of the 196 participants, 9 people had no risks (4.6%), 34 (17.3%) had 1 risk, 69 (35.2%) had 2 risks, 56 (28.6%) had 3 risks, 27 (13.8%) had 4 risks, and 1 person had (0.5%) had 5 risks.

**Regression Analyses**

All hypotheses were tested using hierarchical multiple regression. The first regression analysis was performed to test both hypothesis 1 and 2 simultaneously. Hypothesis 1 states that children with a higher number of biological birth risk factors would have poorer overall cognitive scores. Hypothesis 2 states that children with a higher number of maternal health and socio-demographic risk factors would have poorer overall cognitive scores. The regression was performed to predict child cognitive scores (IQ) using maternal cumulative risk and infant risk indices.

A hierarchical multiple regression was performed to examine the relation between linear and quadratic infant biological risk and cumulative maternal risks on child cognitive ability. One hundred and ninety-one participants were included in this analysis. Child gender was included in Step 1 of the regression because it was significantly correlated with IQ at \(p < .01\), and was therefore controlled for. At the second step, the maternal cumulative risk index and the infant biological risk score were entered simultaneously. On the third step, the maternal cumulative risk
index was entered as quadratic term. Squaring the maternal cumulative risk index variable created the quadratic term for Step 3. Table 3 summarizes the key statistics from this analysis.

At Step 1, child gender was entered into the regression equation, $R^2 = .05$, $F(1, 191) = 8.92$, $p < .01$. In this Step, child gender was a significant predictor ($\beta = .21$, $p < .01$). In Step 2, the Maternal cumulative risk index and the dichotomized child’s birth weight were entered, $R^2 = .11$, $\Delta F(3, 189) = 6.89$, $p < .001$. In this Step, child gender ($\beta = .19$, $p < .01$) and the linear maternal cumulative risk ($\beta = -.25$, $p < .001$) were significant predictors. At Step 3 the quadratic maternal cumulative risk index was added to predict cognitive ability, $R^2 = .11$, $\Delta F(4, 188) = .23$, $p = .63$. However, the only significant predictor in the model was child gender ($\beta = .18$, $p < .01$).

As can be seen in Table 3, the infant biological birth risk factor was not a significant contributor to the multiple regression model and, therefore, hypothesis 1 was not supported. Maternal cumulative risk had a significant negative relationship with IQ, indicating that children who had a higher maternal cumulative risk index scores had lower child cognitive ability scores. This supports the second hypothesis that children with a higher number of maternal health and socio-demographic risk factors will have poorer overall cognitive scores than children who have not experienced as many maternal risk factors. As a result, the model in the second step appears to be the best fit because the additional quadratic variable was not significant and therefore the model at Step 2 is more parsimonious.

Because the quadratic cumulative maternal risk index was not significant, there was no evidence of a threshold effect in these data. Therefore follow-up analyses to examine the existence of a threshold effect were not conducted.

To test the third hypothesis, which states that the combined effects of cumulative infant birth risks and cumulative maternal risks will be multiplicative rather than additive, such that the
impact of each risk cumulative risk index is worse when the other one is present, multiple regression was utilized to examine the potentially multiplicative effects of combined infant biological risk and cumulative maternal risks. Table 4 summarizes these results. One hundred and ninety-one participants were included in this analysis. Child’s gender was included in Step 1 of the regression because it was significantly correlated with IQ at \( p < .02 \). At the second step, the maternal cumulative risk index and the infant biological risk scores were entered. In Step 3, an interaction term for child birth weight and maternal cumulative risks was entered. An interaction term was created for maternal and infant risk by multiplying the maternal cumulative risk index by the child birth weight risk. The results from both Step 1 and Step 2 of this model were similar to those found in the previous regression model. In Step 3, the interaction variable was added to predict cognitive ability, \( R^2 = .33 \), \( \Delta F(4,188) = .23, p = .63 \). However, the interaction variable in Step 3 was not significant. The only significant predictors were child’s gender \((\beta = .19, p < .01)\) and the maternal cumulative risk index \((\beta = -.24, p < .01)\). This indicated that the combined multiplicative effects of infant biological and maternal risks were not significant.
Table 3

Multiple Regression of Gender, Child Birth Weight, and the Maternal Cumulative Risk Index on Cognitive Outcomes, Linear and Quadratic Analyses

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1, ( F (1, 191) = 8.92, p &lt; .01, R^2 = .045 )</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Gender</td>
<td>5.30</td>
<td>1.78</td>
<td>.21**</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2, \( F (3, 189) = 7.75, p < .001, R^2 = .110 \)** |      |     |       |      |
| Child Gender              | 4.77 | 1.73| .19*  | .07**|
| Maternal Cumulative Risk Index (Linear) | -2.94| .80 | -.25**|      |
| Child Birth Weight (Linear) | -1.73| 2.70| -.04  |      |

| **Step 3, \( F (4, 188) = 5.89, p < .01, R^2 = .111 \)** |      |     |       |      |
| Child Gender              | 4.60 | 1.75| .18*  | .002 |
| Maternal Cumulative Risk Index (Linear) | -4.64| 2.93| -.40  |      |
| Child Birth Weight (Linear) | -1.70| 2.70| -.04  |      |
| Maternal Cumulative Risk Index (Quadratic) | .37  | .62 | .15   |      |

*a = male, 1 = female.
**p < .001, *p < .01
Table 4

*Multiple Regression of Gender, the Maternal Cumulative Risk Index, and the Infant Biological Cumulative Risk Index on Cognitive Outcomes, Linear and Interaction Analysis*

<table>
<thead>
<tr>
<th>Step 1, $[F(1, 191) = 8.92, p &lt; .001, R^2 = .045]$</th>
<th>$B$</th>
<th>SE</th>
<th>Beta</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Gender$^a$</td>
<td>5.30</td>
<td>1.78</td>
<td>.21*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2, $[F(3, 189) = 7.75, p &lt; .001, R^2 = .110]$</th>
<th>$B$</th>
<th>SE</th>
<th>Beta</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Gender</td>
<td>4.77</td>
<td>1.73</td>
<td>.19*</td>
<td>.07**</td>
</tr>
<tr>
<td>Maternal Cumulative Risk Index (Linear)</td>
<td>-2.94</td>
<td>.80</td>
<td>-.25**</td>
<td></td>
</tr>
<tr>
<td>Child Birth Weight (Linear)</td>
<td>-1.73</td>
<td>2.70</td>
<td>-.04</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3, $[F(4, 188) = 5.85, p &lt; .001, R^2 = .111]$</th>
<th>$B$</th>
<th>SE</th>
<th>Beta</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Gender</td>
<td>4.60</td>
<td>1.75</td>
<td>.18*</td>
<td>.002</td>
</tr>
<tr>
<td>Maternal Cumulative Risk Index (Linear)</td>
<td>-4.64</td>
<td>2.93</td>
<td>-.40*</td>
<td></td>
</tr>
<tr>
<td>Child Birth Weight (Linear)</td>
<td>-1.70</td>
<td>2.71</td>
<td>-.04</td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>.37</td>
<td>.62</td>
<td>.15</td>
<td></td>
</tr>
</tbody>
</table>

$^a$ 0 = male, 1 = female.

**$p < .001$, $p < .01$**
Discussion

The purpose of this study was to examine the influence of maternal socio-demographic, maternal health, and infant biological risks on the cognitive abilities of low-income African-American preschool children. Specifically, this study examined the impact of these risk factors using the cumulative risk model. This study contributed to the current literature by examining the joint impact of both infant biological risk and maternal risk factors. Additionally, this study examined these relationships among urban, low-income, African-American children, who are underrepresented in cumulative risk studies.

Initial zero-order correlations revealed important findings between the risk variables and the cognitive outcome measure. Children’s cognitive abilities were significantly influenced by maternal factors such as unemployment, marital status, and lower educational attainment. Children of unemployed mothers were more likely to have lower cognitive scores. Children of mothers who were not married were more likely to perform lower on cognitive tests. Additionally, children whose mother had a high school education or lower were also more likely to have lower cognitive scores.

Surprisingly, positive correlations were found between maternal health and illness factors and child cognitive scores, indicating that the presence of these risk factors resulted in higher children’s cognitive scores. As a result, these two factors were not considered a “risk” in this sample and were, therefore, not included in the cumulative risk index. Further analysis into this unexpected relationship revealed that mothers who reported a significant illness or poorer health were more likely to be older and have higher educational attainment. This may mean that maternal age and education level served as protective factors against health related risk factors when examining their impact on children’s cognitive scores. For example, mothers who were
more educated and older may be more aware of their medical issues or may seek medical help more often, therefore lessening the burden of their medical issues through the use of medical treatment.

Another explanation for the lack of a negative relationship between maternal health and illness and child cognitive abilities may be because maternal health and illness are not directly correlated to cognitive abilities, but instead, are related to child academic performance more broadly. For example, some of the studies that examined the impact of maternal health or illness on children’s academic performance or academic achievement measured child’s academic achievement through the use of grades, overall GPA, and did not specifically look at the child’s cognitive abilities (e.g. Anderson & Hammen, 1993; Forehand et al., 1998). This suggests that though maternal health may still play a role in child cognitive achievement, it is possibly negatively impacting a different domain other than cognitive abilities (IQ). For example, children who have a parent with health problems may struggle more emotionally, or may be more distracted during the school day, and therefore, have difficulty learning the material and preforming well on academic tasks. In this situation, the maternal illness is impacting a child’s ability to learn, but it does not directly diminish their cognitive abilities (IQ). Additionally, it is possible that the items that were chosen to measure maternal health were too general and subject to the interpretation of the mothers participating in the study. In a study that found modest correlations between mothers with medical illnesses and child cognitive outcomes (Pike et al., 2006), the researchers gathered more data on maternal health to create the dichotomized “health risk” factor. Examples of health risk variables included in the study were, high blood pressure, the use of cigarettes and alcohol, prescribed bed rest during pregnancy, and complications at
birth (Pike et al., 2006). By collecting more robust information about maternal health, one may be able to better examine the impact of maternal health on children’s cognitive ability.

A marginal positive relationship was also found between early child delivery time and child cognitive scores. The results of the analysis indicated that children who were born early had higher cognitive scores, indicating that this variable was also not considered a risk for this sample, and it was therefore removed from the child cumulative risk index. Further analyses revealed that child’s time of delivery was significantly negatively correlated with birth weight in the expected direction, meaning that children born early had lower birth weights. However, in the current sample child birth weight was unrelated to the cognitive outcome. The lack of the expected finding for delivery time may also have been because the measurement of the variable was not specifically asking parents if their child was born preterm. The question simply asked if the baby was “early,” “on time,” or “late.” There was no way to determine if “early” was two days early or two weeks early, for example. Future studies should aim to collect medical record data on child’s birth weight and prematurity, as well as ask more specific questions around the child’s delivery time. In addition to the measurement error, previous studies that have reported significant findings between prematurity and lower cognitive scores also examined the impact of prematurity within the context of low birth weight (e.g., Liaw & Brooks-Gunn, 1994; Rouse et al., 2011). Since low birth weight and prematurity were also correlated in this study, it may indicate that the impact of prematurity is confounded by low birth weight.

This, a total of five risk factors comprised the final maternal cumulative risk model. Maternal risks that contributed to the significant model were marital status, education, employment status, age at child’s birth, and depression. All of these risk factors were found to negatively contribute to children’s cognitive scores, meaning that the presence of these risks
resulted in lower cognitive scores for the preschool child. Specifically mothers who were single, living with a partner, divorced, or widowed, had lower levels of education, were unemployed, and who were depressed predicted had children with lower cognitive scores. Additionally, because time of child’s delivery was removed from the infant biological cumulative index, only one risk factor, child’s birth weight, remained in the infant biological cumulative risk index.

The infant biological risk in the cumulative risk model, low birth weight, did not significantly contribute to lower cognitive scores. This finding did not support the first hypothesis that children with a higher number of biological birth risk factors would have poorer overall cognitive scores. This finding may have resulted from only one risk being evaluated for infant risk. Studies examining the impact of infant biological characteristics often included the infant risks in an overall cumulative risk model, rather than having them as a separate risk factor (e.g., Liaw & Brooks-Gunn, 1994). Similarly, in this study, infant birth weight could have been added to the maternal index as one overall risk index. However, the interaction between maternal cumulative risks and the infant risk (hypothesis 3) would not have been examined. Another study that looked at infant risk as its own cumulative risk index, examined cumulative infant medical risk with the use of the Neurobiological Risk Score, which ranges from 0-20 (Candelaria, O’Connell, & Teti, 2006). Therefore, research that found significant findings regarding infant biological risks either added them to a larger cumulative risk model or simply had more infant risk variables in their cumulative index.

The second hypothesis, that children with a higher number of maternal health and socio-demographic risk factors would have poorer overall cognitive scores, was partially supported in the analyses. With health status removed from the risk index, the higher number of maternal risks did relate to lower preschool cognitive scores. This shows the direct effect of cumulative
maternal risks on preschool cognitive scores. Meaning that as children experienced more maternal risks, their cognitive abilities were negatively affected. Though all of the risk factors are thought to negatively impact children’s development individually, the results of this study show that when examined together, the multiple risk factors seem to increase the negative effect of those risks on children’s’ cognitive development. This finding supports previous literature that found relationships between cumulative maternal risks and lower cognitive and achievement scores (Candelaria, O’Connell, & Teti, 2006; Rouse et al., 2011; Stanton-Chapman et al., 2004; Stevens, 2006). This supports the hypothesis that the maternal cumulative risk index can assist in predicting lower cognitive scores in preschool children.

The hypothesis that examined the potentially multiplicative effects of combined infant biological risk and maternal risks was found to be non-significant. This disconfirms the third hypothesis, which stated that the combined effects of cumulative infant birth risks and the cumulative maternal risks will be multiplicative rather than additive, such that the impact of each cumulative risk index is worse when the other one is present. The results of this analysis indicate that contrary to our hypothesis, the effects of the cumulative risks were only additive (linear) for this sample. This is likely due to the limited information we had on infant biological risk, with only birth weight in the analysis. A better, more comprehensive look at infant risk in future research may reveal multiplicative effects between maternal and child risk.

**Strengths and Limitations**

There are a number of strengths in the present study that should be noted. First, the study addresses gaps in the literature by examining the cumulative effects of infant biological and maternal risks on low-income African-American preschoolers’ cognitive outcomes. Though there have been studies that have looked at the impact of the cumulative risk model in relation to
poverty (Janus & Duku, 2007), few studies have examined the impact of both infant biological health and maternal risk factors in combination (Ayoub et al., 2009; Candelaria et al., 2006; Liaw & Brooks-Gunn, 1994; Stevens, 2006). Even fewer studies have looked at the impact of maternal cumulative risk on preschool cognitive scores (Perry & Fantuzzo, 2010). Therefore, the study offered valuable insight into the impact of both cumulative maternal and infant biological risks on preschool cognitive capabilities.

The use of the cumulative risk model to examine the impact of risks on cognitive abilities is another strength of this study. Initial proponents of the cumulative risk model have found that the total amount of risks were more important than any one risk factor by itself (Sameroff et al., 1993). This study was able to show that the accumulation of risk factors did, in fact, have a negative impact on children’s cognitive development. In many other studies examining the negative impact of environmental risks on children’s development, the impact of risk factors are often examined separately (e.g., Berger, Paxson, & Waldfogel, 2009; Perry & Fantuzzo, 2010; Pike, Iervolino, Eley, Price, & Plomin, 2006), and as a result, do not provide information on the impact of multiple risks on a child’s development. Utilizing the cumulative risk model allows us to examine the additive effect of risks.

Another strength of the study was the examination of the cumulative risk model among a low-income, African-American family sample. African-American families are typically underrepresented in cumulative risk studies and most often, cumulative risk results are more generalizable to middle-class or Caucasian families (Appleyard et al., 2005; Forehand et al., 1998; Stevens, 2006). Therefore, it is a strength that this study examined low-income African-American families.
Despite the number of strengths in the present study, the limitations should also be noted. First, all of the independent variables were collected via a self-report questionnaire that was given to mothers to complete. Responses to self-report questionnaires may be subject to response biases such as social desirability. In the case of response bias, participants may have wished to look more desirable to researchers and, thus, underreported risks or discounted the severity of risks in their responses. Future studies should strive to collect data via multiple methods beyond mother’s self-report. Additionally, mothers who were asked to complete the questionnaire had to recall previous information from the past, and as a result may have not had the best recall of information that had occurred in the past (e.g. child’s weight at birth). Further data collection via the use of medical records may have provided more accurate data.

Second, though having a population of primarily low-income African-American mother and child pairs in the sample was a unique strength of the study, the findings are not generalizable to a larger population. Therefore, the results of this study may not be applicable to others besides low-income African-American families participating in Head Start in urban areas.

Third, because the data were primarily collected at one time point and are, therefore, cross-sectional in design, the duration in which children have experienced some of the risk factors was unknown (e.g. maternal depression, poverty, and health issues). Therefore, we do not know how the duration and severity of some of the risk factors may influence child’s cognitive scores. For example, is it more harmful to have a mother who currently had depression at the time of preschool, or one that has had depression since birth? Additionally, because the study was cross-sectional, we cannot draw conclusions about the long-term interaction process between risk and protective factors.
Lastly, the number of risk factors that contributed to the cumulative risk indices included in this study was a limitation. Specifically, there were only two original variables to measure infant biological birth risks, when other variables such as length of stay in hospital and complications at birth could have been included in a risk index (Candelaria et al., 2006; Liaw & Brooks-Gunn, 1994). Additionally, other risk factors were not measured, such as overall parenting quality or style, which may also negatively influence child developmental outcomes (Cornelius et al., 2009; McGroder, 2000; Rafferty et al., 2011). Factors such as maternal warmth and supportiveness, number of books in the home, mother and father’s IQ, and time spent reading with their child or exposure to cognitively stimulating material also contribute to child cognitive outcomes (Currie, 2005; Duncan & Magnuson, 2005; Janus & Duku, 2007; Rafferty et al., 2011). The examination of the influence of these risks factors on the cumulative risk model would provide a better understanding of the effects of cumulative risks on children’s cognitive scores.

**Implications of the Current Study**

Clinical and policy implications can be drawn from the current study. Results provide evidence that the cumulative risk model, proposed by Rutter (1979), can be used to predict difficulties in children’s cognitive scores at a very young age, thus contributing to the school entry gap. Interventionists working with low-income African-American preschoolers and their family can utilize the cumulative risk model as a means of identifying families who need interventions the most when resources are already limited. In using this model and making family risks more quantifiable, people working within the Head Start system can anticipate that increased numbers of family risks may increase the risk for poorer cognitive performance in the child in Head Start. Teachers and other Head Start workers can then assist the children who have
an increased number of risks with the appropriate interventions, one of which could focus on
cognitive skills. Additionally, in identifying these multiple risks within a family, referrals can be
made to social service agencies to help ameliorate some of those stressors. By assessing for these
risks early on, referrals for educational resources can be made right away, instead of when a
child shows more clear signs of falling behind academically. This will ensure that children who
are already coming in at risk for poorer cognitive abilities can receive appropriate resources with
the hopes of increasing their skills by the time they enter grade school.

Additionally, intervention and prevention efforts and interventions should focus broadly
on child and family factors, not just solely on increasing cognitive skills. For example, agencies
can assist families with psychological services and other social service resources with the
intention of both decreasing the impact of some of the risks (e.g. depression) and increasing
protective factors such as positive parenting. Clinicians should focus on creating intervention
programs that are comprehensive to the entire family and work towards increasing positive,
protective factors, while decreasing risk factors. For example, early interventions could include
efforts to increase financially stable homes, address maternal depression, increase parental
responsiveness and sensitivity, and increase family social support (M. Burchinal, Campbell,

Future policy, program, and clinical interventions should also focus on preventative
methods, such as working to decrease the number of risks before a child enters preschool, or
even before they are born. Reducing the number of risk factors early in life, prior to preschool
entry, could prevent poor cognitive scores. A focus on early detection of and efforts to reduce
stressors and risks among soon-to-be or early mothers could also be beneficial to the cognitive
outcomes of low-income African-American preschool children. For example, intervention and
prevention programs that identified risks in pregnant mothers could work towards coordinating appropriate services and supports to help decrease some of the environmental risks and increase protective factors.

**Suggestions for Future Research**

The results of this study suggest several directions for future research. First, since this study looked at urban low-income African-Americans, it will be important to replicate this study with larger samples. In particular, including larger samples of low-income and ethnically diverse preschoolers is necessary in order to ensure that these results are more generalizable.

Second, future studies should explore more ways, other than IQ, to evaluate cognitive abilities and future academic success in preschool children. IQ is not the only way to measure preschool children’s cognitive capabilities and future success in school. Measures of school readiness, parental support, and emotional maturity are also critical components of children’s later academic success (Webster-Stratton et al., 2008). Future cumulative risk studies should examine the effects of cumulative maternal and infant biological risks on multiple domains of preschool children’s cognitive and social-emotional capabilities.

Lastly, future studies should collect data that are more comprehensive and longitudinal. Future studies should gather more information to examine the duration of certain risk factors in order to get a more thorough background history. Additionally, future studies should collect data longitudinally to examine relationships between health risks, socio-demographic risks, and infant biological risks on children’s cognitive development. Longitudinal studies may even want to look at risk factors that affect child outcomes during the mother’s pregnancy with the child to get a better understanding of the impact of many of these risk factors on the child’s development even in utero.
Conclusions

In sum, this study has examined the effects of cumulative maternal health and socio-demographic risks, and infant birth weight in relation to low-income, African-American preschoolers’ cognitive abilities. Results indicate that as the number of maternal risks increased, child cognitive scores decreased. Although previous researchers have begun to examine the cumulative risk model in relation to child development, this study added to the literature by examining the impact of both maternal and infant biological risks on child cognitive abilities in a low-income African-American sample. Despite several limitations to the current study, the results provide important information regarding the impact of cumulative maternal risks on low-income African-American preschool children’s cognitive abilities.
References


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Appendix EMU IRB Approval Letter

EASTERN MICHIGAN UNIVERSITY

November 14, 2013

Cassandra Esposito
Department of Psychology

Dear Cassandra:

The College of Arts and Sciences Human Subjects Review Committee (CAS HSRC) of Eastern Michigan University has reviewed and approved as exempt research your proposal (#1213) titled, “The Influence of Cumulative Risk Factors on the Cognitive Abilities of Low-Income, African American Preschool Children.” The CAS HSRC determined that the rights and welfare of the individual subjects involved in this research are carefully guarded. Additionally, the methods used to obtain informed consent are appropriate, and the individuals participating in your study are not at risk.

Exempt research does not require reporting of continuation one year after approval if the project continues. However, should the sample or procedures change as to have an impact on human subjects, then CAS HSRC should be notified by using the Minor Modification to Research Protocol or the Request for Human Subjects Approval form depending upon the scope of the changes (see the forms online).

On behalf of the Human Subjects Committee, I wish you success in conducting your research.

Sincerely,

Alissa C. Huth-Bocks, Ph.D.
CAS HSRC Chair

cc: Heather Janisse, Ph.D.