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# Developmental Psychopathology and Childhood Obesity: A Developmental Cascade Model

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DEVELOPMENTAL PSYCHOPATHOLOGY AND CHILDHOOD OBESITY:  
TESTING A DEVELOPMENTAL CASCADE MODEL

by

CHRISTOPHER R. HARPER

Under the Direction of Christopher Henrich

ABSTRACT

Childhood obesity is a growing concern for practitioners and researchers. In addition to obesity being a risk factor for cardiovascular disease, children classified as obese are more likely to demonstrate other risk factors associated with cardiovascular disease. Furthermore, children classified as obese are more likely to be victims of bullying and discrimination. This dissertation tested a dynamic cascade model of the development of childhood obesity. It was hypothesized that externalizing behaviors and internalizing problems would lead to increased body mass index. This model was tested in *Mplus* v7 (Muthén & Muthén, 1998) using data from the NICHD Study of Early Child Care. This dissertation used parent report of externalizing behaviors and internalizing behaviors, teacher report of externalizing behaviors, and body mass index to examine several different ways in which developmental psychopathology related to childhood obesity. The results suggested that body mass index predicts the development of internalizing problems in late childhood. However, externalizing behaviors were not directly or indirectly associated with body mass index. These findings suggested that the assessment of children with internalizing problems should include an assessment of their weight and weight related concerns.

INDEX WORDS: Childhood obesity, Developmental psychopathology, Cross-lagged analyses

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by

CHRISTOPHER HARPER

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Doctor of Philosophy

in the College of Arts and Sciences

Georgia State University

2013

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2013

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TESTING A DEVELOPMENTAL CASCADE MODEL

by

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## 1 REVIEW

Seventeen percent of children and adolescent aged 2 through 19 meet criteria for obesity (Ogden, Carroll, Kit, & Flegal, 2012). Nearly 1/3 of all children and adolescents are considered overweight or obese. Studies have demonstrated that children who are obese are more likely to demonstrate other risk factors for cardiovascular disease, including high blood pressure and high cholesterol (D. S. Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007)(Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). These results suggested that obese and overweight children and adolescents are 70% more likely to display one additional indicator of cardiovascular disease and are 39% more likely to demonstrate two or more additional risk indicators. Obese and overweight children are more likely to be diabetic, demonstrate liver problems, sleep problems, and musculoskeletal complaints (Taylor et al., 2006; Whitlock, Williams, Gold, Smith, & Shipman, 2005). Furthermore, obese children also face psychological reprisals. They are more likely to be victims of bullying (Lumeng et al., 2010), experience social exclusion (de la Haye, Robins, Mohr, & Wilson, 2011), suffer other forms of stigmatization (Latner, Simmonds, Rosewall, & Stunkard, 2007), and report more internalizing problems (Braet & Beyers, 2009).

Studies on childhood obesity include contextual and individual correlates, ranging from media, neighborhood characteristics, physical activity, nutrition, and even genetics (Borradaile et al., 2009; Harrison et al., 2011; Harest et al., 2012). Behavioral genetics and twin studies suggest heritability estimates between 30% and 77% (Rankinen et al., 2006; Wardle, Carnell, Haworth, & Plomin, 2008). Studies have linked other child characteristics including self-regulation (Francis & Susman, 2009) and inadequate sleep (Taheiri, 2006). Francis and Susman (2009) found that poor impulse control and behavior regulation during preschool and kindergarten was linked with higher BMI in middle school. Studies on the association between sleep patterns and

obesity in childhood have revealed a cyclical process. Poor sleep in toddlerhood has been linked with obesity from school age into young adulthood (Mamun et al., 2007; Taheri, 2006). Furthermore, obesity contributes to obstructive sleep apnea (Ievers-Landis & Redline, 2007). These studies demonstrate important child characteristics that contribute to the development of obesity.

In addition to child-level factors, there is a wealth of evidence suggesting that the environment plays a key role in the development of obesity. Studies on the contextual risk factors can be divided into four broad spheres: family, community, and media. Parent characteristics and behaviors have been related to childhood obesity. Parent education and psychopathology have been linked with childhood obesity (Blissett, Meyer, & Haycraft, 2007; Sanigorski, Bell, Kremer, & Swinburn, 2007). Parent behaviors linked with childhood obesity include not breastfeeding (Robinson et al., 2009), food restriction (Powers et al., 2006), and overeating (Tabacchi, Giammanco, La Guardia, & Giammanco, 2007). Studies of community characteristics suggest that access to health encouraging facilities is linked with decreased BMI (Evenson, Evenson, Scott, Cohen, & Voorhees, 2007). Furthermore, media plays an important role in the development of obesity through food advertising, which encourages greater food intake (McGinnis, Gootman, & Kraak, 2006).

Harrist and colleagues (2012) proposed a hierarchical system for understanding the development of childhood obesity. Harrist et al. (2012) recognized that contextual factors, such as parent management of eating patterns, family activity patterns, and peer dynamics, predict the development of child food intake, activity level, and body mass index. This model also recognizes that these contextual factors are mediated by child-level variables. Harrist and colleagues' (2012) model proposed that child level variables fall within three broad domains:

affective, behavior regulation, and emotional eating. This dissertation extends the field's understanding of child-level characteristics associated with childhood obesity, with an emphasis on the relationship between childhood obesity, externalizing behaviors, and internalizing problems. Externalizing behaviors and internalizing problems are two of the most widely studied domains in developmental psychology. Furthermore, these profiles of psychopathology parallel and intersect with the affective and behavior regulation domains proposed by Harris et al (2012). One of the principal characteristics of internalizing problems is negative emotionality. Externalizing behaviors are often defined in terms of inadequate behavior regulation strategies

The purpose of this dissertation is to expand our understanding of the child- and family-level characteristics associated with childhood obesity, using a developmental psychopathology lens. A marker of developmental psychopathology frameworks is that they consider the antecedents and timing of developmental processes that underlie maladaptive behaviors (Masten & Cicchetti, 2010). The purpose of studying developmental psychopathology is to understand how and when risk and protective factors for maladaptive behaviors emerge. Furthermore, the goal behind understanding developmental psychopathology is to use this information about the emergence of risk factors to develop effective interventions. For example, Masten and colleagues (2005) examined the developmental associations between externalizing behaviors, internalizing problems, and academic competence. Dodge and colleagues (2008) examined the role of numerous risk factors across childhood and adolescence that predict adolescent violence. These studies found that certain risk factors emerge during specific development periods. The emergence of these early predictors increased the likelihood of the emergence of later risk factors. Furthermore, the effects of early risk factors were mediated by the development of later emerging risk factors. The models tested in these studies typify a developmental

psychopathology framework because they examined how and when risk factors for maladaptive behavior emerge.

Developmental psychopathology has recently begun to be analyzed within the field of obesity research. Mustillo and colleagues (2003) examined the associations of externalizing behavior disorders and internalizing disorders with childhood obesity. They documented associations between indices of depression, anxiety, and oppositional behaviors with longitudinal patterns of childhood obesity. Their findings point to a need for an integrative system for studying and understanding the relationship between childhood obesity and behavior problems. This type of system would inform research and theory about how developmental psychopathology and obesity are interrelated across the lifespan. It could be used to identify potential risk and protective factors, and, as such, avenues for intervention. This dissertation proposes one potential framework for understanding the development of obesity during childhood—a developmental cascades model. This dissertation examines how the development of externalizing behaviors and internalizing problems conferred additional risk for the development of obesity in childhood from the a developmental cascade perspective.

## **2 DYNAMIC CASCADES IN DEVELOPMENT**

Recent research in developmental psychopathology has emphasized the role of cumulative effects or “snow balling” effects in forecasting behavior and developmental outcomes across the lifespan (Doan, Fuller-Rowell, & Evans, 2012; Masten & Cicchetti, 2010; Masten, et al., 2005; Shonkoff, Boyce, & McEwen, 2009). These models are subsumed within the developmental cascades literature. This family of models proposes that development psychopathology results from compounding risk and protective factors. There are “spill over” effects in which success or failure confers additional risk for the development of maladaptive

behaviors. The culmination of these “spill overs” can be observed in the emergence of increased risk for psychopathology. According to Dodge and colleagues (2008), the role of a developmental cascade is to identify the incremental components that infer increased risk for developmental outcomes. Furthermore, the developmental processes can operate bidirectly and indirectly across the lifespan. These types of models integrate dynamic systems, bioecological systems, and transactional systems approaches to developmental research (Masten & Cicchetti, 2010). The integrative nature of developmental cascades, as well as emphasis on time-relevant processes, offers an optimal background for studying childhood obesity. The following is a brief review of how developmental cascades have emerged from previous theories regarding developmental processes, with a particular emphasis on the novel ideas that have emerged as foundations for the developmental cascades framework.

The earliest components of developmental cascades models emerged from Bronfenbrenner’s bioecological systems theory (Bronfenbrenner, 1977, 1986; Bronfenbrenner & Morris, 1998). Bioecological systems theory proposed a framework for guiding researchers interested in studying development. Bronfenbrenner suggested that researchers should seek to understand the direct and indirect influence of contextual processes on development (e.g., family in the microsystem, parental employment in the exosystem, or culture in macrosystem). The interaction of the individual within these different contextual layers (i.e., mesosystem) is essential to understanding the processes that underlie development. Bronfenbrenner’s ecological-systems theory has been applied across developmental outcomes, including externalizing behavior problems (Silver, Measelle, Armstrong, & Essex, 2010), internalizing problems (Park, Kim, Cheung, & Kim, 2010), and obesity (Freedman, 2009).

The foremost contribution of bioecological systems theory to the developmental cascades literature is a focus on explaining the aspects of the child or environment that drive development. Bronfenbrenner's focus was not solely on the components of the child's bioecological context, but emphasized the avenues through which these components scaffold the emergence of competence or failure (Bronfenbrenner, 1977, 1986; Bronfenbrenner & Morris, 1998). This focus on processes is integral in developmental cascades models. Developmental cascade models are focused on the order in which risk and protective factors emerge across the lifespan. Furthermore, Bronfenbrenner and colleagues suggested a number of methods for testing these questions about development, such as natural experiments, examining interactions between contextual factors, and mediation models.

Bioecological systems theory recognized that development was hierarchical in nature, meaning certain influences or process superseded others in temporal, physical, or psychological proximity to the child. Later iterations of this theory also proposed the chronosystem. Bronfenbrenner's suggestion was that the temporal spacing of events and transitions between important milestones played a key role in development (Bronfenbrenner, 1977, 1986; Bronfenbrenner & Morris, 1998). Similarly, an integral component of developmental cascades models is that development unfolds through a longitudinal sequence of events or processes with some events taking temporal or theoretical precedence (Masten & Cicchetti, 2010). In order to adequately understand development, we need longitudinal models that consider the temporal sequencing of important drivers of growth or change. Developmental cascades and bioecological systems both emphasize the mediating processes that operate as the drivers of development.



Another influential theory behind developmental cascades is the transactional approach to understanding development (Sameroff, 2009). The distinguishing characteristic of a transactional approach is that there is reciprocity between the individual and the social environment. In other words, there are bidirectional influences between the child and the context. A prime example is the relationship between the child and the parent. The child is born with certain biologically influenced temperamental characteristics. The parent is tasked with meeting the needs of the child given their own interpersonal and extrapersonal resources. The ability of the parent to meet the needs of the child based on the parenting resources further influences the expression of the child's behavioral development, which is commensurate or exceeds the parent's resources. There is a synergy between the individual and the environment, in which developmental process and context influence each other in ways that either promote competence or failure.

Several studies have demonstrated the ability of the transactional model to explain aggressive or antisocial behavior in childhood and adolescence (Anderson, Lytton, & Romney, 1986; Nicholson, Deboeck, Farris, Boker, & Borkowski, 2011; Patrick, Snyder, Schrepferman, & Snyder, 2005). The transactional model has also been used to explain the relationships between peers and academic achievement (Véronneau, Vitaro, Brendgen, Dishion, & Tremblay, 2010), as well as internalizing problems (Burt, Obradović, Long, & Masten, 2008). Sameroff (2009) also suggests that to adequately understand these influences, advanced analyses should be used along with constructs of interest measured across at least four meaningful intervals. Multiple measurement intervals are needed to adequately model the concomitant changes that are a hallmark of transactional models. This type of model for testing theoretical models becomes

important in dynamic systems theory and crucial for adequate evaluation of developmental cascade models.

Developmental cascades models emerged most directly from dynamic systems theory. Dynamic systems theory uses mathematics to explain development. Within this theory, behavioral changes are the result of cycling processes that evolve and change their expression as time proceeds (Lewis, 2000). The engagement of these processes is best thought of as a double helix with intertwined processes that are dependent upon one another for expression (Sameroff, 2010). For example, the parent-child relationship is often described within these terms. Dynamic systems theory emphasizes that development is not an inherently static process; there is a characteristic level of uncertainty within the system that influences development as well. This idea of intertwined processes is very similar to the ideas of bidirectional influences in Sameroff's (2009) work and builds upon the mesosystem and chronosystem within bioecological systems theory. According to dynamic systems theory, development can be described as a non-linear process. Hence, dynamic systems theorists introduced the theory of self-organization and emergence—the idea that a behavior or phenomenon can appear differently across the lifespan as a result of intra- and extrapersonal processes. In other words, a phenomenon changes its expression across the lifespan. Dynamic systems theories have been used to explain a number of behaviors associated with cognitive, linguistic, motor development, and more recently, even topics in socioemotional development (Smith & Thelen, 2003; van Geert, 1998).

Bioecological systems theory, transactional systems theory, and dynamic systems theory each offer guides for conducting developmental research that have been subsumed within the developmental cascade framework. In some respects, these models offer very similar approaches for understanding development. Yet, developmental cascades focuses on the cumulative

consequences of the many transactions and interacting processes across development, including their spreading effects across domains, levels, and even generations (Masten & Cicchetti, 2010). A developmental cascades framework proposes that there is a consistent sequence underlying when certain risk factors emerge. The emergence of risk factors early in development increases the likelihood that other risk factors will emerge later. The effects of early risk factors on developmental outcomes are mediated and moderated by the development of risk factors that emerge later. And, the culmination of the development of multiple risk and protective factors best predicts maladaptive behavior or competence. One of the aims of a developmental cascade is to identify the most apt developmental interval for targeting certain risk and protective factors. The goal is identifying a developmental pathway of risk and protective factors that can be used for intervention. Masten and colleagues' (2005) research on the developmental cascade between externalizing problems, academic achievement, and internalizing problems is the foundational study arguing for cascades or shifts in development. The researchers used multiple informants to measure these constructs across four intervals between late childhood and early adulthood. The researchers found that as the child develops in adolescence, problems in late childhood associated with externalizing behaviors emerge as problems in academic achievement. In young adulthood, these problems in academic achievement predicate the development of internalizing symptoms. This shifting of developmental phenomenon constitutes a developmental cascade.

### **3 BROAD AIMS**

This emphasis on the unfurling of developmental processes has particular relevance for understanding the development of obesity. Several researchers have noted that obesity is a lifelong process, with the children classified as being obese being more likely to demonstrate weight management processes later in life. Furthermore, the shifting between externalizing

behaviors and internalizing problems that is present in the study by Masten and colleagues (2005) could explain the relationship between developmental psychopathology and childhood obesity. Rather than focusing on internalizing and externalizing independently, this method will account for the dynamics over time between these constructs. I am proposing one potential avenue to explain the association between early externalizing behaviors, internalizing problems, and childhood obesity. My model suggests that early externalizing behaviors contribute to the development of childhood obesity. In turn, problems in weight management lead to internalizing problems through a transactional process involving peer rejection and poor emotion regulation. Thus, there is a cascade hypothesized with externalizing behaviors leading to the development of internalizing problems. Additionally, there are transactions occurring between internalizing problems and obesity within this broader developmental cascade.

#### **4 INTERNALIZING PROBLEMS AND CHILDHOOD OBESITY**

Internalizing problems are typified by behaviors associated with anxiety, depression, and social withdrawal (Achenbach, 1991). Children with internalizing problems are more likely to experience problems in relationships, academic failure, and exhibit suicidal behaviors (Hankin & Abramson, 2001; Goldston et al., 2009). Research suggests that the occurrence of internalizing problems increases in late childhood and continues increasing into late adolescence.

There is a wealth of evidence supporting links between internalizing problems and obesity (Goodman & Whitaker, 2002). For example, one study examined the longitudinal associations of depression with obesity (Pine, Goldstein, Wolk, & Weissman, 2001). Children and adolescents with major depression were compared to typical peers 10 to 15 years later. The results indicated that children with a depression diagnosis were twice as likely to be classified as overweight. Researchers also found a positive association between the duration of depressive

symptoms and BMI in adulthood. These findings are also supported by research conducted with the National Institutes of Child Health and Development Study of Early Child Care and Youth Development (NICHD SECCYD). Bradley and colleagues (2008) examined the relationship between parent rated internalizing problems and childhood obesity across infancy into early adolescence. Researchers using cross-lagged analysis found that a consistent association between internalizing problems and BMI emerges in late childhood (Bradley et al., 2008a). This study found that BMI starts to predict internalizing problems late in childhood. This study did not consider interplay between internalizing and externalizing problems, although it did account for their correlation.

There are several explanations for the findings of linkages between internalizing problems and obesity. First, there is evidence of an association between internalizing behavior problems and dysregulated eating behaviors (i.e., binge eating). Researchers examined loss of control eating or binge eating prospectively in a sample of elementary and middle school students (Tanofsky-Kraff et al., 2011). The result suggested that students who experienced loss of control eating were more likely to experience depression.

Furthermore, studies have implicated the role of dysregulated emotionality--the inability to regulate feelings and affective states—in the development of internalizing problems. This affect regulation hypothesis suggests that individuals binge eat because it helps them cope with negative emotions. One study surveyed Dutch children and adolescents and found support for this hypothesis (Goossens, Braet, Van Vlierberghe, & Mels, 2009). This study found that emotional eating mediated the association between binge eating and anxiety, and emotional eating was associated with depression. Studies have also suggested that peer relationships may play a role. Several meta-analyses have demonstrated strong linkages between peer victimization

and internalizing problems (Cook, Williams, Guerra, Kim, & Sadek, 2010; Gini & Pozzoli, 2009; Reijntjes, Kamphuis, Prinzie, & Telch, 2010). Furthermore, obese and overweight children are more likely to be victims of bullying (Fox & Farrow, 2009; Lumeng, et al., 2010). Thus, increased victimization could explain the link with internalizing symptoms. These findings are confounded because studies have also shown that peer victimization is linked with dysregulated emotionality (McLaughlin, Hatzenbuehler, & Hilt, 2009). Finally, another possibility is that stress links both depression and obesity through increased levels of cortisol (Goodman & Whitaker, 2002; Hasler et al., 2005). For example, one study found that salivary levels of cortisol were related to parent-rated depression after a stress-inducing task in a sample of 8 to 13 year olds. These findings provide consistent evidence for a link between internalizing problems and childhood obesity.

## **5 EXTERNALIZING PROBLEMS AND CHILDHOOD OBESITY**

Internalizing problems are likely to cooccur with externalizing behaviors (Angold, Costello, & Erkanli, 1999; Kessler et al., 2011; Lilienfeld, 2003; Reitz, Deković, & Meijer, 2005). Externalizing behaviors are characterized by problems in behavior regulation, problems with authority and adherence to rules/social norms, as well as aggression toward peers (Achenbach, 1991). Research on the development of externalizing behaviors has demonstrated that these behavior patterns emerge early in development and remain fairly constant (Achenbach, Howell, Quay, & Conners, 1991; Pianta, Pianta, & Caldwell, 1990). Studies have shown that externalizing behaviors influence the development of substance use, poor peer relationships, parent-child relationship problems, and conduct disorders (Dodge, et al., 2008). Studies building developmental cascade models of adolescent violence (Dodge, et al., 2008) and internalizing

problems (Hankin, 2008; Hankin & Abramson, 2001; Masten, et al., 2005), have implicated the role of early externalizing behaviors as one of the earliest emerging risk factors.

In comparison to linkages between internalizing problems and obesity, the association between externalizing problems and obesity has received much less empirical focus. However, emerging research suggests that there is an association between externalizing behaviors and obesity (Janicke, Harman, Kelleher, & Zhang, 2008; Judge & Jahns, 2007; Mustillo et al., 2003; Seyedamini, Malek, Ebrahimi-Mameghani, & Tajik, 2012; von Stumm et al., 2011). In particular, researchers have emphasized the role of impulsivity and poor behavior regulation in developing disordered eating patterns (Puder & Munsch, 2010). Furthermore, researchers are striving to understand the mechanisms that underlie people's ability to inhibit poor eating habits and delay gratification. Evidence of an association between externalizing behaviors and obesity is provided by two sources of information.

Support of the externalizing behavior and obesity link is provided by studies linking diagnostic classifications (i.e., oppositional defiant disorder and conduct disorder) and obesity. For example, researchers analyzed data from the *Great Smokey Mountain Survey*, a longitudinal representative survey of rural children and adolescent, and found that for boys, chronic obesity was associated with oppositional defiant disorder. There is also evidence of links between obesity and conduct disorder (Pine, Cohen, Brook, & Coplan, 1997; Pitrou, Shojaei, Wazana, Gilbert, & Kovess-Masféty, 2010). Pitrou and colleagues analyzed cross-sectional data from a representative sample of French children and found that parent-reported conduct disorder was associated with greater risk for being overweight or obese. Researchers have also examined the association between children's weight classification (normal range, at risk, or overweight) and scales of the Child Behavior Check-List in a sample of Korean 10 to 12 year olds (Hwang et al.,

2006). Overweight children were more likely to be classified as having delinquent, social, and total problems as compared to their normal weight peers. Furthermore, children at-risk for being overweight were more likely to demonstrate social problems.

Additionally, there is some empirical evidence that externalizing behaviors and obesity may not be linked in childhood. One study examined linkages between externalizing behaviors and BMI in the NICHD SECCYD (Bradley et al., 2008b). However, they did not find any significant direct effects and they did not consider potential indirect links through internalizing problems. Furthermore, they only focused on parent report of externalizing behaviors and not teacher report. In light of past findings that suggest small correlations between parent and teacher report (Dwyer, Dwyer, Nicholson, & Battistutta, 2006; Stone, Speltz, Collett, & Werler, 2013; Thomas, Forehand, Armistead, Wierson, & Fauber, 1990), studies using teacher report of externalizing behavior may find different linkages with childhood obesity.

Furthermore, many of the studies examining binge eating have ignored externalizing behaviors and focused on internalizing psychopathology. The few studies that have examined the association have reported inconsistent findings. Tanofsky-Kraff and colleagues (2004) found significant differences between non-treatment-seeking overweight and normal children in levels of parent-reported externalizing behaviors measured using the CBCL. However, there was no relationship between binge eating behaviors and the CBCL externalizing score. However, research has demonstrated that parents may use food as a behavior management technique. For example, researchers found evidence that parents of fussy infants were more likely to use food to soothe or reward (Wasser et al., 2011). Parental use of food as a behavior management strategy could explain the relationship between externalizing behaviors and increased obesity risk.



## **6 LINKS BETWEEN EXTERNALIZING AND INTERNALIZING PROBLEMS**

As indicated above, the co-occurrence or comorbidity of psychopathology in childhood and adolescence is well documented (Angold, et al., 1999; Kessler, et al., 2011; Lilienfeld, 2003; Reitz, et al., 2005). Children and adolescents demonstrating comorbid profiles of psychopathology are more likely to demonstrate other behavioral problems and earlier onset of adjustment problems (Fanti & Henrich, 2010; Sourander et al., 2007). This section reviews evidence of the relationships between internalizing and externalizing problems with special relevance to how these patterns can inform a developmental cascade model.

Evidence of a degree of comorbidity between internalizing and externalizing problems in childhood comes from two main sources—community surveys and clinical samples (Angold, et al., 1999; Compas & Ey, 1993). Evidence from community surveys tends to focus on the broad syndromes of externalizing and internalizing scales and tend to demonstrate smaller effects than clinical samples. For example, researchers examined the life course persistence of comorbidity in a Finnish sample (Sourander, et al., 2007). Researchers examined the effects of comorbidity at age 8 on psychiatric diagnoses, criminal offenses, and self-reported quality of life in young adulthood. Comorbidity was defined as a score above the 90<sup>th</sup> percentile on both a measure of depression and externalizing behavior problems. Children who were classified as comorbid were more likely to have psychiatric diagnosis in adulthood, as compared to children with a single diagnosis or no diagnosis. Children identified as comorbid were more likely to have committed a criminal offense in adulthood, and they were more likely to report decreased quality of life. These results provide strong evidence of the effects of comorbidity on later adjustment. Furthermore, they underscore the importance of a life-course perspective on the interplay of internalizing and externalizing behavior problems. The focus on broadband internalizing and

externalizing scores has particular relevance for this study, because this method is used for these analyses.

Studies that focus on children using clinical samples can also inform research on the development of comorbid psychopathology. Several researchers have noted that analyses focusing on children who meet diagnostic criteria for specific disorders tend to indicate that children classified as comorbid have worse outcomes than suggested by community surveys (Angold, et al., 1999; Compas & Ey, 1993). However, they also offer greater detail about the potential causal sequences between externalizing and internalizing pathologies. For example, researchers have documented that conduct disorder with comorbid depression confers additional risk for suicide attempts among children age 12 to 19 (Goldston et al., 2009). However, they noted that these findings were mostly driven by the increased risk of a diagnosis of major depression. Furthermore, suicide risk was greater for depression alone than conduct disorder.

Beyond the implications of comorbidities for mental health outcomes, a great deal of research has considered the likelihood that individuals with a certain diagnosis will be diagnosed with another disorder at a later time-point, successive comorbidity. Angold and colleagues (1999) differentiate between successive and concurrent comorbidity in regards to whether the onset or occurrence of a disorder occurs during the same interval. They note that often researchers only focus on a short time interval and treat disorders as though they are intrinsically co-occurring with no time lag between onsets. This time lag has important implications for testing developmental cascade models.

More importantly, studies that use prospective analyses to understand comorbidity have identified important temporal associations. Rhode, Lewinshon, and Seely (1991) analyzed data from the Oregon Adolescent Depression Project and found that a depression diagnosis was

typically predated by a diagnosis of another mental disorders. This finding has been corroborated with other studies as well. One study examined comorbidity between externalizing and internalizing disorders across early adolescence (McGee, Feehan, Williams, & Anderson, 1992). The findings suggested that among boys, externalizing disorders at age 15 were preceded by internalizing disorders at age 11. Hankin (2008) examined the association between externalizing and internalizing problems using a multiwave prospective analyses. His results suggested that externalizing behaviors drove the development of internalizing behavior problems by interacting with children's cognitive styles. The interaction between ruminations, focusing on negative life events, and externalizing behaviors problems predicted greater increases in internalizing problems. Evidence that externalizing problems influence the development of internalizing problems is also supported by Masten et al. (2005). In this study, researchers found that across pre-adolescence and adulthood, externalizing behaviors preceded the development of internalizing symptoms. This dissertation tests a similar pathway between externalizing and internalizing problems.

## **7 GENDER DIFFERENCES**

There is a wealth of literature suggesting gender differences in externalizing behaviors, internalizing problems, and their effects on BMI. A recent meta-analysis of gender difference and correlates of aggression found that the prevalence of direct forms (i.e., physical bullying) of aggression was higher among boys; whereas gender differences in indirect forms were minor (Card, Stucky, Sawalani, & Little, 2008). Recently, researchers have begun investigating potential gender differences in the effects of psychosocial determinants on the development of externalizing behaviors. Researchers using data from the NICHD SECCYD found that maternal

depression was related to decreases in externalizing behaviors for boys and increases in girls during early childhood (Blatt-Eisengart, Drabick, Monahan, & Steinberg, 2009).

There is also evidence that these gender differences in externalizing problems extend to developmental cascade models. Dodge and colleagues (2008) tested a developmental cascade model of the development of violence in adolescence using data from the Fast-Track multi-year, multi-site evaluation. This developmental cascade proposed the following order of risk factors leading to the development of violence in adolescence: a) early aversive care environment, b) early harsh parenting, c) poor social cognitive readiness, d) conduct problems, e) school failure, f) low parental monitoring, and g) antisocial peer networks. There was empirical support for this model; however, the researchers found that this cascade differed in the paths leading to school failure. Aversive context and harsh parenting played a more important role for girls.

Externalizing behaviors and deficits in social cognitive readiness were better indicators for boys. Additionally, evidence suggests that heterotypical comorbidity is more common among boys (McGee, et al., 1992). This suggests that different cascades may exist from boys versus girls.

Evidence of gender differences in developmental cascades is also presented by Hankin and Abramson (2001). Research on gender differences in the development of internalizing disorders suggests that the prevalence is slightly higher among boys in childhood. In adolescence, girls tend to display greater levels of internalizing problems. These researchers presented a developmental cascade model, which integrates research on genetic vulnerability, contextual antecedents, maladaptive cognitions, and transactional exchanges.

The hypothesis of pronounced effects among girls is also supported by evidence from research on obesity. Despite a higher prevalence among men, there is evidence that obesity and being overweight has a greater impact on women's quality of life (Muennig, Lubetkin, Jia, &

Franks, 2006). Furthermore, research concerning the development obesity has begun to emphasize the shared physiological underpinnings of depression, stress, and BMI. Research using salivary cortisol measures has found an indirect effect of cortisol on the association between depression and BMI among girls but not boys (Dockray, Susman, & Dorn, 2009). The meaning of these gender differences are considered in the context of the specific developmental cascades being proposed and tested.

## **8 HYPOTHESIZED MODELS**

The co-occurrence of externalizing and internalizing psychopathology predicates poorer outcomes and greater distress across the lifespan. There is a growing body of literature suggesting the independent roles of externalizing and internalizing psychopathology for the development of childhood obesity; however, limited research has considered the interplay of externalizing and internalizing psychopathology in the development of childhood obesity. The developmental cascade hypothesized here suggests that as the child grows, the emergence of early externalizing behavior problems facilitates the development of internalizing problems and childhood obesity. As the child ages and greater internalizing problems emerge, the role of externalizing behaviors becomes less salient. In other words, there is a shift of the importance of externalizing to internalizing problems with later development of obesity being driven by transactional process between internalizing problems and obesity. The hypothesized developmental cascade is presented in Figure 1.

This developmental cascade model is compared to a transactional model with all cross-lagged paths estimated (Figure 2), as well as a non-dynamic model in which these behaviors were simply correlated at first grade. The transactional model (Figure 2) posits that there are consistent transactions between externalizing and internalizing problems, as well as internalizing

problems and obesity. However, there was no observable cascading effect. The non-dynamic model does not include any crosslagged paths between externalizing behaviors, internalizing problems, and BMI. In other words, this non-dynamic hypothesizes that the correlation between externalizing behaviors, internalizing problems, and BMI is static.

The hypothesized models were tested with data from the NICHD SECCYD. Past research conducted with the NICHD SECCYD has demonstrated linkages between parent rated internalizing problems and childhood obesity in late childhood (2008a; 2008b). To date no studies have considered teacher report of externalizing behaviors as they relate to linkages between BMI and internalizing problems. Furthermore, recent findings from the NICHD SECCYD suggest that characteristics of the parent-child relationship (Anderson et al., 2012), SES (Lane, Bluestone, & Burke, 2013), and prenatal maternal smoking (L. Wang, Mamudu, & Wu, 2012) are risk factors for childhood obesity. The aim of this dissertation is to build these findings into a unified framework for understanding childhood obesity.

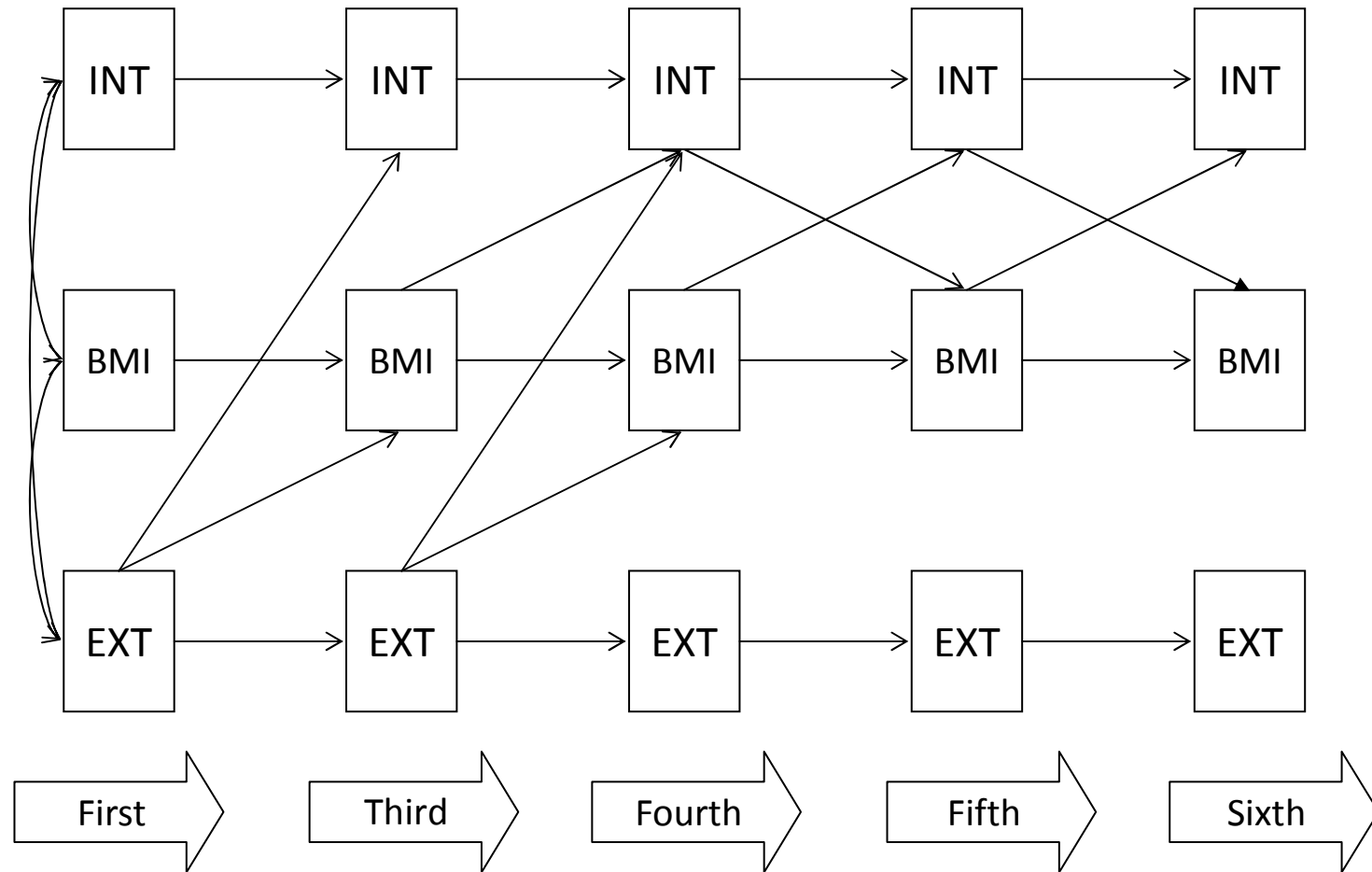


Figure 1.

*Hypothesized dynamic cascade path diagram (BMI = Body mass index; INT = Internalizing problem; EXT = Externalizing behaviors)*

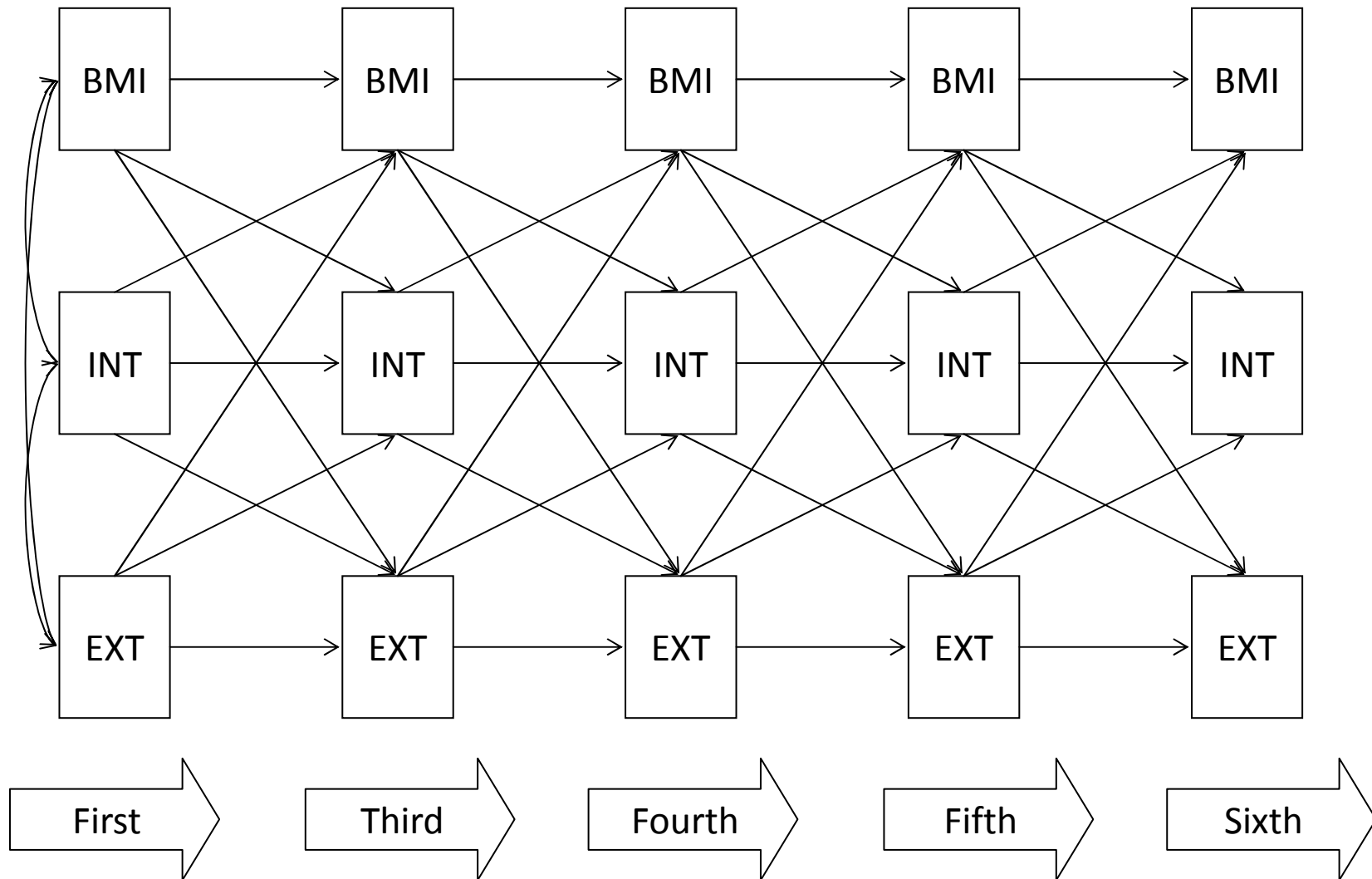


Figure 2.

*Hypothesized Transactional Path Diagram (BMI = Body mass index; INT = Internalizing problem; EXT = Externalizing behaviors)*



## 9 METHODS

Data for this study were collected as a part of the National Institutes of Child Health and Development Study of Early Child Care and Youth Development (SECCYD). The SECCYD was a comprehensive survey of children and families, conducted with the intended purpose of observing the impact of early child care on cognitive, emotional, linguistic, and social development (NICHD, 1994). The SECCYD began collecting data on children and families in 1991. Data collection took place across ten cities in the United States (Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA; and Madison, WI). Recruitment was conducted at maternity hospitals across the 10 cities. In addition to agreeing to participate, mothers had to meet certain criteria: age of at least 18, English speaking, healthy baby, residence with 1 hour of study site, not planning on moving out of study area with a year, and residing in relatively safe neighborhood.

The final participating sample was 1,364 mothers who completed the first interview. This study used data from phase I, II, and III of the survey. Phase I contains data from birth through three years of age, phase II continues into school entry, and phase III continues through 6<sup>th</sup> grade. Approximately, 78% of the sample was followed for all three phases of the survey. The analytical sample for this study included 1,135 children with data from at least one measurement interval for any of the dependent variables. Demographics are reported in Table 1. The sample was almost evenly split between boys and girls (male = 52%). The sample was predominately Caucasian (80%). Thirteen percent of the sample was African-American. Seventy-seven percent of mothers were married living together at 54 months. Median family income at 54 months was \$45,000 ( $SD = \$48,575.38$ ).

## 9.1 MEASURES

*Body Mass Index (BMI).* BMI is the ratio of an individual's height to weight. It is one indicator of obesity. BMI was calculated consistent with current recommended practice for classifying children and adolescents as overweight or obese (Young et al., 2011). In the NICHD survey, child height and weight were measured at the lab or during health and physical development visits with the family. For this study, the measurements from first, third, fourth, fifth, and sixth grades were used. BMI in children is the product of the child's weight(lbs) divided by height(ins)-squared multiplied by a constant of 703. This value is then compared to age and gender specific percentile norms. Children who are in the 95<sup>th</sup> percentile meet criteria for obesity. In addition to treating BMI continuously, it was treated categorically to better capture differences between children who are classified as obese. These percentiles were used to compute a categorical variable comparing obese and children that do not these criteria.

*Internalizing Problems.* Internalizing problems were measured using the Child Behavior Checklist Parent Report (Achenbach, 1991). Many of the studies documenting a link between obesity and internalizing problems in childhood have relied on parent report, including research done with the SECCYD (Bradley et al., 2008; Goodman & Whitaker, 2002; Pine et al., 2001). In the NICHD SCCYD parent report is predominantly maternal report. Ninety-eight percent of CBCLs completed at first grade were completed by the mother. Parent report was used in this study to build upon these previous empirical findings. Furthermore, cross informant analyses have revealed better convergent validity for maternal report when examining mother, father, and teacher report (Grietens et al., 2004). Finally, the use of parent report allows for the inclusion of controls measures to account for documented confounds that significantly predict developmental psychopathology and discrepancies between parent and teacher report. This study included

measures of maternal psychopathology (Chilcoat & Breslau, 1997) and quality of the parent-child interaction (Treutler & Epkins, 2003) to control for these potential confounds.

Parents, mainly mothers, completed the CBCL during a lab visit or at home in first, third, fourth, fifth, and sixth grades. The CBCL is a widely used measure of child and adolescent adjustment. The internalizing broad score consists of 33 items from the anxious/depressed and somatic complaints subscales. Items were rated on ordinal interval with 0 indicating *not true of child* and 2 indicating *very true of the child*. The CBCL has been validated in diverse samples and shown to have strong internal consistency. In this study the total score was used.

*Externalizing Problems.* Externalizing behaviors were measured using both the Teacher Report Form of the Child Behavior Checklist (TRF; Achenbach, 1991) and the parent report CBCL in separate models. The TRF was included in addition to the CBCL to account for the "Halo effect," when ratings are influenced by an overall impression rather than observable behavior (Grietens et al., 2004). For example, parents rating high on externalizing problems because of the child's internalizing problems. Furthermore, past research has found small correlations between parent and teacher report of externalizing problems (Dwyer, et al., 2006; Stone, et al., 2013; Thomas, et al., 1990). This discrepancy suggests that there may be different findings using teacher in lieu of parent report.

The TRF is similar to the CBCL and is a broad measure of child adjustment. The externalizing broad score consists of 33 items from the aggressive and delinquent behaviors subscales. Items were rated on ordinal interval with 0 indicating *not true of child* and 2 indicating *very true of the child*. The TRF has been validated in diverse samples and shown to have strong internal consistency. The CBCL externalizing syndrome scale is also comprised of the aggressive and delinquent behaviors. In this study the total score from both scales was used.

## 9.2 CONTROL MEASURES

*Medical/Perinatal Risk.* Control measures were chosen based on their use in previous research examining the development of internalizing and externalizing psychopathology throughout childhood in data from the NICHD SECCYD (Fanti & Henrich, 2011). Mothers at the one and six month interview were surveyed regarding pregnancy risk factors and health complications. A score of 1 was given for endorsement of (a) maternal smoking, (b) passive smoking, (c) child's ear infections, (d) child respiratory problems, (e) injury resulting in the child visiting the doctor, and (f) maternal health problems during the pregnancy. The scores were summed to create a composite risk index ranging from 0 to 6.

*Adverse Context.* Adverse context was measured using two covariates. First, economic disadvantage was measured using an economic risk index from data collected at the 54 month interval. Consistent with Henrich and colleagues (2004), economic disadvantage was a composite variable of family finances, maternal marital status, and maternal education. Family finances were based on an income-to-needs ratio calculated based on the 1990 census bureau poverty threshold for a given household size. Families below the poverty threshold received a one. Additionally, mothers reported on educational level and whether they were married living with the father. Mothers reporting educational attainment lower than high school received a one. Single mothers also received a one. Scores on the risk index ranged from zero to three.

The physical environment subscale of the HOME Inventory was included as a covariate (Bradley, Caldwell, Brisby, & Magee, 1992). The HOME Inventory is a interview and observational tool intended to gather information about the overall quality of the child's living environment, with particular focus on characteristics of the environment that relate to child

development. The physical environment scale contains eight observer rated items of the quality of the child's physical environment. For example, "child's play environment appears safe and free of hazards." Items are rated dichotomously with the presence of a particular feature being endorsed with a 1. The NICHD survey included multiple measurements of the HOME inventory. This dissertation used the 54 months measurement of the home/caregiving environment.

*Temperament.* As noted previously, there is evidence that mothers who perceive their infant or children as difficult or fussy are more likely to use food to sooth. Temperament was measured using the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 1994 ). The CBQ is parent rated and intended for children between the ages of 3 and 8. This study used an adapted version of the inhibitory control scale. This scale was designed to measure behavioral disinhibition. For example, "Can easily stop an activity when s/he is told 'no'" and "Has difficulty wating in line for something." Items were rated on ordinal interval with 1 being *extremely untrue* and 7 being *extremely true*.

*Cognitive Ability.* Cognitive ability was measured using the Woodcock-Johnson-Revised Psychoeducational Battery (WJR; Woodcock, 1990 ). The WJR is one of the most widely used measures of cognitive development and academic achievement. The WJR is a collection of subtests measuring different domains associated with intelligence and achievement. This dissertation used the fluid reasoning scale, administered at 54 months, as a measure of cognitive ability. Fluid reasoning was defined as the ability to "reason in novel situations." This ability to reason included deductive, inductive, conjunctive, and disjunctive forms of reasoning, as well as drawing conclusions from relationships.

*Maternal Depression.* Maternal Depression was measured using the Center for Epidemiological Studies Depression Scale (CESD; Radloff, 1977 ). The CESD is the standard for measuring depression in population level studies. The CESD contain twenty items measuring depressed mood. For example, “I thought my life had been a failure,” and “My sleep was restless.” Items were rated on ordinal interval with four options: *rarely or none of the time (less than 1 day)*, *some or a little of the time (1-2 days)*, *occasionally or a moderate amount of time (3-4 days)*, or *most of all the time (3-7 days)*. The CESD was administered to mother at the 54 months home visit. The total composite was used in this study.

*Attachment Security.* Attachment security was measured using the strange situation. The decision was made to use the strange situation because of its previous use in a study of child and adolescent obesity (Anderson et al., 2012). Security was rated after a parent child-interaction task at the 36 months laboratory interview (NICHD ECCRN, 1999). The security scale is based on observations of the child’s behavior and was rated by trained coders. Behaviors were rated on ordinal scale with 1 being *minimally characteristic* and 9 being *highly characteristic*.

There were three additional covariates included in the model. Ethnicity was dummy coded with three variables—one with Caucasian as the comparison group and one with African American as the comparison category. Gender was included in the primary models, for hypothesis testing and as a control.

## **10 RESULTS**

### **10.1 DESCRIPTIVE STATISTICS**

Complete information on missingness and descriptives is included in Table 1 for the variables measured at the first grade and the control variables. As can be seen in Table 1, the correlation between BMI and the developmental psychopathology covariates at first grade was

Table 1  
*Descriptive Statistics*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 T-Externalizing- G1														
2 P-Externalizing-G1	0.33													
3 P-Internalizing-G1	0.08	0.55												
4 BMI-G1	0.09	0.07	0.05											
5 SES	0.21	0.17	0.06	0.09										
6 Perinatal Risk	0.12	0.14	0.14	0.06	0.12									
7 Gender (Male = 1)	0.19	0.08	-0.04	0.03	-0.01	0.04								
8 Applied Problems	-0.21	-0.10	-0.03	-0.10	-0.34	-0.11	-0.13							
9 H.O.M.E	-0.12	-0.14	-0.08	-0.09	-0.38	-0.11	0.02	0.30						
10 Maternal Depression	0.16	0.26	0.23	0.05	0.28	0.10	0.04	-0.21	-0.19					
11 Attachment	-0.11	-0.04	-0.04	-0.04	-0.17	-0.07	0.06	0.25	0.11	-0.09				
12 Disinhibition (CBQ)	-0.26	-0.44	-0.20	-0.07	-0.14	-0.11	-0.16	0.25	0.10	-0.23	0.09			
13 African-American	0.22	0.07	0.00	0.09	0.36	-0.02	0.00	-0.33	-0.30	0.20	-0.12	-0.07		
14 Caucasian	-0.18	-0.07	-0.02	-0.09	-0.37	0.05	0.02	0.30	0.27	-0.18	0.10	0.08	-0.78	
<i>Mean</i>	5.63	8.15	4.87	16.81	0.37	1.83	0.52	102.94	6.35	9.83	5.03	4.66	0.13	0.80
<i>SD</i>	8.18	6.59	4.40	2.56	0.74	1.11	0.5	15.63	1.10	8.70	1.73	0.77	0.34	0.40
<i>% Missing</i>	26	25	25	27	21	17	0	23	24	21	16	22	0	0
<i>Skewness</i>	2.07	1.25	1.50	1.93	2.11	0.24	NA	-0.58	-1.91	1.44	-0.43	-0.28	NA	NA
<i>Kurtosis</i>	4.27	2.25	3.07	5.41	3.79	-0.45	NA	0.81	3.55	2.34	-0.52	-0.07	Na	NA



less than 0.10. The correlation between parent rated internalizing and externalizing problems was relatively large (0.55). The correlations between the control variables and BMI were all at or below 0.10. Additionally, the correlation between teacher rated externalizing problems and parent rated internalizing problems was small.

## 10.2 CONTINUOUS BMI AND TEACHER EXTERNALIZING BEHAVIORS

All analyses were conducted in Mplus v7 (Muthen & Muthen, 1998). The first model reported included continuous measures of parent rated internalizing problems, teacher rated externalizing behaviors, and BMI, as well as the preschool control variables. This model was estimated using maximum likelihood estimation with multiple imputation (N = 40) of the exogenous covariates. Full information maximum likelihood estimation (FIML) is standard in Mplus for the endogenous variables (Enders, 2012; Muthén & Muthén, 2008). FIML ensures that any cases with information on any of the endogenous variables are included in the analyses (Enders, 2012; Muthén & Muthén, 2008). However, cases missing data on exogenous variables are ignored. Therefore, multiple imputation was used for the exogenous variables to ensure that any cases with data on the endogenous variables were included in the analyses. Initial models were estimated with maximum likelihood estimation and maximum likelihood estimation with robust standard errors (MLR). MLR with multiple imputations in Mplus did not provide the scale correction factor needed for conducting chi-square difference tests. Therefore, maximum likelihood estimation was selected as the most appropriate estimator. However, several models were run with both ML and MLR to test whether deviations from multivariate normality skewed the results. These results were nearly identical.

Analyses began by estimating and comparing three statistical models: a) the hypothesized cascade model in Figure 1; b) a completely cross lagged “transactional” model with all paths estimated between externalizing behaviors, internalizing problems, and BMI (Figure 2); and c) a non-dynamic model with no cross lagged or cascading paths, only correlations between the first grade waves of measurement. The results of the hypothesized cascade model are presented in Figure 3. Model fit indices are presented in Table 2.

The cascade and transactional models were compared to the non-dynamic model using chi-square difference tests. The chi-square test comparing the cascade model with the non lagged model was significant ( $\Delta\chi^2 = 28.13$ ,  $df = 9$ ,  $p < 0.001$ ), indicating that cascade model fit better than the non-dynamic model. The chi-square test comparing the completely cross lagged transactional model to non-dynamic model was also significant ( $\Delta\chi^2 = 61.51$   $df = 24$ ,  $p < 0.001$ ), indicating the transactional model fit better than the non-dynamic model. Next, the cascade and transactional models, which are nested, were compared. The chi-square difference test suggested that the transactional model improved model fit over the cascade model ( $\Delta\chi^2 = 33.38$ ,  $df = 15$ ,  $p = 0.004$ ). These findings suggest that during childhood the relationship between externalizing behaviors, internalizing problems, and BMI is likely best modeled as a transactional relationship. However, as seen in Figure 3, few of the paths were statistically significant.

Follow-up analyses focused on using a series of chi-square difference tests to examine the relationship between the three constructs of interest across childhood. Analyses focused on the association between externalizing behaviors and BMI; internalizing problems and BMI; and externalizing behaviors with internalizing problems. I focused on these three associations—rather than an overall omnibus model—because of the complexity of the model and number of

measurement waves. These analyses were followed-up with multigroup models that tested for potential gender differences.

*Externalizing Behaviors and BMI.* The estimated paths between externalizing behaviors and BMI were constrained to be equal across time. A chi-square difference test comparing this model with a freely estimated model was non-significant ( $\Delta\chi^2 = 9.07, df = 6, p = 0.170$ ), indicating no change in the relationship between externalizing behaviors and BMI across childhood. However, the standardized coefficient for the effects of externalizing behaviors on BMI and BMI on externalizing behaviors never reached significance for any of the waves of measurement. These findings suggested there was no association between externalizing behaviors and BMI, and this finding does not change across childhood.

*Internalizing problems and BMI.* The paths between internalizing problems and BMI were constrained. A chi-square difference test comparing this model with a freely estimated model was significant ( $\Delta\chi^2 = 13.97, df = 6, p = 0.030$ ), indicating that the association between BMI and internalizing changes across childhood. Based on these findings two models were estimated. First, the paths predicting BMI from internalizing problems index were constrained. A chi-square difference test comparing this model with a freely estimated model was non-significant ( $\Delta\chi^2 = 4.25, df = 3, p = 0.235$ ), indicating that the effects of internalizing

Table 2.  
*Model Fit Indices*

	$\chi^2$	RMSEA ( <i>CI</i> <sub>90%</sub> )	CFI	TLI	S/WRMR
<b>Teacher EXT and BMI</b>					
Non-dynamic ( <i>df</i> = 87)	622.69	0.07 (0.07-0.08)	0.96	0.87	0.04
Cascade ( <i>df</i> = 78)	594.56	0.08 (0.07-0.08)	0.96	0.86	0.04
Transactional ( <i>df</i> = 63)	561.18	0.08 (0.08-0.09)	0.96	0.83	0.04
Multi-group					
Non-dynamic ( <i>df</i> =174)	783.65	0.08 (0.07-0.08)	0.95	0.86	0.05
Cascade ( <i>df</i> =156)	746.74	0.08 (0.08-0.09)	0.95	0.85	0.04
Transactional ( <i>df</i> =126)	704.74	0.09 (0.08-0.09)	0.95	0.82	0.04
Final Model ( <i>df</i> = 159)	703.94	0.05 (0.05-0.06)	0.96	0.93	0.04
<b>Parent EXT and BMI</b>					
Non-dynamic ( <i>df</i> = 87)	1536.94	0.12 (0.12-0.13)	0.91	0.73	0.07
Cascade ( <i>df</i> = 78)	1494.97	0.13 (0.12-0.13)	0.91	0.71	0.07
Transactional ( <i>df</i> = 63)	1438.91	0.14 (0.13-0.15)	0.91	0.65	0.06
Multi-group					
Non-dynamic ( <i>df</i> =174)	1675.44	0.12 (0.12-0.13)	0.91	0.73	0.08
Cascade ( <i>df</i> =156)	1624.43	0.13 (0.12-0.13)	0.91	0.72	0.07
Transactional ( <i>df</i> =126)	1555.15	0.14 (0.13-0.15)	0.91	0.66	0.06
Final Model ( <i>df</i> = 121)	977.102	0.08 (0.08-0.09)	0.92	0.89	0.08
<b>Teacher EXT and Obesity</b>					
Transactional ( <i>df</i> =87)	228.31	0.04 (0.04-0.05)	0.99	0.98	0.98
Final Model ( <i>df</i> =172)	609.54	0.05 (0.04-0.05)	0.99	0.98	1.073
<b>Parent EXT and Obesity</b>					
Transactional ( <i>df</i> =87)	247.62	0.04 (0.04-0.05)	0.99	0.98	0.92
Final Model ( <i>df</i> =178)	611.21	0.05 (0.04-0.05)	0.98	0.98	0.98

*Note.* RMSEA= Root Mean Squared Error of Approximation, CFI = Criterion Fit Index, TLI = Tucker Lewis Index, SRMR = Standardized Root Mean Square Residual, WRMR = Weighted Root Mean Residual

problems on BMI did not change across childhood. A chi-square difference test was also conducted for a model in which internalizing problems was regressed on BMI. This test was significant ( $\Delta\chi^2 = 9.90$ ,  $df = 3$ ,  $p = 0.019$ ), indicating that the effect of BMI on internalizing problems changed across childhood. Therefore, a series of difference tests were conducted to examine changes across time. First the third grade path predicting internalizing problems from BMI ( $\beta = 0.01$ ,  $p = ns$ ) was freed. The chi-square difference test was still significant ( $\Delta\chi^2 = 8.27$ ,  $df = 2$ ,  $p = 0.016$ ). The chi-square test was still significant after freeing the fourth grade path ( $\beta = 0.01$ ,  $p = ns$ ,  $\Delta\chi^2 = 4.65$ ,  $df = 1$ ,  $p = 0.031$ ). These findings suggested that the relationship between internalizing problems and BMI was driven by the effects of BMI on internalizing problems. Furthermore, this relationship becomes stronger as children grow older and the effects of BMI on internalizing problems become more pronounced between fifth ( $\beta = 0.02$ ,  $p = ns$ ) and sixth ( $\beta = 0.09$ ,  $p < 0.05$ ) grades (See Figure 4). However, these effects remain small, and mostly nonsignificant.

*Externalizing Behaviors and Internalizing Problems.* The analyses involving BMI were followed up with analyses that solely focused on internalizing and externalizing problems. The paths between internalizing problems and externalizing behaviors were constrained; this model was compared with a freely estimated model, resulting in a significant chi-square ( $\Delta\chi^2 = 21.30$ ,  $df = 6$ ,  $p < 0.001$ ). These findings indicated that the association between internalizing problems and externalizing problems changed across childhood. However, follow-up tests revealed that these effects were mainly driven by the effects of internalizing problems on externalizing behaviors ( $\Delta\chi^2 = 15.47$ ,  $df = 3$ ,  $p < 0.001$ ), not the effect of externalizing behaviors on internalizing problems ( $\Delta\chi^2 = 6.07$ ,  $df = 3$ ,  $p = 0.108$ ). Follow-up analyses were conducted to determine the effect of internalizing problems on externalizing problems across time. First, the

third grade path was freely estimated ( $\Delta\chi^2 = 13.94$ ,  $df=2$ ,  $p < 0.001$ ), followed by the fourth grade path ( $\Delta\chi^2 = 10.28$ ,  $df=1$ ,  $p < 0.001$ ). Both chi-squares were still significant. As can be seen in Figure 4, these findings suggest that the relationship between externalizing and internalizing problems is mainly driven by the role of internalizing problems on externalizing. As can be seen in Figure 4, the direct of effect switches.

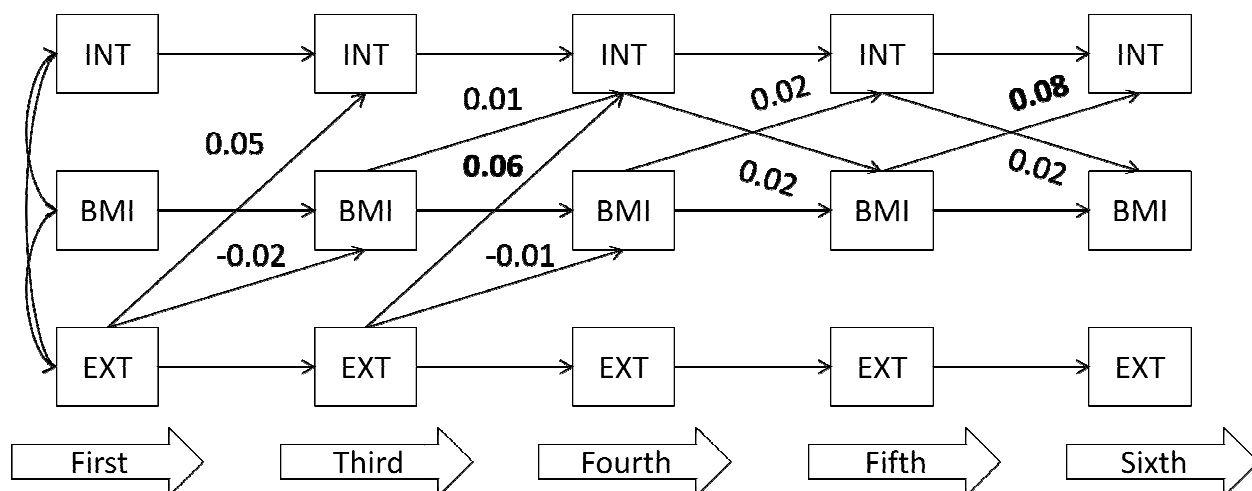


Figure 3. BMI, Parent-Rated Internalizing, and Teacher-Rated Externalizing Cascade Path Diagram. RMSEA = 0.08, CFI = 0.96. The only significant ( $p < 0.05$ ) coefficient is bolded. (BMI = Body mass index; INT = Internalizing problem; EXT = Externalizing behaviors). Coefficients are standardized.

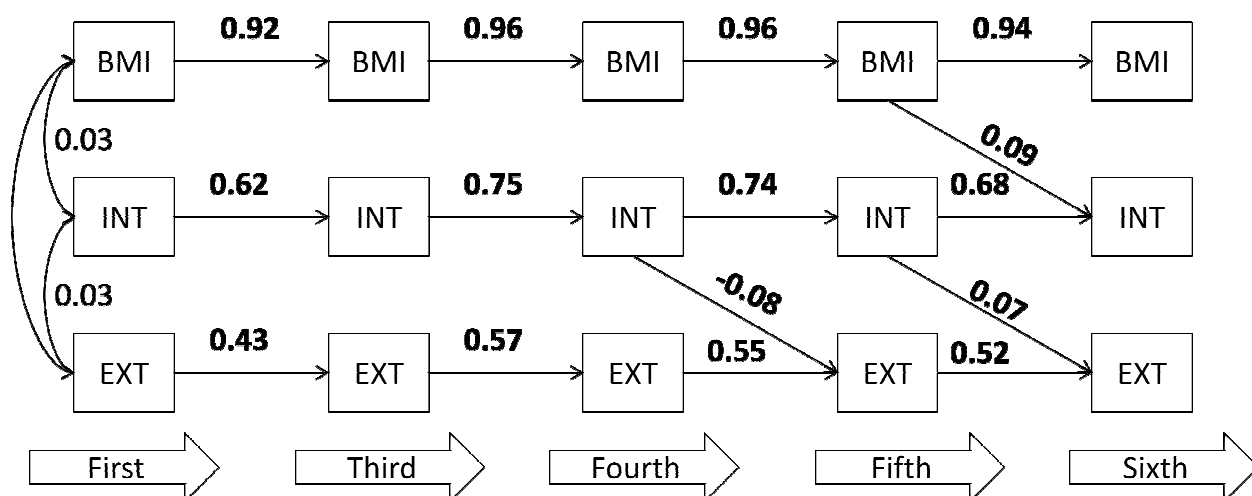


Figure 4. BMI, Parent-Rated Internalizing, and Teacher Rated Externalizing Final Path Diagram. The selected, final model with trimmed non-significant paths, continuous measures of BMI and teacher rated externalizing behaviors. Coefficients are standardized. (BMI = Body mass index; INT = Internalizing problem; EXT = Externalizing behaviors). Significant paths are bolded.

*Gender Differences.* These models were then analyzed within a multigroup framework to account for potential gender differences. A cross lagged model with separate paths for boys and girls was compared to the non-dynamic model with separate paths for boys and girls. This chi-square difference test was significant ( $\Delta\chi^2 = 78.90, df = 48, p = 0.003$ ), indicating that the additional paths should be accounted for in the model. Also, a cascade model (Figure 2) with separate paths for boys and girls was compared to a non-lagged model with separate paths for boys and girls. This chi-square difference test was significant ( $\Delta\chi^2 = 36.91, df = 18, p = 0.005$ ), indicating that the cascade model with separate paths fit better than the non-dynamic model. These cascade and crosslagged models were then compared. However, estimating the additional cross lagged paths did significantly change the chi-square ( $\Delta\chi^2 = 41.99, df = 30, p = 0.072$ ). This suggests that estimating the additional paths in the transactional model did not significantly improve fit. Similar to the model without separate paths for boys and girls, none of the standardized coefficients in the cascade model was greater than 0.10. Based on this finding, the decision was made to focus on exploring the patterns of findings in the cross-lagged model.

The paths from externalizing to BMI were constrained across time to be the same for boys and girls. This model was not significantly different from the freely estimated model ( $\Delta\chi^2 = 17.37, df = 14, p = 0.237$ ). A model with paths between internalizing problems and BMI constrained to be the same across time for boys and girls was not significantly different from a freely estimated multigroup model ( $\Delta\chi^2 = 21.45, df = 14, p = 0.091$ ).

Analyses were also conducted to examine a possible gender by time effect for the association between externalizing behaviors and internalizing problems. A chi-square difference test indicated that a model with paths between internalizing and externalizing problems constrained to be the same across time for boys and girls was significantly different from a freely

estimated model ( $\Delta\chi^2 = 26.88$ ,  $df = 14$ ,  $p = 0.020$ ). However, this effect was driven primarily by differences in the effects of internalizing problems on externalizing behaviors ( $\Delta\chi^2 = 16.93$ ,  $df = 7$ ,  $p = 0.018$ ), not the reverse ( $\Delta\chi^2 = 10.23$ ,  $df = 7$ ,  $p = 0.176$ ). Additional chi-square tests were conducted to determine at which interval the difference occurred. The third grade ( $\Delta\chi^2 = 14.99$ ,  $df = 5$ ,  $p = 0.010$ ) and fourth grade ( $\Delta\chi^2 = 11.43$ ,  $df = 3$ ,  $p = 0.10$ ) paths were successively freed, resulting in significant chi-square tests. As can be seen in Figure 5, these findings suggest that the effects of internalizing on externalizing problems change over time and differ for boys and girls. However, these effects remained small and mostly nonsignificant (Figure 5).

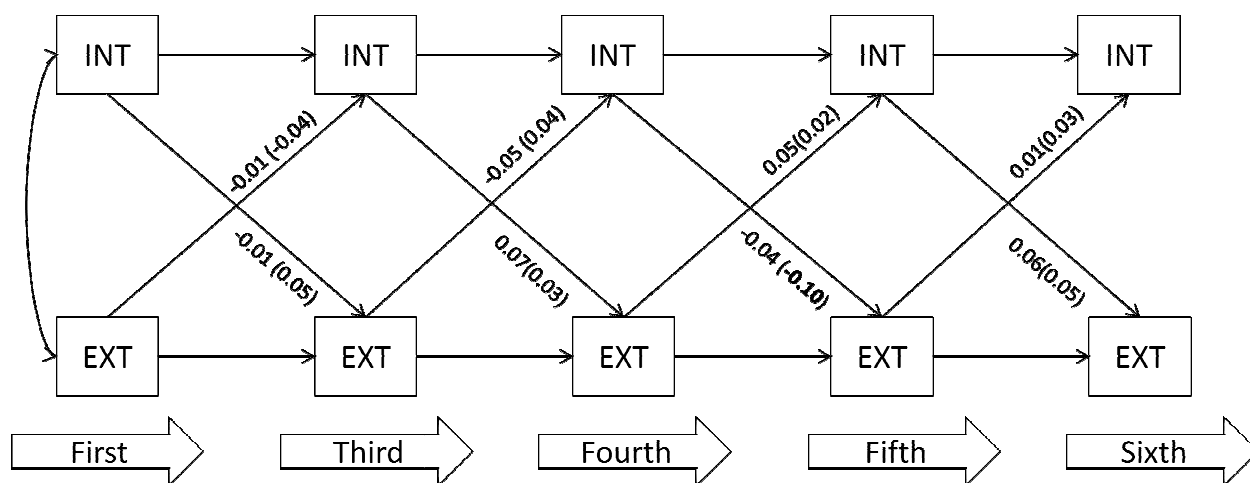


Figure 5. *Gender Differences in Crosslagged Effects Between Externalizing Behaviors and Internalizing Problems*. Coefficients for boys are presented in parenthesis. Coefficients outside of parenthesis are for girls. The only significant coefficient is bolded. INT = internalizing problems, EXT = Externalizing Behaviors. Externalizing behaviors are teacher rated.

*Final Selected Model.* Despite the results of these chi-square test, none of the endogenous covariates exceeded small effects ( $\beta < 0.10$ ). Therefore, the findings reported in Figure 4 are from a model without separate coefficients for boys and girls. The findings suggested that fifth grade BMI significantly, positively predicted sixth grade internalizing problems. Fourth grade internalizing problems significantly, negatively predicted fifth grade externalizing behaviors.



Fifth grade internalizing problems significantly, positively predicted sixth grade externalizing behaviors.

The final stage of the analyses focused on improving parsimony from the original model. The effects of non-significant control variables were dropped from the model. However, all of the pre-school covariates were left predicting the first grade measurements of externalizing behaviors, internalizing problems, and BMI. The standardized coefficients presented in Figure 4 are from this reduced model, as well as the coefficients reported in Table 2-4. The model presented in Figure 1 had a Root Mean Squared Error of Approximation (RMSEA) of 0.05 ( $CI_{90\%}=0.06-0.07$ ) and Comparative Fit Index (CFI) of 0.96. Both values are consistent with thresholds for ensuring adequate model fit and parsimony.

As can be seen in Figure 4, there was a significant, positive effect of BMI at fifth grade on internalizing problems in sixth grade. There was a significant, negative effect of internalizing problems at fourth grade on externalizing problems at fifth grade. At sixth grade, the effect of fifth grade internalizing on externalizing was positive. Furthermore, the auto-regressive paths suggest a high degree of continuity across time for BMI. There was a moderate degree of stability for internalizing problems and externalizing behaviors.

The coefficients for the effects of the covariates on externalizing behaviors are reported in Table 1. There was a significant, positive effect of SES on externalizing problems at first, third, fifth and sixth grade. There was a significant, positive effect of medical risk on externalizing problems at first grade only. Boys had higher externalizing problems at first, third, fourth, and sixth grade. There was a significant, positive effect of maternal depression on externalizing problems at fourth grade only. There was a significant, negative effect of effortful

control on externalizing problems at first, third, and fifth grade. African-Americans had higher externalizing problems at first, third, fourth, and fifth grade.

The coefficients for the effects of the covariates on internalizing problems are reported in Table 2. There was a significant, positive effect of medical risk on internalizing problems at first grade. Girls had higher internalizing problems at first grade only. There was a significant, positive effect of the Woodcock Johnson-R Applied problems score on internalizing problems in first grade; however, in third and fourth grade this effect was negative. Maternal depression was significantly associated with increasing internalizing problems in first, third, fifth, and sixth grades. The coefficients for the effects of the covariates on BMI are reported in Table 4. There was a significant, negative effect of the HOME physical environment inventory on BMI at third and sixth grade. At third grade there was a significant, positive effect of maternal depression on BMI.

These findings suggested that the relationship between externalizing behaviors, internalizing problems, and BMI changed across childhood, although the shift is small. Internalizing problems significantly predicted externalizing problems in fifth and sixth grade; in fifth grade this effect was negative, and this effect was positive in sixth grade. BMI significantly predicts internalizing problems but only in sixth grade. There was no association between externalizing behaviors and BMI, nor were there any meaningful gender differences.

### 10.3 CONTINUOUS BMI AND RATED EXTERNALIZING BEHAVIORS

The hypothesized models were then reanalyzed using the parent-report externalizing behaviors scale from the CBCL. This set of analyses followed the same analytic strategy from the previous section. The only difference was the inclusion of parent rather than teacher report of

externalizing behaviors. As before, models used full information maximum likelihood estimation for the endogenous covariates and multiple imputation ( $N = 40$ ) for the exogenous preschool control variables. First the non-dynamic model was compared to a transactional and cascade model. Chi-square difference tests suggested that the transactional ( $\Delta\chi^2 = 98.03$ ,  $df = 24$ ,  $p < 0.001$ ) and cascade model ( $\Delta\chi^2 = 41.97$ ,  $df=9$ ,  $p < 0.001$ ). Both of these models fit better than the non-dynamic model. Furthermore, a chi-square difference test was used to compare the transactional and cascade models. A chi-square difference tested supported the estimation of the additional paths in the transactional model ( $\Delta\chi^2 = 56.06$ ,  $df = 15$ ,  $p < 0.001$ ). These findings provide increased support for a transactional approach, versus the non-dynamic or cascade model. However, very few coefficients representing cross-lagged effects were significant, similar to the previous analyses.

*Externalizing Problems and BMI.* The paths between externalizing problems and BMI were constrained to be the same across all waves of measurement. This model was compared with a freely estimated model. This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 19.59$ ,  $df = 6$ ,  $p = 0.003$ ), indicating that the association between externalizing behaviors and BMI changes across childhood. Next, the effects of externalizing behaviors on BMI were constrained while the paths from BMI to behavior problems were freed. Again, this was compared with a freely estimated model and resulted in a significant chi-square difference test ( $\Delta\chi^2 = 9.16$ ,  $df= 3$ ,  $p = 0.027$ ), indicating that the effects of externalizing behaviors on BMI change across childhood. The paths from BMI to externalizing problems were then constrained while the previous paths were freed. This was compared to a freely estimated model. This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 10.19$ ,  $df = 3$ ,  $p = 0.017$ ), indicating that

the effects of BMI on externalizing behaviors changes across childhood. Despite these findings, none of the effects between externalizing behaviors and obesity were significant (Figure 6).

Table 3  
*Unstandardized Coefficients for Exogenous Covariates on Teacher Rated Externalizing Behaviors*

	Grade 1			Grade 3			Grade 4			Grade 5			Grade 6		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
( <i>N</i> = 1,135)															
SES	0.87	0.41	0.033	2.26	0.40	0.000				0.82	0.39	0.032	1.53	0.37	0.000
Medical Risk	0.61	0.23	0.009												
Gender (1= male)	2.68	0.49	0.000	1.144	0.50	0.023	2.17	0.45	0.000				2.50	0.51	0.000
WJAP	-0.02	0.02	0.190												
HOME	0.02	0.26	0.955												
Maternal Depression	0.04	0.03	0.178				0.09	0.03	0.002						
Attachment Security	-0.26	0.15	0.083												
CBQ	-1.86	0.34	0.000	-1.19	0.36	0.001				-0.91	0.34	0.008			
African-American	3.44	1.21	0.004	3.59	1.22	0.003	2.84	1.11	0.010	4.52	1.21	0.000			
White	-0.36	0.98	0.71	0.50	1.01	0.619	-0.82	0.88	0.352	0.88	0.98	0.369			

*Note.* WJAP = Woodcock Johnson-R Applied Problems, Home = HOME Physical Environment Inventory, CBQ = Child Behavior Questionnaire, Effortful Control Scale

Table 4  
*Unstandardized Coefficients for Exogenous Covariates on Internalizing Problems*

	(N = 1,135)	Grade 1			Grade 3			Grade 4			Grade 5			Grade 6		
		B	SE	p	B	SE	p	B	SE	p	B	SE	p	B	SE	p
SES		-0.15	0.22	0.505												
Medical Risk		0.49	0.12	0.000												
Gender (1= male)		-0.59	0.26	0.025												
WJAP		0.02	0.01	0.075	-0.03	0.01	0.000	-0.02	0.01	0.005						
HOME		-0.18	0.14	0.210												
Maternal Depression		0.10	0.02	0.000	0.04	0.02	0.005				0.03	0.01	0.028	0.04	0.02	0.020
Attachment Security		-0.02	0.08	0.782												
CBQ		-0.99	0.18	0.000												
African-American		-0.78	0.65	0.233												
White		-0.39	0.54	0.465												

*Note.* WJAP = Woodcock Johnson-R Applied Problems, HOME = HOME Physical Environment Inventory, CBQ = Child Behavior Questionnaire, Effortful Control Scale

Table 5  
*Unstandardized Coefficients for Exogenous Covariates on BMI*

	Grade 1			Grade 3			Grade 4			Grade 5			Grade 6		
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>
( <i>N</i> = 1,135)															
SES	0.09	0.14	0.520												
Medical Risk	0.09	0.07	0.214												
Gender (1= male)	0.12	0.16	0.445												
WJAP	-0.01	0.01	0.378												
HOME	-0.10	0.09	0.246	-0.11	0.05	0.016	0.07	0.04					-0.27	0.06	0.000
Maternal Depression	-0.00	0.01	0.947	0.012	0.01	0.035									
Attachment Security	-0.01	0.05	0.806												
CBQ	-0.12	0.11	0.276												
African-American	0.15	0.39	0.696												
White	-0.31	0.32	0.330												

*Note.* WJAP = Woodcock Johnson-R Applied Problems, Home = HOME Physical Environment Inventory, CBQ = Child Behavior Questionnaire, Effortful Control Scale

As can be seen in Figure 6, this suggests that while the size of the effects or directionality may change, the association between BMI and externalizing behaviors is not significantly large to reach significance during childhood, even in this large of a sample.

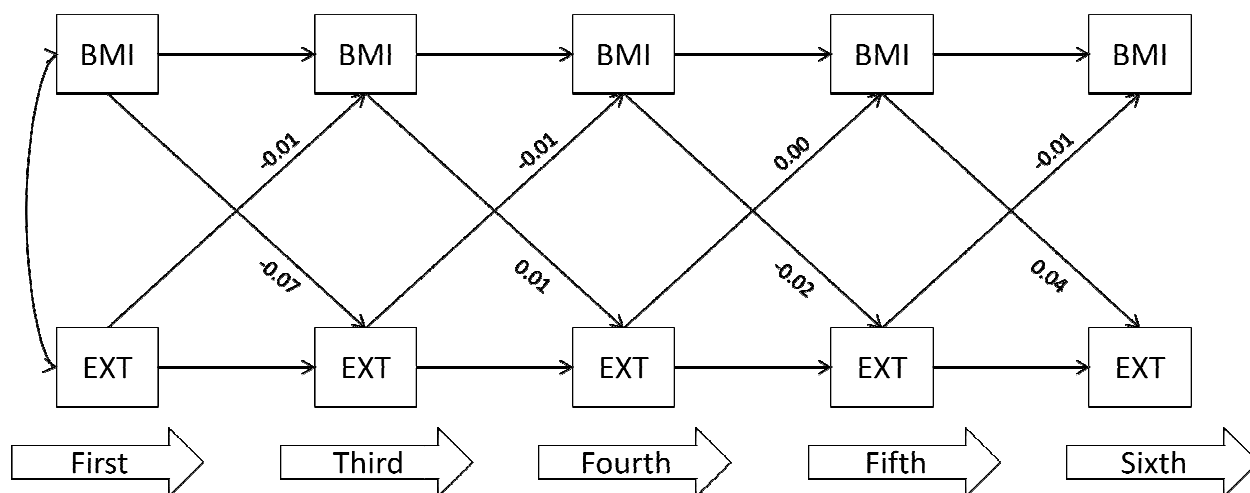


Figure 6. *Path Diagram of Cross-Lagged Between Parent Rated Externalizing Problems and BMI.* Coefficients are Standardized. BMI= Body Mass Index, EXT = Parent Rated Externalizing Behaviors. None of the paths are statistically significant.

*Internalizing Problems and BMI.* These analyses used the same reporter and measure of internalizing problems as reported in the previous section. The results did not vary in form from the previous section and are not re-reported to reduce redundancy. There was the same general pattern of findings. The chi-square difference tests indicated that the association between internalizing problems and BMI changed across childhood. This effect was driven by the effect of BMI on internalizing problems. However, the coefficients were primarily small and nonsignificant until late childhood.

*Internalizing and Externalizing Problems.* After examining internalizing and obesity, analyses focused on the relationship between internalizing and externalizing problems. First, all paths between internalizing and externalizing problems were constrained. This model was compared to a freely estimated model. This resulted in a significant chi-square difference test



( $\Delta\chi^2 = 21.39$ ,  $df = 6$ ,  $p = 0.002$ ), indicating that the relationship between internalizing and externalizing problems changes across childhood. Next, only the paths from externalizing behaviors to internalizing problems were constrained. This model was compared to a freely estimated model resulting in a significant chi-square difference test ( $\Delta\chi^2 = 8.76$ ,  $df = 3$ ,  $p = 0.033$ ), indicating that the effects of externalizing behaviors on internalizing problems changed across childhood. Therefore, the paths were freely estimated, path by path, starting with the third grade wave ( $\beta = 0.05$ ,  $p = ns$ ) of measurement. Removing the constraint on the third grade wave of measurement resulted in a significant chi-square difference test ( $\Delta\chi^2 = 6.39$ ,  $df = 2$ ,  $p = 0.041$ ), meaning differences between fourth ( $\beta = 0.06$ ,  $p = 0.030$ ), fifth ( $\beta = 0.05$ ,  $p = ns$ ), and sixth grade ( $\beta = 0.01$ ,  $p = ns$ ) remained. However, removing both the constraint on the third and fourth grade wave of measurement did not result in a significant chi-square test ( $\Delta\chi^2 = 3.59$ ,  $df = 1$ ,  $p = 0.058$ ). These findings suggest that the effects of externalizing problems changes across childhood.

Next, the paths from externalizing behaviors to internalizing problems were freely estimated and the paths from internalizing problems to externalizing behaviors were constrained to be the same across time. This model was compared to a freely estimated model, resulting in a significant chi-square difference test ( $\Delta\chi^2 = 13.23$ ,  $df = 3$ ,  $p = 0.004$ ), indicating that the effects of internalizing problems on externalizing problems changes across childhood. Therefore, the paths were freed, path by path, starting with the third grade wave of measurement. First, the third grade path was freely estimated ( $\beta = 0.00$ ,  $p = ns$ ). This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 9.99$ ,  $df = 2$ ,  $p = 0.007$ ). Next, both the third and fourth ( $\beta = 0.08$ ,  $p = 0.002$ ) grade waves of measurement were freely estimated, while the fifth and sixth grades were constrained. This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 4.026$ ,  $df = 1$ ,  $p =$

0.045), indicating that the difference is between fourth, fifth ( $\beta = -0.00$ ,  $p = ns$ ), and sixth ( $\beta = 0.04$ ,  $p = ns$ ) grades. These findings suggest that internalizing problems differentially predict externalizing problems across childhood.

*Gender Differences.* These models were compared within a multigroup framework to account for possible gender differences. Again, the chi-square difference test favored the transactional ( $\Delta\chi^2 = 120.29$ ,  $df = 48$ ,  $p < 0.001$ ) and cascade models ( $\Delta\chi^2 = 51.01$ ,  $df = 18$ ,  $p < 0.001$ ) over the non-dynamic model. The chi-square difference test comparing the transactional and cascade model supported the transactional model as better fitting ( $\Delta\chi^2 = 69.28$ ,  $df = 30$ ,  $p < 0.001$ ). Therefore, all further analyses focused solely on the transactional model with all crosslagged paths estimated. The next step in the analyses involved estimating a series of multigroup models to account for potential gender differences between boys and girls. First a model was estimated with the paths between externalizing behaviors and BMI constrained to be the same across time and to be the same for both boys and girls. This model was compared to a freely estimated model, resulting in a significant chi-square ( $\Delta\chi^2 = 25.72$ ,  $df = 13$ ,  $p = 0.028$ ), indicating a gender by time interaction. In follow-up, a model was estimated with the effects of BMI on externalizing behaviors constrained across time and gender to be the same. This was compared to a freely estimated model, but the results were not significant ( $\Delta\chi^2 = 10.27$ ,  $df = 7$ ,  $p = 0.174$ ). Next, a model was estimated with the effects of externalizing behaviors on BMI constrained to be the same across time and gender. This was compared to a freely estimated model, resulting in a significant chi-square difference test ( $\Delta\chi^2 = 16.22$ ,  $df = 7$ ,  $p = 0.023$ ). Despite these findings, none of the effects of externalizing problems ever achieved significance. Therefore, these paths were completely dropped from the model. This reduced model was compared with the freely estimated model. This resulted in a significant chi-square difference

test ( $\Delta\chi^2 = 29.99$ ,  $df = 16$ ,  $p = 0.018$ ), indicating poor fit. However, the removal of these paths improved other model fit indices such as the RMSEA and TLI. The TLI increased from 0.65 with parent rated externalizing to 0.89 without these measures. Therefore, these paths were not included in the final model.

Next the paths between internalizing problems and BMI were constrained and compared to a freely estimated model. This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 29.74$ ,  $df = 13$ ,  $p = 0.008$ ), indicating that the change in associations between internalizing problems and BMI differs for boys and girls. In follow-up, the paths from BMI to internalizing problems were constrained to be the same across time and gender. This model was compared to a freely estimated model, resulting in a significant chi-square difference test ( $\Delta\chi^2 = 17.938$ ,  $df = 7$ ,  $p = 0.012$ ), indicating that the effects of BMI on internalizing problems differs for boys and girls across childhood. Next, paths were freely estimated from the constrained model starting with the third grade wave. Freely estimating the third grade wave still resulted in a significant chi-square difference test ( $\Delta\chi^2 = 14.38$ ,  $df = 5$ ,  $p = 0.013$ ). After the fourth grade wave was freely estimated; this comparison still resulted in a significant chi-square difference test ( $\Delta\chi^2 = 7.90$ ,  $df = 3$ ,  $p = 0.048$ ). These results suggest that the effects of BMI on parent rated internalizing problems differ across childhood between boys and girls (Figure 7), however, the effects in Figure 7 are all relatively similar.

After estimating the effects of BMI on internalizing problems, analyses focused on the effects of internalizing problems on BMI. The paths predicting BMI from internalizing problems were constrained to be the same across time and across gender. This model was compared to a freely estimated model. This chi-square difference test was not significant ( $\Delta\chi^2 = 12.56$ ,  $df = 7$ ,  $p$

= 0.084), indicating no gender by time interaction in the effects of internalizing problems on BMI.

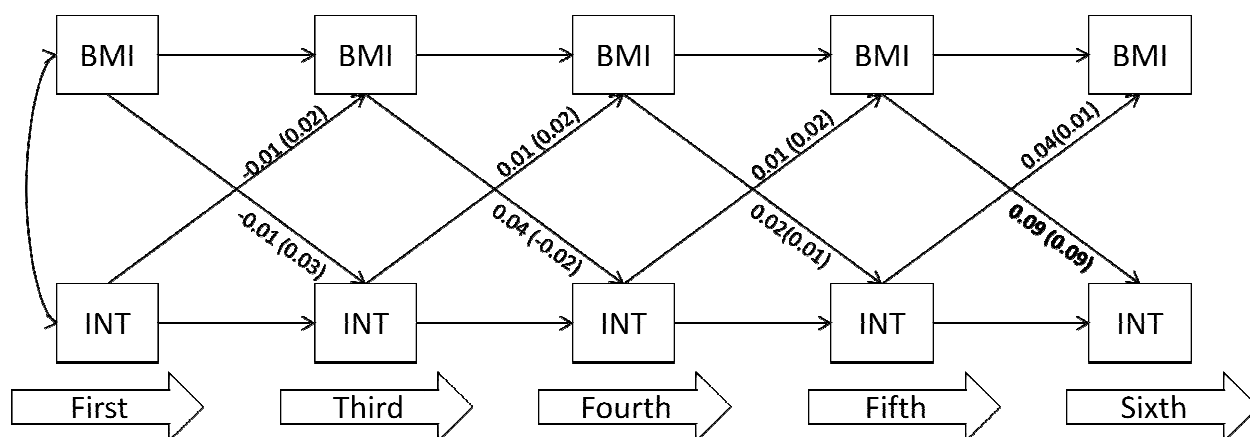


Figure 7. *Gender Differences in Crosslagged Effects Between Parent-Rated Internalizing Problems and BMI.* Coefficients for Boys are reported in parenthesis. Coefficients are standardized. The only significant path coefficient is bolded. BMI = Body Mass Index. INT= Internalizing Problems.

Next, the paths between externalizing behaviors and internalizing problems were constrained and compared with a freely estimated model. This resulted in a significant chi-square difference test ( $\Delta\chi^2 = 35.98, df = 13, p = 0.001$ ), indicating a gender by time interaction in the association between externalizing and internalizing problems. Next, the analyses explored potential gender by time differences in the effects of externalizing behaviors on internalizing problems. A model was estimated in which the effects of externalizing behaviors on internalizing problems were constrained to be the same across time and across gender. This model was compared to a freely estimated model. This chi-square difference test was significant ( $\Delta\chi^2 = 21.25, df = 7, p = 0.003$ ), indicating that the effects of externalizing behaviors on internalizing problems varies as function of gender and time. Next, paths were freely estimated starting with the third grade. The model with third grade freely estimated was compared to a freely estimated model. This chi-square difference test was significant ( $\Delta\chi^2 = 13.62, df = 5, p = 0.018$ ). Next, the

fourth grade path was freed. This model was compared with a freely estimated model. This resulted in significant chi-square difference test ( $\Delta\chi^2 = 10.76, df = 5, p = 0.013$ ).

Next, analyses focus on the effects of internalizing problems on externalizing behaviors across time by gender. A model was estimated in which the effects of internalizing problems on externalizing problems were constrained to be the same across time for boys and girls. This model was compared to a freely estimated model. The chi-square difference test was significant ( $\Delta\chi^2 = 15.71, df = 7, p = 0.03$ ), indicating a gender by time interaction in the effects of internalizing problems on externalizing behaviors. Next, the paths starting at third grade were freed. A model with only the fourth, fifth, and sixth grade paths constrained was compared to a freely estimated model. This chi-square different test was significant ( $\Delta\chi^2 = 12.02, df = 5, p = 0.034$ ). However, freeing the fourth grade path did not result in a significant chi-square difference test ( $\Delta\chi^2 = 5.94, df = 3, p = 0.114$ ). These findings suggest that there are gender by time interactions. However, most of the coefficients were small and non significant.

*Final Model.* The final step in the analyses involved estimating a final model that best represented findings. First, given the consistent findings that there was no association between externalizing behaviors and BMI, parent rated externalizing problems were completely dropped from the model. Furthermore, nonsignificant covariates were dropped from the third, fourth, fifth, and sixth grade cross-lagged paths. This resulted in a final model with an RMSEA of 0.07 (0.08-0.09) and a CFI of 0.91. The final model with standardize coefficients is represented in Figure 8. These findings replicate what was found with teacher reported externalizing problems. There was a significant effect of fifth grade BMI on sixth grade internalizing problems.

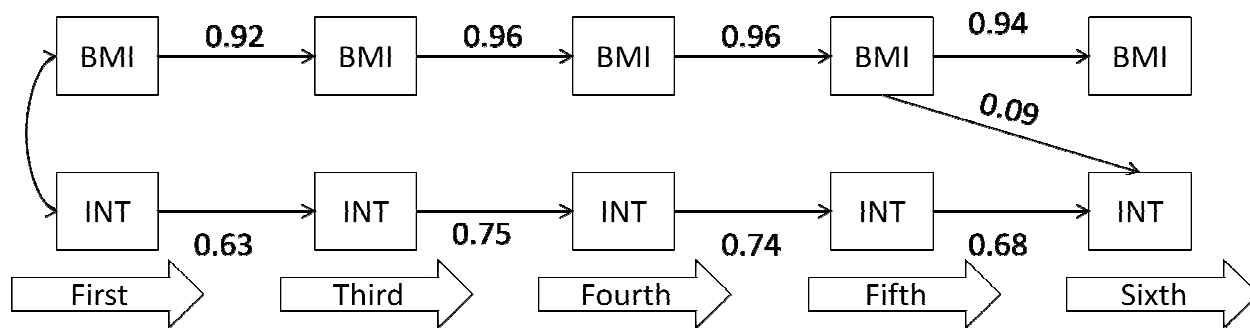


Figure 8. *Final estimated model using parent reported internalizing problems.* Parent report externalizing problems was dropped, resulting in a model with better fit. Coefficients are standardized. BMI = Body Mass Index, INT = internalizing problems.

In terms of covariates, there was a significant, negative effect of cognitive ability and positive effect of maternal depression on internalizing problems at third grade. There was a significant, negative effect of cognitive ability on fourth grade internalizing problems. There was a significant, positive effect of maternal depression on internalizing problems at fifth and sixth grade. There was a significant, negative effect of home environment on BMI at sixth grade. The effects of covariates on externalizing problems were not reported because externalizing problems was dropped from the final model.

These findings were generally the same as for the model with teacher rated externalizing problems. There was a significant effect of fifth grade BMI on sixth grade internalizing problems. However, externalizing problems was removed from the final model because it demonstrated no association with BMI and its removal resulted in a model with better overall fit. There were no significant gender differences.

#### 10.4 OBESITY DICHOTOMIZED AND TEACHER EXTERNALIZING PROBLEMS

The models with continuous BMI were followed up with a series of models, in which BMI was dichotomized at the cut-point for obesity. Mean and Variance Correct Weighted Least Squares estimation with theta parameterization was used with single imputation for the

exogenous preschool covariates (WLSMV). WLSMV is the preferred method for estimation with categorical or ordinal data it assumes that the ordinal variables stem from an underlying latent variable (Beauducel & Herzberg, 2006) . Additionally, MLR is not available in *Mplus* when estimating covariances between endogenous categorical and continuous covariates. Multiple imputation is not available in *Mplus* when conducting chi-square difference testing with WLSMV. The theta parameterization was instead of the default delta parameterization (Muthén & Muthén, 1998). The default delta parameterization imposes improper constraints when endogenous variables are modeled as both predictors and outcomes of other variables in the model (i.e., transactional processes). In the theta parameterization, the residuals for continuous latent variables that represent categorical observed variables are estimated. However, the scale factors for these variable are not estimated. Additionally, when using WLSMV, *Mplus* has a built in DIFFTEST option that allows for the calculation of chi-square differences test. This method is preferable because chi-square values in WLSMV are not distributed as a chi-square.

Given that the previous analyses demonstrated stronger support for the transactional model, these analyses focused on the transactional model with BMI dichotomized. Similar to the continuous models, a series of chi-square difference tests were used to analyze the relationship between the variables of interest across time. As can be seen in Figure 4, there was a similar pattern of findings to the models with continuous BMI and teacher rated externalizing behaviors. The coefficients are relatively small, but they increase as the child approaches adolescence. However, in this model, there is a significant effect of obesity on externalizing behaviors in late childhood. This model had a CFI of 0.98 and WRMR of 0.96. Follow up, chi-square difference tests only focused on the relationship between obesity and psychopathology, ignoring interdependencies between psychopathology, as these analyses would be redundant. The results of

simulation studies have recommended relying on the CFI and WRMR when using WLMV (Yu, 2002).

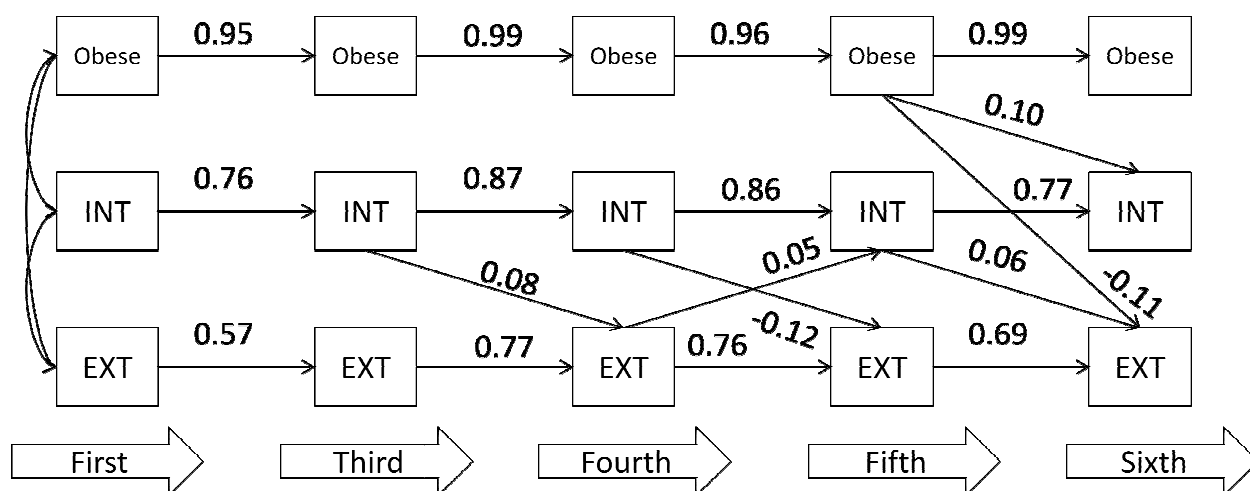


Figure 9. *Final Estimated Model with Dichotomized BMI and Teacher-Reported Externalizing Behaviors*. Coefficients are standardized. Obese = Dichotomized BMI, INT = internalizing problems, EXT = Externalizing Behaviors.

*Externalizing and Obesity.* The paths predicting externalizing from obesity and obesity from externalizing behaviors were constrained to be the same across time. This model was compared to a model in which these paths were freely estimated. The chi-square difference test was non-significant ( $\Delta\chi^2 = 6.68$ ,  $df = 6$ ,  $p = 0.352$ ). These findings suggested the relationship between externalizing behaviors and obesity is relatively stable across childhood.

*Internalizing and Obesity.* The paths predicting internalizing from obesity and obesity from internalizing problems were constrained to be the same across time. This model was compared to a freely estimated model in which these paths were freely estimated. The chi-square difference test was non-significant ( $\Delta\chi^2 = 7.622$ ,  $df = 6$ ,  $p = 0.267$ ). These findings suggested the association between internalizing problems and obesity is relatively stable across childhood.

*Final Models.* Gender differences could not be estimated within these models because of the high-degree of collinearity between the measurements of obesity, in particular for girls.



Multigroup models resulted in error messages and would not converge. Thus, the final resulting model is the model presented in Figure 8. Paths for non-significant covariates were removed at the third through sixth grade waves of measurement. This resulted in a final model with a CFI of 0.985 and WRMR of 1.07. These findings suggest that obesity predicts both internalizing problems and externalizing behaviors but only in sixth grade.

### 10.5 OBESITY DICHOTOMIZED AND PARENT EXTERNALIZING PROBLEMS

After examining dichotomized BMI and teacher rated externalizing behaviors, the same analytic strategy was used for examining the association between categorized obesity, parent rated externalizing behaviors, and parent rated internalizing problems. These models used WLSMV with single imputation. This model demonstrated a very similar pattern of findings to previous models, with the exception of more crosslagged effects between externalizing behaviors and internalizing problems (Figure 9). There was not a relationship between psychopathology until sixth grade and these effects were small. The initial model fit indices included a CFI of 0.97 and WRMR of 0.98.

*Externalizing Behaviors and Obesity.* Again, a series of chi-square difference tests were used to test for changes in the relationship between the constructs over time. First the paths between externalizing behaviors between externalizing behaviors and obesity were constrained to be the same across time. The difference test was nonsignificant ( $\Delta\chi^2 = 5.20$ ,  $df = 6$ ,  $p = 0.519$ ), suggesting no change in the association between externalizing behaviors and obesity across childhood.

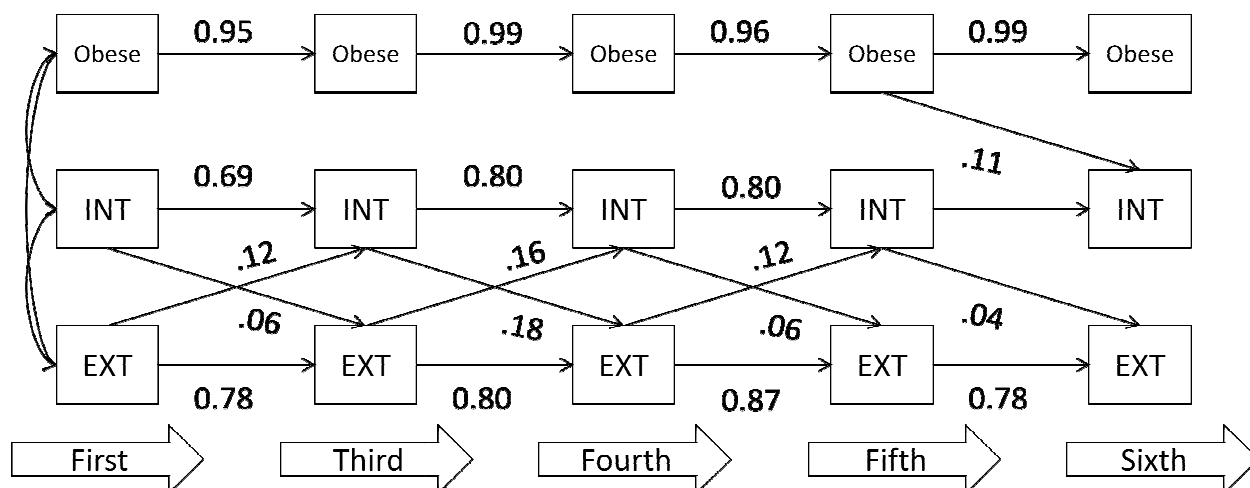


Figure 10. *Final Estimated Model with Dichotomized BMI and Parent-Reported Externalizing Behaviors*. Coefficients are standardized. Obese = Dichotomized BMI, INT = internalizing problems, EXT = Externalizing Behaviors.

*Internalizing Problems and Obesity.* After examining externalizing behaviors and obesity, the association between internalizing problems and obesity was examined. The paths between internalizing problems and obesity were constrained to be the same across the different waves of measurement. The difference test was nonsignificant ( $\Delta\chi^2 = 10.73$ ,  $df = 6$ ,  $p = 0.097$ ), suggesting no change in the association between internalizing problems and obesity across childhood.

*Final Model.* Gender differences could not be estimated within these models because of the high-degree of collinearity between the measurements of obesity, in particular for girls. Multigroup models resulted in error messages and would not converge. Thus, the final resulting model is the model presented in Figure 10. Paths for non-significant covariates were removed at the third through sixth grade waves of measurement. This resulted in a final model with a CFI of 0.98 and WRMR of 0.98.

There was a significant positive effect of medical risk and positive effect of maternal depression on internalizing problems at first grade. Boys had lower internalizing problems at first

grade. SES, medical risk, cognitive ability, and maternal depression were significantly, positively associated with externalizing behaviors in first grade. There was a significant, negative effect of inhibition-control on externalizing problems at first grade. Cognitive ability was negatively associated with internalizing problems in third grade and fourth grade. SES was positively associated with externalizing behaviors in sixth grade and behavior regulation was negatively associated.

## 10.6 SUMMARY OF CROSS LAG MODELS

The main finding from these analyses was that an association between internalizing problems and BMI does not emerge until sixth grade, with BMI predicting internalizing problems. BMI was only found to predict teacher externalizing problems when BMI was dichotomized to compare obese and non-obese children. The effects of BMI on internalizing problems were found in models with BMI categorized as well. No meaningful gender differences were observed.

The effects of the covariates were fairly consistent with past research. There were linkages between parent and child internalizing problems. Boys tended to have higher levels of externalizing problems. Increased regulatory behaviors were associated lower externalizing behaviors. Additionally, the quality home environment was inversely associated with BMI.

## 10.7 POST HOC ANALYSES

Analyses conducted thus far used cross lagged panel data models. These models used data collected at more than one time interval to estimate the causal association between two or more variables. Crosslagged analyses can be used to answer question relating to the cause of an

association, stability across measurement intervals, and the relative strength of one causal variable in comparison to another (Singer & Willett, 2003). The theory behind these analyses is that if variable X causes Y, then there should be a significant effect of  $X_z$  on  $Y_2$  controlling for  $Y_1$ . These analyses focus on using one variable or set of variables to predict residualized change. Furthermore, crosslagged analyses focus on the stability of the rank-ordering of individuals across time.

The findings from cross lagged analyses presented thus far demonstrated strong between time consistency for externalizing behaviors, internalizing problems, and, in particular, BMI. As a result, there was limited variability in residualized change in BMI to be predicted by other variables in the cross-lag models. This high inter-individual stability over time could explain the limited evidence for the effects of pathology on BMI. Therefore, growth curve models were estimated to examine intra-individual change. It was posited that one reason for the lack of significant findings was due to high stability within the repeated measures, in particular BMI. Growth curve modeling could reveal the extent to which within child variability is changing systematically across time.

In comparison to cross-lag longitudinal models, growth curve modeling is a complementary analytic technique that focuses on the overall trajectory of a repeated measure. Growth curve models focus on intra-individual stability of the person's scores across time. This analytic technique is used to answer question about mechanisms that predict increases or decrease in a repeated measure within person. The goal of a growth curve modeling is to identify explain the overall trajectory of a repeated measures rather than continuity between measurement intervals. Additionally, growth curve modeling can be used to identify different repeated measures that have a similar trajectory.

Latent growth curves for teacher rated externalizing behaviors, parent rated internalizing problems, and BMI were estimated using parallel growth curve modeling. MLR was chosen as the estimator because it accounts for assumption violations (Muthén & Muthén, 1998), and did not interfere with chi-square difference test calculation in these analyses. These growth curve models did not use chi-square difference tests. Separate curves were estimated for internalizing problems, teacher rated externalizing behaviors, and BMI. Intercepts were estimated at the first grade wave of measurement with linear slopes. The slopes and intercepts were allowed to correlate and regressed on the preschool control variables. Attempts were made to model linear and quadratic change. However, estimating quadratic change with BMI resulted in a negative residual variance. Therefore, the models presented are from a linear growth model. Additionally, the slopes and intercepts were regressed on the preschool covariates (mean centered) to control for their influence. The estimated growth curves demonstrated relatively good model fit with an RMSEA of 0.04 and CFI of 0.96. The coefficients for the intercepts and slope parameters are presented in Table 11, along with their associated variances. The means of the slopes for externalizing behaviors and internalizing problems were nonsignificant, which means that internalizing problems were not significantly changing. The slope for body mass index was positive and significant. The variances for each of the slope parameters were significant, which means that there is variability in individual growth trajectories.

Figure 9 shows the estimated means for the internalizing and externalizing outcomes. Figure 10 shows the estimated means for BMI. These findings suggest that neither levels of internalizing nor externalizing problems are changing significantly across childhood. However, BMI is significantly increasing across childhood. Table 12 shows the correlations between the slopes and intercept parameters for internalizing problems, externalizing behaviors, and BMI.

The only significant correlation was between growth in internalizing problems and growth in BMI. This suggest that increasing scores on parent rated internalizing problems was related to increasing BMI. The slopes and intercepts of externalizing behaviors were not associated with the slopes or intercepts for internalizing problems or BMI. The intercept of BMI was not significant associated with the slopes or intercepts of externalizing behaviors or internalizing problems. Furthermore, the intercept of internalizing problems was not significantly associated with the slope or intercept of externalizing behaviors or BMI.

Table 6  
*Means and Variances for Growth Trajectories (N = 1, 135)*

	<i>B</i>	<i>SE</i>	<i>p</i>
<b>Body Mass Index</b>			
Mean—Intercept	16.84	0.08	0.000
Variance—Intercept	6.72	0.31	0.000
Mean—Slope	0.73	0.02	0.000
Variance—Slope	0.32	0.02	0.000
<b>Externalizing Behaviors</b>			
Mean—Intercept	6.08	0.25	0.000
Variance—Intercept	41.63	3.35	0.000
Mean—Slope	-0.03	0.06	0.652
Variance—Slope	0.45	0.20	0.020
<b>Internalizing Problems</b>			
Mean—Intercept	4.91	0.13	0.000
Variance—Intercept	14.15	0.90	0.000
Mean—Slope	0.05	0.03	0.069
Variance—Slope	0.23	0.05	0.000

*Note.*

Table 7  
*Correlations between Intercepts and Slopes of Growth Curves for Psychopathology and BMI*  
 (N = 1, 135)

	1	2	3	4	5	6
1 BMI-I						
2 BMI-S	0.63					
3 EXT-I	0.06	-0.01				
4 EXT-S	-0.15	0.01	-0.01			
5 INT-I	0.01	0.05	0.09	-0.07		
6 INT-S	0.10	0.14*	-0.04	0.18	0.04	

Note. \* $p < 0.05$  BMI-I = Body Mass Index Intercept, BMI-S = Body Mass Index Slope, EXT-I = Externalizing Behaviors Intercept, EXT-S = Externalizing Behaviors Slope, INT-I = Internalizing Problems Intercept, INT-S = Internalizing Problems Slope

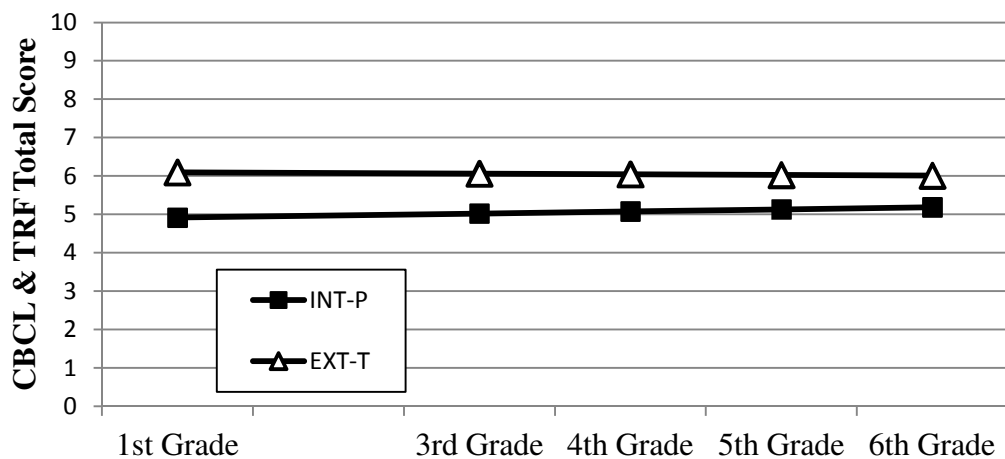


Figure 11. *Estimated Means for Externalizing Behaviors and Internalizing Problems*

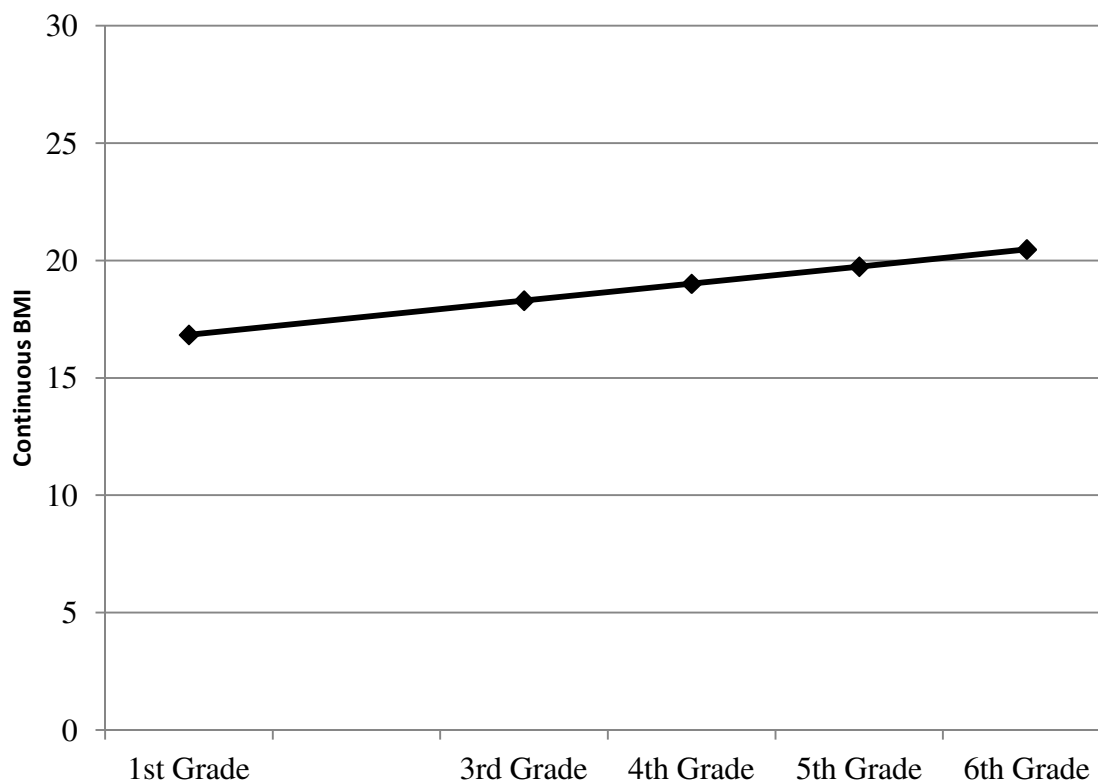


Figure 12. *Estimated Means for BMI*

## 11 DISCUSSION

The purpose of this study was to test a developmental cascade of the development of psychopathology and childhood obesity, and compare this dynamic cascade model with a transactional model. These findings suggest that the development of psychopathology and BMI is best understood in terms of reciprocal interactions, at least during childhood. However, these findings need to be interpreted with caution; only a few of the crosslagged paths were statistically significant, and even the significant paths were small. Furthermore, this study only focused on two potential risk factors or correlates of childhood obesity, externalizing behaviors and internalizing problems. It is plausible that an expanded analysis of more risk factors



associated with childhood obesity might offer better support the developmental cascade hypothesis.

Additionally, there was some evidence of longitudinal interplay between internalizing and externalizing behaviors with these associations changing across childhood. However, this pattern appeared to be dependent upon the reporter. The analyses that used parent report of externalizing behaviors and internalizing problems tended to show more significant effects. Whereas, the analyses focusing relying upon teacher report of externalizing behaviors with parent report of internalizing problems tended to demonstrate fewer significant findings. Again, the coefficients for these findings were small. Further analyses are needed to adequately model the complex association between the development of internalizing and externalizing problems.

This study supports past findings of association between internalizing problems and childhood obesity. The small effects sizes from these analyses are consistent with analyses from the NICHD SECCYD. However, the effect sizes reported by studies vary widely (Bradley et al., 2008a; Bradley et al., 2008b; Goodman & Whitaker, 2002; Pine, Goldstein, Wolk, & Weissman, 2001). Many studies suggest small association between internalizing problems and BMI (Bradley et al., 2008; Goodman & Whitaker, 2002). However, one study suggested that the presence of a diagnosis of depression increases the likelihood of obesity two-fold (Pine, Goldstein, Wolk, & Weissman, 2001). These findings add further longitudinal evidence of the relationship between internalizing problems and childhood obesity. Although prior research conducted with the NICHD SECCYD found that BMI begins to predict internalizing problems during late childhood (Bradley et al., 2008a and Bradley et al., 2008b), this dissertation found that the effect persisted even after taking into account teacher reported externalizing behaviors, and also demonstrates that the growth trajectories of internalizing problems and BMI are correlated over childhood.

The findings in this study do not address the potential causal mechanisms underlying an association between childhood obesity and internalizing problems. Past findings suggest several mediators of the association between internalizing problems and BMI. Past research has found that children with weight related concerns are more likely to be bullied in middle school (Adams & Bukowski, 2008). Furthermore, metaanalyses have consistently linked peer victimization and internalizing problems (Gini & Pozzoli, 2009). Another potential link is the association between stress, cortisol, and adiposity (Tamashiro et al., 2007). It was suggested that increased stress results in increased adiposity via increased cortisol levels.

While findings from this dissertation support small linkages between internalizing problems and obesity, there was limited evidence of linkages between externalizing behaviors and obesity. This finding could be attributed to the chosen measure of externalizing problems. The measures of externalizing behaviors in this dissertation did not include attention problems (Achenbach, 1991). Past research with clinical and non-clinical populations have found the kids with ADHD are more likely to be overweight or obese (Erhart et al., 2012; Waring & Lapane, 2008). It is possible that different findings will emerge with a broader measure of externalizing problems that includes attention problems. However, this finding is confounded by the fact that children with externalizing problems, in particular ADHD, are often treated with stimulants. Past research has found that children treated with stimulants are more likely to display below average weight (Waring & Lapane, 2008). The usage of stimulants may be a potential moderator of the effects of externalizing problems on childhood obesity.

Furthermore, the lack of association between externalizing problems and BMI could be attributed to unobserved heterogeneity in externalizing problems. Person-centered approaches to data analyses would be useful in identifying subpopulations of children that may be more likely

to exhibit comorbid patterns of psychopathology and obesity (Hoff, 2006). This person-centered approach would be invaluable for understanding issues of equifinality and multifinality, two important concerns within developmental psychopathology. One of the primary concerns for developmental psychopathologists is explaining divergent developmental trajectories for kids in similar biological and developmental contexts, as well as convergent trajectories for kids from dissimilar developmental contexts (Masten & Cicchetti, 2010). The person-centered analyses may be one avenue for addressing some of these questions.

Past research has found evidence that some children exhibit different developmental trajectories of externalizing behaviors (Van den Akker, Deković, Asscher, Shiner, & Prinzie, 2013). Studies that treat these subpopulations as categorically different often yield different findings from studies that treat them as one homogenous distribution. Some work has already been conducted using the NICHD SECCYD to examine possible subpopulations. Campbell and colleagues (2006) found evidence that children who exhibit high-stable aggressive behavior have poorer social skills and more peer related problems in comparison to kids with other trajectories. These findings suggest that in order to understand the association between externalizing behaviors and obesity, studies may need to take unobserved heterogeneity into consideration. Given the correlated growth trajectories between internalizing problems and BMI, it is likely that subpopulations of children with an accelerating trajectory of externalizing problems may demonstrate increased risk for obesity.

The same argument for different developmental trajectories of BMI and adiposity is garnering increased attention. However, only one study was found that linked subpopulations in obesity with psychopathology. Mustillo and colleagues (2003) identified four classes of children based on BMI: a low stable class, childhood obesity only, adolescent obesity only, and chronic

obesity. The findings suggested that only chronic obesity was associated with increased likelihood of psychiatric diagnosis, oppositional defiant disorder in girls and depression in boys. Furthermore, multivariate mixture models could be used to identify coccurring trajectories of psychopathology and weight related concerns.

Another explanation for the lack of an association between externalizing behaviors and BMI may be that past studies that suggested an association have not accounted for the interplay between externalizing behaviors and internalizing problems. This dissertation found limited associations between teacher report of externalizing problems and parent report of internalizing problems. However, parent report of externalizing problems was associated with parent report of internalizing problems. Many of the studies suggesting an association between internalizing problems and obesity during childhood have relied upon parent report (Bradley et al., 2008; Goodman & Whitaker, 2002; Pine et al., 2001). Therefore, past findings may be confounded by this comorbidity between parent report of externalizing and internalizing problems. Past findings of linkages between obesity and externalizing problems may be attributed to the fact that researchers have not accounted for the linkages with internalizing problems.

This study used two approaches to examining the longitudinal interplay of psychopathology and BMI. These methods provide complimentary findings regarding the development of behavior and health problems. The cross-lagged models revealed that significant observable effects do not emerge until the transition to middle school. Furthermore, these analyses revealed high-levels of stability in BMI. There was a moderate degree of stability in externalizing behaviors and internalizing problems. The evidence of cross-lagged paths between internalizing problems and obesity, suggests that obesity causes internalizing problems. Additionally, the post-hoc, latent growth curve models demonstrated small, significant

associations between growth in internalizing problems and BMI. The finding of significantly correlated growth trajectory suggests that there may be an underlying shared or covarying risk process that underlies the development of both these outcomes. Future studies should build upon these findings and explore other longitudinal approaches for evaluating these relationships.

### 11.1 LIMITATIONS AND FUTURE DIRECTIONS

There are several limitations that may explain why evidence for a developmental cascade was not found, if one does exist. First, these analyses only focused on the associations between externalizing behaviors, internalizing problems, and obesity during childhood. This time scale could be too brief or may not encompass the developmental period during which the associations between these constructs are emerging or times when they are changing (Masten & Cicchetti, 2010). Other developmental cascade models that have shown interplay between externalizing behaviors and internalizing problems from childhood into adulthood (Masten et al., 2005). It is plausible that looking at a broader time scale might demonstrate the emergence of the hypothesized pathways. This is supported by research showing that levels of internalizing problems, particularly among girls, increase during adolescence (Hankin & Abramson, 2001).

While focusing on a broader time-scale would help identify a potential cascade, focusing on a smaller time-scale could elucidate the drivers of this cascade. In particular, the finding that these processes become more strongly related during the transition to adolescence and middle school is suggestive that understanding this transition may explain the relationship between psychopathology and childhood obesity. The transition to adolescence is typified by changes in peer relationships (Almquist & Östberg, 2013), physical and hormonal changes from the onset of puberty (Pinhas-Hamiel, Lerner-Geva, Copperman, & Jacobson, 2007), and autonomy seeking

(Wilson & Deane, 2012). It would be fruitful to use a longitudinal data to examine the interdependencies of puberty, peer support, psychopathology, autonomy seeking, and obesity in the transition to adolescence. Methods such as latent class (Cantwell, Lewinsohn, Rohde, & Seeley, 1997; Hoff, 2006) and latent transition (Castellini et al., 2012) analyses would be invaluable for discerning the moderating relationships during this developmental period.

These limitations represent a larger issue in the measurement of psychopathology and childhood obesity. In particular, the measurement of externalizing problems used in these analyses does not include attention problems. Future studies should address this limitation by utilizing scales such as the BASC, which provide a different conceptualization of externalizing problems that included attention problems (Dever, Mays, Kamphaus, & Dowdy, 2012; Dowdy, Chin, Twyford, & Dever, 2011; Dowdy et al., 2011). Furthermore, studies should consider other potential reporters of developmental psychopathology. Several studies have demonstrated discrepancies between child and parent report of internalizing psychopathology (Cantwell, et al., 1997). In particular, it is suggested that for internal states the child or adolescent should be the primary reporter (Cantwell, et al., 1997). Several researchers have noted similar limitations when using BMI as a measure of obesity. Measures of skinfold thickness, bioelectrical impedance, underwater weighing, and dual energy x-ray absorption may provide different results (Demerath et al., 2006).

Another notable limitation is that these analyses provide limited insight into contextual covariates related to childhood obesity. These analyses included control measures of attachment, parent psychopathology, socioeconomic status, and physical environment. However, the treatment of these variables was ancillary in comparison to the treatment of the primary variables. These variables were only measured at one interval and do not account for changes

across childhood. Past research has documented contextual antecedents such as community characteristics (Pallan, Parry, & Adab, 2012) and peers (Adams & Bukowski, 2008) that may explain the relationship between developmental psychopathology and obesity. These factors need to be included in the model as more than static control variables. Future research needs to model the intersection of these contextual factors and how they relate to correlates of childhood obesity. In particular, a number of studies have documented that parent factors moderate of the effects of aversive contexts on developmental outcomes. For example, parental weight has been found to be a buffer of the effects of SES on childhood obesity (Semmler, Ashcroft, van Jaarsveld, Carnell, & Wardle, 2009). Future studies should examine the role of other parenting factors that were not included in this study (i.e., parent weight, parent eating habits, parent locus of control) on the association between community factors and childhood obesity.

In addition to focusing on family and community processes, future studies should provide greater detail about the role that peer relationships play in the development of childhood obesity. Several studies have linked peer victimization and social exclusion with childhood obesity (Adams & Bukowski, 2008; Gray, Kahhan, & Janicke, 2009). Recent research suggests that peers play a role in supporting risk or protective factors associated with childhood obesity. Sirard and colleaguse (2013) found that middle and high school students' physical activity was associated with the physical activity of their friends. Students were more likely to affiliate with peers with similar physical activity patterns. These findings were particularly salient for girls. Evidence even suggests that peers influence eating habits among adolescents (Fitzgerald, Heary, Nixon, & Kelly, 2010). Future studies should build upon the current findings in order to increase our understanding of the developmental context surrounding psychopathology and childhood obesity.

## 11.2 CONCLUSIONS AND IMPLICATIONS

These findings provide a limited view about the underlying processes that drive the development of psychopathology and obesity. The results best supported a transactional perspective of developmental psychopathology and obesity during childhood. This suggests that there are concomitant changes during this period that best explain the relationship between psychopathology and obesity during childhood, particularly for internalizing problems. However, these findings were limited. The majority of the coefficients for the cross-lagged paths were nonsignificant. Furthermore, many methodologists caution against interpreting nonsignificant findings (Aberson, 2002). These analyses need to be extended into adolescence in order to better understand the patterns of findings. Furthermore, research extending the time period under examination may provide better support for a developmental cascade model. It is possible, given the past research on developmental cascades (Masten et al., 2005), that these findings are capturing the beginning of a developmental cascade involving internalizing problems and BM that does not completely emerge until adolescence. It is important that future studies examine the continuity of the association between internalizing problems and BMI into adolescence and adulthood.

Many of the contextual antecedents examined in this dissertation, included as control variables, were also not significantly associated with childhood obesity. This implies that our current understanding, conceptualization, and measurement of the child's developmental context are not as relevant to obesity, in comparison to psychopathology. However, the bioecological perspective presented here is limited. Most of the contextual risk factors considered focused on the home environment or parent child dyad. Future research needs to emphasize other contexts as



well. In particular one context that seems to have a great deal of relevance is the school environment. A recent meta-analysis of obesity interventions found that school based interventions with a home and community component demonstrated a high degree of effectiveness (Wang et al., 2013). These findings suggest that understanding the way multiple contexts influence the development of obesity would provide a better model for prevention.

One reason for the mixed patterns of findings from this dissertation may be that there are important developmental factors that these models are not capturing. In particular these findings are not addressing the gene by environment interaction that is a hallmark of the causal sequence underlying obesity risk. Past research has consistently linked genetics with increased risk for obesity (Stunkard, Foch, & Hrubec, 1986). Furthermore, there is a good deal of evidence suggesting that there are genetic markers for developmental psychopathology and mental health (van der Valk, van den Oord, Verhulst, & Boomsma, 2003). Future studies should build upon these findings to determine if there is combination of genetic markers that underlie the developmental of both obesity and developmental psychopathology. Furthermore, it would be interesting to model the interactions between genetic markers that predispose obesity and psychosocial functioning and the environment. This type of analysis would be useful in identifying risk factors for intervention.

Ultimately, these findings suggest that a developmental cascade approach to development that focuses on the interplay between internalizing and externalizing behaviors is inadequate in explaining obesity during childhood. This study's conceptualization of developmental psychopathology was only modestly linked with childhood obesity. It is plausible that linkages between psychopathology and obesity are stronger in adulthood, and the time scale in these analyses was too brief to capture this association. However, it is unlikely that the lack of

support for a developmental cascade is due to the methods used in this dissertation. The methods and measures used in this study are very similar to those used in foundational studies on developmental cascades (Masten et al., 2005). The findings from this study suggest that there is no developmental cascade between externalizing behaviors, internalizing problems, and childhood obesity. Rather, childhood obesity appears to be a risk factor for internalizing problems (Bradley et al., 2008a).

One theme that consistently emerged from these analyses is that the results might be due to the large amount of variability within developmental pathways for developmental psychopathology and obesity. As reviewed, several studies have suggested that there are both subpopulations of children with developmental psychopathology and childhood obesity. These different populations demonstrate a different course of development and often demonstrate differences in the associations between risk and protective factors. This type of heterogeneity poses a challenge for researchers, particularly when examining somewhat heterogeneous outcomes (i.e., psychopathology and childhood obesity). Future research should start to examine specific subpopulations (i.e., consistently obese children or children with accelerating behavior problems) to determine if developmental cascades are nested within certain subpopulations.

The consistent finding that obesity predicts internalizing problems suggests that the diagnostic evaluation and treatment of individuals with internalizing problems should include an assessment of the individual's weight and weight related concerns. Furthermore, greater research should examine the relationship between the social context of obesity and its association with internalizing problems. The literature reviewed suggests that individuals classified as obese are more likely to face discrimination and bullying. This linkage between social exclusion and obesity could also explain the relationship between obesity and internalizing problems.

Furthermore, a linkage with peer victimization would explain why these effects do not emerge until sixth grade. However, more complex analyses would be needed to fully explore these relationships.

In contrast, these findings suggest that targeting psychopathology, or even individual level covariates, may not be as fruitful in preventing or curtailing the obesity epidemic. Instead, interventions may need to focus on holistic programs and interventions that target systems level risk factors with individual level risk factors, at least for the most at-risk children. In particular, it seems that interventions targeting children's consumption of media or the way businesses market fattening foods to children might be more relevant to curbing the obesity epidemic (McGinnis, et al., 2006). Furthermore, building healthy communities with access to fresh produce, activity facilities, and safe streets and public transportation might be beneficial in preventing obesity and other aversive outcomes (Evenson, et al., 2007). However, few systems level interventions designed to prevent or curb the obesity epidemic have been rigorously evaluated using comparison group designs. Therefore, one recommendation has to be improving standards and plans for evaluating systems level obesity interventions and policy.

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