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THE INFLUENCE OF SYMPTOM SEVERITY ON MINOR
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THE INFLUENCE OF SYMPTOM SEVERITY ON MINOR UNINENTIONAL INJURIES AMONG CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

By

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ABSTRACT

THE INFLUENCE OF SYMPTOM SEVERITY ON MINOR UNINENTIONAL INJURIES AMONG CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

By

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The current study explored the understudied phenomenon of minor unintentional injuries in a sample of children considered to be at-risk for such injuries. Using between group analysis of covariance, results revealed no differences in minor unintentional injury among children treated with extended release methylphenidate (N=9) and those treated with extended release mixed amphetamine salts (N=10). For the entire sample (N=31), linear regression procedures indicated that weekly measures of hyperactivity and attention problems were associated with the number of injuries experienced during each respective week of the study. However, results from hierarchical linear regression revealed that symptoms associated with ADHD were not predictive of minor injury after controlling for the presence of comorbid symptoms associated with conduct disorder. Symptoms of conduct disorder accounted for nearly half of the variance in minor injuries experienced by children with ADHD in this study. Finally, the relationships between minor and severe injuries and other demographic variables were examined utilizing logistic regression procedures. Results indicated that the number of parent-report minor unintentional injuries experienced since birth, number of children living in the household, and child age were each related to the likelihood that a child had experienced a medically attended injury.

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Chapter 1

INTRODUCTION

Unintentional injury is the leading cause of death and disability for children and adolescents in the United States (Centers for Disease Control and Prevention, 2004). In 2002, over 11,000 children aged 1 to 18 died from unintentional injuries (Anderson & Smith, 2005). This resulted in approximately 220 deaths per week or 31 deaths every day. Fatal and nonfatal unintentional injuries impart an economic cost of billions of dollars each year (Danesco, Miller, & Spicer, 2000). As such, these injuries pose a significant public health concern and the government has identified the reduction of injury as a major focus within *Healthy People 2010* (United States Department of Health and Human Services, 2005).

The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) has identified accidental injury as an associated feature of attention-deficit/hyperactivity disorder (ADHD; APA, 2000). Additionally, research suggests that children with ADHD are at increased risk for incurring unintentional injuries (DiScala, Lescohier, Barthel, & Li, 1998; Schwebel, Speltz, Jones, & Bardina, 2002). These injuries result in greater health care service utilization and costs for children with ADHD relative to their typically developing peers (Leibson, Katusic, Barbaresi, Ransom, & O'Brien, 2001; Ray et al., 2006). Despite the recognition of the need for unique injury prevention efforts targeted toward children with ADHD (Farmer & Peterson, 1995), research focusing on such efforts is virtually nonexistent.

Research and theory lend preliminary support for the role of stimulant medication as a possible mechanism by which to moderate rates of unintentional injury among children with ADHD (Lage & Hwang, 2004; Rapport, Chung, Shore, & Isaacs, 2001). Stimulant medication is the most commonly utilized treatment for ADHD and following such treatment the majority of children with ADHD evidence a reduction in symptoms associated with the disorder (Pelham et al, 2000; MTA, 1999). A conceptual model of ADHD also suggests that stimulant medication treatment which impacts the core features of ADHD (i.e., inattention, hyperactivity-impulsivity) should subsequently have a trickle down effect on the associated features of the disorder, such as unintentional injury (Rapport et al., 2001). It is clear, however, that the treatment effects of stimulant medication are generally not great enough to normalize behavior (Pelham et al., 2000).

Limited research has directly explored the impact of stimulant use on rates of unintentional injury among children with ADHD. Preliminary data suggest that stimulant medication treatment may mitigate the risk for medically attended unintentional injuries among children with ADHD. For example, following stimulant treatment children with ADHD had significantly fewer emergency department visits and costs when compared to periods off stimulants (Leibson et al., 2006). Moreover, children treated with extended release stimulant medication were less likely to experience a medically attended accident or injury compared to those treated with immediate release stimulant medication (Lage & Hwang, 2004).

No research has examined the relationship between stimulant medication treatment and *minor* unintentional injuries among children with ADHD. Several researchers have articulated the importance of studying minor unintentional injuries as a proxy for more serious injury (Morrongiello, Ondejko, & Littlejohn, 2004; Peterson, Brown, Bartelstone, & Kern, 1996). The prospective study of serious injuries is difficult and would require extremely large numbers of participants. Minor unintentional injuries; however, are relatively common and have been reliably measured and systematically studied (Peterson, Saldana, & Heiblum, 1996).

Research has explored the role of hyperactive and inattentive behaviors as potential mediating/moderating variables for injury risk among children (Schwebel et al., 2004; Spinks, Nagle, Macpherson, Bain, & McClure, 2008). While there is substantial evidence to suggest that such behavior patterns are related to increased injury risk among typically developing children (Schwebel & Barton, 2006), data regarding the relationship between the symptoms of hyperactivity and inattention and injury risk among children with a diagnosis of ADHD have been mixed (Bryne et al., 2003; DuPaul et al., 2001; Pastor & Reuben, 2001). Yet, researchers in the area of pediatric unintentional injury have hypothesized that children with externalizing behavior disorders are at increased risk of injury not because of hyperactive or inattentive behaviors, but instead because of their oppositional, defiant and disruptive behavior (Davidson et al., 1988; Schwebel et al., 2007). Limited research; however, has explored the relationship between the core symptoms of ADHD in addition to the symptoms of comorbid externalizing behavior disorders on unintentional injury risk among children with a diagnosis of ADHD.

Current Study

The current study will investigate the relationship between psychostimulant medication treatment and minor unintentional injuries among children with ADHD. Specifically, the study will examine the influence of two different psychostimulant medication treatments commonly prescribed to target the core symptoms of hyperactivity and inattention in children with ADHD to determine the differential impact of such treatment patterns on unintentional injury. Unintentional injury is the leading cause of morbidity and mortality for children and adolescents, and children with ADHD have been identified as being at increased risk for incurring unintentional injuries. Stimulant medication treatment has consistently been demonstrated to effectively reduce the core symptoms of ADHD, such as hyperactivity and inattention, yet limited research has explored the impact of stimulant medication treatment on unintentional injury. The primary research questions center on investigating (a) the relationship between psychostimulant medication treatments and minor unintentional injuries among children with ADHD, (b) the risk for unintentional injury based on severity of ADHD symptoms and the presence of comorbid symptoms, and (c) the relationship between minor and severe injury among children with ADHD.

Significance of Study

This study will explore an understudied phenomenon of minor unintentional injuries in a population that is considered to be at-risk for such injuries. This project will contribute to the existing knowledge base through an exploration of the relationship between psychopharmacological treatments and rates of minor unintentional injury among children with ADHD. In addition, weekly monitoring of hyperactivity and inattention will permit for an examination of the extent to which symptom severity is predictive of injury. Assessment of symptoms of comorbid disorders will allow for an understanding of the impact of associated disruptive behaviors on injury risk. Given the focus on unintentional injury, ADHD, and medication treatment, this project has significant public health implications. The prevalence of ADHD suggests that this disorder impacts a large number of children and families. Further, the economic burden of managing the medical needs of these children is substantially greater than for typically developing children. Finally, as the leading cause of disability and death in children, unintentional injuries pose a major public health concern and warrant scientific inquiry. Understanding the impact of symptom severity and medication treatment on rates of unintentional injury among children with ADHD may have large-scale implications related to injury prevention efforts and costs associated with injury treatment.

Chapter 2

LITERATURE REVIEW

Unintentional injuries are the leading cause of morbidity and mortality for children and adolescents in the United States (Centers for Disease Control and Prevention, 2004; Guyer et al., 1999). Research has indicated that children with ADHD are at increased risk for incurring such injuries (DiScala et al., 1998; Schwebel et al., 2002). A conceptual model of ADHD along with preliminary research lend support for the role of stimulant medication as a means by which to mitigate injury risk within this population (Lage & Hwang, 2004; Rapport et al., 2001); however, additional research investigating the extent to which stimulant medication might serve as a protective factor is needed. This literature review will begin by defining unintentional injury and highlighting the prevalence and significance of this phenomenon. This will be followed by a brief review of traditional approaches toward injury prevention. Risk and protective factors associated with childhood unintentional injury will be reviewed. The second part of this review will provide a critical analysis of the literature focusing on unintentional injuries among children with ADHD. Finally, this review will present the theory and research reported within the literature to date regarding the use of stimulant medication in relation to unintentional injuries. The purpose of the current study is described and research questions are presented.

Unintentional Injury

Injury has been defined as bodily damage resulting from exposure to physical or chemical agents (Roberts, Brown, Boles, & Mashunkashey, 2004; Roberts, Brown, Boles, Mashunkashey, & Mayes, 2003). The most common unintentional injuries among children and adolescents result from motor vehicle crashes, fires, falls, drownings, bicycle crashes, suffocations, and poisonings (Centers for Disease Control and Prevention, 2004). Outside of the scientific community, a term frequently utilized to describe unintentional injury is "accident." However, utilization of the term *unintentional* rather than *accidental* reflects a change in the understanding of injury. Unintentional injury was traditionally conceptualized as a result of carelessness or chance (Kronenfeld & Glik, 1995). Given this understanding and the presumed unpredictability of injuries, they were largely viewed as unpreventable and described as accidents. However, injury is now recognized as an event that can be subjected to scientific study and whose occurrence can be understood in a manner similar to that of other diseases (Roberts et al., 2004). Research has identified specific factors that place children at increased risk for injury. For example, boys are consistently reported to experience more injuries than are girls (Bijur, Golding, Haslum, & Kurzon, 1988; Bradbury, Janike, Riley, & Finney; 1999), and limited parental supervision is associated with increased injury risk among toddlers (Morrongiello, Corbett, McCourt, & Johnston, 2006). Importantly, unintentional injury is now widely recognized as an event that can be prevented.

Advances in medical knowledge and technologies have resulted in the reduction of morbidity and mortality rates by infectious diseases. This has led to emergence of unintentional injury as the leading cause of death and disability for children and adolescents in the United States (Kronenfeld & Glik, 1995). In 2002, unintentional injury accounted for nearly 40% of deaths among children ages 5-14 (Centers for Disease Control and Prevention, 2004). Among this age range, unintentional injury accounted for more than twice as many deaths as the second leading cause of death, malignant neoplasms (Centers for Disease Control and Prevention, 2004). The leading cause of death by unintentional injury for children, adolescents, and adults is motor vehicle traffic incidents (Centers for Disease Control and Prevention, 2004).

Nonfatal and Minor Injuries. As nonfatal unintentional injuries have the potential to be extremely serious and occur more frequently than fatal injuries such events also warrant attention. For each injury related childhood death, there are approximately 18 hospitalizations, 233 emergency department visits, and a much larger number of home-treated injuries (Grossman, 2000). The leading cause of hospital attended nonfatal injury is unintentional falls (Centers for Disease Control and Prevention, 2004). Minor injuries are typically conceptualized as events which do not require medical attention or treatment. Several researchers have identified the utility of studying minor unintentional injury as a proxy for more serious injury especially given their potential for serious injury (Damashek & Peterson, 2002; Morrongiello et al., 2004; Peterson et al., 1996). As Pless, Taylor, and Arsenault (1995) articulated, prospective studies are almost impossible when studying serious unintentional injuries. Over 35,000 children would have to be followed for 1 year to yield 100 serious injuries (Pless, Taylor, & Arsenault, 1995). Medically attended injuries are low-base rate events and it is unclear as to whether these injuries are consistently more serious than non-medically attended injuries as the decision to seek medical care may be related to factors other than actual injury severity (Peterson, DiLillo, Lewis, & Sher, 2002). Minor unintentional injuries are relatively common and have been reliably measured and systematically studied (Peterson et al., 1996). The relationship between minor and more severe injuries also has been reported within the literature. Children who experience multiple minor injuries have been reported to be more likely to sustain more severe injuries (Alkon et al., 1994) and a significant positive correlation ($r = .67$) has been reported between serious injuries and later occurring minor injuries among toddlers (Morrongiello et al., 2004). Moreover, Jaquess and Finney (1994) found that children, aged 3 to 11, who received medical attention for an injury were more likely to have home treated injuries in the subsequent year.

When considered together, fatal and nonfatal unintentional injuries impart an estimated economic cost of $347 billion each year (Danesco et al., 2000). This estimate includes injury treatment, future lost wages, and diminished quality of life. Additionally, each year there are approximately 7 million emergency department visits and 10 million primary care visits related to injury treatment (Ballesteros, Schneiber, Gilchrist, Holmgreen, & Annest, 2003). Given the scope of the problem comprehensive approaches toward injury prevention and a thorough understanding of factors that place children at risk and protect them from incurring injuries are critical.

Injury Prevention. Injury prevention efforts are typically conceptualized as either passive or active. Passive prevention requires no action by individuals whereas active prevention requires the individual to engage in a specified behavior in order to receive the preventive benefit (Roberts et al., 2004). Passive prevention efforts often consist of changes to existing products which stem from legal mandates or structural changes to the environment (Damashek & Peterson, 2002; Roberts et al., 2004). The installation of airbags in cars is an example of passive prevention. In some instances passive prevention efforts are not entirely passive and require individual action. For example, the passage of a law requiring medicines to be packaged in childproof containers is passive prevention, yet it necessitates that adults replace the caps correctly after use, thus requiring some action (Roberts et al., 2004). Most injury prevention advocates encourage passive prevention efforts such that the preventive benefits are shared by everyone regardless of individual action or inaction (Roberts et al., 2004). Active prevention can be illustrated by car seat belts or bicycle helmets. While these products are designed to prevent automobile and bicycle related injuries, individuals are required to engage in some behavioral action to attain preventive benefits.

Five levels of injury prevention and intervention have been articulated by Damashek and Peterson (2002). National and state level initiatives consist of media campaigns to educate caregivers about safety or federal laws that mandate safety changes in products or behavior. For example, some states have legal mandates regarding the use of bicycle helmets. A second level of intervention occurs at the community level. Interventions at this level include local laws or community injury prevention programs. Family-level initiatives may focus on individual families or groups of families. These interventions may center on educating parents who in turn teach their children safety skills in the home. Finally, caregiver and child level initiatives are typically in the form of education or behavioral training. Behavioral interventions may focus on rewarding children for safety belt use while educational practices may involve health practitioners distributing pamphlets to parents (Damashek & Peterson, 2002).

The use of behavioral rewards and educational training are among the most common components of childhood injury prevention programs described in the literature. While a detailed discussion of individual prevention programs is beyond the scope of this literature review, such approaches have been effectively implemented to increase the use of seat belts, safety seats, and bicycle helmets (Hall, Cross, Howat, Stevenson, & Shaw, 2004; Khambalia, MacArthur, & Parkin, 2005; Roberts, Alexander, & Knapp, 1990; Roberts & Fanurik, 1986). These programs also have yielded increases in safe behavior on playgrounds and improvements in teacher and child knowledge related to safe behavior (Heck, Collins, & Peterson, 2001; Schwebel, Summerlin, Bounds, & Morrongiello, 2006). It is more difficult; however, to determine the extent to which these injury prevention programs actually reduce rates of unintentional injury. Further, it is unclear as to whether these programs are sufficient to meet the needs of children who may be at increased risk for experiencing unintentional injuries.

Risk Factors. Research has identified several factors that appear to consistently place children at increased risk for incurring unintentional injuries. These risk factors are typically conceptualized as characteristics of the child, primary caregiver, or environment. One of the most robust findings within the unintentional injury literature indicates that males are at significantly increased risk for experiencing injuries than are females (Bijur et al., 1988; Danesco et al., 2000; Hambidge, Davidson, Gonzales, & Steiner, 2002; Scheit et al., 1995). A review of 8 years of National Health Survey data for individuals under the age of 21 revealed that males were significantly more likely to experience medically attended nonfatal and fatal injuries than were females. Moreover, the fatal injury rate for males was more than twice that for females (Danesco et al., 2000). Among children and adolescents, males also have been reported to have more nonfatal injury-related primary care visits than females (Hambidge et al., 2002).

With respect to race, injury risk appears to vary with respect to injury severity. Utilizing data from a national sample of over 3,000 children, Danesco and colleagues (1998) reported that white children had higher nonfatal injury rates than non-white children while black children had higher rates of fatal injury compared to white children (Danesco et al., 1998). Partial support for this finding emerged from a recent study by Dal Santo, Goodman, Glick, and Jackson (2004) who reported that white children were at almost three times the risk of experiencing a nonfatal injury than were non-white preschoolers. Others have also reported that non-white preschoolers are at greater risk for incurring fatal injuries than are white preschoolers (Kennedy & Lipsitt, 1998; Morrongiello & Rennie, 1998).

Among typically developing children, indices of vigilance performance have been associated with unintentional injuries among young children. Bennett-Murphy, Murphy, and Rose (2001) reported that vigilance indicators of response bias and perceptual sensitivity were predictive of parent-reported minor unintentional injuries among preschool-aged children (n = 28), with these two variables accounting for nearly half of the variability in unintentional injuries. These findings suggest that children who were less vigilant were injured more often than those who maintained high vigilance. In a case-control study of injured children, aged 5-15, Pless and colleagues (1995) compared 286 children who had received medical attention for involvement in traffic accidents as a bicyclist or pedestrian. Children in the control group (n = 562) experienced injuries where their behavior was not a contributing factor to the injury, for example, as a passenger in a car. The study found that children who had been injured in part due to their own behavior made more errors of omission and commission on a continuous performance task of attention, suggesting that these children were less attentive and more impulsive than controls, respectively. Additionally, children whose behavior contributed to their injury had greater hyperactivity scores as rated by parent and teacher on a standardized behavior rating scale (Pless et al., 1995).

Several early studies reported that hyperactivity and aggressive behavior were important risk factors for childhood injury (Bijur, Stewart, Brown, & Butler, 1986; Langley, McGee, Silva, & Williams, 1983; Meyer, Roelofs, Bluestone, & Redmond, 1963). A critical review of this literature; however, revealed several methodological limitations. Davidson (1987) indicated that these studies utilized poor measures of behavior, lacked appropriate control groups, and were largely retrospective in nature. Results from those studies which prospectively measured injury among children with behavioral difficulties revealed an association between antisocial behavior (e.g., aggression, management difficulties) and injury. The relationship between hyperactivity and injury was reported as limited.

Following this review, Davidson and colleagues further reported that children with discipline and conduct problems were at increased risk for medically attended injuries while hyperactivity and lack of concentration were not associated with injury (Davidson, Hughes, & O'Connor, 1988; Davidson, Taylor, Sandberg, & Thorley, 1992). More recently, utilizing both retrospective and prospective design methodologies, Schwebel and colleagues (2004) found that hyperactivity was a strong predictor for parent-reported medically attended injuries among 5-year-olds and children from 3 to 36 months of age. Among the 5-year-olds ($n > 10{,}000$) studied retrospectively, the odds ratio for hyperactivity was 28.39, suggesting that hyperactive children were over 2,800% more likely to experience an injury than their nonhyperactive peers (Schwebel et al., 2004). Additionally, Spinks and colleagues (2008) investigated the association between hyperactivity, aggression, and childhood injury among children aged 5 to 12 years. Using select items from the Child Behavior Checklist and parent-reported injuries, their results indicated that children with elevated hyperactivity scores had an increased risk for all injuries including medically treated injuries. No significant association between aggression and childhood injury was reported.

In considering the findings of the aforementioned studies, it is important to note that the results do not generalize to children with diagnosed externalizing behavior disorders. These studies only examined injuries among children who were identified as having externalizing behavior difficulties, such as hyperactivity or oppositionality, often at subclinical levels. As such, it is unclear if these patterns of risk would hold true for children with actual clinical diagnoses. However, there does appear to be a clinical perception that children with externalizing behavior difficulties are especially liable for incurring injuries (Byrne, Bawden, Beattie, & Wolfe, 2003). Given the core features of these disorders (e.g., impulsivity, inattention, oppositionality) this association is intuitively appealing. One might expect that a child who is not attending to his environment or who defies safety instructions from an adult may be more prone to experience an injury. As will be reviewed later, empirical data regarding the relationship between these clinical disorders, their core behavioral features, and unintentional injury have been somewhat mixed.

Protective Factors. The literature within the child injury field is replete with studies focusing on injury risk, yet limited attention has been paid to factors that may serve to protect children from injury (Schwebel, Brezausek, Ramey, & Ramey, 2004). Models of developmental psychopathology support the need to identify both risk and protective factors to better understand the development of psychological disorders and the same theoretical approach may serve to enhance our understanding of childhood unintentional injury. As described earlier, Schwebel and colleagues (2004) reported that hyperactivity was a strong predictor for early childhood injury. In this same study, interactions between child and parent characteristics served to protect children from injury. Specifically, among 5-year-old children, those with hyperactive behavior patterns whose parents reported having adequate time resources experienced fewer injuries than children whose parents did not report adequate time resources. This indicates that children without hyperactive behaviors were at increased risk for injury, relative to hyperactive children, if their parents did not have adequate time to spend with them. This finding suggests that aspect of parenting, such as having sufficient time to spend with children, might mitigate injury risk among children who are generally believed to be at increased risk for injury (Schwebel et al., 2004). In order to fully understand injury risk for children, a thorough conceptualization of both risk and protective factors is necessary and additional research exploring how these factors might mitigate injury risk is warranted.

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is one of three externalizing behavior disorders recognized by the American Psychiatric Association (APA; American Psychiatric Association, 2000). This disorder is associated with significant impairments in inattention and/or hyperactivity-impulsivity as well as difficulties related to academics, peer relations, and psychological comorbidities (Barkley, 2003). Prevalence rates of ADHD are estimated between 3 and 7 percent among school-aged children (APA, 2000).

The male-to-female ratio is estimated to be between 2:1 to 9:1 depending on the subtype and setting (APA, 2000). Nearly half of children with ADHD also present with comorbid Oppositional Defiant Disorder (ODD) or Conduct Disorder (CD) (APA, 2000). A significant portion of children identified as having ADHD continue to meet diagnostic criteria for the disorder in adolescence and adulthood (Barkley, 2003).

Unintentional Injury. The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) identifies accidental injury as an associated feature of attention-deficit/hyperactivity disorder (APA, 2000). Early research reported that children with attention-deficit disorder (ADD; as identified within the DSM-III) were more likely to experience physical injuries necessitating sutures, hospitalizations or medical procedures than were controls (Jensen, Shervette, Xenakis, & Bain, 1988). Children with ADD were also reported as more likely to experience burns (Szatmari, Offord, & Boyle, 1989), bone fractures (Szatmari et al., 1989), and unintentional poisonings (Stewart, Thach, & Friedin, 1970) or ingestion of poisonous substances (Jensen et al., 1988). As reported by Barkley (2003), data from Shelton and colleagues (1998) indicated that more than four times as many children with ADHD as control children were reported to experience an accident related to their impulsive behavior (Shelton et al., 1998).

Several recent studies have systematically explored the relationship between unintentional injury and children with ADHD. DiScala and colleagues (1998) examined differences in hospital admitted injuries to children aged 5 to 14 identified with either preinjury ADHD or no preinjury conditions. They reported that children with ADHD were more likely to be injured as pedestrians, bicyclists, and to sustain more head injuries and injuries to multiple body regions relative to children with no preinjury condition.

Further, children with preinjury ADHD were more severely injured and were more frequently admitted to the intensive care unit (DiScala et al., 1998). Others also have reported that children with premorbid ADHD are disproportionately represented among children with closed head injuries (Gerring et al., 1998). The premorbid prevalence of ADHD among children aged 4 to 19 years with moderate to severe closed head injuries was reported at .20 compared with a prevalence of .045 in a reference population. These authors further reported that 77% of children with premorbid ADHD were not receiving mental health treatment at the time of their injury (Gerring et al., 1998).

While these findings appear to support an association between ADHD and injury, specifically head injury, such a conclusion is tenuous for several reasons. First, both of these studies identified the presence of premorbid ADHD through interviews with parents and children following the occurrence of an injury. Such retrospective reports of behavior may introduce bias in that the perception of a child's behavior can be influenced by an injury to that child (Davidson, 1987). Head injuries also have the potential to alter a child's behavior and thus post-injury behavior could influence ratings of premorbid behavior (Davidson, 1987). Additionally, these studies did not control for comorbid psychiatric conditions such as ODD or CD. As such, the influence of these comorbid conditions is unclear as is the heterogeneity of the samples employed.

Two recent studies examined the specific relationship between ADHD and burn injuries (Mangus, Bergman, Zieger, & Coleman, 2004; Thomas, Ayoub, Rosenberg, Robert, & Meyer, 2004). Both studies utilized retrospective chart reviews to assess differences in burn rates among children with and without ADHD. While neither study found a higher prevalence of burn injuries among children and adolescents with ADHD, some differences between the groups did emerge. Mangus and colleagues (2004) reported that children with ADHD were more likely to experience a thermal rather than a flame burn, had more extensive burn injuries, and were less likely to be discharged home than children without ADHD. Thomas and colleagues (2004) reported that impulsive behavior contributed to the burn injury in approximately half of the 21 cases of children with ADHD. Additionally, in 9 of these 21 cases, children with ADHD were not taking their prescribed stimulant medication on the day of the injury (Thomas et al., 2004).

Injury episodes are important reasons that parents seek medical care for their children in emergency departments, outpatient clinics, and primary care offices. As such, patterns of health care service utilization among children with ADHD can provide important information regarding the association between these disorders and unintentional injury. Pastor and Reuben (2006) examined the rates of medically attended nonfatal injuries among children with and without ADHD. They reported that children and adolescents aged 6 through 17 years with ADHD were more than twice as likely to experience a medically attended injury when compared to children without ADHD. Annual injury rates for children with ADHD were 204 episodes per 1000 children compared with 115 episodes per 1000 among children without ADHD. Individuals with ADHD also have been reported to be 1.7 times more likely to have an accident claim than controls (Swensen et al., 2004). The presence of one or more psychiatric comorbidities increased the likelihood of an accident claim among adolescents (Swensen et al., 2004). Additionally, a population-based cohort study utilizing school and medical records revealed that children with ADHD had more hospital inpatient, hospital outpatient, and emergency department admissions than children without ADHD (Leibson et al., 2001).

Children with ADHD also had medical costs that were more than double those of children without ADHD (Leibson et al., 2001). Taken together these findings provide additional support for the association between ADHD and increased risk for injury and associated medical service utilization. However, it is important to note that a clinical diagnosis of ADHD was not verified and the possible confounding influence of comorbid psychiatric conditions was not explored in all of these studies.

Research also has explored the relationship between preschoolers with ADHD and unintentional injury (Byrne et al., 2003; DuPaul, McGoey, Eckert, & VanBrakle, 2001; Lahey et al., 1998). In a study designed to examine the validity of DSM-IV ADHD diagnostic criteria, Lahey and colleagues (1998) reported that children aged 4 through 6 years who met criteria for ADHD Hyperactive-Impulsive type (ADHD-HI) were significantly more likely than controls to have experienced an unintentional injury. When children with comorbid ODD and CD were dropped from the statistical analyses, children who met criteria for ADHD Combined type (ADHD-C) also had significantly more parent reported injuries than control children. No differences in injury rates were observed between children with ADHD Inattentive type (ADHD-PI) and controls. Findings from subsequent studies, however, have not supported these results. While Byrne et al. (2003) found that preschoolers with ADHD were reported by their parents to engage in more behaviors that placed them at-risk for injury, these children did not actually sustain more injuries than control children. Additionally, DuPaul and colleagues (2001) found no differences in the number injuries between 3 through 5 year old children with ADHD and normal controls.

Possible rationale for these discrepant findings center on how injury was measured or diagnostic process. For example, while the later studies reviewed children's medical records to assess injury, it is unclear if Lahey and colleagues (1998) supplemented parent reported injuries with a review of medical charts. Further, it is unclear whether Lahey et al. (1998) measured minor home-treated or medically attended injuries. In contrast to minor injuries, medically attended injuries are low base rate events and young children may not have experienced enough of these injuries to result in statistically significant group differences. Small sample sizes also may have limited the power to detect statistical significance in the studies conducted by DuPaul et al. (2001) and Byrne et al. (2003). Specifically, DuPaul and colleagues (2001) reported that injury data were only available for approximately half of their sample (n = 47). While the group differences did not reach statistical significance the effect size for number of injuries was rather large (1.20), thus indicating practical significance (DuPaul et al., 2001).

Driving Safety. Given that motor vehicle collisions account for a large number of unintentional injuries among children and adolescents, the relationship between ADHD and driving related outcomes has been investigated. In a series of longitudinal studies, adolescents and young adults with ADHD were reported to be 2 to 4 times more likely to experience a motor vehicle collision and more than 3 times more likely to incur associated injuries. These individuals were also more likely to be at-fault in motor vehicle crashes than were individuals without ADHD (Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993; Barkley, Murphy, & Kwansik, 1996). Additionally, adolescents and young adults with ADHD were more likely to have received traffic citations, especially for speeding, as well as to have their licenses suspended. Teenagers with greater comorbid ODD and CD symptoms were found to be at the greatest risk for negative driving outcomes (Barkley et al., 1993). Specifically, symptoms associated with ODD and CD accounted for a significant amount of variance in all of the negative driving outcomes whereas symptoms exclusively associated with ADHD did not. As such, Barkley and colleagues (1993) concluded that negative driving outcomes may be a function of the degree of antisocial symptoms rather than the degree of ADHD.

Research has further reported that individuals with ADHD perform more poorly on computer-simulated driving tests compared to those without ADHD (Barkley et al., 1996). During these driving tasks, adolescents and young adults with ADHD experienced more crashes, scrapes, and erratic steering than the control group. Yet, no group differences were reported with respect to driving knowledge (Barkley et al., 1996). An important consideration of these early studies is that they did not examine the impact of comorbid substance abuse disorder. Research indicates that adolescents and young adults with ADHD who currently exhibit or have previously experienced coexisting conduct problems are at increased risk for substance abuse difficulties compared to those without the disorder (Barkely, 2003). The presence of such difficulties may influence driving outcomes for this population. In one study, twenty percent of individuals with ADHD had received a traffic citation for drunk driving compared to 0% of those in the control group (Barkley et al., 1996). While this finding did not reach statistical significance its clinical importance cannot be ignored.

In a longitudinal study, Nada-Raja and colleagues (1997) further explored the extent to which inattentive and hyperactive symptoms of ADHD at age 15 were associated with driving offenses among adolescents, aged 15 to 18. They reported that driving offenses among males were associated with significant ADHD symptomatology or the presence of conduct disorder. Significant ADHD symptomatology was defined as a score of at least 1.5 standard deviation above the mean on the DSM-III total ADHD symptom scale. Males with ADHD were significantly more likely than males with other disorders or no disorder to drive a car within 2 hours of consuming alcohol, although a higher proportion of males with conduct disorder received actual alcohol related traffic citations. Among females, driving offenses and motor vehicle crashes were more frequently noted among those who scored high on the ADHD symptom scale rather than those who met criteria for conduct or oppositional disorder. While the authors concluded that risky driving behavior cannot be explained entirely by the presence of ADHD (Nada-Raja et al., 1997), these findings do support the importance of assessing symptom severity when studying the relationship between ADHD and injury risk.

Woodward, Fergusson, and Horwood (2000) conducted a longitudinal study to examine the associations between attentional difficulties at age 13 and driving outcomes at age 21. They reported that an increased level of attention problems in adolescence resulted in a subsequent increased risk for motor vehicle collisions involving injury, drunk driving, and illegal driving behavior such as driving without a license. After controlling for confounding factors, including the presence of adolescent conduct problems, the association between attentional problems and injury-related motor vehicle collisions remained significant. The risks related to drunk driving; however, were no longer statistically significant (Woodward et al., 2000).

Pedestrian Safety. As pedestrian related injuries have been reported to occur more frequently among children with ADHD than children without the disorder (DiScala et al., 1998), research also has examined road-crossing behaviors among adolescents with ADHD (Clancy, Rucklidge, & Owen, 2006). Results from a virtual reality hazardous road-crossing task indicated that adolescents with ADHD (n = 24) evidenced twice as many collisions with oncoming vehicles when compared to controls (n = 25). Further, nearly half of the road crossings made by adolescents with ADHD resulted in low margins of safety indicating a substantial risk for injury within a traffic environment relative to their peers. Although not examined statistically, the authors hypothesized that inattention was a critical variable in predicting pedestrian safety (Clancy et al., 2006). While 50% of the ADHD group had at least one other comorbid diagnosis, the influence of these disorders was not explored within this study. Further, participants with ADHD who were being treated with short-acting stimulant medication (n = 18) did not take their medication on the day of testing (Clancy et al., 2006).

Injury Risk. Research has not clearly delineated the underlying or associated features of ADHD that are responsible for the apparent increased injury risk among children with this condition. Given the array of neuropsychological deficits evident among children in this population, it is likely that impairments in executive functioning may play a role in injury liability. The failure to delay or inhibit responses and difficulties with effortful attention are often cited as fundamental deficits among children with ADHD (Barkley, 2003; Stefanatos & Baron, 2007). Deficient inhibitory control has been linked to problems with working memory, self-regulation, internalization of speech, and reconstitution (behavioral analysis and synthesis) (Barkley, 2003). Further, disinhibition has been identified as fundamental in controlling responses to everyday environmental events, including those that may pose a safety threat (Barkley, 1997).

Although children with ADHD appear to have increased injury liability, limited research has investigated the extent to which these children may differ in their ability to recognize hazardous situations, understand the consequences of engaging in risky behavior, or identify strategies for preventing injury. In a study designed to explore these aspects of safety knowledge, Farmer and Peterson (1995) reported that school-aged boys with ADHD were able to identify risky behaviors and safety hazards in a manner comparable to their typically developing peers. These children did, however, anticipate less severe consequences of engaging in risky behavior and generated fewer methods of preventing injuries than typically developing children. Moreover, boys with ADHD knew fewer safety rules for risky situations than boys without ADHD (Farmer & Peterson, 1995). Conversely, Mori and Peterson (1995) reported that school-aged boys rated as highly impulsive and overactive did not differ from boys with low impulsivity and overactivity ratings with respect to injury safety or prevention knowledge. Although, participants in the later study evidenced symptoms consistent with ADHD they were not identified as meeting diagnostic criteria for the disorder.

As research has indicated that poor parental supervision is a risk factor for unintentional injury among typically developing children (Morrongiello et al., 2006), Schwebel, Hodgens, and Sterling (2006) examined the role of parental supervision with respect to increased risk for injury among children with behavior disorders. Twenty-nine clinic-referred children were observed interacting with their mothers in a "hazard room" which contained items that appeared dangerous but were altered to be safe. Results indicated that the strongest correlate of children's injury history (r = .51) was maternal ignoring of behavior in the hazard room. Additionally, dangerous behavior exhibited by children in the hazard room was most closely correlated to maternal ignoring of behavior. Children with ODD/CD symptomatology were more likely to engage in dangerous behavior in the hazard room than were children with only ADHD (Schwebel et al., 2006).

The presence of comorbid diagnoses also appears to place children with ADHD at increased risk for unintentional injury. The most common comorbid disorders diagnosed with ADHD-C are ODD and CD. The DSM-IV also identifies increased risk for physical injury as an associated feature of CD (APA, 2000). Among clinic referred children with ADHD, over 50% will meet criteria for ODD by late childhood or early adolescence (Barkley, 2003). Oppositional defiant disorder has been identified as a precursor of CD and prevalence estimates indicate that up to half of adolescents with ADHD present with co-occurring CD (Barkley, 2003). Thus, the developmental trajectory of ADHD suggests that a substantial percent of these children may eventually meet diagnostic criteria for ODD and/or CD and ADHD has been identified as one of the most reliable predicators of the later emergence of these externalizing disorders (Stefanatos & Baron, 2007). As such, research has explored the relationship between these clinical disorders and unintentional injury risk.

Consistent with previous findings (Davidson, 1987), recent research has suggested that oppositional behaviors rather than the core features of ADHD are responsible for increased rates of unintentional injury. Schwebel, Speltz, Jones, and Bardin (2002) conducted a two-year prospective longitudinal study to examine the relationship between injuries among preschool-aged boys with ODD and the presence of comorbid ADHD. Parents reported medically attended injuries at one and two-years following a clinical diagnosis. Results indicated that boys with ODD had twice the number of injuries than a matched comparison group. The presence of comorbid ADHD in children with ODD did not increase risk for injury.

A similar pattern for injury risk emerged from a study by Schwebel and colleagues (2007) which examined unintentional injury risk in children with externalizing behavior disorders. They reported that among children with clinical diagnoses of ADHD, symptoms of ODD and CD were related to injury incidence but symptoms of ADHD were not. Observed rule violations and intentional aggression toward others were the symptoms which predicted injury occurrence. It is important to note; however, that the children were observed during a 6-week treatment camp for children with ADHD. As such, the ongoing treatment regimen may have influenced the relationship between ADHD symptoms and injury risk in this study (Schwebel, Tavares, Lucas, Bowling, & Hodgens, 2007).

Still others have reported differential risk for injury based on psychiatric diagnosis (Rowe, Maughan, & Goodman, 2004). After controlling for psychosocial risk factors and comorbid psychopathology, children and adolescents with ODD were 2.3 times more likely to experience burns and 3.9 times more likely to experience a poisoning than children without ODD. Children with ADHD were found to be at increased risk for experiencing a fracture relative to children without ADHD. Conduct disorder was not independently associated with any specific type of injury. The authors concluded that ODD and ADHD rather than CD are the externalizing behavior disorders associated with unintentional injury (Rowe et al., 2004). Thus, it is clear that controlling for or assessing the impact of comorbid diagnoses is critical when examining the relationship between ADHD and unintentional injuries.

Stimulant Medication and Unintentional Injury

The American Academy of Pediatrics (2001) recommends a target outcome of ADHD treatment as increased safety in the community (e.g., riding bicycles, crossing streets). This recommendation makes sense given the wealth of empirical literature indicating that children with ADHD incur more unintentional injuries and greater medical expenses than those without ADHD (Chan, Zhan, & Homer, 2002; Leibson et al., 2001). Stimulant medication is the most commonly utilized treatment for children with ADHD and methylphenidate hydrochloride (MPH) is the most frequently prescribed stimulant (Habel, Schaefer, & Levine, 2005; Olfson, Gameroff, Marcus, & Jensen, 2003). The trade names for MPH include Concerta, Metadate, and Ritalin. Rowland, Lesesne and Abramowitz (2002) reported that over 1.5 million children were taking methylphenidate. Data from 2005 indicate that amphetamine mixes accounted for 32% of medication use while methylphenidate accounted for 47% of the ADHD medication use in 2005. Atomoxetine accounted for nearly 17% of ADHD medication use during the same year (Castle et al., 2007). The short-term efficacy and safety of MPH treatment in children and adolescents has been well established (MTA Cooperative Group, 1999) and approximately 70-80% of children respond positively to stimulant medication (Pelham et al., 2000). While MPH has been documented to improve core (i.e., inattention, hyperactivity/impulsivity) as well as peripheral features (e.g., academic achievement) associated with ADHD, the effects are often not great enough to normalize behavior (Pelham et al., 2000).

Methylphenidate is typically considered the "gold standard" stimulant medication treatment for ADHD, however, other psychostimulant medications including Amphetamine (Adderall), Dextroampehtamine (DEX; Dexedrine), and Pemoline (PEM; Cylert) are commonly prescribed to manage symptoms of ADHD. While these medications have not been studied as thoroughly or rigorously as MPH, research suggests that these stimulants are comparable with MPH with respect to managing symptoms of inattention, hyperactivity, and impulsivity in children with ADHD (Pliszka, 2007). In a review of ADHD treatment studies, Brown and colleagues (2005) reported no clear differences among MPH, DEX, and PEM. A limited number of controlled trials examining of Adderall have been conducted (Manos et al., 1999; Pelham et al., 1999; Pliszka, Browne, Olvera, & Wynne, 2000), yet these studies consistently reported that both medications were superior to placebo and were comparable in managing symptoms of ADHD. Specifically, Pliszka and colleagues (2000) reported that both Adderall and methylphenidate were superior to placebo in reducing inattention and oppositional symptoms while Adderall produced significantly more improvements in teacher ratings of behavior.

Trends in medication treatment for ADHD over the past several years have reflected an increase in the use of extended release medication formulations relative to immediate release or short-acting formulations (Castle, Aubert, Verbrugge, Khalid, & Epstein, 2007). Pharmacy claims data from 2005 revealed that among children and adolescents extended release formulations accounted for 68% of stimulant medication usage. While similar treatment effects sizes have been reported for long-acting (.95) and short-acting (.91) stimulant medications there are differences between these medication formulations that warrant consideration. The treatment effects of immediate release formulations typically last 2 to 4 hours and these medications are taken 2 to 4 times daily while the effects of extended release formulations last up to 12 hours with such medications being administered only once daily (The Medical Letter, 2006). These differences may influence treatment adherence (Lage & Hwang, 2004; Swanson, 2003) and may be related to a phenomenon known as the rebound effect (Carlson & Kelly, 2003). Stimulant rebound is considered to be the behavioral deterioration that occurs in children with ADHD after medication wears off. Behaviors such as tearfulness, irritability, and hyperactivity during this state are worse than in the unmedicated state (Carlson & Kelly, 2003). This phenomenon has been most critically evaluated among children treated with short-acting stimulant medications (Johnston, Pelham, Hoza, & Sturges, 1988; Carlson & Kelly, 2003) with some research suggesting the presence of behavioral deterioration in approximately 30% of children taking short-acting stimulants (Carlson & Kelly, 2003). However, recent data suggest that this effect may also be present following treatment with long-acting or extended release stimulant medications (Cox et al., 2008). Given the relationship between children's behavior and unintentional injury risk, consideration of the potential for a rebound effect is justified when examining the relationship between stimulant medication treatment and unintentional injury among children with ADHD.

A conceptual model articulated by Rapport and colleagues (2001), outlines the underlying components of ADHD and suggests that biological influences create individual differences with respect to neurobiological system functioning. These neurobiological systems are responsible for the core features of ADHD which include hyperactivity, impulsivity, and inattention. This model further indicates that the peripheral features of ADHD, as outlined in the DSM-IV (e.g., accidental injury, academic difficulty) are a consequence of dysfunction associated with the core features of ADHD. Therefore, treatments that target the neurobiological substrates, such as stimulant medication, would impact the core features of ADHD and subsequently have a trickle-down effect on the peripheral features, which are postulated to be derived from the core features. As such, stimulant medication should have an effect on the rates of unintentional injury experienced by children with ADHD.

Despite a theoretical rationale centering on the use of stimulants to reduce rates of unintentional injury, limited research has directly explored the relationship between stimulant medication use and unintentional injury among children with ADHD. Lage and Hwang (2004) reported that among children with ADHD, those treated with extended release MPH were significantly less likely to experience a medically attended accident or injury than those treated with immediate release MPH. In addition, extended release MPH was associated with fewer emergency room visits and general practitioner visits. In subsequent research, Kemner and Lage (2006) reported that children with ADHD initiated on extended release MPH treatment were significantly less likely to visit an emergency room and had fewer visits to the emergency room than children initiated on the immediate release formulation of MPH. Kemner and Lage (2006) also reported that children whose treatment was initiated with the extended release MPH formulation had a significantly longer duration of medication treatment and were less likely to switch to another ADHD medication than children who received the immediate release formulation. Several limitations were apparent with these studies, however. The study was retrospective in nature and utilized an administrative health care database. Dependence on such data precludes confirmation of an ADHD diagnosis or comorbid conditions, directly linking specific medications to diagnoses, or determining how effective a given medication is for a specific child (Rappley et al., 1999). Data from medical databases are also likely to have varying levels of accuracy. Further, it is unclear how injuries and accidents were defined and measured. The authors indicated that accidents and injuries were associated with claims for outpatient visits or hospitalizations. As noted by Peterson and colleagues (2002), the definition of an injury that requires medical treatment is subjective. Caregivers may opt to seek medical treatment for a variety of reasons (e.g., child distress, medical insurance) which may ultimately result in the inclusion of very minor injuries or the exclusion of severe injuries.

Research also has explored the relationship between stimulant treatment and emergency department use and costs among children with ADHD (Leibson et al., 2006). The findings revealed that while receiving stimulants, children with ADHD had significantly fewer emergency department visits and costs when compared to periods during which they were not receiving stimulants. Moreover, the proportion of time on stimulants was inversely associated with emergency department costs and visits. Extended stimulant treatment was associated with decreased emergency department visits and costs for children with ADHD (Leibson et al., 2006). Although fewer emergency room visits may be associated with fewer injuries, rates of injuries were not directly measured in this study. In addition, this study did not measure stimulant medication treatment compliance/integrity or control for the use of additional medications.

Others have explored rates of unintentional injury and medical service utilization among children treated with MPH for presumed ADHD (Brehaut, Miller, Raina, & McGrail, 2003; Miller, Brehaut, Raina, McGrail, & Armstrong, 2004). These reports indicated that children treated with MPH evidenced greater odds of experiencing an injury resulting in hospital admission than those who were not treated with MPH. Specifically, children treated with MPH were at increased risk for numerous injuries such as fractures, poisoning, and concussions and were more likely to be injured by way of falls, motor vehicle collisions, and pedestrian incidents (Brehaut et al., 2003). While research has reported that MPH may reduce unintentional injuries among children with ADHD, data from these studies suggest that stimulant medication treatment may not "normalize" rates of injury among children with ADHD. This finding is consistent with research on the effectiveness of stimulant medication among children with ADHD (Pelham et al., 2000). Although these studies yield useful preliminary data they are limited in the fact that MPH treatment may not be an accurate proxy for ADHD. Stimulant medication is also utilized in the treatment of other child psychiatric disorders such as autism and depression (Aman, Lam, & Van Bourgondien, 2005; Jerrell & Shugart, 2004). Further, interpretation of the findings is hindered by the inability to account for the impact of comorbid behavior disorders, such as ODD.

More recently, Marcus, Wan, Zhang, & Olfson (2008) reported on risk factors for injury among children and adolescents who initiated stimulant treatment for ADHD. They reported a higher injury risk for adolescents than children, males than females, and for whites than minorities. Injury risk was also significantly higher for patients prescribed anxiolytics/hypnotics, mood stabilizers, and or antidepressants than for patients not prescribed these medications and for patients treated for a comorbid mood disorder than for patients without a mood disorder. The authors also reported a nonsignificant trend toward an inverse relationship between stimulant medication adherence and risk of injury. The results of this study are limited primarily by the fact that the data were derived through medical and pharmacy claim records which may have varying levels of accuracy. Additionally, the influence of comorbid externalizing behavior disorders was not examined.

Other researchers have examined the impact of stimulant medication on driving performance among adolescents and young adults with ADHD. Extended release MPH has been reported to be superior to placebo, extended release mixed amphetamine salts (Adderall), and immediate release MPH with respect to improving driving performance on a driving simulator (Cox, Merkel, Kovatchev, & Seward, 2000; Cox, Merkel, Moore, Thorndike, Muller et al., 2006; Cox, Merkel, Penberthy, Kovatchev, & Hankin, 2004). Relative to placebo, individuals treated with MPH demonstrated less time driving off-road, fewer instances of speeding, less erratic speed control, and less inappropriate use of breaks on a driving simulator (Cox et al., 2006). Individuals treated with Adderall did not demonstrate such improvements relative to placebo (Cox et al., 2006). Additionally, extended release MPH has been shown to yield improved evening driving performance on a computer simulator relative to immediate release MPH (Cox et al., 2004). Data also suggest that during late evening hours, simulator and on-road driving performance variance is significantly greater during Adderall treatment conditions compared to long-acting MPH treatment conditions (Cox et al., 2008). These findings have practical implications given that a significant percentage of motor vehicle crashes among adolescents and young adults occur during the evening hours (National Safety Council, 2004). Finally, under real-life driving conditions individuals treated with controlled release MPH evidenced fewer driving errors resulting from inattention (e.g., attending to traffic signals) relative to no medication conditions (Cox, Humphrey, Merkel, Penberthy, & Kovatchev, 2004).

While these improvements in driving performance are postulated to reduce the number of unintentional injuries as a result of motor vehicle crashes involving this population, rates of injury resulting from motor vehicle crashes have not been systematically studied in response to stimulant medication treatment.

Although a dearth of data exist regarding the relationship between stimulant medication treatment and injuries in children with ADHD, preliminary data and a theoretical understanding of the effects of stimulant medication indicate that future research is warranted. In addition, research should continue to explore the differential effects of extended release and immediate release stimulant medications on unintentional injury as this information may ultimately impact the prescribing practices of service providers and inform medication choices made by parents of children with ADHD.

Current Study

No research has examined the relationship between stimulant medication treatment and *minor* unintentional injuries in children with ADHD, yet preliminary data suggest that stimulant medication may serve to mitigate risk related to severe or medically attended injuries. As noted previously, researchers have identified the utility of studying minor injuries as a proxy for more serious medically attended injuries in children. This study will explore the relationship between psychostimulant medication treatment and minor unintentional injuries among children with ADHD. The influence of symptom severity and the presence of comorbid symptoms on injury occurrence also will be examined.

Research Questions

The following research questions will be addressed in the current study:

1. Are there differences in injury rates among children treated with extended release methylphenidate and children treated with extended release mixed amphetamine salts?

Given the conceptual model of ADHD (Rapport et al., 2001), stimulant medication treatment which impacts the core symptoms of ADHD also should have an effect on the peripheral features, such as unintentional injury. Research on the treatment effectiveness of extended release methylphenidate and mixed amphetamine salts has suggested that these drugs are equivalent in reducing the core symptoms of inattention and hyperactivity among children with ADHD (Plizska et al., 2000). Given the proposed relationship between these behavioral characteristics and unintentional injury, it is hypothesized that there will be no difference in injury rates among children treated with extended release methylphenidate and mixed amphetamine salts.

2. Does symptom severity predict minor unintentional injury among children with ADHD?

Although limited research has investigated the impact of ADHD symptom severity on injury, Nada-Raja and colleagues (1997) reported that increased symptom severity predicted negative driving outcomes for adolescents. Moreover, Schwebel and colleagues (2005) indicated that hyperactivity was a strong predictor of injury among young children. It is therefore hypothesized that children with increased ADHD symptom severity (i.e., hyperactivity, inattention) will experience a greater number of minor unintentional injuries.

3. Does the presence of symptoms of comorbid externalizing behavior disorders predict minor unintentional injury among children with ADHD?

Several studies have revealed that the presence of comorbid ODD and/or CD symptoms is associated with increased injury risk among children and adolescents with ADHD (Schwebel et al., 2002; Rowe et al., 2004). As such, it is hypothesized that children who have elevated scores on the ODD and/or CD scales of the Child Behavior Checklist will incur more injuries than children who do not exhibit significant comorbid symptomatology.

4. What is the relationship between minor and severe unintentionally injuries among children with ADHD?

A positive association between minor and severe injuries has been reported among typically developing children within the literature (Morrongiello et al., 2004). Moreover, Jaquess and Finney (1994) reported that the occurrence of a severe injury was associated with subsequent minor injuries. It is hypothesized that the nature of this relationship will hold true for children with ADHD. Specifically, it is hypothesized that children who experience a medically attended injury will be more likely to incur subsequent minor injuries.

Chapter 3

METHOD

Participants

The participants in the current study included 31 parents of school-aged children between the ages of 5 and 12. Participants were recruited from Michigan and Connecticut and are from predominately middle-class suburban communities. The demographic characteristics of the sample reflected national service utilization data which suggest that Caucasians are more likely to utilize stimulant medication than minority children (Cox, Motheral, Hendersen, & Mager, 2003). Further, this study also revealed a male-to-female ratio similar to the 3:1 ratio reported within current literature (Strine et al., 2006).

To be included in the study children were required to have a current diagnosis for one of the three subtypes of ADHD (e.g., predominately inattentive, predominately hyperactive-impulsive, combined type) as determined by parent report of a clinical diagnosis and/or parent behavioral rating scales. Children who were treated pharmacologically must have received a consistent dosage level and formulation of stimulant medication for no less than 4 weeks prior to beginning the study in order to establish a stable pattern of treatment. Participants were excluded if their children were receiving any type of psychopharmacological treatment not indicated as a first-line treatment of ADHD (e.g., antidepressants). Given that the purpose of several research questions was to examine the relationship between symptom severity and unintentional injury, children with a diagnosis of ADHD who were not treated pharmacologically were permitted to enroll in the study. However, data for these children were only included in analyses which did not examine the impact of medication treatment on injury. Finally, in order to participate in the proposed study, parents were also required to indicate intent to maintain the treatment utilized at the beginning of the study (e.g., medication, no medication) for the duration of the study. From the larger sample, two secondary groups of participants were identified: parents of children with ADHD who were receiving extended release methylphenidate treatment (N = 9) and parents of children with ADHD who were treated with extended release mixed amphetamine salts (N = 10). To be included in the subgroup analysis children could not be taking multiple medications concurrently (e.g., extended release in conjunction with immediate release formulation) or a medication not classified as a long-acting psychostimulant (e.g., Strattera). Psychostimulants classified as extended release mixed amphetamine salts included Adderall XR. Psychostimulants classified as extended release methylphenidate included Concerta, Metadate ER, Focalin XR, and Ritalin LA. Due to initial recruitment difficulties institutional review board approval was obtained to provide participants who enrolled in the study after February 2008 with a $25 stipend for participation.

Materials

Parents completed the following measures:

Demographic Information Questionnaire. An investigator developed questionnaire was utilized to obtain information regarding child age, sex, ethnicity, psychiatric diagnoses, and medication treatment regimen (i.e., dosage and formulation). Data regarding parental education, parental employment status, and family composition was also collected.

Vanderbilt ADHD Parent Rating Scale (VADPRS). The VADPRS is a 55-item measure that includes all 18 DSM-IV criteria for ADHD. The scale also includes criteria for ODD and CD as well as items that screen for anxiety and depression. Each item related to psychopathology is rated on a 4-point scale (i.e., never, occasionally, often, very often). The VADPRS also contains a performance scale related to academic performance and relationships. These items are rated on a 5-point scale (i.e., excellent, above average, average, somewhat of a problem, problematic). The psychometric properties of the VADPRS have been reported in one study within the literature (Wolraich et al., 2003). Internal consistency alpha coefficients were reported as >.90 for parent ratings within a clinical sample of over 200 children. A concurrent validity coefficient of .79 was reported with the Diagnostic Interview Schedule for Children- IV (DISC-IV), which has well-established reliability and validity (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Additionally, internal consistency reliabilities of the DISC-IV and VADPRS were .93 or higher (Wolraich et al., 2003).

Child Behavior Checklist – Parent (CBCL). The Behavior Problems Scale of the CBCL (Achenbach & Rescorla, 2001) consists of 113 items which are rated on a 3-point scale (i.e., not true, somewhat or sometimes true, and very or often true). Scores fall in clinical, borderline, or normal range. This scale includes a total problems behavior index comprised of two broad-band factors, Externalizing and Internalizing Syndromes. The Externalizing factor includes problem behaviors such as hyperactivity and aggression, whereas the Internalizing domain includes anxious and depressive behaviors. The CBCL also has DSM-oriented scales which include oppositional defiant problems, conduct problems, attention-deficit/hyperactivity problems, affective problems, and anxiety problems which will be used to assist in identifying children with comorbid psychiatric conditions. Recent data indicate that the CBCL is a useful measure to screen for comorbid disorders among children with ADHD (Biederman, Monuteaux, Kendrick, Klein, & Faraone, 2005). The CBCL is probably the most researched behavior rating scale for children and has adequate to excellent psychometric characteristics (Lengua, Sadowski, Friedrich, & Fisher, 2001). Test-retest alpha coefficients range from .82 to .97, indicating high reliability. Further, the CBCL accurately differentiates between clinically-referred and non-referred children. A computer scoring program was used to generate behavioral profiles for each of the participants. Data was entered into the program on two occasions to ensure reliable data entry.

Behavior Assessment System for Children-Monitor for ADHD - Parent (BASC-Monitor). The BASC-Monitor is a norm-referenced rating scale used to measure attention problems, hyperactivity, internalizing problems, and adaptive skills (Kamphaus & Reynolds, 2001). The form is ideal for repeated use during treatment evaluation. The rating form uses a simple four point response scale for each behavior, ranging from "Never" to "Almost Always." Internal reliability alpha coefficients range from .67 to .85 while test-retest reliabilities range from .60 to .90. Validity has been demonstrated through high correlations between the BASC-Monitor and the CBCL. The BASC-Monitor also has been found to differentiate between ADHD subgroups and non-ADHD children. A computer scoring program was used to generate behavioral profiles for each of the participants. Data was entered into the program on two occasions to ensure reliable data entry.

Minor Injury Severity Scale (MISS). The MISS allows for objective assessment of injuries which do not necessitate medical intervention. This measure is sensitive to minor injuries and categorizes injuries into 22 types (e.g., cut, bruise/bump, burn). Injuries are rated on a 7-point severity scale to quantify tissue damage. For the purposes of this study severity ratings will not be determined. The measure is an accepted and widely-cited instrument for studying minor unintentional injury. The MISS has demonstrated adequate reliability and stability (Peterson et al., 1996). Test-retest reliability was reported at .99 and intercoder reliability was reported at .71. Divergent validity data on the MISS indicates that measured tissue damage is related to but not the same as injury outcomes such as pain, fear, and disability.

Injury History Questionnaire (IHQ). This measure provides an index of the frequency during the past several months with which the child has sustained moderate to severe injuries, which include medically attended injuries. The higher the score the more frequently the child had sustained non-minor injuries. Reliability and validity data have not been reported within the literature; however, this instrument has emerged as a useful tool in the study of unintentional injury (see Morrongiello et al., 2006; Morrongiello et al., 2004).

Procedures

Participants were recruited from medical clinics and schools via public outreach efforts. Over 200 letters describing the study were mailed to physicians, psychiatrists, psychologists, and school counselors throughout multiple states (Michigan, Ohio, Connecticut, and North Carolina). Informational flyers were included with these letters for distribution to patients by medical and/or mental health providers. An e-mail describing the study with the informational flyer attached was distributed to over 100 school psychologists registered with the Michigan Association for School Psychologists. Additionally, informational flyers were posted in libraries throughout central Michigan. Upon recruitment, informed consent was obtained and an ADHD diagnosis was confirmed through parent report of physician diagnosis and completion of the VADPRS by telephone interview. To assess for symptoms associated with comorbidity, the CBCL was administered prior to beginning bi-weekly data collection. Participants were enrolled in one 4-week interval of data collection over a nine month period. Data collection across the year served to control for potential seasonal variation in injury rates. The BASC-Monitor for ADHD was administered weekly during the 4-week interval to measure levels of inattention and hyperactivity. Reported injuries were coded and quantified through the use of minor unintentional injury rating scales. These logs were completed through bi-weekly phone calls to parents during the 4-week interval. Parents also completed an Injury History Questionnaire upon study enrollment to report the frequency with which the child sustained moderate to severe injuries in the previous 3 months. Prior research indicates that parents accurately recollect childhood injury information for more serious injuries (Pless & Pless, 1995), but their recollection for minor injuries is poorer (Peterson, Harbeck, & Moreno, 1993). For these reasons it was appropriate for severe injuries to be reported using 3 month recall measures while minor injuries were reported bi-weekly. Integrity of medication treatment was monitored weekly throughout the study. Parents reported on the number of days the child took medication each week as prescribed well as the dose and formulation of the medication.

Research Design & Data Analysis

The design of the present study afforded the opportunity to glean a clearer understanding of the relationship between different formulations of psychostimulant medications and minor unintentional injury as well as the relationship between symptom severity and minor unintentional injury among children with ADHD. Unintentional injuries in school-aged children with ADHD treated with extended release methylphenidate and children treated with extended release mixed amphetamine salts were compared using a between subjects, non-equivalent control group design. Analysis of covariance (ANCOVA) was used to test the differences related to minor unintentional injuries between the two groups. This specific method of data analysis was selected as the use of covariates statistically reduces the error variance, and therefore increases the relative effect size. Further, this statistical technique can increase the power of a treatment effect in between subjects designs with small sample sizes (Algina & Olenjnik, 2003). Additionally, Stevens (1996) recommends the use of two or three carefully chosen covariates to reduce error variance with small sample sizes. The analysis in this study employed three covariates related to ADHD symptom severity as well as the presence of symptoms associated with comorbid externalizing behaviors disorders (i.e., ODD and CD). This analysis allowed for the investigation of the impact of these covariates on rates of minor injury among the groups. The dependent measure, minor unintentional injuries was entered as a continuous variable.

Prediction models using linear regression analysis were examined for minor unintentional injuries. Prior to examining the prediction models, group differences in minor injuries and potential predictor variables were examined using the Mann-Whitney U Test. This is a non-parametric alternative to the t-test for independent samples, and is often employed when variables are nonnormally distributed. The two groups were compared on several characteristics including gender, age, parental education, injury history, scores on the attention-deficit/hyperactivity problems, conduct problems, and oppositional defiant problems DSM-oriented scales from the CBCL, and mean weekly hyperactivity and attention problem scores from the BASC-Monitor. An alpha level of .01 was used for all between group analyses to control for inflated experiment-wise Type 1 error.

To investigate the association between ADHD symptom severity and minor unintentional injury, four separate linear regression analyses were conducted to examine the relationship between weekly levels of hyperactivity and attention problems as measured by the BASC-Monitor and the number of unintentional injuries reported during each respective week. For each of the separate regression analyses, the total number of weekly unintentional injuries was entered as a continuous dependent variable. Weekly hyperactivity and attention problem scores were entered as independent variables using backward deletion procedures.

Hierarchical linear regression was utilized to examine the contribution of multiple predictor variables on minor unintentional injury. In the first step of the model, the presence of comorbid symptoms associated with conduct disorder was examined using scores from the CBCL. Next, ADHD symptom severity (i.e., inattention, hyperactivity) as measured by the CBCL, was entered into the model. Finally, the contribution of severe injury history as measured via parent report of a medically attended injury on the IHQ was examined.

Bijur, Golding, and Haslum (1988) recommend that risk ratios be calculated for low base-rate events such as unintentional injury in order to more adequately reflect their relationship with predictor variables. An odds ratio which provides an estimate of relative risk was calculated. To this end, logistic regression analysis was performed to predict the presence or absence of a medically attended injury. A lifetime history of medically attended injury was utilized as only 3 children experienced an injury serious enough to warrant medical attention during the course of the study and all children experienced at least one minor injury throughout the course of the study. Age, ethnicity, number of children living in the household, and number of minor unintentional injuries experienced since birth were entered as independent variables in the regression model.

Chapter 4

RESULTS

Descriptive Statistics

Thirty-three parents of children diagnosed with attention-deficit/hyperactivity disorder (ADHD) participated in the study. Data are only reported for 31 children as one participant was identified as an extreme outlier in terms of the number of weekly minor unintentional injuries reported and another was identified as an outlier with respect to consistently extreme weekly hyperactivity scores. Table 1 displays the demographic characteristics of children in the sample, including age, gender, ethnicity, parental education, and household type. Twenty-eight of the children were reported to be taking medication for the management of ADHD symptoms while 3 children were not taking medication. Table 2 provides a breakdown of the types of medication prescribed. The duration of medication treatment prior to study enrollment ranged from 1 to 60 months ($M = 26.67$, $SD = 19.89$).

Clinical Symptoms. Descriptive statistics concerning the clinical features of children as reported by their parents are presented in Tables 3 and 4. Mean scores along with standard deviations are provided for the scales comprising the Child Behavior Checklist (CBCL) and Behavior Assessment System for Children-Monitor for ADHD (BASC-Monitor). Based on data derived from the Vanderbilt ADHD Rating Scales (VADPRS) upon study enrollment, 10 children met criteria for ADHD predominately inattentive type, 1 child met criteria for ADHD predominately hyperactive type, 4 met criteria for ADHD combined type, and 5 children met criteria for Oppositional Defiant Disorder. Sixteen children did not meet criteria for any of the ADHD diagnostic categories based on scores from the VADPRS. The average total ADHD symptom score was 7.96 with a standard deviation of 3.87. The mean performance score was 2.91 with a standard deviation of .607. Table 5 displays the correlations among scores on the behavioral rating scales utilized to measure symptom severity and the presence of comorbid symptoms.

Unintentional Injuries. As a part of descriptive analyses, the ecological aspects of injuries children experienced were also considered. The number of injuries each child incurred within the 4-week period ranged from 3 to 62 injuries, with a mean of 5.5 (SD = 4.2) injuries per week. The mean number of injuries experienced during the course of entire the study was 22 (SD = 16.8, Median = 16). Children experienced an average of 7.2 injuries during the first week, 4.6 during the second week, 5.1 during the third week, and 5.2 during the fourth week of the study. The most commonly reported minor injures were bruises and bumps followed by scrapes and scratches. Based on the Injury History Questionnaire, children experienced an average of 11.3 minor injuries and 3.5 moderate injuries within the past 3 months. The average number of lifetime medically attended injuries ranged from 0 to 20, with a mean of 2.8. Only 1 child had ever been hospitalized because of an injury. The most common injuries reported to have been experienced by children since birth included cuts and falls from moving objects. During the course of the study, 3 children were reported to receive medical attention for an injury.

Relationships among Clinical Symptoms and Unintentional Injuries.

Visual inspection of histograms, normal Q-Q plots, and detrended normal Q-Q plots as well as the Kolmorgorov-Smirnov statistical test of normality revealed that the injury data were non-normally distributed. Correlation coefficients were calculated using

Spearman's rho, a non-parametric alternative to the Pearson product-moment correlation coefficient, to examine relationships between clinical symptom scores derived from the behavior ratings scales and number of parent-reported injuries. There were several strong positive correlations between the number of minor unintentional injuries experienced during the study and parent-reported clinical symptoms. Significant correlations emerged among total number of minor unintentional injuries and the CBCL conduct problems DSM-oriented scale ($r_s = .744$, $p = .002$); CBCL attention-deficit/hyperactivity problems DSM-oriented scale ($r_s = .639$, $p < .001$); CBCL oppositional defiant DSM-oriented scale ($r_s = .648$, $p < .001$); CBCL attention problems ($r_s = .705$, $p < .001$); CBCL somatic problems ($r_s = .596$, $p = .001$); CBCL rule breaking behavior ($r_s = .659$, $p < .001$); CBCL aggressive behavior ($r_s = .676$, $p < .001$); VADPRS total ADHD symptoms ($r_s = .403$, $p = .015$); BASC-Monitor mean weekly hyperactivity ($r_s = .437$, $p = .014$); and, the BASC-Monitor mean weekly attention problems ($r_s = .383$, $p = .033$).

Several significant correlations were found between number of unintentional injuries as measured by the Injury History Questionnaire and clinical symptom scores. The number of minor injuries since birth was positively correlated with the CBCL conduct problems DSM-oriented scale ($r_s = .372$, $p = .047$); CBCL attention-deficit/hyperactivity problems DSM-oriented scale ($r_s = .455$, $p = .010$); CBCL attention problems scale ($r_s = .673$, $p < .001$); and the VADPRS total ADHD symptom ($r_s = .370$, $p = .041$). No statistically significant correlations were found among minor injuries in the previous 3 months and clinical symptom scores. Moderate injuries since birth were significantly correlated with the CBCL attention-deficit/hyperactivity problems DSM-oriented scale ($r_s = .367$, $p = .043$) and the CBCL attention problems scale ($r_s = .538$, $p =$

.002). Moderate injuries experienced in the past 3 months were significantly correlated with CBCL somatic problems scale ($r_s = .416$, $p = .025$) and the CBCL attention problems scale ($r_s = .362$, $p = .047$). There was a moderate positive correlation between the number of medically attended injuries experienced since birth and the CBCL somatic problems scale ($r_s = .407$, $p = .029$). No statistically significant relationships were found between the number of medically attended injuries experienced during the previous 3 months and any of the clinical symptom scores.

Research Question 1: Medication Treatment

Employing a subgroup analysis of the 28 children treated with medication, this research question examined differences in injury rates among children treated with extended release methylphenidate (N = 9) and children treated with extended release mixed amphetamine salts (N = 10). A one way between subjects analysis of covariance (ANCOVA) was used to test the differences related to minor unintentional injuries between the two groups. The analysis employed three covariates: the CBCL ADHD problems DSM-oriented scale, CBCL oppositional defiant problems DSM-oriented scale, and CBCL conduct problems DSM-oriented scale. The dependent measure, minor unintentional injuries was entered as a continuous variable. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariates. Given the nonnormal distribution of minor unintentional injury, a square root transformation was employed on the dependent variable. Visual examination of the histogram, normal and detrended normal Q-Q plots as well as the Kolmorgorov-Smirnov statistical test of normality indicated that the transformation was successful and yielded normal distributions for the minor unintentional injury variable. After adjusting for scores of ADHD symptom severity and comorbid symptom severity, there was no significant difference between the two medication treatment groups in the number of minor unintentional injuries reported $F(1,13) = .58$, $p = .46$, partial eta square = .041. The adjusted mean injury score for the medication group treated with extended release methylphenidate was 4.37 compared with an adjusted mean injury score of 3.83 for the group of children treated with extended release mixed amphetamine salts. There was a significant relationship between the scores on the CBCL conduct problems DSM-oriented scale and minor unintentional injuries, $p = .041$, partial eta square = .285.

Using the Mann-Whitney U Test, a non-parametric alternative to the t-test for independent samples, these groups of children were compared on several characteristics including gender, age, parental education, injury history, scores on the attention-deficit/hyperactivity problems, conduct problems, and oppositional defiant problems DSM-oriented scales from the CBCL, and mean weekly hyperactivity and attention problem scores from the BASC-Monitor. Results indicated that no significant differences emerged between the groups on any of the above characteristics. Given sample size of 19 for this analysis, the power to detect significant between group differences with an effect size of .25 was less than .20.

Medication treatment integrity was also assessed throughout the course of the study. Fifty-seven percent (N = 16) of children took their medication as prescribed during each week of the study. Twenty-nine percent (N = 8) took their medication as prescribed on a daily basis for 3 of the 4 weeks. Fourteen percent (N = 4) took their medication as prescribed during 2 weeks or fewer across the 4 week period. No statistical differences were found in number of injuries incurred by children based on level of medication treatment integrity. No relationship was found between length of medication treatment prior to study enrollment and number of parent-reported minor unintentional injuries.

Research Question 2: ADHD Symptom Severity

The second research question of this study examined the relationship between ADHD symptom severity and minor unintentional injuries. Four separate linear regression analyses were conducted to examine the relationship between weekly levels of hyperactivity and attention problems as measured by the BASC-Monitor and the number of unintentional injuries reported during each respective week. For example, hyperactivity and attention problem scores from week 1 were regressed on total number of minor unintentional injuries reported in week 1. For each of the separate regression analyses the total number of unintentional injuries was entered as a continuous dependent variable. Standardized T-scores based on age and gender norms for hyperactivity and attention problems derived from the BASC-Monitor were entered as independent variables using backward deletion procedures.

Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. Examination of the data revealed that several of the continuous variables were non-normally distributed. For each of these variables a square root transformation was employed. Visual examination of histograms, normal and detrended normal Q-Q plots as well as the Kolmorgorov-Smirnov statistical test of normality indicated that the transformations were successful and yielded normal distributions for each of the variables.

Since age and gender are factors known to influence injury, a preliminary analysis was conducted to determine whether these variables should be controlled for in the regression models. Age was collapsed into two groups, with children ages 5 to 8 comprising the first group and children ages 9 to 12 comprising the second group. Results revealed that there was no relationship between age, gender, and injury in this study, so these variables were excluded from the regression analyses.

Significant regression models are presented in Table 6. The regression model for unintentional injuries incurred during week 1 was nonsignificant. Neither level of hyperactivity or attention problems were significant predictors of the number of injuries reported. For week 2, attention problems significantly predicted injuries following removal of hyperactivity from the initial model, $F(1, 29) = 4.97$, $p = .034$. In the final model attention problems accounted for 15% of the variability in injuries. The model including both hyperactivity and attention problems as predictors of injury for week 3 was significant, $F(2, 28) = 4.92$, $p = .015$. Together these variables accounted for 26% of the variance in the model; however, neither measure was independently statistically significant. Following removal of attention problems from the model, hyperactivity contributed significantly to the model $F(1, 29) = 7.63$, $p = .010$, accounting for 21% of the variance. Injuries reported in week 4 were also significantly predicted by measured levels of hyperactivity and attention problems, $F(2, 28) = 4.28$, $p = .024$, with these variables accounting for 23% of the variance in this regression model. Again neither measure was independently statistically significant when both were included in the model. Following deletion of hyperactivity from the regression model, attention problems contributed significantly to the model, $F(1, 29) = 8.04$, $p = .008$, accounting for 22% of the variance.

Mean ADHD symptom scores across the four week study period were calculated and regressed on mean number of weekly injuries reported. Consistent with the previous models, hyperactivity and attention scores were entered into the regression model using backward deletion procedures. The initial model including both hyperactivity and attention problems as predictor variables approached significance, $F(2, 28) = 3.11$, $p = .060$. Removal of attention problems from the model, yielded a significant final model, $F(1, 29) = 5.62$, $p = .025$, with hyperactivity accounting for 16% of the variability in injuries.

Additionally, a regression analysis was conducted to determine if parent-reported ADHD symptoms at the beginning of the study predicted the occurrence of minor injuries throughout the duration of the study. The initial model which included three predictor variables, CBCL attention problems syndrome scale, CBCL ADHD problems DSM-oriented scale, and the VADPRS total ADHD symptom score, was statistically significant, $F(3, 27) = 4.57$, $p = .010$. Only in the final model, which included the CBCL ADHD problems DSM-oriented scale, did a single measure significantly predict minor injuries, $F(1, 29) = 14.31$, $p = .001$. The final model accounted for 33% of the variance among minor unintentional injuries.

Finally a one-way between group analysis of covariance (ANCOVA) was conducted to examine differences in the number of minor unintentional injuries among children who met criteria for one of the three subtypes of ADHD based on the VADPRS ($N = 15$) upon study enrollment and those who did not meet such criteria ($N = 16$). After adjusting for scores on the CBCL conduct problems DSM-oriented scale, there was no significant difference between the children who met VADPRS diagnostic criteria ($M = 24.58$, $SD = 16.77$) in the number of minor unintentional injuries reported $F(1, 26) = .001$, $p = .978$. There was a significant relationship between scores on the CBCL conduct problems DSM-oriented scale and minor unintentional injuries, $p < .0001$, partial eta square = .285.

Research Question 3: Comorbid Symptoms

This research question examined the influence of comorbid symptoms on rates of unintentional injuries experienced by children during the course of the study. A regression analysis was utilized to assess the impact of comorbid symptoms associated with externalizing behavior disorders as measured by the CBCL on childhood injuries. Specifically, the conduct problems DSM-oriented scale score and oppositional defiant problems DSM-oriented scale score were entered as continuous independent variables. An examination of tolerance and the variable inflation factor indicated potential problems with multicollinearity when rule-breaking behavior and aggressive-behavior syndrome scale scores were included in the model, thus those variables were omitted from the model. The regression model including conduct problems and oppositional defiant problems was significant, $F(2, 26) = 14.05$, $p < .001$, accounting for 52% of the variance in injuries. However, only the conduct problems scale contributed significantly to the model (beta = .579, $p = .016$), indicating that children with elevated conduct problems were more likely to experience subsequent minor injuries.

Hierarchical multiple regression was used to assess the ability of the CBCL attention-deficit/hyperactivity problems DSM-oriented scale to predict injuries after controlling for the influence of the CBCL conduct problems DSM-oriented scale. The conduct problems scale was entered at Step 1, explaining 50% of the variance (beta = .706), F (1, 27) = 26.86, $p < .001$. After entry of attention problems scale at Step 2, the total variance explained by the model as a whole was 51%, F (2, 26) = 13.38, $p < .001$. The attention-deficit/hyperactivity problems DSM-oriented scale (beta = .133) explained less than an additional 1% variance in injuries, after controlling for conduct problems, R-square change = .008. In the final model, only the conduct problems DSM-oriented scale was statistically significant (beta = .610) in terms of predicting the occurrence of minor unintentional injuries.

Research Question 4: Unintentional Injuries

The final research question examined the relationships between minor, moderate, and medically attended unintentional injuries. Relationships between parent-reported injuries based on the Minor Injury Severity Scale and the Injury History Questionnaire were computed and correlations among the variables are presented in Table 7. Given the nonnormal distribution of the injury history variables, correlations were calculated using Spearman's rho non-parametric alternative.

The relationship between injuries was also explored using regression analyses. Given that a normal distribution is an underlying assumption of regression analyses, injury history variables were transformed using logarithmic transformations (Log10). While these transformations improved the distribution of the minor and moderate injury history variables, the large number of participants who had not experienced a medically attended injury limited the utility of statistical transformation for these variables. As such, medically attended injury history variables were excluded from the following regression analysis. Employing a backward elimination procedure, minor and moderate injury history variables were regressed on minor unintentional injuries. The only significant predictor of minor injuries was the number of parent-reported minor injuries experienced since birth, $F (1, 20) = 4.63$, $p = .044$. The total variance explained by the final model, which included only one predictor, was 18%. Parent-reported moderate injuries and minor injuries over the past 3 months failed to contribute significantly to the final model that predicted minor unintentional injuries.

To examine whether or not a history of minor injuries was able to predict unintentional injuries after controlling for the presence of conduct problems, hierarchical multiple regression was utilized. The conduct problems scale was entered at Step 1, explaining 50% of the variance, $F (1, 27) = 26.86$, $p < .001$. After entry of minor injury history at Step 2, the total variance explained by the model as a whole was 56%, $F (2, 26) = 16.50$, $p < .001$. The minor injury history measure explained an additional 6% variance in injuries, after controlling for conduct problems, R-square change = .061. In the final model only the conduct problems DSM-oriented scale was significant and recorded a higher beta value (beta = .635, $p < .001$) than the history of minor injuries (beta = .265, $p = .070$).

Binary logistic regression was performed to assess the impact of a number of factors on the likelihood that children had ever experienced a medically attended injury. A total of 31 observations were included in the analysis, with 8 observations included in the "1" category and 23 included in the "0" category. The model contained four independent variables (age, ethnicity, number of children living in the household, and number of minor unintentional injuries experienced since birth). The full model containing all predictors was statistically significant, χ^2 (4, N = 31) = 14.94, p = .005, indicating that the model was able to distinguish between children who had and had not experience a medically attended injury. An examination of regression diagnostics indicated that there were no outliers or influential data points. The Hosmer and Lemeshow goodness-of-fit test was nonsignificant. The model as a whole explained between 38.2% and 56.2% of the variance in injury occurrence, and correctly classified 87.1% of the cases. The strength of the prediction was .38 according to Cox's and Snell's R^2. As shown in Table 8, three of the independent variables made a unique statistically significant contribution to the model (number of children living in household, child age, and number of minor injuries experienced since birth) while ethnicity approached statistical significance. Parents who reported fewer children living in the household were likely to have a child who had experienced a medically attended injury as compared to those who reported households with a greater number of children (OR = .198, 95% CI = .057-.690.).

Chapter 5

DISCUSSION

This study examined differences in minor unintentional injuries among children with attention-deficit/hyperactivity disorder (ADHD) who were treated with long-acting methylphenidate and extended release mixed amphetamine salts. Further, this study explored the extent to which severity of hyperactivity and inattention symptoms placed children at risk for incurring minor unintentional injuries. The impact of symptoms of comorbid externalizing behavior disorders on injury was also investigated. Finally, the relationship between minor and medically attended injuries among children diagnosed with ADHD was examined. This study offers a unique contribution to the literature considering psychopathology and injury because it only included children diagnosed with ADHD, and those children were followed prospectively for 4 weeks to track injury occurrences and behavior disorder symptoms.

Unintentional Injuries

Results on the ecology of injuries among this sample paralleled results from research with disordered (Schwebel et al., 2007) and non-disordered children (Morrongiello et al., 2004; Schwebel et al., 2002). In the current study, children experienced bumps and bruises most often followed by scrapes and scratches. This is consistent with results reported by Schwebel and colleagues (2007) who examined unintentional injuries in children with externalizing behavior disorders and reported that these children most frequently experienced bumps and bruises (53% of injuries) followed by cuts and scrapes (32% of injuries).

A difference between this study and previous research centers on the frequency of injury. The rate of injury in this study was high with parents reporting an average of 5.5 minor unintentional injuries per week. This rate is significantly higher than the average (2.18) number of injuries Schwebel et al. (2007) reported among behavior disordered children across a 6-week period. A potential rationale for this large discrepancy centers on how injuries were measured. The current study focused specifically on parent-reported minor unintentional injuries while Schwebel and colleagues (2007) utilized observations from camp counselors who coded injuries requiring adult attention or those which left tissue damage lasting at least 10 minutes. Children may be more likely to report minor injuries to their parents than unfamiliar camp counselors and parents may be more likely than camp counselors to observe minor tissue damage for their individual child. The children enrolled in the study conducted by Schwebel and colleagues (2007) were attending a summer camp for children with ADHD and thus injury rates may have been influenced by ongoing behavioral treatment regimens utilized as a part of the structured camp protocol. Moreover, poor adult supervision has been associated with injury risk and the level of close supervision provided at camp would likely influence injury rate. Finally, an elevated frequency in injury rate observed in the current study may also stem from response bias or self-selection of participants. Given the expansive recruitment process, yet limited number of participants enrolled in the study, it is plausible that parents chose to participate in the study because their children had a history significant for injuries or because they experienced injuries on a regular basis.

Medication Treatment

A discussion of between group differences with respect to medication treatment must be qualified by fact that given the small sample the power to detect statistical significance in the current study was less than .20. Thus, interpretive conclusions are limited as it is unclear if there was sufficient power to detect group differences if they were present in the current sample. No significant relationships between medication treatment patterns and unintentional injuries emerged from the current study. Specifically, no differences in the number of parent-reported unintentional injuries were evident among children treated with extended release methylphenidate and children treated with extended release mixed amphetamine salts. Yet, it is important to note that the frequency of minor injuries was high in both groups. While no previous research has examined the differential impact of these specific medications on injury occurrence, data from research on adolescent driving performance do seem to suggest that these medications have a differential impact on negative driving outcomes (Cox et al., 2006; Cox et al., 2008). Specifically, both simulated and on-road driving performance was compromised among adolescents during extended release mixed amphetamine salts compared to long-acting methylphenidate conditions. Importantly, these studies only reported differential medication effects in the late evening. Children in the current study would likely be sleeping at those times and would not be engaged in behavior that placed them at-risk for experiencing injury. Therefore, the differential medication impact on behavior observed in the late evening may be irrelevant when considering injury rates in the current study. Additionally, the studies by Cox and colleagues (2006; 2008) focused on driving performance and thus examined a behavior believed to place adolescents at-risk for incurring unintentional injury rather than reporting on actual injury occurrences.

In the current study, children treated with methylphenidate and mixed amphetamine salts did not differ with respect to parent-reported ADHD symptom severity. This finding matches results from recent studies demonstrating equivalent effectiveness of different drugs in managing the behavioral symptoms of ADHD (Pliska et al., 2000). The majority of children in the current study were treated with extended release or long-acting rather than immediate release or short-acting medications. This is consistent with reported trends in the medication management of ADHD which highlight an increase in prescription rates of long-acting or extended release medications (Castle et al., 2007). This shift in prescribing patterns may be related to increased treatment adherence associated with long-acting medications (Lage & Hwang, 2004; Swanson, 2003) and/or an observed rebound effect which has been investigated in children with ADHD treated immediate release or short-acting medications (Johnston et al., 1988; Carlson, Kelly, et al., 2003). This phenomenon involves the worsening of ADHD symptoms beyond baseline as medication wears off (e.g., between doses) and has been implicated in poor driving outcomes for adolescents with ADHD who are treated with short-acting stimulant medication (Cox et al., 2004). However, recent data have also revealed potential rebound effects following the use of extended release mixed amphetamine salts (Cox et al., 2008; McGough et al., 2003; Swanson et al., 2004). Given the recent shift in prescribing patterns resulting in an increased use of long-acting medications for the treatment of ADHD symptoms future research on rebound effects is warranted as it relates to behaviors placing children at increased risk for injury.

The current study reported no relationship between duration of medication treatment and minor unintentional injury. Previous research has reported a relationship between medication treatment length and medically attended injuries (Leibson et al., 2006). Specifically, the proportion of time on stimulant medication was inversely associated with emergency department visits such that extended stimulant medication treatment was associated with decreased emergency department visits for children with ADHD (Leibson et al., 2006). A similar pattern may not have emerged from the current study for several reasons. In the current study parents reported the length of time their children had been receiving medication for the treatment of ADHD symptoms and not the length of time the child had been on the current medication treatment regimen. Leibson et al. (2006) only included children treated with stimulant medication and reported on medically attended injuries while the current study included children treated with different medication regimens and examined the frequency of minor rather than medically attended injuries. It may be that stimulant medication serves to mitigate risk for medically attended but not minor injuries and additional research is necessary.

Compliance with medication treatment regimens was also unrelated to the occurrence of injury in the current study. This may have been influenced by the fact that the majority of parents reported relatively high levels of medication treatment integrity. Previous research has suggested that children were more likely to incur injuries during periods of time when they were not taking their medication (Thomas et al., 2004) or receiving any form of treatment (Gering et al., 1998). In the current study, treatment integrity was assessed on a weekly basis which precluded the examination of a direct relationship between daily treatment compliance and injury occurrence. Consistent with high levels of parent-reported treatment integrity, weekly monitoring of ADHD symptoms revealed that levels of symptom severity were relatively stable and just below the at-risk range. Therefore, it appears that the approaches utilized for the management of the symptoms of ADHD among children in this sample resulted in consistent effects across the 4-week period but did not result in a reduction of behavioral symptoms to a normalized level. This parallels data from previous literature that stimulant medication treatment effectively targets the core features of ADHD but does not result in a normalization of behavior (Pelham et al., 2000) which may suggest the need for close monitoring and titration of medication to achieve optimal treatment effects.

ADHD Symptomatology and Unintentional Injuries

The current study identified an association between parent-reported weekly ADHD symptoms and minor unintentional injuries among children. For 3 of the 4 weeks of the study, weekly injuries experienced by children were predicted by symptoms of hyperactivity and/or attention problems. This is consistent with the theoretical understanding of increased injury risk among children with ADHD which is thought to be mediated through inattention, impulsivity, and hyperactivity that are the central clinical features of the disorder (Pless, Taylor, & Arsenault, 1995). Specifically, increased symptoms of hyperactivity predicted injuries during the third week of the study while increased attention problems predicted injuries during the second and fourth weeks. It is important to note that during the second and third weeks of the study, regression models including both hyperactivity and attention problems as predictors reached statistical significance. However, neither factor independently contributed significantly to the models prior to the removal of the other factor. This suggests that the shared variance among hyperactivity and attention problems may also be related to the occurrence of minor unintentional injuries. When average symptom severity scores across the 4 weeks were examined, measured levels of hyperactivity predicted the average number of weekly injuries experienced by children.

One possible explanation as to why neither hyperactivity nor attention problems predicted injuries during the first week of the study centers on parent reporting of injury data. Parents reported greater numbers of injuries during the first week of the study than they did during each of the subsequent weeks. This trend may have been influenced by the fact that during the first data collection period, parents were asked to report on the number of minor injuries their children had experienced since birth and over the past 3 months in addition to the number of minor injuries experienced over the past 2 to 3 days. Therefore, recall of injury may have been influenced by recall involving multiple periods of time. Whereas each subsequent data collection point required parents to recall injuries during a distinct 2 to 3 day period, the onset of which was marked by the end of a previous reporting period.

The results of this study are consistent with recent literature supporting a relationship between the behavioral symptoms associated with ADHD and childhood unintentional injuries (Schwebel et al., 2004; Spinks et al., 2007). Specifically, Spinks and colleagues (2007) reported that children with high hyperactivity scores were at increased risk of all injuries in addition to medically attended injuries, and Schwebel and colleagues (2004) found that hyperactivity was a strong predictor for parent-reported medically attended injuries among young children. Additionally, others have reported associations between vigilance deficits and inattention and injury risk among children

(Bennett-Murphy et al., 2001; Pless et al., 1995). A notable distinction between these studies and the current study; however, centers on the samples employed. While the former studies included children who did not have a clinical diagnosis of ADHD, the current study included children whose parents reported a diagnosis of ADHD. Thus, hyperactivity and attention deficits may have a differential impact on injury risk among children with and without ADHD or children with clinical versus subclinical levels of symptom severity.

Studies which have examined the relationship between ADHD and injury risk have reported mixed results. For example, Bryne and colleagues (2003) reported that preschoolers with an ADHD diagnosis did not sustain more injuries than control children and DuPaul et al. (2001) found no differences in the number of injuries between 3 through 5 year old children with ADHD and normal controls. Conversely, Lahey and colleagues (1998) reported that children aged 4 through 6 years who met criteria for ADHD hyperactive-impulsive type or combined type were significantly more likely than controls to have experienced an unintentional injury. While the results from Lahey et al. (1998) appear to point to the influence of symptoms hyperactivity-impulsivity on injury risk among children with ADHD, the former studies only examined differences in injuries between children with an ADHD diagnosis and controls and did not specifically explore the impact of ADHD symptomatology on injury risk. As such, the relationship between the behavioral symptoms of ADHD and injury risk among children with ADHD has been poorly understood from an empirical basis. The current study contributes to the existing literature by reporting that among children with an ADHD diagnosis, elevated symptom severity appears to be a salient predictor of minor unintentional injuries when the presence of comorbid symptoms is not considered.

Comorbid Symptomatology and Unintentional Injuries

While there is substantial evidence that hyperactive and inattentive behavior patterns are related to increased injury risk among typically developing children (Schwebel & Barton, 2006), researchers in the area of pediatric unintentional injury have hypothesized that children with externalizing behavior disorders are at increased risk of injury not because of hyperactive or inattentive symptoms, but instead because of their oppositional, defiant and disruptive behavior (Davidson et al., 1988; Schwebel et al., 2007). The results of the current study provide partial support for this hypothesis in that symptoms associated with ADHD did not predict the occurrence of minor unintentional injuries after controlling for the presence of comorbid symptoms associated with conduct disorder (CD). However, inconsistent with the aforementioned hypothesis, symptoms of oppositional defiant disorder (ODD) did not contribute to injury risk in the current study. Symptoms of CD reported by parents at the beginning of the study accounted for half of the variance in minor injuries experienced by children during the 4-week study period.

This finding, which illuminates the importance of examining comorbid behaviors, is consistent with those from two recent studies which explored injury risk among children with a clinical diagnosis of ADHD who also had diagnoses or symptoms of comorbid externalizing behavior disorders (Schwebel et al., 2007; Schwebel et al., 2006). Among a sample of children with ADHD, Schwebel and colleagues (2007) reported that symptoms of ODD and CD rather than symptoms of ADHD were significantly related to injuries. The researchers developed an ODD/CD composite which was comprised of behaviors related to violations of rules, intentional aggression, noncompliance, and intentional property destruction. Only intentional aggression and violations of rules were significantly related to injury occurrence. Given this methodological approach, it remains unclear how symptoms of ODD and CD are differentially related to injury occurrence. The current study reported that symptoms specifically related to CD and not necessarily ODD as measured by a standardized behavior rating scale predicted injury in children diagnosed with ADHD.

Schwebel and colleagues (2006) reported that young children with ODD were at increased risk for injury relative to children with ODD and comorbid ADHD, suggesting that the presence of ADHD did not increase injury risk. These researchers did not; however, examine the influence of symptoms of CD on injury risk among children with ADHD. Exploratory analyses in the current study revealed that symptoms of ODD also predicted injury occurrence above and beyond ADHD symptoms; however, this was only true when symptoms of CD were not included in the analysis. When symptoms associated with CD were included in the regression model, symptoms of ODD and ADHD no longer significantly predicted injury. While the current study provides additional support for the hypothesis that comorbid disruptive behaviors influence injury occurrence among children with ADHD, it also extends the previous literature in recognizing the unique contribution of symptoms associated with CD (e.g., aggression toward others, serious violations of rules) rather than ODD (e.g., refusing to go along with adult requests, deliberately annoying others).

One reason children with disruptive patterns of behavior may experience greater frequency of injury is because they intentionally violate rules and defy authority.

Schwebel and Gaines (2007) outlined an argument suggesting that children who are only hyperactive or inattentive may place themselves in potentially dangerous situations. But, if these children are appropriately supervised by an adult who warns the child to stop behaving in a dangerous manner, an injury may be averted. If the child has comorbid defiant and disruptive behavior problems; however, he or she may not heed the warning to stop a dangerous behavior and may suffer an injury (Schwebel and Gaines, 2007). Consistent with the argument, results from this study suggest that symptoms such as hyperactivity and poor attentional capacity were not the factors that placed children with ADHD at increased risk for injury. Rather children who had symptoms of comorbid behavior disorders were shown to experience more injuries.

Medically Attended Unintentional Injuries

The final aspect of this study considered the relationships between minor and medically attended unintentional injuries as well as demographic factors related to the occurrence of a medically attended injury. Several positive correlations were reported between child injury history variables and minor injuries experienced during the study. The total number of minor injuries experienced since birth was positively correlated with all other injury measures, with the exception of recent medically attended injuries. In general these findings are consistent with previous research among typically developing children which has reported a positive association between minor and severe injuries (Morrongiello et al., 2004). No relationships were found between medically attended injuries experienced during the previous 3 months and any other injury variable. This may be due to the extremely low number of children who had experienced a medically attended injury during the 3 month interval. This is consistent with injury morbidity and mortality statistics which suggest that medically attended injuries are relatively low base rate events (Peterson et al., 1996; Pless et al., 1995).

When considering injury history variables, the only type of previous injury to predict minor injuries experienced during the 4-week study period was parent-reported minor injuries since birth. Among typically developing children, Jaquess and Finney (1994) reported that the occurrence of a severe injury was associated with subsequent minor injuries and it was hypothesized that the nature of this relationship would hold true for children with ADHD; however, this relationship was not found within the current sample. It is possible that the occurrence of a medically attended injury in a child with ADHD resulted in the initiation or alteration of treatment regimen which may have influenced the occurrence of subsequent injuries.

Binary logistic regression results did suggest a relationship between the number of minor injuries experienced since birth and the likelihood of children having experienced a medically attended injury. The odds that a child had ever experienced a medically attended injury increased slightly for each additional minor injury reported. This finding makes sense given that minor injuries have the potential to be serious. Therefore, children who experience more minor injuries may be increasingly likely to have one of these injury episodes result in the need for medical attention. The likelihood that a child had ever experienced a medically attended injury was greater for children who were younger in age. This result may seem unexpected given that older children simply by nature of their age have had more time to experience injury. However, this finding is consistent with literature suggesting that young children are at increased risk for injury relative to their older counterparts. Additionally, this finding suggests that children diagnosed with ADHD at a young age may be especially vulnerable for experiencing a medically attended injury. The number of children living in the household was the variable most strongly associated with the likelihood of children having experienced a medically attended injury. This variable was inversely related to injury such that as the number of children living in the household decreased the likelihood of a child having experienced a medically attended injury increased. Given that poor parental supervision, which is often associated with an increased number of children in the household, is a risk factor for childhood injury (Morrongiello et al, 2006; Schwebel et al., 2006), one might have anticipated a finding in the opposite direction. However, it is important to note the household size was assessed after the occurrence of the medically attended injury. Therefore, household size may indirectly be influenced by the occurrence of a medically attended injury rather than the number of children in the household influencing the likelihood that a child had a history of a medically attended injury.

Conclusions

The results from this study seem to support findings from the literature that children with ADHD have higher levels of injury compared to other children their age. While a control group was not employed in the current study, the number of weekly injuries reported in this study was greater than the average number of injuries reported among a group of children with ADHD during a summer camp (Schwebel et al., 2007). The design of the study by Schwebel and colleagues (2007) permitted a comparison of injury rate among their sample and injury rates reported in the literature among typically developing children. Specifically, the injury rate among the children with ADHD was comparable or slightly higher than that of nondisordered children who were engaged in high-contact athletic activities (Schwebel et al., 2007). This suggests that the children enrolled in the current study demonstrated higher rates of injury than what would be expected to be observed among nondisordered children.

Although the literature on unintentional injury has suggested an association between disruptive behaviors and injury risk among children with ADHD, this claim has been largely unsubstantiated empirically. Findings from the current study parallel those from two recent studies (Schwebel et al., 2006; Schwebel et al., 2007) and suggest that symptoms of comorbid externalizing behavior disorders are associated with increased injury risk among children with ADHD. However, the majority of previous research has examined the relationships between injury and clinical diagnoses. This study extends the current line of research through its examination of the association between symptom severity and injury. While previous literature and theory have implicated the role of disruptive behaviors commonly associated with diagnoses of CD and ODD with injury risk, this study suggests that symptoms of CD (e.g., aggression toward others, serious violations of rules) are the strongest predictor of the occurrence of minor unintentional injuries among children with ADHD. While the behavioral symptoms of hyperactivity and inattention predicted the occurrence of weekly minor injuries in the current study, symptoms of ADHD were not predictive of minor unintentional injuries after controlling for the presence of behaviors associated with CD. Although hyperactivity and inattention have consistently been associated with injury risk among typically developing children, it seems to be the associated disruptive behaviors often present in children with ADHD that make this group of children increasingly likely to experience injury.

The results of this study cautiously support that no differences in injury existed among children with ADHD treated with extended release methylphenidate and extended release mixed amphetamine salts. Moreover, no differences in ADHD or comorbid symptom severity were found between these treatment groups. Previous literature has supported the later finding in demonstrating similar treatment effects of these different psychostimulants in reducing ADHD symptom severity (Plizska et al., 2001). However, data from this study provide a preliminary indication of the equivalence of these different extended release psychostimulants on injury rate. Observed group differences, especially with such a small sample size, would be concerning and have substantial implications for treatment.

Clinical Implications

Several implications related to the prevention of childhood unintentional injuries can be gleaned from the results of this study. Perhaps most importantly is the need for close supervision and monitoring of children with ADHD who also exhibit defiant, destructive, and disruptive patterns of behavior. The results of this study suggest that children with ADHD who also exhibit comorbid behavioral difficulties are more likely to incur minor unintentional injuries than children with ADHD who do not have associated behavioral difficulties. While this study did not specifically examine the relationship between supervision and injury, previous research has reported that among typically developing children poor parental supervision is related to increased injury risk (Morrongiello et al., 2006), and among hyperactive children parental supervision has been identified as a protective factor for injury risk. Among children with ADHD poor parental supervision has been associated with increased risk taking behaviors especially for children with ADHD who also presented with symptoms of ODD and CD (Schwebel et al., 2006). Taken together, these findings indicate that close supervision and monitoring of children with ADHD and comorbid behavioral difficulties are essential as these children are not only more likely to engage in risky behavior under conditions of poor supervision but also are at increased risk for experiencing unintentional injury. In light of the clinical significance of the frequency of minor injuries during a given week, children with ADHD without clinical diagnoses of ODD and CD warrant close monitoring. Strategies such as titrating medications or the implementation of parent training programs as a means to successfully reduce symptoms of associated behavioral disorders will be important in order to effectively mitigate injury risk among children with ADHD. Medication treatment and behavioral parent training have been identified as evidenced-based interventions for the treatment of childhood behavior disorders and the targeted use of such treatments may serve to reduce injury in this at-risk population (APA, 2007).

Additionally, injury prevention programs and efforts should be targeted toward children with ADHD who also exhibit defiant and disruptive patterns of behavior. In order for targeted prevention efforts to be implemented, the results of this study speak to the importance of monitoring symptom severity among children with ADHD who are and are not treated pharmacologically. In order for symptom monitoring to inform injury prevention efforts, such monitoring will need to involve measuring not only symptoms of ADHD but also symptoms of associated behavioral disorders. This will likely necessitate open lines of communication between physicians, parents, and school personnel. Effective school-based medication monitoring involves several important steps and school psychologists are often well positioned to contribute to these practices (Carlson, 2008; DuPaul and Carlson, 2005). Specific areas of functioning to assess must be identified and the use of objective, psychometrically sound measures such as behavioral rating scales and direct observations are critical (DuPaul & Carlson). When monitoring medication effectiveness it is imperative to simultaneously monitor medication side effects as these may have deleterious effects on child behavior (Carlson). School psychologists are uniquely positioned to collect, interpret, and share data about symptom severity and medication effects with families and physicians and decisions made as a result of these practices may serve to reduce injury risk among children with ADHD.

Moreover, schools provide an ideal context for the implementation of universal and targeted injury prevention programs. School-based prevention programs have the potential to reach a large number of children in a cost-effective manner. Schwebel and colleagues (2006) demonstrated that school-based programs are effective in reducing risky playground behaviors among young children by increasing supervision and monitoring of school staff. The basic line of reasoning holds that the reduction of dangerous behavior should subsequently reduce injury risk. Importantly, school-based programs have the benefit of reaching children who are identified as at-risk in addition to children who may not exhibit the prototypic behavioral profile of an at-risk child, yet may be an increased risk for injury because of other variables (e.g., deficits in executive functioning, physical disability).

Future Research

The results of this study support recent data which have identified the role of associated behavioral difficulties as an important mechanism of injury risk among children with ADHD (Schwebel et al., 2007). It will be important for researchers to continue to delineate the contribution of multiple behavioral symptoms among clinical samples on pediatric unintentional injury risk. Moreover, future research should examine the extent to which injury risk among children with externalizing behavior disorders is mediated by deficits in executive functioning, which are consistently linked with the core behavioral features of ADHD (Stefanatos & Baron, 2007).

Theoretical and empirical works have provided support for the idea that stimulant medication treatment may mitigate unintentional injury risk among children with ADHD (Rapport et al., 2001; Lage & Hwang, 2004). Specifically, stimulant medication treatment has been implicated in reducing risk of medically attended injuries (Lage & Hwang, 2004; Pastor & Reuben, 2006) among children with ADHD relative to children with ADHD who were not treated pharmacologically. The extent to which medication treatment may normalize rates of injury occurrence among children with ADHD relative to typically developing children remains unclear. Given the increased utilization of extended release medications (Castle, 2007), future research examining the differential impact of different extended release medication formulations on injury risk is warranted. Although the current study did not report differences between two commonly prescribed extended release medications, additional research comparing the effects of extended release methylphenidate and extended release mixed amphetamine salts is necessary given the consistent differences reported within the adolescent driving literature (Cox et al., 2006; 2008). Previous research has demonstrated differences between immediate release and extended release psychostimulant medications with respect to the occurrence of medically attended injuries (Kemner & Lage, 2006; Lage & Hwang, 2004). It will be important for future research to examine the differential impact of short-acting and long-acting medications on minor injury risk among children with ADHD. Finally, with respect to medication treatment, research should continue to explore the role of the rebound effect and how such behavioral deterioration may be related to injury occurrence in children treated pharmacologically for ADHD.

Limitations

Given the nature of the study design, a major limitation of the current study centered on lack of random assignment to medication treatment condition. More importantly, between group analyses were limited with respect to sample size. The power to detect group differences was extremely low and it is unclear if group differences failed to emerge because there were actually no group differences in injury rates or if there was simply insufficient power to detect such differences. As such, these findings cannot be considered conclusive for this sample of participants or generalized beyond the current sample. Another limitation centers on the identification of children with ADHD. Participants were included in the study per parent report of a physician diagnosis of ADHD or if they met diagnostic criteria based scores derived from a standardized rating scale. As such, many children did not evidence clinically significant symptoms upon study enrollment. This suggests that the medication treatments might have been working effectively to reduce the core behavioral symptoms of ADHD as children with elevated symptoms may have been in need of a medication adjustment. It is unclear how this may have influenced injury occurrence across the 4 week study period. However, this does suggest the need to monitor injury rates both before and after the initiation of medication treatment to more clearly delineate the role of medication in mitigating injury risk among children with ADHD. Future medication trials should measure injury occurrence as a peripheral symptom that would be ideal to have altered by medication or any alternative intervention for ADHD.

Additionally, this study relied exclusively on parent report which is limited primarily in terms of reliability. One possible alternative to parent report of minor injury centers on monitoring of injury by professional caregivers such as camp counselors or school nurses. Schwebel and colleagues (2007) utilized reports from summer camp counselors to record the occurrence of minor injuries. The current study utilized bi-weekly phone calls to monitor injury, but others have had parents report injury through the completion of daily phone calls or daily injury logs (Bennett-Murphy et al, 2001; Peterson et al., 2002). This study also relied on parent reports of symptom severity. Alternative methods of corroborating such data include direct observations in classrooms or home settings as well as the use of reports from other individuals such as school teachers. Finally, this study did not include systematic measures of parental supervision which has been associated with injury risk among children with externalizing behavior disorders. Previous studies have attempted to measure this variable through direction observations of parent-child interactions in clinical settings (Schwebel et al., 2004) or homes (Morrongiello et al., 2004) as well as through parent report of amount and quality of supervision provided (Morrongiello et al., 2006).

APPENDICIES

APPENDIX A

Table 1. Demographic characteristics (N = 31)

Variable	N (%)
Child Gender	
Male	24 (77.4)
Female	7 (22.6)
Child Ethnicity	
Caucasian	27 (87.1)
African-American	1 (3.2)
Other	3 (9.7)
Child Age	
5-8 years	11 (35.5)
9-12 years	20 (64.5)
Parent Education	
High School (GED)	9 (29.0)
Some College	9 (29.0)
College Graduate	8 (25.8)
Post-Graduate	5 (16.1)
Parent Martial Status	
Married	20 (64.5)
Single	2 (6.5)
Divorced	4 (12.9)
Widowed	2 (6.5)
Living with partner	3 (12.9)

APPENDIX B

Table 2. Medication Treatment (N = 28)

Medication	N (%)
Drug Name	
Adderall	10 (32.3)
Concerta	7 (22.6)
Focalin	2 (6.5)
Daytrana	2 (6.5)
Ritalin	3 (9.7)
Metadate	1 (3.2)
Strattera	2 (6.5)
Vyvanse	1 (3.2)
Tenex	1 (3.2)

APPENDIX C

Table 3. Clinical symptoms: CBCL (N = 31)

Scale	Mean (SD)
Anxious/depressed	62.29 (8.17)
Withdrawn/depressed	60.35 (8.56)
Somatic complaints	59.13 (7.52)
Social problems*	62.48 (8.41)
Thought Problems*	64.31 (7.41)
Attention problems	67.90 (9.46)
Rule-breaking behavior*	59.83 (8.65)
Aggressive behavior	61.61 (9.21)
Internalizing problems	61.32 (9.08)
Externalizing problems	60.10 (10.89)
Total problems	63.45 (9.13)
Affective problems	63.45 (8.46)
Anxiety problems	60.39 (7.20)
Somatic problems	59.66 (9.16)
Attention-deficit/hyperactivity problems: DSM-oriented	65.45 (8.02)
Oppositional defiant problems: DSM-oriented	59.81 (7.08)
Conduct problems: DSM-oriented*	61.72 (9.33)

* Scores based on age and gender norms, (M=50, SD=10)

** Composite score not available for children under 6 years of age (N = 29)

APPENDIX D

Table 4. Clinical symptoms: BASC-Monitor* (N = 31)

Scale	Mean (SD)
Hyperactivity	58.96 (11.18)
Week 1	59.48 (11.58)
Week 2	59.22 (12.14)
Week 3	57.55 (12.49)
Week 4	59.58 (12.58)
Attention problems	59.70 (9.75)
Week 1	57.45 (10.48)
Week 2	61.61 (11.71)
Week 3	59.74 (9.79)
Week 4	59.58 (12.58)

* Scores based on age and gender norms, (M=50, SD=10)

APPENDIX E

Table 5. Correlations among behavioral ratings of ADHD and comorbid symptoms

	1	2	3	4	5	6	7	8	9	10	11	12
1. CBCL conduct problems	1.00											
2. CBCL ADHD problems	.724**	1.00										
3. CBCL ODD problems	.761**	.734**	1.00									
4. CBCL externalizing problems	.899**	.742**	.892**	1.00								
5. CBCL somatic problems	.547**	.355	.339	.411*	1.00							
6. CBCL rule breaking behavior	.949**	.624**	.730**	.865**	.479**	1.00						
7. CBCL aggressive behavior	.895**	.813**	.903**	.933**	.391*	.832**	1.00					
8. CBCL attention problems	.659**	.792**	.517**	.555**	.504**	.540**	.644**	1.00				
9. VADPRS total symptoms	.532**	.582**	.464**	.535**	.156	.462*	.541**	.525**	1.00			
10. VADPRS average performance	.585**	.315	.478**	.505**	.519**	.553**	.530**	.552**	.235	1.00		
11. BASC mean hyperactivity	.626**	.615**	.664**	.600**	.477**	.612**	.649**	.545**	.462**	.425*	1.00	
12. BASC mean attention problems	.545**	.289	.419*	.405*	.515**	.509**	.397*	.524**	.333	.652**	.650**	1.00

* $p < .05$ level. ** $p < .01$.

APPENDIX F

Table 6. Relationship between weekly ADHD symptom severity and unintentional injuries: Regression Models

Dependent Variable	Predictor	Excluded Variable	R^2	Beta	p-value
Week 2 Injuries	Attention Problems		.146	.383	.034
		Hyperactivity		.038	.884
Week 3 Injuries	Hyperactivity		.208	.456	.010
		Attention Problems		.265	.173
Week 4 Injuries	Attention Problems		.217	.466	.008
		Hyperactivity		.162	.438
Mean Injuries	Mean Hyperactivity		.162	.403	.025
		Mean Attention Problems		.184	.421

APPENDIX G

Table 7. Correlation matrix: parent-reported injuries (N = 31)

	1	2	3	4	5	6	7
1. IHQ: minor birth	1.00						
2. IHQ: minor 3 months	.605**	1.00					
3. IHQ: moderate birth	.835**	.662**	1.00				
4. IHQ: moderate 3 months	.679**	.531**	.711**	1.00			
5. IHQ: medically attended birth	.375*	.100	.282	.434*	1.00		
6. IHQ: medically attended 3 months	.347	.199	.258	.072	.209	1.00	
7. MISS: 4-weeks	.485**	.298	.402*	.448*	.309	.030	1.00

* $p < .05$ level. ** $p < .01$.

APPENDIX H

Table 8. Logistic regression predicting the likelihood of a medically attended injury since birth

	B	S.E.	Wald	*df*	*P*	Odds Ratio	95% C.I. for Odds Ratio	
							Lower	Upper
Ethnicity	4.24	2.26	3.51	1	.061	.014	.000	1.22
Age	-.922	.468	3.89	1	.049	.398	.159	.996
Number Children in Household	-1.621	.638	6.46	1	.011	.198	.057	.690
Number Minor Injuries	.007	.004	3.88	1	.049	1.01	1.00	1.02

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