



# Injury risks in schoolchildren with attention-deficit/hyperactivity or autism spectrum disorder: Results from two school-based health surveys of 6- to 17-year-old children in Sweden

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## ABSTRACT

**Introduction:** Injuries are one of the leading causes of death and disability among children in Sweden and attention-deficit/hyperactivity disorder (ADHD) has previously been associated with an increased risk of injury in pediatric populations elsewhere in the world. Current evidence regarding the possible link between autism spectrum disorder (ASD) and injury risk appears limited, even though some potentially risk-increasing symptoms overlap. The purpose of this study was thus to study the association between both ADHD and ASD concerning the risk of injury among Swedish schoolchildren. **Methods:** Two samples were used: a population-based register study containing data from 18,416 children ranging from the ages of 6–17 years collected by school nurses during 2012/2014 (Survey A), and a national cross-sectional study of 3202 ninth-grade children (~15 years old) collected from 92 schools in 2011 (Survey B). The data were analyzed using  $\chi^2$ -tests and log-binomial generalized linear models to obtain risk ratios (RR), comparing cases reportedly affected by ADHD or ASD to unaffected controls. **Results:** After adjusting for confounders, ADHD was associated with a 65% increased risk of injury (RR 1.65 [95% CI: 1.32–2.05] in Survey A, and a 57% increased risk of injury (RR 1.57 [95% CI: 1.27–1.95]) in Survey B. ASD was not significantly associated with any differences in injury risk (RR 0.81 [95% CI: 0.57–1.14]). **Conclusions:** The results indicate that there is an elevated injury risk among Swedish schoolchildren with ADHD but not for children with ASD. Future studies should focus on causal mechanisms mediating the association between ADHD and injuries in order to facilitate injury prevention strategies. **Practical applications:** Parents and teachers of schoolchildren with ADHD should be made aware of the elevated injury risks associated with the diagnosis. Safety experts and injury control professionals should consider the development of specialized prevention strategies in order to reduce these risks.

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## 1. Introduction

Autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) are the two most common diagnoses of neurodevelopmental disorders in the world. About 5% of the Western world's child and adolescent population suffer from ADHD (Polanczyk, de Lima, Horta, Biederman & Rohde, 2007). ASD, while not as common as ADHD, affects 0.6–1.0% of the population (Elsabbagh et al., 2012). Both diagnoses are more common in boys than in girls (Wittchen et al., 2011). ASD commonly causes problems with social interaction, communication, and restricted and stereotyped patterns of interests and behaviors.

ADHD is usually characterized by persistent symptoms of inattention, hyperactivity, and impulsiveness. The hyperactivity, in combination with issues with attentional and inhibitory control, may interfere with functioning at home, at school and with school performance, or with social relations (American Psychiatric Association, 2013). Evidence also suggests that ADHD and ASD symptoms often co-occur, with studies reporting a prevalence of overlap from 14 to 78% (Simonoff et al., 2008; Gargaro, Rinehart, Bradshaw, Tonge & Sheppard, 2011).

Both disorders can have long-term negative impacts on academic achievement, work performance, and mental health and have been associated with an increased risk of substance abuse and the development of antisocial personality disorder (Brook, Brook, Zhang, Seltzer & Finch, 2013; Crump et al., 2013; De Alwis et al., 2014; Scholtens, Rydell & Yang-Wallentin, 2013). There is also a wide range of evidence linking ADHD to an increased risk of mortality and morbidity stemming from accidental injuries (see e.g. Dalsgaard, Leckman, Mortensen, Nielsen &

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Simonsen, 2015; Hurtig, Ebeling, Jokelainen, Koivumaa-Honkanen & Taanila, 2016). Some research has also been conducted regarding the causal mechanisms behind this association. For instance, Stavrinou et al. (2011) provided evidence that executive dysfunction (i.e., issues with processes that enable physical, cognitive, and emotional self-control) mediates the entire difference in safe pedestrian crossing behavior between children with and without ADHD. Children with ASD also exhibit some of the same executive dysfunctions as children with ADHD (Corbett, Constantine, Hendren, Rocke & Ozonoff, 2009), which could suggest that they are also at higher risk of injury. However, apart from a body of literature detailing self-injurious behaviors in people with ASD (see e.g. Murphy et al., 2005), considerably less research has been conducted regarding ASD and injury risk in general. The results from these studies are ambiguous, showing negative (Furlano, Bloechliger, Jick & Meier, 2014) and positive (Cavalari & Romanczyk, 2012) associations, along with heterogeneity in the risk of different injury types (Schlenz, Carpenter, Bradley, Charles & Boan, 2015). Although symptoms commonly associated with ADHD prevalently appear in children with ASD (Lecavalier, 2006), other possible mediating factors in the relationship between these neurodevelopmental disorders and injuries may vary between them, so a theoretical connection between ASD and injury is far from self-evident. For instance, adolescents with ADHD have been documented to exhibit risk-taking behaviors in terms of substance abuse, gambling, and risky sexual behaviors (see e.g. Flory, Molina, Pelham, Nagay & Smith, 2006; Lee, Humphreys, Flory, Liu & Glass, 2011; Groen, Gastra, Lewis-Evans & Tucha, 2013).<sup>1</sup> There is also evidence linking ADHD to the anticipation of less severe consequences of risky behavior compared to their unaffected peers (Bruce, Ungar & Waschbusch, 2009; Farmer & Peterson, 1995). Taking this into consideration along with the fact that people with ASD are less likely to attempt to enter into social relationships than people with ADHD due to the core social deficiencies that characterize the disorder, there may be reason to believe that even though some symptoms may affect injury risks overlap between the two diagnoses, exposure to injury risks may differ largely due to peer effects, social behavioral patterns, and interests.

Furthermore, there is some ambiguity in the literature regarding the role of specific behavioral factors commonly associated with these disorders and injury risk. While hyperactivity has long been hypothesized to be a significant injury risk factor in children, early critical reviews of the literature have suggested that aggression and antisocial behavior, rather than hyperactivity, may be stronger independent predictors of injury (Davidson, 1987; Wazana, 1997). However, a more recent prospective study has found evidence of the contrary (Spinks, Nagle, Macpherson, Bain & McClure, 2008). Nevertheless, aggression is also a common symptom in children with ASD (Kanne & Mazurek, 2011), but as far as we know, no study has reported the possible mediating effects of aggression on injury risk in children diagnosed with this disorder. Also, studies including behavioral and family predictors of injury have also showed signs that family factors, such as living with a single parent, are more important than behavioral factors, including hyperactivity and aggression (Dudani, Macpherson & Tamim, 2010).

Injury is the leading cause of death and hospitalization among Swedish adolescents (Lundqvist, Tennlind, Schyllander & Stenbäck, 2012), and while evidence of an increased injury risk among children with ADHD is starting to accumulate, this association has to our knowledge not yet been studied in a Swedish setting with regard to children. Current evidence regarding the possible link between ASD and injury risk also appears limited, and as far as we know, no previous studies have analyzed the risk of injury among ADHD and ASD children in the same sample and thus being able to control for the same confounding variables. The purpose of this study was therefore to study the association between both ADHD and ASD concerning the risk of injury in a

Swedish setting, using comparable cross-sectional data from two different samples of schoolchildren: a nationally representative sample of ninth-graders and a population-based data collected by school nurses in the county of Värmland, Sweden.

## 2. Methods

### 2.1. Data collection and study population

We used data from two different surveys, denoted below as Survey A and B. The questionnaires are similar in terms of questions asked, albeit with a few differences of consequence for the interpretation of our study. Firstly, data from Survey A are in part guardian and self-reported, while data from Survey B are entirely self-reported.

#### 2.1.1. Survey A

Data for Survey A was derived from the Student Health Data Base [ELSA], established in 2010 in the county of Värmland, Sweden.

All schoolchildren in Sweden are offered a health examination by the school nurse three times during their compulsory school years as well as one occasion in high school (non-compulsory). In Värmland, data are collected when schoolchildren are 6 (pre-school class), 10 (4th grade), 13 (7th grade), and 16 (1st year in high school) years of age. ELSA includes information from health examinations by school nurses, student interviews, and guardian questionnaires about mental and physical health, social relations, physical activity, and school experience. Information regarding the children's guardians is restricted to birth country and occupation. In pre-school, 4th and 7th grade, a guardian questionnaire is also distributed. All data entered into ELSA is anonymized, and sensitive information regarding, for example, health status cannot be linked to specific individuals. The current data set, which contains 18,416 individuals, is from the school years 2012/2013 and 2013/2014. The attrition rates were 14% in pre-school, 8% in 4th grade, 10% in 7th grade, and 13.4% in the 1st year of high school. The attrition depends mainly on that the school nurse did not have time to conduct all health visits within the given time frame, but also that some students did not show up to the health examination, or that the health questionnaire was only available in Swedish.

The study has been approved by the regional ethics committee in Uppsala, Sweden (reg. no: 2013/160).

#### 2.1.2. Survey B

Cross-sectional data from a Swedish national survey on children's experiences of upbringing practices and maltreatment were also used for this study (see Jernbro, Tindberg, Lucas & Janson, 2015 for details). In brief, the survey was aimed toward children in 9th grade (~15 years old) and was carried out in September 2011. The data consisted of a random sample of schools that contain 9th grade. Of the 225 sampled schools, 105 were not able to participate due to scheduling difficulties and 28 schools could not be reached. Finally, 92 schools (41%) and a total of 158 classes participated in the study. In total, 3202 students (84% of the sampled classes) answered the questionnaire.

This study was approved by the regional research ethics committee in Stockholm (reg. no 2010/1512–31/5).

## 2.2. Measures

### 2.2.1. Survey A

To measure the prevalence of injuries, the following question was asked: "Have you suffered any serious accident/injury?" The response alternatives were "Yes" and "No." A question measuring the prevalence of several chronic diseases and disabilities was included and formulated as follows: "Has the child been diagnosed with any disability/physical illness?" with binary response alternatives for a pre-defined set of disabilities ("Yes/No" for ADHD and ASD, respectively). Background

<sup>1</sup> Whether this is a causal effect of ADHD or common co-morbidities has been debated, see e.g. Lee et al. (2011) and Vaa (2014) for details.

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