

The relationship between childhood behaviour disorders and unintentional injury events

Beth Bruce RN PhD¹, Susan Kirkland PhD², Daniel Waschbusch PhD³

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OBJECTIVE: To examine the controversy regarding the existence of a relationship between behavioural disorders and unintentional injuries in children.

DESIGN: A retrospective cohort analysis of children between six and 19 years of age, who were diagnosed with attention deficit hyperactivity disorder (ADHD) only (n=955), ADHD plus conduct problems (CP) (n=160), or CP only (n=234), were compared with a nondisorder group of children (n=21,308) for unintentional injury events resulting in a physician office or emergency room visit, or hospitalization.

RESULTS: The risk of an injury event was greater among children with a behaviour disorder diagnosis and severity of injury varied among the behaviour disorder groups. Children with ADHD were the only disorder group at increased risk for all three injury outcomes. Children with a comorbid diagnosis were at a greater risk for both minor and more serious emergency injury visits, and children with CP only were at greatest risk for the most serious injuries (hospital admission).

CONCLUSIONS: These findings provide further support that children with ADHD are at an increased risk for not only hospitalized injury events but also minor injury events. In addition, these findings provide evidence that serious injuries are more likely to be experienced by children with CP.

Key words: ADHD; Conduct problems; Behaviour disorders; Database analysis; Unintentional injuries

Children with a behaviour disorder are generally thought to be more at risk of an injury compared with typically developing children. This may be due to the nature of their behaviour, specifically impulsivity and inattentiveness (1-3), and aggressiveness (4,5). However, research examining this possibility has provided mixed results (2,5-8).

Davidson (5) was among the first researchers to review studies examining the association between hyperactive and antisocial behaviour and rates of injuries in children. She reported that existing literature was difficult to interpret due to methodological limitations and mixed findings, but concluded that children with conduct problems (CP) were at increased risk of injury; this association among children with hyperactive and impulsive behaviours was less clear. Subsequently, DiScala et al (6) used the National Trauma Registry to determine that children who were diagnosed

Le lien entre les troubles de comportement pendant l'enfance et les blessures non intentionnelles

OBJECTIF : Examiner la controverse entourant le lien entre les troubles de comportement et les blessures non intentionnelles chez les enfants.

MÉTHODOLOGIE : Les auteurs ont procédé à une analyse rétrospective de cohorte comparant des enfants de six à 19 ans qui avaient reçu un diagnostic de trouble de déficit de l'attention avec hyperactivité (TDAH) seulement (n=955), de TDAH et de troubles des conduites (TC) (n=160) ou seulement de TC (n=234) à un groupe d'enfants non atteints de ces troubles (n=21 308) s'étant rendus au cabinet d'un médecin ou à l'urgence ou ayant été hospitalisés en raison d'une blessure non intentionnelle.

RÉSULTATS : Le risque de blessure était plus élevé chez les enfants ayant un trouble de comportement diagnostiqué et variait selon les groupes ayant des troubles de comportement. Le groupe des enfants ayant un TDAH était le seul à être plus vulnérable aux trois issues des blessures. Les enfants atteints d'une maladie comorbide diagnostiquée étaient plus susceptibles d'aller à l'urgence en raison d'une blessure mineure ou plus grave, tandis que les enfants ayant seulement des TC étaient plus susceptibles de subir les blessures les plus graves (hospitalisation).

CONCLUSIONS : Ces observations étayaient le fait que les enfants ayant un TDAH sont plus susceptibles de se blesser assez gravement pour se faire hospitaliser, mais également de subir une blessure mineure. En outre, elles démontrent que les enfants ayant des TC risquent davantage de subir des blessures graves que les autres.

with attention deficit hyperactivity disorder (ADHD) were at increased risk for serious injuries. More recently, Brehaut et al (8) found that children with behaviour disorders (proxy diagnosis using prescription for methylphenidate) had a 50% greater risk of injury than children without a behaviour disorder in a population-based study. The same researchers found that health service use is higher among children with ADHD treated with methylphenidate than nontreated children, with ORs ranging between 1.49 and 3.17 (9). In an attempt to deal with the lack of control for comorbidity in previous studies, Rowe et al (10), using a nationally representative sample of children, examined comorbid psychopathology of oppositional defiant disorder (ODD), ADHD and conduct disorder (CD) in relation to injuries. They reported that children with a clinical diagnosis of ODD or ADHD were

¹Faculty of Health Professions; ²Department of Community Health & Epidemiology, Department of Medicine, Dalhousie University, Halifax, Nova Scotia; ³Department of Psychology, University at Buffalo, Buffalo, New York, USA

Correspondence: Dr Beth Bruce, 42 Twilight Lane, Dartmouth, Nova Scotia B2X 2R9. Telephone 902-435-7634, fax 902-425-7858, e-mail bsbruce@dal.ca

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at greater risk than children with CD for some hospitalized injuries. It should be noted that injury events were based on parent recall and were limited to five types of serious injuries resulting in hospitalization. In another study of comorbid behavioural disorders and injuries, Schwebel et al (7) studied preschool boys with clinically diagnosed ODD, with and without comorbid ADHD. They found a greater risk of injuries requiring medical attention, based on parent report, for children with ODD regardless of comorbidity. However, this finding was limited to preschool boys and the researchers did not examine children with only ADHD. Although there is evidence that children with behaviour disorders are at increased risk for serious injuries, there is limited and controversial evidence of the salient features of behaviour disorders that may be significantly contributing to this association.

Interestingly, most research has focused on the association between behaviour disorders and serious injury events, with limited research on the association with injuries of a less serious nature and those treated in the emergency room and no studies of minor injuries managed in physician offices. Miller et al (9) have recently reported that children with ADHD experience a range of injuries, both minor and more serious. Byrne et al (1) compared emergency injury visits for preschool children with a clinical diagnosis of ADHD to children with no behaviour disorders. Although the ADHD cohort exhibited more injury risk behaviours that could place them at an increased risk of an injury, there was no evidence of any difference in the actual number of emergency injury visits between the groups. On the other hand, Hoare and Beattie (2) found that children with ADHD experienced an increased relative risk of 1.42 of an emergency injury visit compared with the control group. These studies draw competing results that suggest further research is needed to resolve such inconsistencies for emergency room visits.

Despite the conclusions drawn by Davidson (5) almost two decades ago, research in this field remains methodologically flawed with mixed findings. An important limitation is that few studies have taken comorbidity into account. Failure to take CP into consideration when examining ADHD is a serious methodological flaw (1,11-13) because ADHD and CP are highly likely to co-occur and often have different characteristics when they present together than when they present alone (14). Approximately 50% of children who have one disorder also have the other, and correlations between the constructs average at 0.70 (13). In addition, children with both ADHD and CP often exhibit unique types and amounts of aggression and other antisocial behaviours compared with ADHD-only and CP-only children, and controls (14). Recently, Junger et al (15) reported that ADHD was a risk factor for both delinquent behaviour (CD) and injuries, proposing an association between CDs and injuries, but this remains unconfirmed. Overall, this research persuasively argues that taking comorbidity into account is an important component of understanding the link between injury and disruptive behaviour. A further limitation of previous research is the

lack of attention to the accuracy and diversity of injury outcome measures. There are important differences in the types of injury events, ie, those treated in physician offices or emergency facilities and, for the most serious injuries, admission to hospital. The seriousness of the injury event could hold significant consequences for child outcomes and implications for future intervention initiatives.

To address these gaps, the present study selected children for inclusion in the exposed cohort on the basis of a physician diagnosis of one of three behaviour disorders – ADHD alone, comorbid diagnosis of ADHD and CP (defined as ODD, CD or disruptive behaviour disorder [DBD]), or any one of the CP (CD, ODD or DBD) but not ADHD. This cohort was compared with a nondisorder group of children six to 19 years of age on three unintentional injury event outcomes resulting in physician office and emergency visits and hospital admissions to determine whether children with a behaviour disorder experience a greater number of childhood injuries than those children who are not diagnosed with any of the above behaviour disorders.

METHODS

A retrospective cohort design was used to compare children with a diagnosis of ADHD and/or CP to children with none of these behavioural diagnoses on injury events. All data were obtained by linking existing administrative health databases using encrypted health card numbers with ethical approval.

Diagnostic grouping

The Provincial Medical Services Insurance database was used to obtain information on children's ADHD and CP diagnoses. The administrative database for this program contains records of physician billing for services rendered. Included in this database are the International Classification of Diseases – Ninth Revision (ICD-9) codes that describe the patient's diagnosis or reason for medical treatment. These diagnostic data (codes 314, 312.8, 313.81 and 312.9) for the period between 1995 and 1998 were used.

The Community Services Family Benefits and Pharmacare database was used to obtain data about prescriptions for children. The Family Benefits program is provided to those who are financially unstable and in need of assistance and it provides pharmacare coverage. Information on prescriptions for a stimulant medication, defined as methylphenidate, dextroamphetamine or pemoline, for the period between 1995 and 1998, were used.

These data were combined to select all eligible children between six and 19 years of age and to determine their diagnostic status. If the diagnostic codes and prescription records were present at least once, selected children were assigned to one of the following four groups:

1. ADHD + CP – defined as children who received a diagnosis of ADHD and a prescription for a psychostimulant medication, and a diagnosis of CP (ie, ODD, CD or DBD);

2. ADHD-only – defined as children who received a diagnosis of ADHD and received a prescription for a psychostimulant medication, but did not receive a CP diagnosis;
3. CP-only – defined as children who received a diagnosis of CP (CD, ODD or DBD) but did not receive an ADHD diagnosis and did not receive a prescription for psychostimulant; and
4. None – defined as all other children.

Unintentional injury events

Data on unintentional injury events were obtained from two sources. Data on injury-related office visits and emergency room visits were extracted from the Medical Services Insurance physician billing database using physician billing data between 1995 and 2001. Data on injury-related hospital admissions between 1995 and 2000 were extracted from the Canadian Institute for Health Information Discharge Abstract Database, which collects national data on hospital discharges (16). Each patient who had a hospital stay, emergency room or physician office visit between 1995 and 2000 was included in the database using the ICD-9 codes to define patient injury diagnosis (codes 800 to 848, 850 to 854 and 860 to 995). For both injury event datasets, multiple records per child for the same injury within the same year were only counted once.

RESULTS

Sample demographics

A total of 1349 children (6%) were identified with one of the three behavioural disorders between 1995 and 1998. The prevalence of children with ADHD only was 4%, the prevalence of children with CP only was less than 1%, and the prevalence of ADHD + CP was also less than 1% (Table 1). Each of the diagnostic groups was predominantly male (57% to 84%), while the nondisorder group was 40% male. In addition, although the nondisorder group was fairly equally represented with younger and older children, the disorder groups were predominantly younger children (60% to 68%).

Crude associations

There were significant differences among the groups for each of the injury outcomes, with borderline significant differences in physician office visits ($\chi^2[3]=7.54$; $P=0.05$). The proportions of emergency visits and hospital admissions were slightly greater for all three groups of behaviour disorder children, but particularly for those children with CP only.

The unadjusted OR for children in any of the behaviour disorder groups for physician office visits did not differ significantly (Table 2). The children in all three disorder groups were at increased risk for emergency visits, with ORs ranging between 1.40 and 1.69. There was an increased risk for hospital admissions among children with ADHD only (OR 1.46; 95% CI 1.10 to 1.93) and CP only (OR 2.22; 95% CI 1.40 to 3.53), respectively. Overall, children with CP only were most

TABLE 1
Demographic characteristics and injury events by behaviour group

	None n=21,308 n (%)	ADHD + CP n=160 n (%)	ADHD only n=955 n (%)	CP only n=234 n (%)	χ^2*	P
Sex					691.65	0.00
Male	8602 (40)	135 (84)	753 (79)	134 (57)		
Female	12,706 (60)	25 (16)	202 (21)	100 (43)		
Age, years					98.05	0.00
6–12	11,307 (53)	103 (64)	654 (68)	140 (60)		
13–19	10,001 (47)	57 (36)	301 (31)	94 (40)		
Injuries						
Office visits					7.54	0.05
0	10,194 (48)	65 (41)	467 (49)	97 (41)		
1	7789 (37)	61 (38)	336 (35)	89 (38)		
>1	3325 (15)	34 (21)	152 (16)	48 (20)		
Emergency visits					64.85	0.00
0	12,272 (58)	78 (49)	446 (47)	103 (44)		
1	6726 (32)	54 (34)	357 (37)	88 (38)		
>1	2310 (11)	28 (17)	152 (16)	43 (18)		
Hospital admissions					19.53	0.00
0	20,463 (96)	154 (96)	900 (94)	214 (91.5)		
1	800 (4)	6 (4)	54 (6)	20 (8.5)		
>1	45 (0.2)	0 (0)	1 (0.1)	0 (0)		

*n-1 degrees of freedom. ADHD Attention deficit hyperactivity disorder; CP Conduct problems

at risk for more serious injuries than those requiring an emergency visit (OR 1.69; 95% CI 1.30 to 2.19) or a hospital visit (OR 2.22; 95% CI 1.40 to 3.53).

Adjusted associations (age, sex and person years observation)

Age and sex were examined as potential effect modifiers of the association between each behavioural diagnostic classification and injury outcome using stratified analyses. Children were grouped as young (six to 12 years of age) and older (13 to 19 years of age), and male and female. There was no evidence of effect modification for age or sex in the CP-only group. However, age was identified as a potential effect modifier for both of the other disorder groups (ADHD-only and ADHD + CP groups) for physician office and emergency room visits. In addition, sex modified the association between ADHD-only and physician office visits. These modifiers, sex and age, were further explored using multivariate logistic regression, with separate analyses for each of the outcomes (physician office visits, emergency visits and hospital admissions). Interaction terms (disorder group *age and disorder group* sex) and person years of observation were included in the analytical models (Table 3). There was no evidence of an interaction between behavioural diagnosis and age or sex for hospital admissions and physician office visits. However, there was an interaction between age and diagnosis for emergency visits. Children with ADHD + CD who were of older age had a twofold increase in risk of an emergency room visit compared with younger children with no disorder.

TABLE 2
Crude OR of injury events by disorder group

Visits	None, n=21,308		ADHD + CP, n=160		ADHD only, n=955		CP only, n=234	
	n	OR	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
Office	11,114	1.00	95	1.34 (0.98 to 1.84)	488	0.95 (0.84 to 1.09)	137	1.30 (0.99 to 1.67)
Emergency	9036	1.00	82	1.40* (1.02 to 1.90)	509	1.54* (1.35 to 1.75)	131	1.69* (1.30 to 2.19)
Hospital	845	1.00	6	0.91 (0.40 to 2.07)	55	1.46* (1.10 to 1.93)	20	2.22* (1.40 to 3.53)
Total†	20,995		183		1052		288	

* $P < 0.05$; †Individual children may have experienced more than one event. ADHD Attention deficit hyperactivity disorder; CP Conduct problems

TABLE 3
Adjusted OR for injury event for disorder groups

Outcome/variable	OR	95% CI
Physician office visit		
None	1.00	–
ADHD + CP	1.54*	1.12 to 2.12
ADHD only	1.17*	1.02 to 1.33
CP only	1.26	0.96 to 1.63
Age	1.32*	1.24 to 1.40
Sex	0.96	0.91 to 1.02
Person years observed	1.14*	1.11 to 1.17
Emergency visit		
None	1.00	
ADHD + CP	1.02	0.69 to 1.51
ADHD only	1.37*	1.17 to 1.61
CP only	1.58*	1.13 to 2.22
Age	1.03	0.97 to 1.09
Sex	1.40*	1.32 to 1.48
Person years observed	1.10*	1.07 to 1.13
ADHD + CP * older age	2.12*	1.08 to 4.15
ADHD only * older age	1.42*	1.06 to 1.89
CP only * older age	0.99	0.58 to 1.68
Hospital admission		
None	1.00	
ADHD + CP	0.83	0.36 to 1.89
ADHD only	1.43*	1.07 to 1.92
CP only	2.03*	1.27 to 3.25
Age	1.85*	1.60 to 2.14
Sex	1.99*	1.74 to 2.29
Person years observed	1.12*	1.04 to 1.20

All variables entered into regression, diagnostic group, age, sex, person years observed and interaction terms between age and diagnosis, and sex and diagnosis. Behaviour coded as present = 1, absent = 0; age coded as old = 1 (13 to 19 years of age), young = 0 (six to 12 years of age); sex coded as male = 1, female = 0; person years observed = continuous. * $P < 0.05$. ADHD Attention deficit hyperactivity disorder; CP Conduct problems

Physician office visits

When controlling for age, sex and person years observed, children with ADHD + CP (adjusted OR 1.54; 95% CI 1.12 to 2.12) and ADHD only (adjusted OR 1.17; 95% CI 1.02 to 1.33) experienced a greater number of injury-related physician office visits than children with no behaviour disorder. Furthermore, older children were at an increased risk

for a physician office visit (OR 1.32; 95% CI 1.24 to 1.40). There were no significant differences between boys and girls.

Emergency room visits

Boys were found to be at an increased risk (OR 1.40; 95% CI 1.32 to 1.48) of an emergency room visit for an injury. With the interaction between disorder diagnosis and age, older children with ADHD + CP (OR 2.12; 95% CI 1.08 to 4.15) were found to be at increased risk but not younger children (OR 1.02; 95% CI 0.69 to 1.51). Older and younger children diagnosed with ADHD only were at a similar and elevated risk of an emergency room visit. Younger children with CP only were at increased risk of an emergency visit (OR 1.58; 95% CI 1.13 to 2.22) but not older children (OR 0.99; 95% CI 0.58 to 1.68).

Hospital admissions

With respect to hospital admissions for injuries, children in the CP-only group were at the greatest risk (OR 2.03; 95% CI 1.27 to 3.25), followed by ADHD-only children (OR 1.43; 95% CI 1.07 to 1.92). Older children (OR 1.85; 95% CI 1.60 to 2.14) and boys (OR 1.99; 95% CI 1.74 to 2.29) were at an increased risk compared with younger children and girls.

DISCUSSION

Physician's office visits

The present study showed that children with ADHD, either with or without co-occurring CP, are at increased risk compared with nondisordered children for a minor injury requiring a physician office visit. Similar conclusions were reported by Miller et al (9) in that children treated with methylphenidate used a range of injury-related health services, including those for less severe injuries. Injuries that are managed by a visit to a physician's office are generally considered to be minor injury events. Thus, the present study extends previous research showing that not only are ADHD children at risk for more serious injuries but also for minor injuries. This is consistent with a hypothesis proposed by Byrne et al (1), who asserted that children with ADHD may be at risk for minor injuries. The fact that both children with ADHD only and children with ADHD + CP experienced minor injury outcomes, whereas children with CP only did not, suggests these injuries may be more closely associated with ADHD than CP.

Interestingly, our definition of ADHD included use of psychostimulant medication treatment, suggesting that the ADHD children in our study experienced greater rates of minor injuries despite receiving medication. However, it is also possible that many of these children were not receiving psychostimulant treatment at the time of the injury because a substantial proportion of children who receive medication treatment for ADHD at one time point discontinue taking that medication at future time points (17,18). It would be informative, both for research and treatment, to further examine this association while considering potential effects of current and specific treatment programs.

Emergency room visits

The association between childhood behaviour disorders and injuries requiring an emergency room visit was different for older and younger children. For older children, the risk for ADHD + CP was more than twice that of nondisorder children, whereas the risk was 42% greater for ADHD-only children. These findings suggest that the comorbidity between ADHD and CP significantly increases the risk of injury requiring emergency care among older children, relative to children with ADHD alone. This builds on previous research that has suggested that a comorbid diagnosis rather than either diagnosis alone poses a unique risk (1,19,20). In addition, there may be developmental changes occurring because some of the children may have had an ADHD-only diagnosis initially, but further developed to a comorbid diagnosis of ADHD + CP when older. It is unclear why there is an increase in the risk of emergency room visits but not hospital admissions or physician office visits. It may be that the number of hospitalizations is too small to establish stable estimates. On the other hand, older children with comorbid behavioural disorders may engage in riskier activities requiring an emergency room visit; alternatively, it could be a chance finding that stems from multiple inquiries. Further exploration of the role of comorbid CP when examining injuries in children with ADHD would help better understand this finding. Finally, research also shows that ADHD + CP children have other important differences relative to children with ADHD only or CP only, including higher rates of inattention and impulsivity, lower IQ, more stable ADHD and CP over time and more negative parenting in their development (13). Any one of these factors could arguably increase these children's risk of injury, warranting further examination.

Hospital admissions

Children in the CP-only group were at the greatest risk for a hospital stay with more than twice the risk of nondisorder children. This supports the notion that CDs, such as delinquency, may be related to injuries as proposed by Junger et al (15). ADHD-only children were found to have a 43% increased risk of hospitalization. Noteworthy, the children in the CP-only group were the only children among the disorder groups that were not treated with psychostimulant medication. This raises the question of whether these

children may exhibit impulsive behaviour that is not managed with medications. Furthermore, questions arise in the ADHD-only group as to whether a relationship may exist between active treatment program and injury event experience. More generally, are children in the disorder groups under other forms of treatment and what, if any, relationships exist between those treatments and risk of injuries? Further exploration is clearly needed on whether pharmacotherapy or other forms of treatment alters the risk of injuries in these children.

POTENTIAL LIMITATIONS

The reliability of administrative databases has been challenged on many fronts. Several sources of misclassification must be considered, including errors in data recording and physician reporting. With respect to data recording, it is possible that the nature and volume of data housed in these databases are subject to human error during recording. Moreover, the issue of misclassification could be a result of inaccurate physician coding or potentially inappropriate decisions with regard to ICD-9 codes chosen. It is possible, for example, that a diagnosis may have been coded by the physician to investigate the possibility of a disorder rather than to confirm the presence of a disorder. However, because a diagnosis of behaviour disorder carries a significant social and medical burden, it is likely that physicians are conservative in their use of these diagnostic codes. If children were included who were not 'true' cases, the OR is likely to be a conservative estimate. We attempted to reduce the potential for misclassification by requiring both a diagnosis and a psychostimulant prescription in the determination of ADHD. However, if children were misclassified as 'true' cases, it could introduce error, making it more difficult to detect an association between diagnosis and injury patterns.

Another issue of misclassification is with respect to the level of distinction among disorder groups. There may be a tendency among physicians to diagnose children using the predominant presenting symptoms. For example, if a child presents with impulsive, inattentive behaviour, the diagnosis may be ADHD, without consideration of the other symptoms that could place the child in a comorbid group. Similarly, children who present with a CP may also have a subclinical diagnosis of ADHD. The ability to classify children appropriately to each diagnostic group is limited by the diagnostic process of the physicians. Although it was expected that most physicians are familiar with the accepted symptomatology and use criteria on which to make a diagnosis, the use of cross-referencing with prescription use of stimulant drugs again attempted to minimize inaccurate diagnoses. Although the sample selection process strengthened the accuracy of diagnosis, it does not ensure a precise diagnosis and such issues can best be resolved by thorough systematic verification of the diagnosis from a number of independent sources.

The study sample was drawn from the Provincial Medical Insurance database initially; secondary screening

for prescription use was linked with the Community Services Family Benefits database. This limits the sample to those families who require support, possibly providing an over-representation of children from lower socioeconomic status and predominantly single-parent families. Replication in a general population would be valuable to establish trend.

CONCLUSIONS

The present study is the first to explore all three injury outcomes for children with single and comorbid behaviour disorders. The findings demonstrated unique and different injury outcomes for each disorder group. Children with ADHD were the only disorder group at increased risk for all three injury outcomes. Whereas the CP-only children were at greatest risk for the most serious injuries (hospitalization), children with a comorbid diagnosis were at risk for

both minor and more serious emergency injury visits. These findings provide further support for the increased risk of serious injuries among children with ADHD and more so for those children with CP, but moreover provide evidence of the lack of contribution of comorbidity to the risk of serious injuries.

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