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Childhood problem behaviors and injury risk over the life course

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Background: Childhood externalizing and internalizing behaviors have been associated with injury risk in childhood and adolescence, but it is unknown whether this association continues to hold in adulthood. We examined whether externalizing and internalizing behaviors expressed in childhood predict injuries in childhood, adolescence, and adulthood. **Methods:** The participants were from the 1958 British birth cohort (n = 11,537). Problem behaviors were assessed by teachers at ages 7 and 11. Injuries were reported by the participants' parents (at ages 7, 11, 16) and by the participants (at ages 23, 33, 42, and 46). Data on injury severity were available at ages 23 and 33, and on types of injuries at ages 23, 33, and 42. Measures of childhood family environment included father's social class, family size, and family difficulties. Adult psychological distress, treated as a potential mediating factor, was assessed at ages 23, 33, and 42. **Results:** Externalizing behavior predicted increased injury risk: one SD increase in externalizing score was associated with 10–19% increase in the rate of injuries in childhood, adolescence, and adulthood. In contrast, internalizing behavior decreased injury rate by 3–9% in adolescence and adulthood. Externalizing behavior was associated with various types of injuries, including injuries in traffic, at home, at work, and from violent assaults, while internalizing behavior predicted decreased injury risk particularly in sports, in traffic, and at home. These associations were largely independent of childhood family environment and adult psychological distress. **Conclusions:** The findings suggest that childhood problem behaviors predict injury risk over the life course from childhood to midlife, with externalizing behaviors increasing and internalizing behaviors decreasing this risk. **Keywords:** Externalizing disorder, internalizing disorder, injury, follow-up studies, adulthood.

In children, adolescents, and young adults, unintentional injuries are among the leading causes of mortality and morbidity (Centers for Disease Control and Prevention, 2008; National Statistics, 2005). In the United States, for example, approximately one-third of the deaths before the age of 45 are due to unintentional injuries (Centers for Disease Control and Prevention., 2008). Non-fatal injuries, in turn, are a source of considerable morbidity as they may lead to longstanding disabilities (Barker & Power, 1993; Brehaut, Miller, Raina, & McGrail, 2003).

Childhood problem behaviors are known to be related to children's accident proneness and thus to influence injury risk. Several studies on conduct disorders, impulsivity and antisocial behavior suggest that such externalizing behaviors increase the risk of injuries in children and adolescents (Di-Scala, Lescohier, Barthel, & Li, 1998; Jaquess & Finney, 1994; Mawson et al., 1996; Rowe, Simonoff, & Silberg, 2007; Schwebel, 2004; Schwebel, Speltz, Jones, & Bardina, 2002; Shepherd, Farrington, & Potts, 2002, 2004; Vollrath, Landolt, & Ribi, 2003). Childhood problem behaviors may also be expressed as internalizing behaviors, e.g., depressiveness and anxiousness, and some studies in children and adolescents have found such behaviors to be associated with increased risk of injuries (Chen et al., 2005; Rowe, Maughan, & Goodman, 2004; Rowe et al., 2007). On the other hand, in one study (Lee, Wadsworth, & Hotopf, 2006) high anxiety in adolescence predicted decreased rather than increased risk of accidental death up to the age of 25, suggesting that the avoidant and withdrawn behavioral disposition associated with internalizing behavior might protect from rather than expose to unintentional injuries.

While the association between problem behaviors and injury risk has been established in studies of children and adolescents, most of these studies have not assessed how childhood problem behaviors predict injuries beyond adolescence and young adulthood (cf. Barkley, Murphy, & Kwasnik, 1996; Fischer, Barkley, Smallish, & Fletcher, 2007; Shepherd et al., 2004). Hence, it is unclear whether the injury risk associated with early problem behaviors diminishes with age or whether such behaviors remain predictors of injuries in adulthood. Childhood problem behaviors may predict adult injury risk because childhood externalizing and internalizing behaviors show moderate continuity over time (adult psychological distress as mediators of childhood problem behaviors). The presence of adult psychological distress may also strengthen the influence of childhood problem behaviors on adult

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injury risk (adult psychological distress as moderators of childhood problem behaviors).

The present study addressed the role of childhood externalizing and internalizing behaviors in predicting life-course injury risk. In the 1958 British birth cohort (Atherton, Fuller, Shepherd, Strachan, & Power, 2008; Power & Elliott, 2006), we examined whether teacher-assessed externalizing and internalizing behaviors at the ages of 7 and 11 predicted injuries at the ages of 7, 11, 16, 23, 33, 42, and 46 years, and whether these associations were specific to severity and types of injuries. We also examined whether adult psychological distress mediated or moderated the association between childhood problem behaviors and injury risk in adulthood. Adverse family environment, e.g., low socioeconomic status, is known to be associated with problem behaviors and increased injury risk (e.g., Campbell, 1995; van Aken, Junger, Verhoeven, van Aken, & Dekovic, 2007), so measures of family environment (father's social class, family size, and family difficulties) were taken into account in the analyses.

Methods

Participants

The participants were from the nationally representative 1958 British Birth Cohort Study (also known as the British National Child Development Study). The sample has been described in detail elsewhere (Atherton et al., 2008; Power & Elliott, 2006). In brief, the original participants were 17,634 individuals born in England, Wales, and Scotland during one week in March 1958. Data have been collected in follow-up phases at ages 7, 11, 16, 23, 33, 42, and 46. The main sample of the present study included all 11,537 participants (5,922 men, 5,615 women) with data on teacher-assessed problem behaviors at the age of 7 and 11 and other covariates used in the study. The number of participants included in individual analyses varied from 6,927 to 11,537 depending on the follow-up phases. Written informed consent was obtained from the parents for childhood measurements and ethical approval for the study was obtained from the South East Multi-Centre Research Ethics Committee. A previous study (Atherton et al., 2008) assessed the loss to follow-up in detail and concluded that at age 45 the sample was broadly representative of the original cohort. However, children with behavioral and cognitive problems and those with lower adult socioeconomic achievement and poorer health have been somewhat more likely to drop out of the study.

Childhood problem behavior

At the ages of 7 and 11 the participants' problem behaviors were assessed by their teachers using the standardized Bristol Social Adjustment Guide (BSAG; Stott, 1963; see also Ghodsian, 1977). The 146 items of the instrument assess children's problematic behaviors that are grouped into 10 'syndromes.' Based on the 10 syndromes two general dimensions of problem behaviors can be assessed: Externalizing behavior is assessed by 6 syndromes, i.e., hostility towards children, hostility toward adults, inconsequential behavior, restlessness, anxiety for acceptance by children, and anxiety for acceptance by adults (Cronbach's alpha = .72 and .74 at ages 7 and 11). Internalizing behavior is assessed by 4 syndromes, i.e., depression, withdrawal, unforthcomingness, and dismissing adult values (Cronbach's alpha = .70 and .68). The labels of some of the subsyndromes may not be the best possible, e.g., the subsyndrome 'anxiety for acceptance by children' may sound like a subscale of internalizing rather than externalizing behavior, but it comprises items such as 'inclined to fool around', 'misbehaves when teacher is out of the room', and 'follower in mischief' that clearly reflect externalizing rather than internalizing behavior. An exploratory factor analysis fitted separately for age-7 and age-11 subsyndromes supported the above categorization (Table 1).

The correlation between the age-7 and age-11 measurements was r = .43 for externalizing (r = .59 when adjusted for attenuation due to measurement error) and r = .35 for internalizing (r = .51 adjusted for measurement error), indicating moderate continuity in problem behaviors in childhood. In order to have robust assessment of these behaviors, we calculated the mean values of the scales over the two measurement times and used these mean values in the analyses

Table 1 An exploratory factor analysis of 10 'subsyndromes' of childhood externalizing and internalizing behaviors at ages 7 and 11

	Age 7		Age 11	
	Externalizing	Internalizing	Externalizing	Internalizing
Hostility towards children	**.67**	.11	**.66**	.22
Hostility towards adults	**.61**	.23	**.66**	.14
Inconsequential behavior	**.76**	.20	**.76**	.20
Restlessness	**.56**	.11	**.53**	.09
Anxiety for acceptance by children	**.65**	–.03	**.67**	–.03
Anxiety for acceptance by adults	**.41**	–.16	**.43**	–.11
Depression	.27	**.65**	.34	**.61**
Withdrawal	.07	**.66**	.09	**.67**
Unforthcomingness	–.05	**.65**	–.06	**.62**
Writing off adult values	.44	**.55**	.47	**.51**

Note: Values are varimax-rotated factor loadings of a principal factor analysis. Factor loadings of subsyndromes defining externalizing and internalizing behaviors are shown in bold face.

(with the exception of age 7 when only age-7 measurement was used as the independent variable). The scales were positively skewed, so we transformed externalizing scale by inverse transformation and internalizing by logarithmic transformation and then standardized the scales (Mean = 0, SD = 1) in order to facilitate the interpretation and comparison of the regression coefficients. There was a positive correlation between externalizing and internalizing behavior scores (r = .39). In previous studies in the cohort, the scales have been shown to predict premature mortality risk (Jokela, Ferrie, & Kivimäki, 2009), psychiatric illnesses (Clark, Rodgers, Caldwell, Power, & Stansfeld, 2007; Done, Crow, Johnstone, & Sacker, 1994) and low socioeconomic status (Fronstin, Greenberg, & Robins, 2005).

Injuries

Information on injuries was provided by the participants' parents in follow-ups at ages 7, 11, and 16, and by the participants themselves in follow-ups at ages 23, 33, 42, and 46, with the content of the questions varying somewhat across the follow-up phases. We examined three injury indicators: the number of injuries, the probability of a permanent disability due to an accident, and types of injuries.

Number of injuries. At age 7 the parents reported whether the child had ever been to a hospital because of a home, traffic or other accident (each item coded as a dichotomous variable: 0 = no, 1 = yes), and these three items were summed together to create a dependent variable of the number of injuries at age 7. At age 11 the parents reported whether the child had ever been in a traffic accident or whether the child had had accidents causing scalds/burns, fractures, stitch wounds, or unconsciousness (each item coded as a dichotomous variable), and these five items were summed together to create a dependent variable of the number of injuries at age 11. Because at ages 7 and 11 the parents were asked whether the child ever been injured, injuries reported at age 7 were included in reports of injuries at age 11. At age 16, the parents reported the number of the child's accidents after age 11 needing hospital attendance. In follow-ups at ages 23, 33, 42, and 46, the participants reported the number of accidents they had had after the age at previous follow-up. In follow-ups at age 42 and 46 the questions were specified by querying accidents that had led the participants to seek medical attention. Given that only few individuals reported more than four injuries in any of the follow-ups, we top-coded the injury scales as 5-point scales that ranged from 0 to 4 or more injuries (for age-7 follow-up the range was from 0 to 3).

Severity of injuries. At ages 23 and 33 the participants reported whether they had been in an accident that had caused them a permanent disability (0 = no, 1 = yes).

Types of injuries. At age 23 the participants reported the types of up to 8 accidents they had been in (1 = road, pedestrian, 2 = road, driver, 3 = work, 4 = home, 5 = sports, 6 = other). At age 33, the types of up to 6 accidents/assaults were reported (1 = road, pedestrian, 2 = road, driver, 3 = work, 4 = home, 5 = sports, 6 = other, 7 = violent assault, 8 = rape). At age 42, the types of up 5 accidents were reported (1 = road, pedestrian, 2 = road-driver, 3 = work, 4 = home, 5 = school/college, 6 = sports, 7 = other, 8 = violent assault or mugging, 9 = sexual assault). Only few participants reported a sexual assault at ages 33 and 42, so this category was combined with violent assaults category. At age 42 only few participants reported accidents in school/college, so this category was combined with work category.

Childhood family environment

Family environment was assessed with three indicators when the participants were 7 years of age: father's social class, family difficulties, and family size. Father's social class was assessed on the basis of Registrar General's social class categorization on a 6-point scale (from unskilled manual to professional). Households without a father (n = 316) were included in the group of unskilled fathers. Family size was determined on the basis of persons living in the household. Family difficulties were assessed by the health visitors carrying out the home interviews with the parents, i.e., the family-difficulties instrument was not administered to the parents in this format in the structured interview. After the interview, the health visitor completed a 13-item scale that queried whether the family was having difficulties due to housing, finances, physical illnesses, mental illnesses, mental subnormality, father's death, mother's death, divorce or separation, domestic tension, 'in-law' family conflicts, unemployment, alcoholism, or for other reasons. Each item was coded on a dichotomous scale (0 = no, 1 = yes), and an indicator of family difficulties was created by summing these scores together and top-coding the variable so that it ranged from 0 to 4 or more difficulties.

Adult psychological distress

Psychological distress at ages 23, 33, and 42 was assessed using the psychological subscale of the Malaise Inventory (Grant, Nolan, & Ellis, 1990; Rodgers, Pickles, Power, Collishaw, & Maughan, 1999; Rutter, Tizard, & Whitmore, 1970). The subscale includes 15 items assessing psychological symptoms (e.g., Do you often feel miserable or depressed? Do you often get into a violent rage? Are you easily upset or irritated? Do you feel tired most of the time?) rated on a dichotomous response scale (0 = no, 1 = yes). The Cronbach alpha reliabilities of the scales were .78, .81, and .83 at ages 23, 33, and 42. Regression coefficients were calculated for standardized scales (Mean = 0, SD = 1).

Statistical analysis

The association between childhood problem behaviors and number of injuries at ages 7, 11, 16, 23, 33, 42, and 46 was assessed with separate Poisson regression models. The models were additionally adjusted for measures of family environment to examine potential confounding due to early environmental influences. To

assess whether the association between childhood problem behaviors and adulthood injuries was mediated or moderated by adulthood psychological distress, we examined whether adjusting for adulthood distress attenuated the influence of childhood problem behaviors and whether there were interaction effects between childhood and adulthood psychological distress on risk of injury. In order to maintain a completely prospective study design, the number of injuries at 33, 42, and 46 was predicted by adult psychological distress assessed at ages 23, 33, and 42, respectively.

The association between problem behaviors and risk of disabling injury at ages 23 and 33 was assessed with logistic regression, adjusting for the number of injuries at that age. The association between problem behaviors and types of injuries at ages 23, 33, and 42 was assessed with multinomial regression analysis. As some participants reported more than one type of injuries in a given follow-up phase, we structured the dataset so that injuries were nested within individuals and each injury (rather than participant) represented a case, which increased the number of observations. The reference group was individuals reporting no injuries. Standard errors were calculated applying robust estimator with individual clustering in order to take account the non-independence of the cases. All models were adjusted for sex, and sex differences were assessed by testing sex × problem behavior interaction effects.

Results

Table 2 shows the descriptive statistics for the sample. On average, the participants (or their parents) reported less than one injury at each follow-up phase (note that the means are not directly comparable between follow-up phases because injuries were reported for different lengths of time at different follow-up phases). Injuries at work, at home, in sports, and in traffic were the most common types of injuries, and the risk of these injuries decreased with age with the exception of injuries at home which peaked at age 33. Less than 5% of the participants had experienced an injury leaving a permanent disability. Table 3 presents the correlations between the numbers of injuries at different ages. The correlations suggested weak stability of injury-proneness over time, so that correlations between any two adjacent follow-ups tended to be above $r > .15$ while most correlations over longer periods of time were less than $r < .10$.

Number of injuries

Table 4 shows associations between problem behaviors and the number of injuries. In models mutually adjusted for the two types of problem behaviors (model 1), externalizing behavior predicted an increased rate of injuries at each follow-up from adolescence to adulthood; one SD increase in externalizing increased injury rate by 10–19%. Internalizing behavior was not associated with injury risk at ages 7 and 11, but between ages 16 and 42 one SD increase in internalizing decreased the rate of injuries by 7–9%. At age 46, the association was into the same direction (3% decreased rate), although not statistically significant. Adjusting for family background did not substantially change these associations (Table 4, model 2).

Table 2 Descriptive statistics for the sample

	Age						
	7	11	16	23	33	42	46
Sex							
Male*	51.3	51.1	51.3	49.8	49.2	49.4	48.7
Female*	48.7	48.9	48.7	50.2	50.8	50.6	51.3
Father's social class	3.2 (1.3)						
Family size	5.1 (1.7)						
Family difficulties	.4 (.9)						
Externalizing behavior[z]	.0 (1.0)	.0 (1.0)					
Internalizing behavior[z]	.0 (1.0)	.0 (1.0)					
Number of injuries	.2 (.4)	.3 (.6)	.3 (.7)	.8 (1.2)	.7 (1.0)	.5 (.9)	.2 (.5)
Disability due to injury*				2.7	4.5		
Type of injury							
No injuries*				56.0	58.9	64.8	
Road, pedestrian*				1.8	1.0	.7	
Road, driver*				15.0	9.6	8.5	
Work*				26.7	22.8	10.5	
Home*				10.9	22.8	8.1	
Sports*				20.0	19.7	9.1	
Violent assault*				–	3.2	2.7	
Other*				13.5	4.4	3.3	
Psychological distress[z]				.0 (1.0)	.0 (1.0)	.0 (1.0)	
*n***	11,537	10,560	8,449	9,012	8,197	8,202	6,927

Note: Values are means (and standard deviations) unless otherwise noted. * Values are percentages of participants. Each participant could report more than one type of injury, so the percentages in the 'type of injury' variable do not sum up to 100%. ** Values are the number of participants of the main sample (n = 11,537) with data at the particular follow-up phase. [z] Standardized variable (Mean = 0, SD = 1).

Table 3 Spearman's rank-order correlations between the numbers of injuries at different age periods

	Age 7	Age 11	Age 16	Age 23	Age 33	Age 42
Age 7	–					
Age 11	.28	–				
Age 16	.05	.27	–			
Age 23	.07	.08	.22	–		
Age 33	.06	.07	.15	.34	–	
Age 42	.03	.07	.10	.19	.26	–
Age 46	.02	.02	.06	.11	.12	.14

Note: All correlations were statistically significant at the level of $p < .05$ (minimum). $N = 6{,}927$–$11{,}537$.

Tests of sex differences indicated that of the 14 interaction effects between sex and problem behaviors only two were statistically significant and indicated that externalizing behavior predicted injury risk slightly more strongly in women than in men at ages 7 (Women: IRR = 1.19, CI = 1.12–1.27, $p < .001$; Men: 1.09, CI = 1.04–1.14, $p < .001$) and 33 (Women: IRR = 1.18, CI = 1.11–1.26, $p < .001$; Men: IRR = 1.08, CI = 1.04–1.11, $p < .001$). We fitted all the Poisson regression models separately for men and women, but these analyses indicated that problem behaviors predicted injury risk in a similar fashion in both sexes (data not shown), suggesting that sex differences in the association between problem behaviors and injury risk, if any, were small.

Next we assessed whether the association between childhood problem behaviors and number of injuries at ages 33, 42, and 46 was mediated or moderated by adulthood psychological distress (online supplementary table S1). Distress assessed at the previous study phase predicted increased injury risk at ages 33 (IRR = 1.06, CI = 1.03–1.09, $p < .001$), 42 (IRR = 1.09, CI = 1.05–1.12, $p < .001$), and 46 (IRR = 1.10, CI = 1.05–1.16, $p < .001$). When the two childhood problem behaviors and adulthood distress were mutually adjusted, they all remained independent predictors of injuries (Table S1, models 1), suggesting that adult psychological distress did not mediate the influence of childhood problem behaviors. Furthermore, there were no statistically significant interaction effects between childhood problem behaviors and adulthood distress (Table S1, models 2), indicating that adult psychological distress did not moderate the association between childhood problem behaviors and adult injuries.

Severity of injuries

We then evaluated whether problem behaviors were related to severity of injuries, i.e., whether the participant had a permanent disability due to an accident. Adjusted for number of injuries at age 23, childhood externalizing behavior predicted increased probability of disabling injury reported at the age of 23 (OR = 1.17, CI = 1.02–1.35, $p = .02$) while the association of internalizing with this probability was smaller and not statistically significant (OR = 1.11, CI = .97–1.28, $p = .14$). Further adjustment for measures of family background did not substantially alter these associations (externalizing OR = 1.16, CI = 1.01–1.33, $p = .03$; internalizing OR = 1.10, CI = .96–1.27, $p = .18$). When predicting disabling injury at age 33, adjusted for number of injuries at that age, externalizing behavior again predicted increased risk of disability (OR = 1.15, CI = 1.02–1.29, $p = .02$) while internalizing did not (OR = 1.06, CI = .94–1.19, $p = .34$). Further adjustment for family background had little effect on these associations (externalizing OR = 1.14, CI = 1.01–1.28, $p = .03$; internalizing OR = 1.04, CI = .92–1.18, $p = .51$). There were no sex differences (all p-values > .05).

Types of injuries

Finally, we examined whether problem behaviors predicted specific types of injuries reported at ages 23, 33, and 42 (Table 5). Externalizing behavior predicted almost all types of injuries, particularly traffic, work, and home injuries. In addition, externalizing was a strong predictor of becoming injured in a violent assault. Internalizing was associated with decreased risk of sport and home injuries and also to some extent traffic injuries. Adjustment for

Table 4 Predicting the number of injuries at different ages by childhood externalizing and internalizing behaviors. Seven nested Poisson regression models

	Model 1		Model 2		
	Externalizing	Internalizing	Externalizing	Internalizing	*n*
Age 7	1.12*** (1.08–1.16)	.99 (.95–1.03)	1.11*** (1.07–1.15)	.97 (.94–1.02)	11537
Age 11	1.16*** (1.12–1.20)	1.03 (.99–1.07)	1.14*** (1.10–1.19)	1.01 (.97–1.05)	10560
Age 16	1.19*** (1.15–1.24)	.91*** (.88–.95)	1.19*** (1.14–1.23)	.91*** (.87–.94)	8449
Age 23	1.15*** (1.12–1.18)	.93*** (.91–.96)	1.15*** (1.12–1.18)	.93*** (.90–.95)	9012
Age 33	1.10*** (1.07–1.13)	.92*** (.90–.95)	1.10*** (1.07–1.13)	.92*** (.89–.95)	8197
Age 42	1.16*** (1.12–1.19)	.91*** (.88–.95)	1.15*** (1.11–1.19)	.91*** (.87–.94)	8202
Age 46	1.18*** (1.12–1.24)	.97 (.92–1.03)	1.17*** (1.11–1.23)	.95 (.90–1.01)	6927

Note: Values are standardized (SD = 1) incidence-rate ratios (and 95% confidence intervals in parentheses) of injury risk associated with externalizing and internalizing behaviors (mutually adjusted) at different ages. Model 1 is adjusted for sex. Model 2 is adjusted for model 1 and father's social class, family difficulties, and family size. *** $p < .001$, * $p < .05$.

Table 5 Predicting the risk of specific types of injuries at different ages by childhood externalizing and internalizing behaviors. Three multinomial regression models

	Age 23		
	Externalizing behavior	Internalizing behavior	*n*
No injuries	1.00 (reference)	1.00 (reference)	5,044
Road, pedestrian	1.55*** (1.30–1.85)	.96 (.80–1.15)	160
Road, driver	1.30*** (1.20–1.40)	.90* (.83–.98)	1,351
Work	1.29*** (1.20–1.39)	.97 (.90–1.05)	2,405
Home	1.39*** (1.28–1.52)	.90* (.82–.99)	981
Sports	1.20*** (1.10–1.32)	.67*** (.60–.73)	1,804
Other	1.26*** (1.16–1.38)	.96 (.88–1.05)	1,220
	Age 33		
	Externalizing behavior	Internalizing behavior	*n*
No injuries	1.00 (reference)	1.00 (reference)	4,830
Road, pedestrian	1.18 (.94–1.49)	1.18 (.94–1.48)	85
Road, driver	1.30*** (1.19–1.42)	.90* (.82–.99)	783
Work	1.20*** (1.10–1.30)	1.06 (.98–1.15)	1,865
Home	1.15** (1.06–1.26)	.84*** (.77–.93)	1,000
Sports	1.13** (1.03–1.23)	.69*** (.62–.76)	1,613
Violent assault	1.52*** (1.26–1.84)	.91 (.77–1.08)	265
Other	1.11 (.97–1.26)	.92 (.80–1.07)	362
	Age 42		
	Externalizing behavior	Internalizing behavior	*n*
No injuries	1.00 (reference)	1.00 (reference)	5,317
Road, pedestrian	1.15 (.84–1.57)	1.12 (.86–1.47)	59
Road, driver	1.22*** (1.11–1.33)	.99 (.91–1.08)	694
Work	1.31*** (1.21–1.41)	.96 (.88–1.04)	863
Home	1.29*** (1.18–1.41)	.87** (.79–.96)	667
Sports	1.06 (.97–1.17)	.77*** (.70–.85)	750
Violent assault	1.54*** (1.35–1.76)	.94 (.81–1.10)	221
Other	1.05 (.92–1.20)	.99 (.87–1.13)	269

Note: Values are standardized (SD = 1) relative risk ratios (and 95% confidence intervals in parentheses) of reporting specific types of injuries associated with externalizing and internalizing behaviors (mutually adjusted) at different ages compared to reporting no injuries. All models are adjusted for sex. ***$p < .001$, **$p < .01$, *$p < .05$.

family background did not substantially alter these associations (data not shown). With three exceptions, there were no sex differences. At age 23, externalizing predicted traffic injuries (Men: RRR = 1.40, SE = .07, $p < .001$; Women: RRR = 1.13, SE = .08, $p = .10$) and the class of 'other injuries' (Men: RRR = 1.36, SE = .08, $p < .001$; Women: RRR = 1.10, SE = .10, $p = .29$) more strongly in men than in women. At age 33, externalizing was significantly associated with pedestrian accidents only in men (RRR = 1.39, SE = .20, $p = .03$) but not in women (RRR = .79, SE = .18, $p = .30$). Models fitted separately by sex suggested no consistent sex differences in the associations between problem behaviors and injury types (data not shown).

Attrition analysis

As reported in previous studies of the sample (Atherton et al., 2008), problem behaviors were associated with selective attrition. At ages 16, 23, 33, 42, and 46 the odds ratios of participating in the follow-up associated with one SD of externalizing behavior were .94, .86, .87, .88, and .83, respectively (all *p*-values < .02). The corresponding ORs for internalizing behavior were .94, .88, .86, .85, and .82 (all *p*-values < .01). In other words, individuals with high externalizing and internalizing behaviors were progressively more likely to drop out of the study during the follow-up.

Discussion

The present study of a large, nationally representative British birth cohort is unique in tracking the association between problem behaviors and injury risk over the life course from childhood to midlife. In agreement with previous studies in children and adolescents (e.g., DiScala et al., 1998; Rowe et al., 2007), we found that teacher-assessed externalizing behavior expressed in childhood was consistently associated with increased injury risk. This risk was considerably stable across the life course from childhood to adulthood, and was related to a wide range of injury types, including traffic, work, and home injuries. Childhood externalizing behavior was also particularly strong in predicting adult injuries caused in violent assaults. Furthermore, children with high externalizing scores were more likely to be

permanently disabled in accidents than children with low externalizing scores, even when their increased rate of injuries was taken into account, suggesting that externalizing behavior was also related to more severe injuries. All these associations were largely independent of measures of childhood family environment.

The present study provides novel insight into the role of internalizing behavior in injury proneness. Most previous studies in children and adolescents have found internalizing to be associated with increased injury risk (e.g., Rowe et al., 2004, 2007; Chen et al., 2005). In contrast, we observed no association between internalizing and injury risk in childhood and that internalizing behavior predicted decreased rather than increased risk of injuries in adolescence and adulthood. This was mainly due to decreased probability of sport, domestic, and traffic injuries. There are at least two possibilities why the present results on internalizing behavior differ from previous findings in children and adolescents. First, the positive association between internalizing behaviors and injuries reported in previous cross-sectional studies may be due to reverse causality (Rowe et al., 2004), because negative life-events, including accidents, may increase internalizing behaviors (e.g., Goodyer, Cooper, Vize, & Ashby, 1993; Li, Roberts, & Power, 2001). Second, internalizing behaviors may be differently related to injury risk in childhood and adolescence than in adulthood. Indeed, the present findings are in agreement with a previous study on anxiety and mortality in the 1946 British birth cohort which found that high anxiety in adolescence predicted decreased risk of accident mortality up to the age of 25 (Lee et al., 2006).

The pathways connecting childhood problem behaviors with adult injury risk remain to be established in more detail. Externalizing and internalizing behaviors may predict how individuals become exposed to risky situations. For instance, the 'protective effect' of internalizing behavior in sport-related injuries probably reflects the fact that children exhibiting high internalizing behaviors are less likely to take part in physical activities that may cause injuries. These individuals may tend to behave in a cautious and wary manner more generally, thus decreasing their exposure to physically hazardous circumstances in adolescence and adulthood. In contrast, high childhood externalizing behaviors may increase individuals' exposure to risky environments later in life which is suggested, for instance, by the association between externalizing behavior and risk of violent assaults.

Furthermore, it seems plausible that childhood problem behaviors predict later injuries because these behaviors exhibit moderate continuity across the life course (e.g., Clark et al., 2007; Colman, Wadsworth, Croudace, & Jones, 2007; Roza, Hofstra, van der Ende, & Verhulst, 2003; Sourander et al., 2007). Thus, childhood externalizing and internalizing behaviors may act as markers of injury-proneness that individuals carry into adulthood and that influence the way individuals react and behave in potentially risky situations. We found that adult psychological distress at ages 23, 33, and 42 predicted increased injury risk over periods of 4 to 10 years, but it did not mediate or moderate the association between childhood problem behaviors and number of accidents in adulthood. In other words, childhood problem behaviors predicted adult injury risk independently of adult psychological distress. However, other adult dispositions related to childhood problem behaviors may mediate the association. In particular, childhood problem behaviors may influence individuals' risk-taking behavior (e.g., lack of self-control; Baumeister & Heatherton, 1996; cf. Junger, West, & Timman, 2001) and attitudes toward physical risks (e.g., sensation seeking; Zuckerman, 2006; cf. Thuen, 1994) which, in turn, influence injury proneness in adulthood.

The strengths of the present study include a large nationally representative sample, assessment of problem behaviors at two points in childhood with a standardized instrument, the use of multiple informant data, and a long follow-up period with repeated assessments of injuries. However, three sources of potential bias need to be considered. First, previous studies of the sample have shown that high problem behaviors predict selective attrition (Atherton et al., 2008). It seems unlikely that attrition would have substantially biased the present results, however, since problem behaviors consistently predicted injuries with a similar magnitude in childhood, adolescence, and adulthood. Second, self-reported data on injuries and accidents may have introduced some bias in the results, as problem behaviors might be related to how people report or seek help for injuries. The role of reporting bias was mitigated by asking participants to recall accidents for which they had sought medical help. Such incidents are more objectively defined and probably more accurately recalled (Harel et al., 1994). The use of multiple informant data, i.e., problem behaviors assessed by teachers, injuries reported by the parents and the participants, also reduced the possibility of common informant bias. Third, injuries and accidents were not assessed with the same (or standardized) instrument across the follow-ups. The slightly differing instruments did provide consistent results, but the use of different measurements at different follow-up phases may have yielded underestimates of the stability of individual differences in injury proneness.

Conclusion

The present study shows that the injury risk associated with childhood problem behaviors persists

into adulthood. Children exhibiting externalizing behaviors are more likely than others to become injured and disabled due to accidents. High childhood internalizing behaviors, in contrast, are associated with decreased injury risk in adolescence and adulthood. These findings suggest that childhood problem behaviors may influence the manner in which individuals become exposed to physical risks and how they behave in potentially risky situations later in life. The effect sizes of these associations were modest, as might be expected given the long follow-up period, but even small effects may have important health consequences especially when such small effects persist over the life course.

Supporting information

Additional supporting information may be found in the online version of this article:

Table S1. Predicting the number of injuries at different ages by childhood problem behaviors and adult psychological distress. Three separate nested Poisson regression models

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Key points

- Childhood externalizing and internalizing behaviors have been associated with the risk of injuries in childhood and adolescence, but there is a lack of data assessing the influence of these behaviors on long-term injury risk over the life course.
- In the present study, participants with high childhood externalizing behavior were more likely to be injured in a wide range of contexts in childhood, adolescence, and adulthood. In contrast, high childhood internalizing behavior predicted fewer injuries, sport- and home-related injuries in particular, in adolescence and adulthood.
- Childhood externalizing and internalizing behaviors may have a long-term influence on how individuals are exposed to physical risks and how they behave in potentially risky situations.

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