

# Childhood behavior problems and health at midlife: 35-year follow-up of a Scottish birth cohort

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**Background:** Childhood behavior problems are associated with premature mortality. To identify plausible pathways that may account for this association, we explored the extent to which childhood behavior problems relate to health behaviors and health outcomes at midlife. **Methods:** The Aberdeen Children of the 1950s (ACONF) study comprises 12,500 children from the Aberdeen area, Scotland, UK. Childhood behavior problems were assessed by teacher ratings at children's age of 6–12 years. Between 2001 and 2003, surviving study members, then aged 46–51 years, were mailed a questionnaire containing enquiries about physician-diagnosed conditions (long-term disease, diabetes, high blood pressure), general health, well-being, weight, smoking, and alcohol intake. A total of 7,183 responded. **Results:** Two dimensions of externalizing (conduct problems and hyperactivity) and one of internalizing (emotional problems) behaviors were associated with adult health. Childhood conduct problems were related to an increased risk of long-term disease (odds ratio per one standard deviation increase; 95% confidence interval: 1.15; 1.02–1.29 for men; 1.26; 1.08–1.47 for women), obesity (1.16; 1.01–1.33 in men; 1.38; 1.14–1.68 in women), cigarette smoking (1.20; 1.07–1.34 in men; 1.17; 1.01–1.35 in women), and lower well-being. Childhood hyperactivity was associated with earlier initiation of smoking in men and women; smoking more cigarettes in women; and binge-drinking, as well as a higher frequency of hangovers in men. Internalizing behavior was related to a reduced risk of ever smoking (.87; .80–.95 in men; .92; .85–.99 in women) and to healthier drinking patterns. In women but not men, internalizing problems also predicted a later age of smoking onset. Adjusting for socio-economic status of origin, childhood intelligence, education and age had negligible effects on these results. **Conclusions:** Childhood behavior problems were associated with a series of adult health-related habits that may partially account for the link between early problem behaviors and premature mortality. **Keywords:** Childhood behavior disturbance, conduct problems, emotional problems, hyperactivity, health, smoking, alcohol, obesity.

Life-course epidemiological research has recently acknowledged the importance of psychological variables in the prediction of morbidity and mortality. For example, childhood characteristics, such as higher mental ability and conscientiousness or dependability, have been shown to be associated with reduced mortality risks up to six decades later (e.g., Deary, Batty, Pattie, & Gale, 2008; Friedman et al., 1993). Conversely, childhood behavior disturbances were found to be associated with higher rates of death and injury in midlife (Jokela, Ferrie, & Kivimäki, 2009; Jokela, Power, & Kivimäki, 2009), as well as social maladjustment and poorer mental health (Colman et al., 2009; Sourander et al., 2007). The pathways that may account for these associations, such as the long-term effects of childhood behavior problems on mediating factors including adult health outcomes and health-related behaviors, have attracted increasing interest (e.g., Caspi, 2000).

Childhood behavior disturbance is typically divided into externalizing problems, such as aggression and restlessness, and internalizing problems, as for example anxiety and withdrawal (Hinshaw, 1987). In prospective studies, externalizing problems predicted substance abuse, problem drinking and smoking in adulthood (King, Iacono, & McGue, 2004; Pulkkinen & Pitkänen, 1993; Timmermans, van Lier, & Koot, 2008), as well as anti-social behavior patterns with a heightened probability of violent assaults (Caspi, 2000; Jokela, Power et al., 2009). Internalizing problems, in turn, have been associated with anxiety disorders and depression in adulthood (Clark, Rodgers, Caldwell, Power, & Stansfeld, 2007), as well as suicidal behaviors, and marital and occupational instability (Caspi, Elder, & Bem, 1988; Ferguson, Horwood, & Ridder, 2005). However, some studies suggest a protective effect for internalizing behaviors, as they are associated with a lower injury risk in sports and traffic, and reduced mortality from accidents in young adulthood (Jokela, Ferrie et al.,

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2009; Lee, Wadsworth, & Hotopf, 2006). In general, externalizing problems tend to be more often and strongly associated with health risk behaviors, whereas the consequences of internalizing problems are less clear (e.g., Pitkänen, 1999; Pulkkinen, 2004). Furthermore, associations of childhood behavior problems and health behaviors and outcomes seem to vary across sexes (e.g., Pitkänen, Kokko, Lyrra, & Pulkkinen, 2008), with men showing more often externalizing behaviors and women being more prone to internalizing problems (Pulkkinen, 2004). For example, it has been suggested that problem drinking is linked with externalizing behavior problems in men but not in women, whose alcohol consumption may be more closely associated with internalizing behavior problems (e.g., Pitkänen, 1999).

In the current study, we sought to investigate whether childhood behavior problems predict a range of health behaviors and health outcomes at midlife to identify pathways that may account for the mortality–problem behavior association. The *Aberdeen Children of the 1950s Study* (ACONF) offers a rare opportunity to examine prospectively the associations of childhood behavior disturbance assessed between 6 and 12 years of age with health outcomes and risk factors for chronic disease measured four decades later in a large, representative birth cohort from Scotland. As detailed information was recorded on cohort members' childhood cognitive ability, educational qualification and social class of origin, we were able to control for these potential powerful confounders (ability and origin) and mediators (education) in order to accurately quantify the long-term predictive value of childhood behavior problems for adult health and risk factors.

## Methods

### Sample

The ACONF comprised 12,150 men and women born in Aberdeen, Scotland, between 1950 and 1956 (see Batty et al., 2004 and Leon et al., 2006 for detailed summaries of the study design). Cohort members attended primary schools in the city in 1962 when they were aged 6 to 12 years; they completed mental ability tests, while teachers rated children's behaviors. The data were linked with socio-demographic information from birth certificates and hospital records. The sample was followed up with a postal questionnaire between 2001 and 2003 when participants were aged 46 to 51 years, achieving a response of 64% ( $N = 7,183$ ). The follow-up survey included questions on educational, occupational and socio-economic status.

### Measures

*Childhood predictors and control variables.* *Childhood behavior.* Class teachers completed the 26-item Rutter Scale B (Rutter, 1967; note that the administered scale was an early but identical version of the Rutter B2 scale), and rated behaviors of the children,

who were aged 6 to 12 years, on a three-point scale ranging from 'Does not apply', 'Applies somewhat', to 'Definitely applies'. The scale assesses a variety of behaviors, including aggression, clumsiness, worrying, and concentration difficulties. Individual item scores were documented in the official Aberdeen school records.

*Intelligence.* Within 6 months of their 11th birthday, children completed four mental ability tests, including the Moray House Verbal Reasoning Test I and II (Thomson, 1940), and an arithmetic and an English test. The tests were administered and scored by primary school teachers; scores were normed according to local standards in line with the test manuals, which reported reliabilities of above .90 for all tests.

*Social class of origin, education, and age.* Information on father's occupational social class at the time of child's birth was extracted from obstetric hospital records and coded on a seven-point scale ranging from unskilled, semi-skilled manual, skilled manual with a) an apprenticeship and b) other skilled manual occupations, skilled non-manual, managerial to professional, according to the OPCS Registrar General's Classification of Occupations (Office of Population Censuses and Surveys, 1990). Categories of skilled manual a) and b) were collapsed into one, resulting in a six-point scale overall. Fathers who were unemployed or had died before the child's birth were treated as missing ( $N = 680$ ). Dichotomous items on education were transformed into a seven-point education index, ranging from no formal education, simple school leaving certificate, clerical qualifications, O-levels (certificate of secondary education), Highers or Certificate of Secondary Education (advanced school leaving certificates which enable university entry), National Certificate (HNC), to degree level. Participants' highest educational qualification was taken as marker of their educational attainment. Participants stated their year and month of birth in December 1962 when surveyed in school; this information was supplemented by data from birth records.

*Adulthood outcome variables.* *Physician-diagnosed conditions.* The follow-up questionnaire from 2001 to 2003 included self-report items on several medical conditions, which began with the phrase 'Has your doctor ever told you have ...?' A positive response resulted in a number of supplementary questions. In the present study, only responses to the initial question were evaluated, including the dichotomous variables of long-term illnesses<sup>1</sup> (yes/no), high blood pressure (yes/no), and diabetes (yes/no).

*General health.* One item asked respondents to rate their general health over the past 12 months on a four-point scale ranging from 'excellent' to 'poor'. This item is a widely reported measure of health with good external validity, and was previously found to predict mortality in a dose–response fashion (Der et al., 2009).

<sup>1</sup>The item was: 'Do you have any long-term illness, health problem or disability which limits your daily activities or the work you can do?' Answers spanned 40 different complaints including, for example, cancer, asthma, back problems, muscle and joint problems, arthritis and reproductive system problems.

*Well-being.* Four items (GHQ-4; Jacobsen, Hasvold, Hoyer, & Hansen, 1995) assessed the psychological well-being of the participants who rated their enjoyment in day-to-day activities, levels of depression, loss of confidence and overall happiness and well-being over the past few weeks on a four-point scale ranging from 'much less than usual' to 'much more than usual'. The items were inter-correlated with values ranging from  $r = .36$  to  $r = .68$ . An exploratory principal axis factor analysis resulted in a first unrotated factor with an Eigenvalue of 2.54 accounting for 63.50% of the total variance ( $N = 7,112$ ) and hence, a unit-weighted<sup>2</sup> composite scale was computed with a coefficient alpha of .80.

*Body Mass Index.* Participants were asked to report on their height and weight in either imperial or metric measures ( $N = 6,405$ ). All data were transformed into lbs for weight and into inches for height. Subsequently, the Body Mass Index (BMI) was computed based on the following formula:  $BMI = \text{weight (lbs)} * 703 / \text{height (inches)}^2$  for conversion to the standard units of  $\text{kg}/\text{m}^2$ . BMI values below 18.5 indicate underweight, values between 18.5 and 25 indicate normal weight, values from 25 to 30 are classified as overweight, BMI values of above 30 indicate obesity, and values above 40 suggest severe obesity (WHO, 2008).

*Smoking.* Participants were asked to report on their smoking habits, including if they had ever smoked regularly; at what age they had started smoking regularly; when they had stopped smoking; and how many cigarettes per day they currently smoked or had smoked in the past. The number of cigarettes per day was transformed into a categorical variable of smoking behavior because of its non-normal distribution: light smoking with fewer or equal to 5 cigarettes a day; moderate smoking with 6 to 15 cigarettes per day; standard smoking with 16 to 20 cigarettes per day; strong smoking with 21 to 30 cigarettes per day; and extreme smoking with 31 and more cigarettes per day (this classification follows Timmermans et al., 2008).

*Alcohol intake.* The frequency of alcohol consumption was recorded on a seven-point scale including 'every day', 'most days during the week and weekends', 'weekends only', 'less than once a week', 'special occasions', 'have never drunk alcohol' and 'no longer drink alcohol'. Participants also reported on the amount of alcohol they had consumed throughout the week prior to questionnaire completion, including the number of pints of beer, glasses of wine, glasses of martini, sherry and port, spirit measures and number of other alcoholic beverages. The counts of drinks were multiplied by their corresponding weighting in alcohol units (half a pint of beer equals 1 unit; a glass of wine equals 1.5 units; martini, port and sherry equal 1 unit; spirits in standard pub measures equal 1.5 units), one of which contains 10 milliliters or approximately 8 grams of ethanol. The total of units were classified into light drinkers (ranging from 0 to 15 units for men, and 0 to 9 in women), moderate drinkers (15.5 to 24 in men, 9.5 to 16 in women) and extreme drinkers (24.5 and 16.5 through highest in men and women, respectively).

Participants were asked how often they had four or more drinks on a single occasion in the past year, as

well as the number of hangovers they experienced in the past 12 months. Both variables were recorded on a five-point scale ranging from 'not at all in the past year', less than once a month', 'once a month', '2–3 times a month', to 'at least once a week'.

### Statistical analysis

All analyses were computed using PASW 17. In a first, data-preparing step, principal axis factor analyses were applied to explore the psychometric structure of behavior disturbance and intelligence.

A series of binary logistic regression models was conducted to estimate the odds for long-term illness (yes/no), high blood pressure (yes/no), diabetes (yes/no), overweight (yes/no), smoking (ever/never), smoking cessation (yes/no), and alcohol consumption (stopped/drinker; there were also 69 alcohol abstainers who were excluded from the analyses on alcohol consumption because, due to missing data in other variables, the final numbers were insufficient for meaningful statistical tests). For categorical outcomes of weight (underweight, normal weight, overweight, obese, severely obese), frequency of alcohol consumption (every day, most days, weekends, less than once a week, special occasions), amount of alcohol consumed (light, moderate, risk drinker) and smoking (non-smoker, light, moderate, standard, strong and extreme smoker), multinomial regression models were calculated. Finally, linear regression models were conducted for outcomes treated as continuous variables, including general health, well-being, BMI, age of starting to smoke, age of smoking cessation, frequency of having four or more drinks on one single occasion and the number of hangovers.

Binary logistic and linear regression models were built entering factors of childhood behavior, and adjusting for age, intelligence, social class of origin, and education in a second step; in the interest of saving space, only adjusted models are presented for multinomial logistic regression analyses. All regression models required listwise omission of cases with missing data points and were computed separately for subsamples of men and women.

## Results

### Analysis of missing data

Differences in means between the baseline analytic sample and those with missing data on covariates were generally small (online only, eTable S1). The most notable differences are in age and IQ, with people with missing data points among the covariates having a lower IQ score and being younger on average than those with complete data.

### Principal axis factoring of Rutter Scale B and intelligence tests

For a total of 13 Rutter Scale items, the initial communalities were below .25 (Kline, 1986). These items were excluded from all further analyses. The

<sup>2</sup> Unit-weighted composite scores refer to adding all scale items together with equal weights.

remaining 13 items had extracted communalities above .30 and were retained in subsequent analyses. A three-factor solution emerged under oblique rotation accounting for 59.3% of the total variance with Eigenvalues of 4.56, 1.94, and 1.21. The factors were identified as hyperactivity (3 items; coefficient alpha of .76), conduct problems (7 items; coefficient alpha of .83), and emotional problems (3 items; coefficient alpha of .72). This interpretation is consistent with McGee and colleagues' (1985) factor solutions of the Rutter Scale, and it is also in line with the Strengths and Difficulties Scale (Goodman, 1999), which is the successor to the Rutter Scale. Table 1 shows the retained items with corresponding factors. Unit-weighted composite score were computed adjusting for the number of items (scores ranged from 3 to 9 for hyperactivity and emotional problems, and from 7 to 21 for conduct problems).

From the four ability scales, a first unrotated factor accounted for 88.8% of the total variance with an Eigenvalue of 3.55; factor loadings ranged from .880 (Arithmetic) to .962 (Verbal). The scales were added to form a unit-weighted composite score adjusted for the number of tests (scores ranged from 55 to 145);

**Table 1** Retained Rutter scale items after three-factor solution with oblique rotation

	Conduct problems	Emotional problems	Hyperactivity
Fights other children	<b>.841</b>	-.013	.027
Bullies other children	<b>.728</b>	-.054	.095
Irritable	<b>.635</b>	.027	-.015
Often lies	<b>.583</b>	.001	-.074
Often disobedient	<b>.500</b>	-.080	-.307
Not liked by others	<b>.490</b>	.178	-.032
Destroys belongings	<b>.483</b>	-.049	-.135
Worries about things	-.057	<b>.745</b>	.007
Afraid of new events	-.109	<b>.741</b>	-.064
Miserable and tearful	.178	<b>.565</b>	.033
Fidgety child	-.038	-.035	<b>-.908</b>
Child very restless	.066	-.054	<b>-.783</b>
Poor concentration	.074	.165	<b>-.461</b>

Note: Items were shortened. Factor loadings above .45 are shown in bold.

descriptives for this and all other scales are shown in Table 2.

*Associations of childhood behaviors with mid-life health outcomes*

For men, one standard deviation increase in conduct problems was associated with 15% greater odds of long-term disease and for women the effect was even greater with a 26% increase in the odds of long-term disease (Tables 3 and 4). Adjustment for confounding variables, including age, intelligence, social class of origin and education, had essentially no impact on these effect estimates. Emotional problems were related to the risk of diabetes in women, with a 36% increase in the odds, which did not change substantially after controlling for confounders.

Across sexes, children who showed higher levels of conduct problems and hyperactivity had poorer general health at midlife with beta coefficients of  $-.08/-.08$  and  $-.06/-.05$  for men and women, respectively (Tables 5 and 6). However, these effects became non-significant after multiple adjustment. Conduct problems in childhood were associated with lower levels of well-being, assessed by the GHQ-4, with beta coefficients of  $-.09$  for men and women, which reduced to  $-.08$  for men but remained the same for women after model adjustment. In men, hyperactivity had a positive effect on well-being with a coefficient of  $.07$  (unadjusted  $.04$ ), which only became significant after controlling for confounders. Generally, the regression coefficients were of small magnitude.

*Associations of childhood behaviors with health risk factors*

Weight was examined in terms of a dichotomous variable of overweight (yes/no), and a five-level categorical variable of weight classifications according to the WHO (2008). For men, childhood behaviors did not contribute significantly to the odds of overweight at midlife (Table 4). In contrast, a standard deviation increase in conduct problems was

**Table 2** Descriptives for men and women for continuously treated variables

	N		Men		Women	
	Men	Women	M (SD)	(SD)	M (SD)	(SD)
Intelligence	5,029	4,585	103.82	(13.46)	104.81	(12.98)
Hyperactivity	6,062	5,701	4.06	(1.52)	3.69	(1.23)
Conduct problems	6,035	5,678	7.88	(1.95)	7.45	(1.28)
Emotional problems	6,055	5,698	3.42	(.91)	3.48	(.97)
General health	3,428	3,716	3.06	(.78)	2.97	(.78)
Well-being	3,412	3,700	9.67	(1.88)	9.37	(2.05)
Age (months in Dec 1962)	6,282	5,868	116.17	(17.45)	115.88	(17.48)
Four or more drinks	3,256	3,431	3.57	(1.35)	2.83	(1.36)
Hangovers	3,254	3,429	1.94	(1.01)	1.60	(.81)
Smoking start age (years)	1,841	1,861	16.50	(3.74)	17.25	(4.34)
Cessation age (years)	932	837	33.69	(8.74)	33.32	(9.20)

**Table 3** Associations between childhood behavior problems and dichotomous adult outcomes in men (odds ratios per one standard deviation increase and 95% confidence intervals)

	Frequencies			Hyperactivity	Conduct problems	Emotional problems			
	N	Yes	No						
Long-term disease	2,518	392	2,126	1.10 .97 <sup>a</sup>	(.97, 1.24) (.85, 1.11)	<b>1.15</b> <b>1.13<sup>a</sup></b>	( <b>1.02, 1.29</b> ) ( <b>1.01, 1.27</b> )	1.06 1.04 <sup>a</sup>	(.95, 1.19) (.92, 1.16)
High blood pressure	2,547	484	2,063	1.00 1.01 <sup>a</sup>	(.88, 1.13) (.89, 1.15)	1.06 1.06 <sup>a</sup>	(.95, 1.19) (.95, 1.20)	.95 .97 <sup>a</sup>	(.85, 1.07) (.86, 1.09)
Overweight (BMI > 25)	2,318	842	1,476	1.04 1.01 <sup>a</sup>	(.94, 1.16) (.90, 1.13)	1.08 1.07 <sup>a</sup>	(.96, 1.20) (.96, 1.19)	.95 .94 <sup>a</sup>	(.86, 1.04) (.86, 1.04)
Diabetes	2,551	51	2,500	1.14 1.06 <sup>a</sup>	(.84, 1.54) (.77, 1.46)	1.07 1.04 <sup>a</sup>	(.81, 1.41) (.79, 1.38)	1.12 1.12 <sup>a</sup>	(.86, 1.46) (.85, 1.47)
Ever smoked	2,556	1360	1,196	<b>1.31</b> <b>1.17<sup>a</sup></b>	( <b>1.18, 1.45</b> ) ( <b>1.05, 1.30</b> )	<b>1.20</b> <b>1.17<sup>a</sup></b>	( <b>1.07, 1.34</b> ) ( <b>1.04, 1.31</b> )	<b>.87</b> <b>.86<sup>a</sup></b>	( <b>.80, .95</b> ) ( <b>.78, .94</b> )
Smoking cessation	1,360	707	653	.96 1.07 <sup>a</sup>	(.85, 1.08) (.94, 1.22)	<b>.86</b> .88 <sup>a</sup>	( <b>.76, .97</b> ) (.78, 1.00)	.93 .97 <sup>a</sup>	(.82, 1.06) (.85, 1.10)
Drinking cessation	2,542	105	2,437	1.09 .98 <sup>a</sup>	(.87, 1.35) (.78, 1.24)	1.12 1.10 <sup>a</sup>	(.92, 1.35) (.91, 1.33)	1.12 1.09 <sup>a</sup>	(.92, 1.35) (.90, 1.33)

<sup>a</sup>Adjusted for age, intelligence, social class of origin, and educational qualification.

Note: All dichotomous outcome variables were coded 0 for no and 1 for yes. Higher values on childhood behavior factors indicate a greater degree of behavior disturbance. Significant odds ratios are shown in bold.

**Table 4** Associations between childhood behavior problems and dichotomous adult outcomes in women (odds ratios per one standard deviation increase and 95% confidence intervals)

	Frequencies			Hyperactivity	Conduct problems	Emotional problems			
	N	Yes	No						
Long-term disease	2,634	440	2,194	1.02 .89 <sup>a</sup>	(.88, 1.17) (.77, 1.04)	<b>1.26</b> <b>1.25<sup>a</sup></b>	( <b>1.08, 1.47</b> ) ( <b>1.07, 1.46</b> )	1.04 1.01 <sup>a</sup>	(.94, 1.15) (.91, 1.12)
High blood pressure	2,699	386	2,313	1.06 1.04 <sup>a</sup>	(.92, 1.23) (.89, 1.22)	1.08 1.07 <sup>a</sup>	(.91, 1.28) (.90, 1.27)	1.05 1.06 <sup>a</sup>	(.94, 1.17) (.95, 1.18)
Overweight (BMI > 25)	2,400	1,155	1,245	1.04 .95 <sup>a</sup>	(.92, 1.17) (.84, 1.08)	<b>1.24</b> <b>1.22<sup>a</sup></b>	( <b>1.06, 1.45</b> ) ( <b>1.04, 1.43</b> )	1.00 .98 <sup>a</sup>	(.92, 1.09) (.90, 1.07)
Diabetes	2,687	41	2,656	1.18 1.11 <sup>a</sup>	(.80, 1.74) (.73, 1.69)	.80 .78 <sup>a</sup>	(.44, 1.46) (.43, 1.43)	<b>1.36</b> <b>1.35<sup>a</sup></b>	( <b>1.08, 1.71</b> ) ( <b>1.07, 1.71</b> )
Ever smoked	2,706	1,336	1,370	<b>1.41</b> <b>1.25<sup>a</sup></b>	( <b>1.26, 1.59</b> ) ( <b>1.11, 1.42</b> )	<b>1.17</b> <b>1.17<sup>a</sup></b>	( <b>1.01, 1.35</b> ) ( <b>1.01, 1.35</b> )	<b>.92</b> <b>.88<sup>a</sup></b>	( <b>.85, .99</b> ) ( <b>.81, .96</b> )
Smoking cessation	1,336	619	717	<b>.83</b> .95 <sup>a</sup>	( <b>.72, .96</b> ) (.82, 1.11)	.98 .97 <sup>a</sup>	(.83, 1.15) (.82, 1.15)	.99 1.03 <sup>a</sup>	(.88, 1.12) (.91, 1.16)
Drinking cessation	2,677	137	2,540	1.12 1.05 <sup>a</sup>	(.89, 1.40) (.83, 1.34)	1.10 1.08 <sup>a</sup>	(.85, 1.42) (.84, 1.40)	1.02 1.00 <sup>a</sup>	(.86, 1.22) (.84, 1.19)

<sup>a</sup>Adjusted for age, intelligence, social class of origin, and educational qualification.

Note: Dichotomous outcome variables were all coded 0 for no and 1 for yes. Higher values on childhood behavior factors indicate a greater degree of behavior disturbance. Significant odds ratios are shown in bold.

associated with a 24% increase in the odds of overweight at midlife in women, which was minimally attenuated to 22% in the adjusted model (Table 4). For both sexes, the multinomial odds ratios of conduct problems for the obese category were significant in fully adjusted models. A standard deviation increase in conduct problems was associated with a 16% and a 38% increase in the odds for being obese compared to having normal weight for men and women, respectively (Tables 7 and 8).

**Smoking.** Odds ratios for never versus ever smoking showed significant effects for all three childhood behaviors in men and women. A standard deviation increase in hyperactivity was associated with a 31% and a 41% increase in the odds of ever smoking for men and women, respectively (Tables 3 and 4). Both

effects remained significant after adjustment but lowered to 17% and 25%. A standard deviation increase in conduct problems was associated with a 20% and a 17% increase in the odds of ever smoking for men and women, respectively. In the fully adjusted model, these effects were at 17% for both sexes. One standard deviation increase in emotional problems was significantly associated with a 13% and 8% decrease in the odds for ever smoking for men and women, respectively. After model adjustment, these protective effects increased moderately to 14% and 12%. The odds for giving up smoking were not significantly affected by childhood behavior for men and women in the fully adjusted model (Tables 3 and 4).

The age (in years) of starting to smoke was significantly related to hyperactivity in both sexes: more

**Table 5** Associations between childhood behavior problems and continuous adult outcomes in men (standardized regression weights and 95% confidence intervals)

	N	Hyperactivity		Conduct problems		Emotional problems	
		$\beta$	CI	$\beta$	CI	$\beta$	CI
General health	2555	<b>-.08</b> -.00 <sup>a</sup>	(-.07, -.02) (-.03, .03)	<b>-.06</b> -.05 <sup>a</sup>	(-.05, -.01) (-.05, .00)	.01 .02 <sup>a</sup>	(-.03, .05) (-.01, .06)
Well-being	2547	.04 <b>.07<sup>a</sup></b>	(-.00, .04) (.01, .06)	<b>-.09</b> <b>-.08<sup>a</sup></b>	(-.06, -.02) (-.06, -.02)	.02 .03 <sup>a</sup>	(-.01, .03) (-.01, .04)
Smoking start age	1340	<b>-.08</b> -.07 <sup>a</sup>	(-.52, -.06) (-.49, .00)	-.02 -.01 <sup>a</sup>	(-.27, .16) (-.24, .20)	.00 .00 <sup>a</sup>	(-.24, .24) (-.24, .24)
Smoking cessation age	701	.06 .04 <sup>a</sup>	(-.24, 1.33) (-.50, 1.16)	.08 .08 <sup>a</sup>	(-.12, 1.41) (-.11, 1.44)	-.04 -.04 <sup>a</sup>	(-1.26, .34) (-1.19, .44)
Four or more drinks	2427	<b>.07</b> .04 <sup>a</sup>	(.03, .16) (-.01, .13)	-.01 -.01 <sup>a</sup>	(-.07, .06) (-.09, .05)	<b>-.07</b> <b>-.08<sup>a</sup></b>	(-.17, -.05) (-.18, -.06)
Hangovers	2429	<b>.07</b> <b>.07<sup>a</sup></b>	(.03, .13) (.03, .13)	-.00 -.00 <sup>a</sup>	(-.05, .05) (-.05, .04)	<b>-.05</b> <b>-.05<sup>a</sup></b>	(-.10, -.01) (-.10, -.01)

<sup>a</sup>Adjusted for age, intelligence, social class of origin, and educational qualification.

Note: Higher scores on general health and well-being indicated better health and higher well-being; higher scores on frequency of drinking, four or more drinks and hangovers indicated a more frequent occurrence of these events. Significant coefficients are shown in bold.

**Table 6** Associations between childhood behavior problems and continuous adult outcomes in women (standardized regression weights and 95% confidence intervals)

	N	Hyperactivity		Conduct problems		Emotional problems	
		$\beta$	CI	$\beta$	CI	$\beta$	CI
General health	2,689	<b>-.05</b> .01 <sup>a</sup>	(-.07, -.01) (-.03, .04)	<b>-.06</b> -.05 <sup>a</sup>	(-.07, -.01) (-.06, .00)	-.03 -.01 <sup>a</sup>	(-.06, .01) (-.04, .00)
Well-being	2,677	-.02 -.00 <sup>a</sup>	(-.04, .01) (-.03, .03)	<b>-.09</b> <b>-.09<sup>a</sup></b>	(-.10, -.04) (-.10, -.04)	-.01 .00 <sup>a</sup>	(-.03, .02) (-.02, .02)
Smoking start age	1,328	<b>-.10</b> -.05 <sup>a</sup>	(-.76, -.19) (-.54, .06)	-.02 -.03 <sup>a</sup>	(-.46, .21) (-.47, .18)	<b>.11</b> <b>.11<sup>a</sup></b>	(.21, 2.23) (.10, 2.18)
Smoking cessation age	609	<b>.11</b> <b>.10<sup>a</sup></b>	(.16, 2.15) (.03, 2.05)	.01 -.01 <sup>a</sup>	(-1.02, 1.36) (-1.07, 1.23)	-.05 -.04 <sup>a</sup>	(-1.29, .37) (-1.19, .45)
Four or more drinks	2,509	<b>.06</b> .02 <sup>a</sup>	(.02, .17) (-.05, .12)	.01 .01 <sup>a</sup>	(-.08, .11) (-.08, .10)	<b>-.04</b> <b>-.06<sup>a</sup></b>	(-.12, -.01) (-.14, -.02)
Hangovers	2,506	.02 .02 <sup>a</sup>	(-.03, .07) (-.03, .07)	.02 .02 <sup>a</sup>	(-.04, .08) (-.03, .08)	-.01 -.01 <sup>a</sup>	(-.04, .03) (-.04, .02)

<sup>a</sup>Adjusted for age, intelligence, social class of origin, and educational qualification.

Note: Higher scores on general health and well-being indicated better health and higher well-being; higher scores on frequency of drink, four or more drinks and hangovers indicated a more frequent occurrence of these events. Significant coefficients are shown in bold.

hyperactive boys and girls started smoking at a significantly younger ages with coefficients of  $-.08$  and  $-.10$ , but these effects became non-significant after model adjustment. In men and with reference to non-smokers, a standard deviation increase in hyperactivity augmented the adjusted odds of being a moderate and standard smoker significantly by 17%; conduct problems were associated with a significant increase in odds of being a moderate to extreme smoker by 16% to 21%, whereas a unit decrease in emotional problems was associated with a significantly reduced risk of being a strong or extreme smoker (28% and 29%, respectively). Similar patterns were observed in women, whereby hyperactivity showed the most consistent effects (Tables 7 and 8).

In men, age of smoking cessation was not related to childhood behaviors; in women, higher hyperac-

tivity in childhood significantly predicted a later age of smoking cessation with a coefficient of  $.11$ , which was not affected by model adjustment.

**Alcohol consumption.** Childhood behaviors did not significantly contribute to the odds of currently consuming alcohol versus having fully stopped drinking. Also, there was no effect of childhood behavior disturbance for the frequency of alcohol consumption in women. In men, however, a standard deviation increase in hyperactivity contributed significantly to the odds of drinking every day or most days compared to only drinking on special occasions by 32% and 25%, respectively (Tables 7 and 8).

In men and with reference to light drinkers, a standard deviation increase in emotional problems was significantly associated with a 20% reduction in the odds of being a moderate drinker. However, this

**Table 7** Adjusted odds ratios (95% confidence intervals) per one standard deviation increase in childhood behavior problems in relation to adult weight, smoking and alcohol categories in men

Adult outcome	N	Hyperactivity	Conduct problems	Emotional problems
<b>Weight</b>				
Underweight	9	.67 (.25, 1.78)	1.41 (.78, 2.56)	1.04 (.52, 2.08)
Overweight	1,080	1.04 (.92, 1.18)	1.03 (.92, 1.17)	.95 (.86, 1.06)
Obese	380	.91 (.77, 1.07)	<b>1.16</b> ( <b>1.01, 1.33</b> )	.92 (.80, 1.06)
Severely obese	16	.64 (.30, 1.40)	1.30 (.76, 2.22)	.63 (.27, 1.48)
<i>Reference group: Normal weight (N = 832)</i>				
<b>Smoking</b>				
Light smoker	50	1.04 (.70, 1.57)	1.16 (.79, 1.69)	.62 (.37, 1.02)
Moderate smoker	<b>382</b>	<b>1.17</b> ( <b>1.01, 1.36</b> )	<b>1.16</b> ( <b>1.00, 1.34</b> )	.93 (.81, 1.05)
Standard smoker	<b>530</b>	<b>1.17</b> ( <b>1.03, 1.34</b> )	<b>1.15</b> ( <b>1.00, 1.31</b> )	.90 (.80, 1.02)
Strong smoker	246	1.15 (.96, 1.38)	<b>1.19</b> ( <b>1.01, 1.41</b> )	<b>.72</b> ( <b>.60, .88</b> )
Extreme smoker	145	1.20 (.98, 1.48)	<b>1.21</b> ( <b>1.01, 1.45</b> )	<b>.79</b> ( <b>.63, .98</b> )
<i>Reference group: Non-smokers (N = 1,197)</i>				
<b>Alcohol frequency</b>				
Every day	235	<b>1.32</b> ( <b>1.04, 1.69</b> )	.96 (.78, 1.19)	.99 (.82, 1.21)
Most days	681	<b>1.25</b> ( <b>1.02, 1.55</b> )	.85 (.70, 1.03)	.88 (.75, 1.04)
Weekends	964	1.21 (1.00, 1.48)	.94 (.80, 1.11)	.92 (.79, 1.07)
< once a week	350	1.23 (.98, 1.53)	.93 (.77, 1.12)	.94 (.78, 1.12)
<i>Reference group: Drinking on special occasions (N = 207)</i>				
<b>Alcohol amount</b>				
Moderate drinker	468	1.02 (.88, 1.18)	1.01 (.88, 1.16)	<b>.80</b> ( <b>.69, .92</b> )
Extreme drinker	747	1.07 (.95, 1.21)	.99 (.88, 1.11)	.94 (.85, 1.05)
<i>Reference group: Light drinkers (N = 1,126)</i>				

Note: All odd ratios were adjusted for age, intelligence, social class of origin, and educational qualification. Significant odds ratios are shown in bold.

**Table 8** Adjusted odds ratios (95% confidence intervals) per one standard deviation increase in childhood behavior problem in relation to adult weight, smoking and alcohol categories in women

Adulthood Outcome	N	Hyperactivity	Conduct problems	Emotional problems
<b>Weight</b>				
Underweight	29	.64 (.34, 1.22)	1.41 (.81, 2.45)	.90 (.58, 1.38)
Overweight	736	.93 (.81, 1.08)	1.19 (.99, 1.42)	.98 (.88, 1.08)
Obese	373	.90 (.75, 1.07)	<b>1.38</b> ( <b>1.14, 1.68</b> )	.97 (.85, 1.10)
Severely obese	46	1.22 (.85, 1.77)	.81 (.46, 1.42)	1.20 (.93, 1.54)
<i>Reference group: Normal weight (N = 1,215)</i>				
<b>Smoking</b>				
Light smoker	114	1.03 (.75, 1.40)	1.22 (.88, 1.69)	.93 (.76, 1.14)
Moderate smoker	555	<b>1.22</b> ( <b>1.05, 1.42</b> )	1.09 (.91, 1.31)	<b>.89</b> ( <b>.80, .99</b> )
Standard smoker	475	<b>1.32</b> ( <b>1.13, 1.54</b> )	<b>1.21</b> ( <b>1.01, 1.44</b> )	.89 (.80, 1.00)
Strong smoker	142	1.22 (.95, 1.57)	1.21 (.92, 1.59)	<b>.78</b> ( <b>.63, .96</b> )
Extreme smoker	45	<b>1.49</b> ( <b>1.06, 2.11</b> )	1.31 (.93, 1.85)	.88 (.65, 1.19)
<i>Reference group: Non-smokers (N = 1,372)</i>				
<b>Alcohol frequency</b>				
Every day	111	1.25 (.94, 1.66)	1.27 (.94, 1.72)	.88 (.69, 1.13)
Most days	454	.84 (.67, 1.05)	.98 (.75, 1.28)	1.00 (.88, 1.15)
Weekends	982	1.06 (.90, 1.13)	1.01 (.84, 1.21)	.92 (.83, 1.03)
< once a week	470	.98 (.81, 1.18)	1.11 (.90, 1.36)	1.05 (.92, 1.18)
<i>Reference group: Drinking at special occasions (N = 523)</i>				
<b>Alcohol amount</b>				
Moderate drinker	495	<b>1.21</b> ( <b>1.04, 1.41</b> )	.95 (.78, 1.16)	.91 (.81, 1.02)
Extreme drinker	445	.92 (.76, 1.10)	<b>1.27</b> ( <b>1.06, 1.52</b> )	.90 (.79, 1.02)
<i>Reference group: Light drinkers (N = 1,293)</i>				

Note: All odd ratios were adjusted for age, intelligence, social class of origin, and educational qualification. Significant odds ratios are shown in bold.

effect was not significant for male extreme drinkers in the fully adjusted model. In women, a standard deviation increase in hyperactivity increased the odds of being a moderate drinker by 21%, and an increase in conduct problems contributed significantly to the

odds of being an extreme drinker (27%) with reference to light drinkers (Tables 7 and 8).

In men, higher hyperactivity was associated with having more often four or more drinks on a single occasion with a coefficient of .07; however, this effect

became non-significant in the fully adjusted model. No significant effects were observed for women. Higher childhood emotional problems reduced the frequency of having more than four drinks on a single occasion in the past year significantly for men and women with coefficients of  $-.07$  and  $-.04$ ; these values increased modestly in the fully adjusted model.

Childhood behaviors did not significantly predict the frequency of hangovers at midlife in women. For men, higher levels of conduct problems predicted a greater frequency of hangovers with a coefficient of  $.07$ , whereas emotional problems had a reverse, negative effect on hangovers with a coefficient of  $-.05$ ; these results were stable in fully adjusted models.

## Discussion

The current study investigated the effects of childhood behavior problems on a wide range of health outcomes at midlife. Two externalizing (conduct problems and hyperactivity) and one internalizing (emotional problems) behavior dimensions were significantly associated with health outcomes, even after adjusting for potential confounders and mediators including cognitive ability, education and social class of origin.

In both men and women, conduct problems were associated with an increased risk of reporting suffering from a long-term disease, being of poor general health, having a low well-being score and a higher risk of obesity. Childhood hyperactivity was associated with smoking initiation at a younger age in both sexes; also, in women who smoked, higher hyperactivity was linked with a later age of smoking cessation and a higher consumption of cigarettes. In men, both hyperactivity and conduct problems were significantly associated with smoking more cigarettes; furthermore, higher childhood hyperactivity was associated with a higher frequency of alcohol consumption, while greater conduct problems were related to more frequent hangovers throughout the past year. In women, hyperactivity and conduct problems were associated with the amount of alcohol consumed, and they also differentiated moderate and extreme drinkers from light drinkers. Overall, these findings accord with previous research (Colman et al., 2009; Pitkänen, 1999; Pulkkinen & Pitkänen, 1994; Timmermans et al., 2008; Sourander et al., 2007), and confirm that externalizing behavior problems relate to poor health status and hazardous health behaviors in midlife, whereby associations somewhat differ for men and women (Pulkkinen, 2004).

Health risk factors and health problems tend to cluster in individuals (Ebrahim, Montaner, & Lawlor, 2004): having long-term disease and/or being overweight are likely to negatively affect one's general health and overall well-being, and also confer increased risk of diabetes and high blood pressure. It is well established that smoking and harmful drinking patterns have negative long-term conse-

quences for health and well-being and both are strong predictors of all-cause mortality (Doll, Peto, Boreham, & Sutherland, 2004; Norström, 2001; Poikolainen, 1995; Roberts, Der, Deary, & Batty, 2009). It is not possible to disentangle precisely the inter-relations of the health variables in this study because of their contemporaneous assessment; the current results suggest, however, that externalizing behavior problems predict (un)healthy habits that are likely to lead to poor health status over time.

One of the causal pathways, which may explain the poor health association with externalizing behavior problems, refers to educational and professional attainment (Caspi, 2000; Caspi et al., 1988; McLeod & Kaiser, 2004; von Stumm, Macintyre, Batty, Clark, & Deary, 2010). For example, in the National Survey of Health and Development (1946 birth cohort study), Colman and colleagues (2009) showed that externalizing behavior was associated with an increased risk of leaving school without any qualifications and of experiencing economic problems throughout a 40-year follow-up. Therefore, externalizing behavior problems facilitate social exclusion and result in a lack of material resources, which is associated with poorer health and health care provision (Marmot et al., 1991). That is, externalizing problems may affect health not directly but through their consequences on social and economic factors.

A second route suggests that externalizing behavior problems lead to an accumulation of physical insults, which harm the functionality and status of body and brain. Jokela et al. (2009) showed previously that externalizing behavior problems were associated with an increased risk of injury in adolescence and adulthood. As childhood behaviors exhibit continuity across the lifespan (Caspi, 2000), it seems plausible that life-course physical injuries manifest in long-term illnesses and poor health.

The current results emphasize a third perspective: childhood behavior problems result in harmful habits, such as smoking and drinking, which are hazardous to health and life expectancy (e.g., Doll et al., 2004; Roberts et al., 2009). In the present study, externalizing behavior problems, and particularly conduct problems, were shown to be conducive to adopting harmful lifestyles. Conversely, internalizing behaviors or emotional problems were associated with less hazardous drinking: more emotionally troubled boys and girls engaged less frequently in binge-drinking in adulthood, and in men, childhood emotional problems significantly reduced the rate of hangovers. Furthermore, greater childhood emotional problems decreased the risk of smoking in men and were associated with a later age of starting to smoke in women. These findings are consistent with the results of Jokela et al. (2009) and Lee et al. (2006), suggesting that higher internalizing behavior in childhood is protective of risk exposure in adolescence and adulthood. Overall, our study showed that externalizing behavior problems

promoted hazardous health behaviors, while internalizing behavior problems had protective effects. Therefore, it is likely that childhood behavior problems affect long-term health outcomes through their associations with health behaviors and habits.

This study has some notable strengths, including a large, representative cohort sample, teacher ratings of childhood behavior problems using a standardized instrument (excluding common informant bias), assessment of important of confounding and mediating variables to compute fully adjusted models, and a sufficiently long follow-up period. It is also not without its weaknesses. As all longitudinal studies, the current sample suffers from attrition, resulting in the omission of cases with missing data points (for details, see eTable 1). The sample has been previously shown to remain representative, although individuals from less privileged social backgrounds are underrepresented (Batty et al., 2004), which might result in a general underestimation of the true effect sizes. Another weakness of this study is the assessment method of health outcomes in midlife. All health information was self-reported, and the health diagnostics were recorded without reference to disease onset or duration, because of which their inter-relations cannot be precisely disentangled. However, studies comparing self-reported illnesses and medical records have shown self-reports to be generally reliable (e.g., Beckett, Weinstein, Goldman, & Lin, 2000).

In conclusion, childhood behavior problems were shown to be associated with a wide range of health behaviors and health outcomes in midlife. Although

these effects partially differed for the sexes, they were in line with two previously proposed causal pathways: externalizing problems facilitate social exclusion and bodily insults, both of which predict poor health and reduced life expectancy. The current study added mostly to the understanding of a third link: externalizing childhood behavior problems were significantly related to unhealthy behaviors, such as smoking and harmful drinking. Conversely, internalizing behavior problems were found to have health-protective consequences because they were associated with a decreased risk of smoking and binge-drinking.

## Supporting information

Additional Supporting Information may be found in the online version of this article:

**Online Appendix:** Analysis of sample attrition

**Supplementary eTable S1** Characteristics of participants with complete data and those with missing data on study covariates.

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### Key points

- Childhood behavior problems are associated with an increased risk of mortality but causal pathway as not very well understood.
- Here, externalizing and internalizing behavior problems at age 6–12 years were shown to predict lifestyle choices and negative health outcomes at age 46–51 years.
- Specifically, externalizing childhood behavior problems were related to harmful smoking and drinking; conversely, internalizing behavior problems were somewhat health-protective and associated with fewer unhealthy lifestyle choices.
- Childhood behavior problems affect life-trajectories through multiple pathways and have long-term consequences for health.

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