Childhood hyperactivity and mood problems at mid-life: evidence from a prospective birth cohort

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Acknowledgements

The authors express their gratitude to the National Child Development Study participants, to the UK data archive for providing access to the anonymised data, and to Olga Eyre for comments on a previous draft of the paper. A final version of the published article is available at DOI: 10.1007/s00127-016-1285-5

Abstract

Purpose: Childhood hyperactivity leads to mental health problems, but it is not known whether there are long-term risks for adult mood problems in unselected population cohorts that extend to mid-life. Aims were to examine links between childhood hyperactivity and mood problems up to age 50 years, and to consider confounding factors and gender differences in associations.

Methods: The National Child Development Study (NCDS) is a UK cohort of children born in 1958. Children with (N=453) and without (N=9192) pervasive and persistent hyperactivity were followed to age 50. Adult mood was assessed using the Malaise Inventory at ages 23, 33, 42 and 50 years, and the CIS-R interview at 45 years.

Results: Childhood hyperactivity predicted low mood at all adult assessments (ES = 0.27-0.45), including after covariate adjustment (childhood adversity, emotional and behavioural problems, attainment).

Conclusion: Hyperactivity has enduring risk effects on low mood throughout the life course that extend to middle age.

Key words: Hyperactivity; ADHD; Depression; Mood; Life course; Prospective

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is defined by age-inappropriate, persistent and maladaptive symptoms of hyperactivity, impulsivity and inattention, [1-4] and has an estimated prevalence of 1-5% [1, 5]. ADHD is often comorbid with other psychiatric problems and impacts upon children's academic, social and interpersonal functioning [1, 3, 6] Existing evidence suggests that ADHD behaves dimensionally with respect to childhood correlates, risk factors and developmental outcomes [1, 2]. Clinical follow-ups of children with ADHD and ADHD-like problems that fall below the diagnostic threshold show high continuing impairment, compromised educational and occupational attainment, substance misuse, and social dysfunction in adolescence and adulthood [1, 7-10]. To date, few studies, of clinic-referred males, have examined clinical and functional outcomes of ADHD into adulthood. Prospective, longitudinal studies have yielded inconsistent findings regarding ADHD as a risk factor for adult depression [7, 9, 11, 12]. For example, Biederman et al (2006) found an elevated risk for mood disorders in males with ADHD in early adulthood, whilst Klein et al (2012) found no increased risk for depression or anxiety at midlife. Both samples, were highly selected clinical samples of males. Evidence from unselected population cohorts followed into later adulthood is lacking.

Additional research thus is needed to estimate the scale of risk for affective problems beyond early adulthood among children with ADHD problems, the extent of risk in representative population samples, and whether ADHD problems or co-occurring childhood difficulties account for any later mental health risk. Testing whether ADHD problems are associated with adult mood difficulties both in men and in women is also important. ADHD has a male preponderance, but mood problems are more common in females [1, 13]. Evidence on outcomes is lacking as many previous studies have excluded females with ADHD. This is the

first study to evaluate risk for mood problems up to age 50, to do so in a representative population cohort, and to control for co-occurring childhood emotional, behavioural and cognitive difficulties. Using one of the earliest UK birth cohorts, the National Child Development Study (NCDS), this study aims to: (1) establish links between childhood ADHD difficulties (operationalised using repeated multi-informant measures of hyperactivity) and mood problems across adulthood; (2) test whether observed associations are influenced by confounding risk factors and (3) examine if risk effects of childhood hyperactivity on adult mood are evident for men and for women.

Methods

Sample

NCDS includes all children in England, Scotland and Wales born 3-9 March, 1958 [14]. Following the initial birth survey of over 18,500 babies, representing 98% of live births, there have been nine sweeps of cohort members at ages 7, 11, 16, 23, 33, 42, 46, 50 and 55 to monitor physical, educational and social development, and a biomedical survey at age 45. All surviving and UK resident cohort members were eligible for participation at each sweep. Of the 9645 with relevant childhood data at ages 7 and 11, adult outcome data were available from 7582 (78.6%), 6889(71.4%), 6894 (71.5%) and 5941(61.6%) cohort members at ages 23, 33, 42 and 50 respectively (see supplementary table 1). All datasets used in this study are publicly available and were downloaded from the UK data archive (usage number 86906) so additional ethics approval was not required.

Measures

Childhood hyperactivity

Rutter behaviour questionnaires (completed by parents and teachers) are widely used and well-validated screening tools for childhood emotional, behavioural and hyperactivity problems [15]. Abbreviated parent (Rutter A) and teacher (Rutter B) questionnaires included

two items each indexing hyperactivity ("difficulty settling" and "squirmy or fidgety behaviour"; each rated 0 'not true', 1 'somewhat true', 2 'certainly true', scale range 0-4). A group of children with persistent and pervasive problems was identified according to high parent and teacher scores at ages 7 and 11 (top quintile, 2+ on all measures).

Adult mood

Two measures were used to index mood problems in adulthood. The Malaise Inventory was completed by cohort members at each adult assessment [15]. The Malaise shows good validity with respect to interview-assessed major depressive disorder [16]. To rule out age-dependent variation in somatic complaints, the present study used the 15-item psychological subscale at ages 23, 33 and 42 with items (e.g. 'do you often feel miserable or depressed?'; 'are you easily upset or irritated?') coded 0 'no' or 1 'yes' [16]. In addition to standardised total scores (alphas = 0.75-0.87), a threshold of 5+ was used to indicate low mood [16]. With depressive disorder as the criterion, this cut point has sensitivity and specificity of 0.90 and 0.65 respectively [16]. At age 50, the survey used a shortened 8-item version (alpha = 0.78) [17], with an adjusted threshold of 3+ to indicate low mood. Depression was also assessed by trained research nurses using the CIS-R face-to-face diagnostic interview at age 45 [18]. Four questions assessed low mood and anhedonia during the previous week. Individuals with two or more core symptoms were identified [19].

Childhood covariates

Demographic information was collected at birth: male gender; low birthweight (<2500 gr); maternal smoking during pregnancy; single parent; young maternal age (<20 years at birth of study child); no maternal education past minimum school leaving age (15/16 years). Information about childhood emotional and behavioural problems and educational attainment at age 7 years was assessed using the Rutter A questionnaire and standardized school-based reading and mathematics tests [20]. Scale scores were standardized for the purposes of these

analyses. This information was used for the purposes of modelling non-response and as covariates in primary analyses.

Analysis

Preliminary analyses examined patterns of selective attrition at each adult follow-up, estimated sweep-specific attrition weights using predicted probabilities derived from logistic regression analyses of childhood predictors of adult response [20], and considered associations between childhood hyperactivity and covariates.

Main analyses were stratified by gender and examined links between childhood hyperactivity and adult mood outcomes using linear or logistic regression as appropriate. Unadjusted models and models adjusted for childhood covariates were compared to examine the role of potential confounders.

Results

Prevalence of childhood hyperactivity and covariates

Of the 9645 cohort members with complete childhood data, 453 (4.7%) met operational criteria for childhood hyperactivity - 322 boys (6.5%) and 131 girls (2.8%). As shown in Table 1, children with hyperactivity had lower birth weights, increased behavioural and emotional problem scores, and lower reading and maths test scores when compared with children without hyperactivity.

Multivariate logistic regression models showed that retention to mid-life was more common for females, children of married parents, children of mothers who stayed at school beyond the minimum school-leaving age, and for children with higher age 7 reading and maths test scores (all $p<0.05$). Missing data weights (calculated separately for each adult sweep) were effective in correcting observed patterns of selective non-response (supplementary Table 2).

Childhood hyperactivity and adult mood problems

As shown in Table 2, males with childhood hyperactivity had higher mean Malaise scores than comparison cohort members (*d'* = 0.27-0.34), and an increased likelihood of high symptom scores (Malaise 5+, OR = 1.5-2.0) at all adult assessments (ages 23-50). Females with childhood hyperactivity had higher mean Malaise scores (*d'* = 0.33-0.55), and an increased likelihood of high symptom scores (Malaise 5+, OR =1.9-2.2) at ages 23, 33, and 42 but not at age 50. Interactions by gender were tested for continuous Malaise score outcomes. Significant interactions were not observed at any age (23 years: beta = -.13 [-.36, .09], 33 years: beta = -.16 [-.40, .08], age 42: beta = -.03 [-.27, .21], 50 years: .20 [-.06, .45]). Analyses of the CIS-R at age 45 also showed an increased risk of past-week episodes of depression for women with childhood hyperactivity (18.4% vs 9.0%, OR = 2.29 [1.26-4.14], p=.006), and for men with childhood hyperactivity although here, the difference did not achieve statistical significance (10.6% vs 6.8%, OR = 1.63 [0.97-2.76], p=.068). Sensitivity analyses examined associations with childhood hyperactivity and incident mood problems at each adult sweep. Incident mood problems were defined as an above threshold Malaise score amongst those with below threshold scores on all previous occasions. Findings showed increased risk for incident mood problems for males at age 50 and for females at ages 33 and 42 years (supplementary Table 3).

Adjustment for childhood covariates

A series of multivariate models tested whether the link between hyperactivity and adult mood problems was accounted for by hypothesised childhood confounders (Table 3, unadjusted model 1 and adjusted models 2a-e). Associations were not affected by controls for social adversity or emotional problems, and were somewhat attenuated when adjusting for co-

occurring childhood behaviour problems and attainment test scores. Associations between childhood hyperactivity and adult mood remained significant at all ages for men and at ages 33 and 42 for women in fully adjusted models controlling for childhood adversity, emotional problems, behavioural problems and attainment.

Discussion

Evidence from this prospective longitudinal population-based cohort study extends our understanding of the link between childhood ADHD problems and later mood problems in important ways. First, the study demonstrates a population-level risk for adult mood problems associated with childhood hyperactivity. Second, the study advances our knowledge by tracking cohort members' mental health beyond early adulthood to middle age. It shows that childhood hyperactivity is an important risk factor for adult mood problems throughout the life course. Third, the study was able to show that risk for adult low mood was not accounted for by co-occurring childhood psychopathology, attainment difficulties or social adversity. Finally, an additional important finding is that childhood hyperactivity, though less common in females, appears strongly associated with risk for adult depression both in women and in men.

Prior research demonstrates that children with ADHD are at increased risk for antisocial behaviour and substance use disorders in early adulthood, and they also experience broader psychosocial impairments [1, 7-12]. However, evidence has been inconsistent with respect to risk for depression in adult follow-ups of children with ADHD. This may reflect the mostly small or selected clinical samples that have been followed prospectively. The present study of a whole birth cohort demonstrates that hyperactivity does predict life course persistent risks for adult low mood, including probable depressive episodes at mid-life.

In this cohort, children with pervasive and persistent hyperactivity experienced more emotional and behavioural problems in childhood, and they already experienced poorer school attainment at age 7 (reading and maths test scores were a third to a half of a standard deviation lower). This fits well with findings on clinically defined samples with ADHD, where comorbid psychopathology and cognitive deficits are common [1]. Given that child emotional, behavioural and cognitive deficits are all well-established risks for adult depression [20-23] it is surprising that few prior studies have adjusted for this in testing links with adult mood. The current study thus provides an important extension of past research by showing that risk for adult low mood in children with hyperactivity is largely independent of these other correlated risk factors.

Many follow-ups of clinical ADHD samples to date have only included boys. The finding that hyperactivity predicts adult depression as strongly in females is important, given the relatively high rate of adult depression in women [24].

The findings were broadly consistent across multiple measures and measurement occasions. The main exception was there was no association between hyperactivity and low mood in women at age 50. This may reflect a real developmental change in the life-course risk for depression in women [25]. Alternatively, this finding may simply reflect methodological differences in sample size, attrition or measurement at this assessment in this cohort. Further follow-up of NCDS and replication in other cohorts once they reach later adulthood will be important in clarifying the extent to which childhood hyperactivity predicts depression across the life course in men and women.

Strengths and limitations

The study is the longest prospective follow-up to date to address the link between childhood hyperactivity and adult mood problems. By using a representative birth cohort, the study avoids some of the problems involved in follow-ups of clinic samples where findings might

be affected by referral biases and study-specific selection criteria (e.g. exclusion of children with comorbid childhood disorders). The use of multiple informants - parent and teacher reports in childhood and cohort member reports in adulthood - is a further strength. Finally, as noted, the study was able to examine risk effects in males and in females, and considered a range of likely confounders.

There are also limitations. First, the study was constrained by the childhood measures included in NCDS in the 1960s. It was not possible to consider clinical diagnoses. However, both ADHD and depression behave dimensionally in terms of their associations with risk factors and adverse outcomes and there is also evidence that subthreshold cases are at risk for adverse outcomes [1, 2]. Similarly, some caution is needed with respect to measures of adult mood problems. The Malaise Inventory is a broad symptom screen that assesses symptoms of psychological distress, though there is evidence of validity with respect to diagnostic measures of depression [16], and findings were broadly replicated using the CIS-R interview administered at midlife. Also, measures of adult ADHD/hyperactivity were not available so it is not known how far risk for low mood is contingent on continuing hyperactivity in mid-adult life.

Second, as with nearly all longitudinal studies, there was evidence for selective attrition. Analyses included attrition weights to account for measured childhood predictors of non-response, but individuals with more severe impairment (e.g. those with very severe childhood ADHD problems or adult affective disorders) may be under-represented. Results may therefore present conservative estimates of prevalence and risk.

Third, as expected, the female subsample with hyperactivity was relatively small, raising the possibility of type II errors.

Fourth, it is important to see the findings in their historical context. It is not certain that life course risk effects will remain the same for the current generation of children with

hyperactivity. Whilst it would be hoped that better recognition, educational supports and health care (including pharmacological treatment [26]) would ameliorate long term risk effects associated with ADHD problems, evidence from cross-cohort comparisons suggests that the reverse may also be true [27].

Finally, further research is needed to identify mechanisms that explain adverse outcomes in this high risk group. Shared genetic liability for childhood hyperactivity and adult mood problems [28], accumulating life stress and social disadvantage, and the impact of health risk behaviours [29] may all be important contributors. For example, children with ADHD-like problems are more likely to engage in antisocial behaviour and health-related risks (such as smoking, drinking and drug use) in adolescence, and these in turn may act as risk factors for adult mood problems [1]. In addition to testing mediating mechanisms, it will also be important to consider protective factors that act as risk buffers for children with hyperactivity, in the context of current healthcare and support services.

Implications

Given the burden of adult depression, the identification of high-risk groups for mood problems opens a window for early prevention and intervention. This study makes clear that hyperactivity even in the absence of a clinical diagnosis of ADHD is an important risk factor for mood problems in adulthood. Recent reviews highlight that care provision for children with disorders such as ADHD is far from optimal, that the lifelong psychosocial and mental health consequences remain under-recognised by practitioners, and that the transition from child to adult services needs to be improved for those who do receive clinical recognition in childhood [30]. The present study extends this by demonstrating that such concerns are more broadly relevant at the population level. This raises important questions about the role of parents, teachers and primary care workers in identifying and ameliorating risk for mood problems associated with childhood hyperactivity. The next steps are to better understand the

mechanisms by which hyperactivity confers risk for mood difficulties, and whether existing early prevention programs for depression can help improve outcomes in those at high risk by virtue of childhood hyperactivity.

Ethical standards

The manuscript does not contain clinical studies or patient data.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Table 1. Childhood correlates of hyperactivity

	Male			Female		
	Hyperactive (n=322)	Control (n=4622)	OR (95% CI)/ B (95% CI)	Hyperactive (n=131)	Control (n=4570)	OR (95% CI)/ B (95% CI)
Low birth-weight (<2500g), n (%)	20 (6.2%)	161 (3.5%)	1.835 (1.136, 2.963)*	17 (13.0%)	226 (4.9%)	2.866 (1.692, 4.854)***
Maternal smoking in pregnancy, n (%)	115 (35.7%)	1472 (31.8%)	1.189 (0.939, 1.506)	56 (42.7%)	1459 (31.9%)	1.592 (1.120, 2.263)**
Single parent at birth, n (%)	11 (3.4%)	132 (2.9%)	1.203 (0.644, 2.249)	11 (8.4%)	141 (3.1%)	2.879 (1.519, 5.460)***
Young maternal age at birth (<20 yrs), n (%)	15 (4.7%)	223 (4.8%)	0.964 (0.564, 1.646)	15 (11.5%)	229 (5.0%)	2.451 (1.409, 4.265)**
No maternal further education, n (%)	25.3 (78.6%)	3483 (75.4%)	1.199 (0.911, 1.578)	106 (80.9%)	3390 (74.2%)	1.476 (0.950, 2.293)
Public housing tenure (7 years), n (%)	135 (41.9%)	2011 (43.5%)	0.937 (0.746, 1.178)	62 (47.3%)	1964 (43.0%)	1.192 (0.842, 1.688)
Emotional problems (7 years), mean (SD)[b]	0.12 (1.02)	-0.04 (0.99)	0.16 (0.04, 0.27)**	0.32 (1.19)	0.03 (0.99)	0.284 (0.11, 0.46)***
Emotional problems (11 years), mean (SD)[b]	0.21 (1.12)	-0.05 (0.99)	0.26 (0.14, 0.38)***	0.45 (1.14)	0.02 (1.00)	0.44 (0.26, 0.61)***
Behavioural problems (7 years), mean (SD)[b]	0.81 (1.12)	0.10 (0.97)	0.71 (0.60, 0.82)***	0.57 (1.21)	-0.20 (0.93)	0.77 (0.61, 0.94)***
Behavioural problems (11 years), mean (SD)[b]	0.81 (1.08)	0.11 (0.98)	0.70 (0.59, 0.82)***	0.70 (1.06)	-0.22 (0.92)	0.93 (0.76, 1.09)***
Reading score (7 years), mean (SD)[b]	-0.57 (1.11)	-0.03 (0.99)	-0.54 (-0.652,-0.427)***	-0.32 (1.09)	0.21 (0.87)	-0.53 (0.68, 0.38)***
Maths score (7 years), mean (SD)[b]	-0.24 (0.98)	0.10 (0.98)	-0.34 (-0.45, -0.23)***	-0.30 (0.97)	-0.00 (0.97)	-0.29 (-0.46, -0.12)***

[a] Data are given as number (percentage) of study participants with hyperactivity data and predictors of non-response at birth and age 7 unless otherwise indicated.

[h] Symptom and attainment scores standardised (population mean = 0; sd = 1); * p ≤.05, ** p ≤.01, *** p ≤.001

Table 2. Adult mood problems for males and females with childhood hyperactivity. Standardised mean and above threshold Malaise scores.

		23 years			**33 years**			**42 years**			**50 years**	
Males	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR
	n=250	n=3637	(95% CI)	n=209	n=3320	(95% CI)	n=225	n=3294	(95% CI)	n=193	n=2810	(95% CI)
z score	-0.01	-0.27	0.27	0.16	-0.18	0.34	0.13	-0.17	0.30	0.14	-0.15	0.29
mean (sd)	(1.04)	(0.78)	(0.16, 0.37)***	(1.15)	(0.85)	(0.22, 0.46)***	(1.16)	(0.90)	(0.17, 0.42)***	(1.05)	(0.91)	(0.15, 0.42)***
High score,	29	230	1.95	23	203	1.88	46	496	1.45	53	463	1.92
n (%)	(11.6%)	(6.3%)	(1.30, 2.94)***	(11.0%)	(6.1%)	(1.19, 2.97)**	(20.4%)	(15.1%)	(1.04, 2.04)*	(27.5%)	(16.5%)	(1.38, 2.67)***
Females	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR	Hyp	Control	Beta/OR
	n=106	n=3591	(95% CI)	n=101	n=3262	(95% CI)	n=94	n=3281	(95% CI)	n=93	n=2861	(95% CI)
z-score,	0.59	0.19	0.40	0.60	0.11	0.450	0.43	0.10	0.33	0.25	0.16	0.09
mean (sd)	(1.32)	(1.06)	(0.19, 0.60)***	(1.52)	(1.06)	(0.28, 0.71)***	(1.26)	(1.02)	(0.12, 0.54)**	(1.10)	(1.08)	(-.14, 0.31)
High score,	33	618	2.20	22	407	2.01	35	734	2.04	27	753	1.14
n (%)	(31.1%)	(17.2%)	(1.45, 3.34)***	(21.8%)	(12.5%)	(1.24, 3.25)**	(37.2%)	(22.4%)	(1.33, 3.13)***	(29.0%)	(26.3%)	(0.72, 1.79)

Analyses weighted according to sweep-specific attrition weights. *p ≤.05, **p ≤.01, ***p ≤.001

Table 3. Childhood hyperactivity and adult mood problems (standardized mean differences on Malaise score). Comparison of unadjusted and adjusted models[b]

	23 years	**33 years**	**42 years**	**50 years**
	Beta (95% CI)	Beta (95% CI)	Beta (95% CI)	Beta (95% CI)
Males				
Model 1: Unadjusted	0.27 (0.16, 0.37)***	0.34 (0.22, 0.46)***	0.30 (0.17, 0.42)***	0.29 (0.15, 0.42)***
Model 2a (adjusted for family background)	0.27 (0.16, 0.37)***	0.34 (0.21, 0.46)***	0.29 (0.17, 0.42)***	0.29 (0.15, 0.42)***
Model 2b (adjusted for child emotional)	0.26 (0.16, 0.36)***	0.34 (0.21, 0.46)***	0.29 (0.17, 0.42)***	0.28 (0.15, 0.42)***
Model 2c (adjusted for child behaviour)	0.20 (0.10, 0.31)***	0.30 (0.18, 0.42)***	0.25 (0.12, 0.37)***	0.24 (0.11, 0.38)***
Model 2d (adjusted for child attainment)	0.19 (0.09, 0.29)***	0.29 (0.17, 0.41)***	0.26 (0.13, 0.38)***	0.24 (0.10, 0.37)***
Model 2e (all childhood covariates)	0.15 (0.05, 0.25)**	0.27 (0.15, 0.39)***	0.22 (0.10, 0.35)***	0.20 (0.07, 0.34)**
Model 3 (all childhood + Malaise 23)				
Females				
Model 1: Unadjusted	0.40 (0.19, 0.60)***	0.50 (0.28, 0.71)***	0.33 (0.12, 0.54)**	0.09 (-0.14, 0.31)
Model 2a (adjusted for family background)	0.35 (0.15, 0.56)***	0.46 (0.24, 0.67)***	0.30 (0.09, 0.51)**	0.08 (-0.14, 0.31)
Model 2b (adjusted for child emotional)	0.37 (0.17, 0.58)***	0.48 (0.27, 0.70)***	0.31 (0.10, 0.52)**	0.06 (-0.16, 0.29)
Model 2c (adjusted for child behaviour)	0.25 (0.04, 0.46)*	0.38 (0.17, 0.60)***	0.27 (0.06, 0.48)*	0.01 (-0.21, 0.24)
Model 2d (adjusted for child attainment)	0.30 (0.10, 0.50)**	0.39 (0.18, 0.61)***	0.28 (0.07, 0.49)**	0.04 (-0.19, 0.26)
Model 2e (all childhood covariates)	0.17 (-0.03, 0.38)	0.30 (0.08, 0.51)**	0.23 (0.02, 0.45)*	-0.012 (-0.24, 0.22)

Analyses weighted according to sweep-specific attrition weights. *p ≤.05, **p ≤.01, ***p ≤.001

Supplementary Table 1. Cohort response rate at each adult follow-up for those with childhood data

	Childhood[a]	23 years[b]	33 years[b]	42 years[b]	50 years[b]	Any adult[c]
Total	9645	7582 (78.6%)	6889 (71.4%)	6894 (71.5%)	5941 (61.6%)	8765 (90.9%)
Hyperactivity	453	333 (73.5%)	281 (62.0%)	295 (65.1%)	253 (55.8%)	402 (88.7%)
Control	9192	7249 (78.9%)	6608 (71.9%)	6599 (71.8%)	5688 (61.9%)	8363 (91.0%)

[a] Cohort members with complete childhood data (hyperactivity at ages 7 and 11 and childhood covariates).

[b] Cohort members with childhood data and Malaise response at ages 23, 33, 42, or 50 years respectively.

[c] Cohort members with childhood data and Malaise response in one or more adult sweeps.

Supplementary Table 2. Efficacy of weights in correcting for selective attrition by mid-life

	Childhood data	**42 years**		**50 years**	
	n=9645[a]	n= 6894[b]		n=5941[c]	
		Un-weighted	Weighted	Un-weighted	Weighted
Male	4944 (51.3%)	3385 (49.1%)	3520 (51.1%)	2920 (49.1%)	3002 (50.4%)
Low birth-weight (<2500g)	295 (3.1%)	295 (4.3%)	300 (4.4%)	255 (4.3%)	255 (4.3%)
Maternal smoking during pregnancy	3102 (32.2%)	2192 (31.8%)	2216 (32.1%)	1841 (31.0%)	1932 (32.4%)
Single parent at birth	295 (3.1%)	190 (2.8%)	216 (3.1%)	157 (2.6%)	184 (3.1%)
Young maternal age at birth (<20 years)	482 (5.0%)	336 (4.9%)	354 (5.1%)	274 (4.6%)	307 (5.2%)
No maternal education beyond minimum leaving age	7232 (75.0%)	5079 (73.7%)	5167 (74.9%)	4341 (73.1%)	4483 (75.3%)
Public housing	4172 (43.3%)	2925 (42.4%)	2990 (43.4%)	2469 (41.6%)	2614 (43.9%)
Emotional problems at 7 years (mean, sd)	1.39 (1.30)	1.40 (1.30)	1.39 (1.29)	1.40 (1.30)	1.39 (1.30)
Behavioural problems at 7 years (mean, sd)	2.30 (1.73)	2.25 (1.69)	2.29 (1.71)	2.22 (1.68)	2.30 (1.72)
Reading at 7 years (mean, sd)	23.77 (6.83)	24.26 (6.48)	23.75 (6.79)	24.48 (6.32)	23.67 (6.83)
Maths at 7 yeas (mean, sd)	5.19 (2.44)	5.31 (2.41)	5.19 (2.42)	5.38 (2.40)	5.15 (2.42)

[a] Cohort members with complete childhood data (hyperactivity at ages 7 and 11 and childhood covariates).

[b] Cohort members with childhood data and Malaise response at age 23, 33, 42, or 50 years respectively.

[c] Cohort members with childhood data and Malaise response in one or more adult sweeps.

Supplementary Table 3. Sensitivity analyses for new incidence of adult mood problems for males and females with childhood hyperactivity.

		33 years			**42 years**			**50 years**	
	Hyp	Control	OR	Hyp	Control	OR	Hyp	Control	OR
Males	n=190	n=3164	(95% CI)	n=196	n=3032	(95% CI)	n=148	n=2309	(95% CI)
High score	14	150	1.56	26	355	1.15	26	225	2.00
n (%)	7.4%	4.7%	(0.88,2.78)	13.3%	11.7%	(0.75,1.76)	17.6%	9.7%	(1.28, 3.12)**
Excluded[a]	31	236		43	386		73	751	
	Hyp	Control	OR	Hyp	Control	OR	Hyp	Control	OR
Females	n=76	n=2784	(95% CI)	n=62	n=2606	(95% CI)	n=51	n=1974	(95% CI)
High score	13	228	2.40	15	388	1.86	8	305	1.03
n (%)	17.1%	8.2%	(1.31,4.39)**	24.2%	14.9%	(1.04,3.34)*	15.7%	15.5%	(0.48,2.21)
Excluded[a]	35	619		47	847		69	1286	

Analyses weighted according to sweep-specific attrition weights. *p ≤.05, **p ≤.01, ***p ≤.001

[a] At each age, individuals who had had an above threshold Malaise score at any prior sweep (23, 33, or 42 years) were excluded.