

Do mental health problems in childhood predict chronic physical conditions among males in early adulthood? Evidence from a community-based prospective study

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Background. Previous studies have documented associations between mental and physical health problems in cross-sectional studies, yet little is known about these relationships over time or the specificity of these associations. The aim of the current study was to examine the relationship between mental health problems in childhood at age 8 years and physical disorders in adulthood at ages 18–23 years.

Method. Multiple logistic regression analyses were used to examine the relationship between childhood mental health problems, reported by child, parent and teacher, and physical disorders diagnosed by a physician in early adulthood.

Results. Significant linkages emerged between childhood mental health problems and obesity, atopic eczema, epilepsy and asthma in early adulthood. Specifically, conduct problems in childhood were associated with a significantly increased likelihood of obesity and atopic eczema; emotional problems were associated with an increased likelihood of epilepsy and asthma; and depression symptoms at age 8 were associated with an increased risk of asthma in early adulthood.

Conclusions. Our findings provide the first evidence of an association between mental health problems during childhood and increased risk of specific physical health problems, mainly asthma and obesity, during early adulthood, in a representative sample of males over time. These data suggest that behavioral and emotional problems in childhood may signal vulnerability to chronic physical health problems during early adulthood.

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Introduction

With the start of the twenty-first century, several chronic physical conditions have emerged as leading public health problems among young persons. Unlike infectious diseases, the rapid increase in chronic physical conditions (e.g. type II diabetes, asthma)

among younger age groups over the past several decades is considered preventable in part. Therefore, the need for the identification of modifiable risk factors for these chronic problems is urgent. Research on each chronic physical condition has yielded important information on the etiology and risk factors within each discipline. However, it has become increasingly evident that the degree to which a single methodological and theoretical focus can result in a comprehensive understanding of the causal processes involved in population-wide trends in chronic physical conditions

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is inherently limited because of the heterogeneous nature of proximal and distal risk factors in disease onset. It has therefore become clear that an interdisciplinary approach is needed to advance our understanding of the etiology and modifiable risk factors at a population level.

Evidence to date consistently suggests a link between chronic physical conditions and mental health problems (Merikangas *et al.* 1990, 1993; Roy-Byrne *et al.* 1999; Lecrubier, 2001; Pincus & Petit, 2001; Goodwin *et al.* 2003, 2005, 2006; Demet *et al.* 2005; Gupta *et al.* 2005; Simon & Fischmann, 2005; Aina & Susman, 2006; Avendano *et al.* 2006; Koenig *et al.* 2006; Konijnenberg *et al.* 2006; Levy *et al.* 2006; Solano *et al.* 2006; Wiefferink *et al.* 2006). Specifically, community-based cross-sectional studies among youth and adults suggest linkages between physical health problems and mental disorders, especially depression (Lecrubier, 2001; Pincus & Petit, 2001; Simon & Fischmann, 2005). Clinical data (Roy-Byrne *et al.* 1999; Aina & Susman, 2006) suggest higher than expected rates of mental disorders among patients in both primary care and pediatric clinic settings (Goodwin *et al.* 2005; Konijnenberg *et al.* 2006; Wiefferink *et al.* 2006), as well as among specialty practices, including cardiology, neurology, dermatology, allergy and endocrinology (e.g. diabetes) (Gupta *et al.* 2005; Avendano *et al.* 2006; Levy *et al.* 2006). However, despite mounting evidence of a link, several questions remain unanswered. First, the nature of the relationship between mental health problems in childhood and the likelihood of chronic physical conditions into adulthood has not been comprehensively examined. Second, although studies have examined links between specific chronic physical conditions and mental health problems, previous studies have not examined whether or to what degree there is specificity in these links. Third, the majority of previous studies examining linkages between physical and mental health problems in community-based samples have relied on self-report of physical disorders, and are vulnerable to report bias. In addition, the majority of studies that have documented associations between mental health problems during childhood and physical health have relied on parental report of behavior but have not been able to incorporate other sources of information, such as teacher reports or self-report from youth. With the growing incidence and prevalence of earlier onset of numerous chronic physical conditions (e.g. asthma, obesity), understanding the links between behavioral problems and onset of chronic physical disease early in life becomes increasingly important in efforts to better understand the etiology of these disorders, potentially develop new prevention and intervention strategies, and curtail these seemingly preventable

epidemics. Understanding these links has potential implications for both clinical and community-wide prevention of common chronic physical conditions.

The current study aimed to begin to fill these gaps by examining the association between mental health problems during childhood and the risk of a wide range of chronic physical conditions in early adulthood using physician-diagnosed physical health problems in adulthood, and parent, teacher and child self-report of mental health problems in childhood. Based on previous findings, we hypothesized that mental health problems in childhood would be associated with higher levels of chronic physical conditions in early adulthood, compared with those without mental health problems in childhood.

Method

This investigation is part of the nationwide 'From Boy to Man' study, a 15-year follow-up study included in the Epidemiological Multicenter Child Psychiatric Study in Finland (Almqvist *et al.* 1999; Sourander *et al.* 2004). The Joint Commission on Ethics of Turku University and Turku University Central Hospital approved the research plan. Informed consent was obtained from the children's parents at baseline, and from the adolescents themselves at follow-up. Permission for the use of the military register data was obtained from the Finnish Defense Forces. The combination of information from questionnaires and register data was analyzed in such a way that the subject could not be identified.

First Assessment: childhood

The original study sample was drawn from the total population of Finnish children born during 1981 ($n=60\,007$). The first assessment was conducted in October and November 1989. The original sample consisted of 6017 children, which was 10% of the basic population. Of the selected 6017 children, 5813 (96.6%) took part in the study in 1989. Of the 5813 children, 2946 were boys. A sample of the age cohort was drawn by selecting a representative sample of communities (Almqvist *et al.* 1999; Sourander *et al.* 2004). Information at baseline and at follow-up was obtained from 2712 boys.

Mental health problems in childhood

Child behavior was assessed using information collected from three different sources: parents, teachers, and children at age 8. Parent- and teacher-evaluated psychopathology was assessed with the Rutter questionnaire, which is a validated child psychiatric

instrument and used widely in child psychiatric research (Rutter, 1967, 1970). The parents were asked to fill in the parent version of the Rutter Scale (Rutter, 1970), which consists of 31 items rated on a scale of 0–2. The teachers were asked to fill in the teacher version of the scale (Rutter, 1967), developed to evaluate behavior occurring at school (26 items rated on a scale of 0–2). The parent and teacher questionnaires include three subscales, those of conduct, hyperkinetic and emotional symptom domains. The conduct scale inquires about behaviors such as disobedience, defiance, fits of temper, aggression or cruelty towards others, destruction of property, stealing and lying. The hyperactivity scale includes questions related to inattentive behavior, short attention span, distractibility, restlessness and hyperactivity. The emotional scale asks about shyness, anxiety and withdrawal behaviors. At age 8, children completed the Children's Depression Inventory (CDI) by self-report, which assesses depression symptoms in children (Kovacs, 1992). The questionnaire consists of 27 items rated on a scale of 0–2, with a total score ranging from 0 to 54 points. The question concerning suicide was excluded for ethical reasons. Thus, the Finnish version of the CDI consisted of 26 questions. Children completed the CDI in the classroom.

Parent and teacher information from the Rutter Scale were combined to generate conduct, hyperkinetic and emotional scales, whereas the depressive scale was based on child self-report alone. To generate easily interpretable measures of psychopathology, the results of the four mental health scales were categorized into below the 50th percentile (absence of mental health problem), between the 50th and 90th percentile (moderate problems) and above the 90th percentile (severe problems). As previous studies have found that even moderate levels of conduct problems and hyperkinetic symptoms in childhood are associated with subsequent adverse outcomes, we chose to examine both moderate and severe problems in childhood in relation to physical health conditions in adulthood (Fergusson *et al.* 2005). The cut-off points were based on the distribution of scores in the present sample.

Other childhood variables at age 8

Additional data were collected on: (1) parental education level: father's or mother's completion of at least 12 years of education (in Finland compulsory education consists of 9-year comprehensive school, after which education can be continued in vocational school or in upper secondary school concentrating on theoretical subjects); (2) family structure: families were classified as an intact two biological-parent family or

as non-intact family structure; (3) child's somatic health problems at age 8 using the question 'Is the child physically healthy?' (1=yes, 2=no) based on parental report; and (4) child's asthma symptoms at age 8 based on parent report (0=no asthma symptoms, 1=asthma symptoms less frequently than once a week, 2=asthma symptoms at least once a week; alternatives 1 and 2 were pooled).

Follow-up assessment: early adulthood

Information about ICD-10 physical disorders in early adulthood was obtained from the Finnish national military register. The Finnish national military call-up register contains information about every male Finnish citizen. The register information is updated weekly, and comes from, among others, the National Population Register Center, the Driving Licence Register, Statistics Finland, the National Research and Development Center for Welfare and Health (STAKES), and the Finnish Defense Forces own registers.

Finnish men born in 1981 received their military call-up in 1999, providing the opportunity to reach nearly all boys in the age group. Military service lasting from 6 to 12 months is compulsory for Finnish males, and they have a medical examination during the spring of the year they turn 18 years of age. The purpose of the examination is to obtain a preliminary assessment of their fitness class for military service. The cumulative information on physical disorders in the present study was based on the military register information including all ICD-10 diagnoses from the call-up health examination in autumn 1999, and the military register information at two time-points, in October 2002 and March 2004. The military call-up examination is based on all health documents available and a physical examination by a physician. If the participant has some changes in his health condition during the service, all those medical diagnoses are included in the military registry. In addition, if the participant did not start his military service for some health reason, the changes in health condition (based on medical examination) are recorded in the military registry. Short-lived and/or minor diagnoses, such as acute infections, are not made because they do not usually affect military fitness except for a short period. The more severe and chronic ICD-10 diagnoses are usually based on consultation with the specialized medical services, whereas a less severe diagnosis may be based only on assessment by a general practitioner. Greater detail about the methodology of the study has been reported previously (Almqvist *et al.* 1999; Sourander *et al.* 2005).

Measurement

Outcome variables: physical health in early adulthood

According to the information pooled from three different time-points, subjects were classified, based on clinical diagnosis, into eight groups of physical disorders: (1) diabetes mellitus (ICD-10 E10–E11; $n=21$, 0.8% of the sample), (2) obesity (ICD-10 E66, $n=88$, 3.2%), (3) epilepsy (ICD-10 G40–G41, $n=27$, 1.0%), (4) migraine (ICD-10 G43, $n=27$, 1.0%), (5) asthma (IC-10 J45, $n=155$, 5.7%), (6) atopic eczema (IC-D10 L20, $n=80$, 3.0%), (7) allergic rhinitis (ICD-10 J30, $n=406$, 15.0%), and (8) acne (ICD-10 L70, $n=62$, 2.3%). Subjects who had the specific ICD-10 diagnosis at any of the three time-points (1999, 2002 or 2004) were classified as positive. The subject could belong to more than one physical disorder group. The reference group ($n=1421$, 52.3%) comprised those who had no ICD-10 diagnosis or only ICD-10 diagnosis H52 (eye disorders of refraction or accommodation) and/or H53 (visual disturbances, mostly color vision deficiencies H53.5). In total, 576 (21.2%) subjects had an ICD-10 diagnosis but could not be classified in any of the eight groups. These subjects were not included in the further analysis.

Statistical methods

Each physical disorder group was studied as a dichotomous response variable with the categories 'yes' and 'no ICD-10 diagnosis'. The reference group in the logistic regression analyses for each physical disorder group belonged to the group with no ICD-10 disorder. Explanatory variables at age 8 measuring child's symptomatology (parent and teacher conduct, hyperkinetic and emotional scales and child self-reported depression) and other explanatory variables at age 8 (parental educational level, family structure, and child's somatic health problems) were used categorically. Logistic regression models adjusted by mother's education level and child's somatic health problems at age 8 were used to analyze the predictive associations between the response variables at follow-up and the explanatory variables when the child was 8 years of age. These associations were quantified by calculating odds ratios (ORs) and 95% confidence intervals (CIs). p values <0.05 were considered statistically significant. All tests were two-tailed.

Information was also available on asthma at age 8 by parental report. We examined the relationship between mental health problems in childhood and the likelihood of asthma at both age 8 and age 19–23; and at age 19–23 among those without asthma at age 8 using multinomial logistic regression analyses. As asthma onset shows a bimodal distribution in the

population, we sought to examine the links between mental health problems in childhood and early- and later-onset asthma. Statistical computations were performed using the SAS system for Windows, release 8.2/2000 (SAS, 2001).

Results

Demographic characteristics in childhood and physical disorders in adulthood

In univariate analyses, higher levels of maternal education were associated with significantly decreased likelihood of migraine and asthma during adulthood (see Table 1). No other significant differences in parental education or family structure emerged among those with and without physical disorders during adulthood. Health problems at age 8 were associated with increased risk of all physical health problems in adulthood.

Association between childhood mental health problems and physical health problems in early adulthood

Parent/teacher-reported conduct problems at a moderate level in childhood were associated with increased risk of obesity, asthma and atopic eczema in early adulthood (see Table 2). Severe conduct problems were associated with increased risk of obesity and asthma. Severe hyperkinetic problems in childhood were associated with increased risk of obesity in young adulthood; emotional problems were associated with increased likelihood of epilepsy and asthma. Self-reported depressive symptoms at a moderate level were associated with migraine and asthma in early adulthood and severe depressive symptoms were associated with asthma.

Adjusted association between childhood mental health problems and physical health problems in early adulthood

After adjusting for differences in parental education and physical health problems in childhood, associations remained significant between moderate conduct problems and obesity and atopic eczema (see Table 3). Severe conduct problems also remained significantly linked with obesity. Severe emotional problems were associated with significantly increased likelihood of epilepsy and asthma. Finally, moderate and severe depressive symptoms were associated with increased likelihood of asthma in childhood as well as in early adulthood. To examine whether the results would be influenced by the use of continuous, rather than categorical, measures of mental health problems, all analyses were rerun using mental health problems as

Table 1. Description of childhood demographics and mental health problems at age 8 and physical disorders in adulthood at age 18–23

	Diabetes (n = 21)	Obesity (n = 88)	Epilepsy (n = 27)	Migraine (n = 27)	Asthma (n = 155)	Atopic eczema (n = 80)	Allergic rhinitis (n = 406)	Acne (n = 62)	Reference (n = 1421)
Mother's education level									
Lower than upper secondary	66.7	77.4	72.0	88.5	79.5	62.7	68.2	65.5	67.4
Upper secondary or higher	33.3	22.6	28.0	11.5	20.6	37.3	31.8	34.5	32.6
Father's education level									
Lower than upper secondary	66.7	79.2	80.9	95.8	83.0	77.9	76.3	75.9	75.9
Upper secondary or higher	33.3	20.8	19.1	4.2	17.0	22.1	23.7	24.1	24.1
Family structure									
Two biological parents	90.5	89.4	76.0	84.0	82.8	88.2	84.6	80.0	85.2
Other	9.5	10.6	24.0	16.0	17.2	11.8	15.4	20.0	14.8
Health problems at age 8									
No	47.6	82.4	60.0	80.0	59.1	68.0	83.2	93.4	92.1
Yes	52.4	17.4	40.0	20.0	40.9	32.0	16.8	6.6	7.9
Conduct symptoms									
<50th percentile	42.9	33.7	53.9	64.0	40.3	34.7	54.3	61.0	51.2
50–90th percentile	47.6	49.4	34.6	36.0	46.7	60.0	39.0	32.2	40.8
≥90th percentile	9.5	16.9	11.5	0	12.8	5.3	6.6	6.8	8.0
Hyperactivity symptoms									
<50th percentile	57.1	53.7	53.9	80.0	54.0	52.7	58.5	72.9	58.6
50–90th percentile	38.1	32.9	34.6	20.0	37.2	37.8	34.5	20.3	34.2
≥90th percentile	4.8	13.4	11.5	0	8.8	9.5	7.0	6.8	7.2
Emotional symptoms									
<50th percentile	71.4	62.7	57.7	72.0	56.1	57.3	61.0	61.0	66.8
50–90th percentile	19.1	26.5	15.4	20.0	25.0	32.0	27.0	25.4	23.2
≥90th percentile	9.5	10.8	26.9	8.0	18.9	10.7	12.0	13.6	10.0
Self-reported depressive symptoms									
<50th percentile	61.9	53.5	44.4	38.5	34.7	50.0	55.7	55.7	59.3
50–90th percentile	38.1	39.5	37.0	46.1	48.0	39.7	34.8	36.1	30.4
≥90th percentile	0	7.0	18.5	15.4	17.3	10.3	9.6	8.2	10.4

Values given as percentages.

continuous, rather than dichotomous, variables and all results were consistent (data available on request).

Association between mental health problems in childhood and early- and later-onset asthma

Data on asthma assessed by parent report in childhood, and physician diagnosis at follow-up, were available for additional analyses. We were therefore able to examine the links between mental health problems at age 8 and asthma outcomes in greater depth. Out of 150 participants who had ICD-10 diagnoses of asthma at follow-up, 77 (51%) had asthma symptoms at age 8 ('early-onset group'), whereas 73 (49%) had no asthma symptoms at age 8 ('later-onset group') according to parent reports. Information about asthma symptoms at age 8 was missing from five of the cases who had an asthma diagnosis at follow-up.

Having early-onset asthma was associated with moderate and severe conduct problems (OR 1.7, 95% CI 1.03–2.8; OR 2.5, 95% CI 1.2–5.2, respectively), moderate and severe emotional problems (OR 1.7, 95% CI 1.02–3.0; OR 2.6, 95% CI 1.4–4.9), and moderate and severe depressive symptoms (OR 2.6, 95% CI 1.6–4.4; OR 2.5, 95% CI 1.3–5.3) also at age 8. Having incident onset of asthma in young adulthood (i.e. those who did not have asthma problems at age 8 but had asthma diagnosed at follow-up) was predicted by moderate and severe depressive problems (OR 2.9, 95% CI 1.7–5.0; OR 3.5, 95% CI 1.7–6.5).

Discussion

This study investigated the associations between mental health problems in childhood and chronic physical symptoms in early adulthood among males

Table 2. Univariate associations between childhood psychopathology at age 8 and early adulthood physical disorders at age 18–23

Childhood variables	Diabetes		Obesity		Epilepsy		Migraine		Asthma		Atopic eczema		Allergic rhinitis		Acne	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Family																
Mother's low education level	1.0	0.4–2.5	1.7	0.98–2.5	1.3	0.5–3.3	3.3	1.1–10.0	2.0	1.2–2.5	0.8	0.5–1.2	1.0	0.8–1.3	0.9	0.5–1.7
Father's low education level	0.6	0.3–1.7	1.3	0.7–2.0	1.4	0.5–5.0	10.0	0.99–50.0	1.7	0.97–2.5	1.1	0.6–2.0	1.0	0.8–1.4	1.0	0.5–2.0
Other than two biological parents	0.6	0.1–2.6	0.7	0.3–1.4	1.8	0.7–4.6	1.1	0.4–3.2	1.2	0.8–1.7	0.8	0.4–1.6	1.2	0.9–1.6	1.4	0.7–2.8
Health problems at age 8	12.8	5.3–30.9	2.5	1.4–4.5	7.8	3.4–17.7	2.9	1.1–7.9	8.1	5.5–11.9	5.5	3.2–9.3	2.4	1.7–3.3	0.8	0.3–2.3
Mental health problems at age 8																
Conduct																
50–90th percentile	1.4	0.6–3.5	1.8	1.1–3.0	0.8	0.3–1.9	0.7	0.3–1.6	1.5	1.02–2.1	2.2	1.3–3.6	0.9	0.7–1.1	0.7	0.4–1.2
>90th percentile	1.4	0.3–6.7	3.2	1.6–6.3	1.4	0.4–4.8	N.A.	N.A.	2.0	1.2–3.5	1.0	0.4–2.9	0.8	0.5–1.2	0.7	0.2–2.0
Hyperkinetic																
50–90th percentile	1.1	0.5–2.8	1.1	0.6–1.7	1.1	0.5–2.6	0.4	0.2–1.1	1.2	0.8–1.7	1.2	0.7–2.0	1.0	0.8–1.3	0.5	0.2–1.1
>90th percentile	0.7	0.1–5.3	2.0	1.02–4.1	1.8	0.5–6.2	N.A.	N.A.	1.3	0.7–2.5	1.5	0.6–3.4	1.0	0.6–1.5	0.8	0.3–2.2
Emotional																
50–90th percentile	0.8	0.3–2.3	1.2	0.7–2.0	0.8	0.3–2.3	0.8	0.3–2.2	1.3	0.9–1.9	1.6	0.96–2.7	1.3	0.98–1.7	1.2	0.6–2.2
>90th percentile	0.9	0.2–3.9	1.2	0.6–2.4	3.1	1.2–7.8	0.7	0.2–3.2	2.3	1.4–3.6	1.2	0.6–2.7	1.3	0.9–1.9	1.5	0.7–3.3
Depressive symptoms																
50–90th percentile	1.2	0.5–2.9	1.4	0.9–2.3	1.6	0.7–3.8	2.3	1.01–5.5	2.7	1.9–3.9	1.6	0.96–2.5	1.2	0.96–1.6	1.3	0.7–2.2
>90th percentile	N.A.	N.A.	0.7	0.3–1.8	2.4	0.8–6.9	2.3	0.7–7.4	2.9	1.7–4.7	1.2	0.5–2.6	1.0	0.7–1.5	0.8	0.3–2.2

OR, Odds ratio; CI, confidence interval; N.A., not applicable because of low frequencies; bolded $p < 0.05$, the reference group was those within 0–50th percentile in psychopathology scales.

Table 3. Childhood psychopathology at age 8 and early adulthood physical diagnosis at age 18–23. Analysis adjusted for mothers' education level and somatic health problems at age 8

	Diabetes		Obesity		Epilepsy		Migraine		Asthma		Atopic eczema		Allergic rhinitis		Acne	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Conduct																
50–90th percentile	1.4	0.5–4.4	1.9	1.1–3.1	0.8	0.3–1.9	0.7	0.3–1.6	1.3	0.9–2.0	2.1	1.3–3.5	0.9	0.7–1.1	0.7	0.4–1.2
>90th percentile	1.4	0.3–7.1	3.3	1.6–6.5	1.5	0.4–5.4	N.A.	N.A.	1.7	0.9–3.1	1.0	0.4–3.1	0.7	0.5–1.2	0.6	0.2–1.9
Hyperkinetic																
50–90th percentile	1.2	0.5–3.0	1.0	0.6–1.7	0.9	0.4–2.3	0.3	0.1–0.97	1.2	0.8–1.7	1.3	0.8–2.2	1.0	0.8–1.3	0.4	0.2–1.1
>90th percentile	0.5	0.1–4.1	1.7	0.8–3.6	1.5	0.4–5.5	N.A.	N.A.	1.1	0.6–2.2	1.4	0.6–3.3	0.9	0.6–1.4	0.8	0.3–2.4
Emotional																
50–90th percentile	0.7	0.2–2.3	1.1	0.7–1.9	0.8	0.2–2.4	0.6	0.2–1.9	1.1	0.7–1.8	1.5	0.9–2.5	1.1	0.9–1.5	1.2	0.6–2.2
>90th percentile	0.9	0.2–4.3	1.2	0.6–2.5	3.0	1.1–8.0	0.8	0.2–3.5	2.0	1.2–3.4	1.3	0.6–2.9	1.3	0.9–1.9	1.2	0.5–2.9
Depressive symptoms																
50–90th percentile	1.1	0.4–2.7	1.4	0.9–2.3	1.2	0.5–3.0	2.3	0.9–5.6	2.5	1.6–3.8	1.4	0.9–2.4	1.3	0.97–1.6	1.3	0.7–2.3
>90th percentile	N.A.	N.A.	0.5	0.2–1.4	1.6	0.5–5.3	2.2	0.7–7.5	2.4	1.4–4.3	1.0	0.4–2.4	0.8	0.5–1.3	1.0	0.4–2.6

OR, Odds ratio; CI, confidence interval; N.A., not applicable because of frequencies; bolded $p < 0.05$, the reference group was those under the 50th percentile in psychopathology scales.

in a community sample. Our results are consistent with, and extend previous knowledge of, several key findings. First, these results suggest a relationship between mental health problems in childhood and chronic physical conditions during young adulthood. Second, the association between childhood mental health problems and chronic physical conditions is fairly specific and is linked only with asthma, obesity, atopic eczema and epilepsy in young adulthood.

Our findings are consistent with previous evidence showing cross-sectional associations between asthma and mental health problems in childhood (Ortega *et al.* 2002) and young adulthood (Fergusson *et al.* 2005; Goodwin *et al.* 2005). These results are of interest for at least three reasons. First, these data are the first to show a link between mental health and asthma through the developmental period from childhood to young adulthood. Second, we find that this link is evident when mental health is examined both by parent/teacher observational assessment and by self-report, suggesting that youth with mental health problems, particularly depression, may be a high risk group for the development of asthma during adulthood, which appears to be distinct from the association between mental disorders and asthma during childhood, as this persists after removing childhood asthma from the analysis. Third, we find that childhood mental health problems not only are associated with the early onset of asthma during childhood, which may progress into chronic asthma and persist into adulthood, but also predict the onset of asthma in young adulthood even among those without childhood asthma.

Although the mechanism of the association between mental health and the development of asthma in young adulthood is not yet known, many potential explanations have been posited. One possibility is that youth with mental health problems are more likely to have grown up with parents with mental disorders (Weissman *et al.* 2005); and because mental disorders are strongly associated with cigarette smoking and nicotine dependence (Goodwin & Hamilton, 2002; Grant *et al.* 2004), it may be that these children are at increased risk for both asthma and mental disorders through genetic/familial risk factors for depression/anxiety disorders, and at increased risk for asthma through exposure to environmental tobacco smoke (ETS), which is a risk factor for asthma in infants and children (Le Souef, 2000; Hofhuis *et al.* 2003). Alternatively, because anxiety and depression among youth are associated with increased risk of cigarette smoking, it is conceivable that the relationship between childhood depressive symptoms and later-onset asthma may occur through cigarette smoking (Fergusson *et al.* 2003; Breslau *et al.* 2004), which is

associated with increased asthma among adults (Hasler *et al.* 2005; Boulet *et al.* 2006; Butland & Strachan, 2007). However, additional analyses adjusting for cigarette smoking were not possible because information on parental smoking/exposure to ETS was not available. Future studies are needed to investigate this potential pathway.

Our results also suggest a specific link between conduct problems in childhood and obesity in young adulthood. The same pattern was identified by two other longitudinal community-based studies, which had comparable follow-up periods. One of them found a relationship between conduct disorder symptoms in adolescence (mean age 14 years) and body mass index in young adults (mean age 22 years) (Pine *et al.* 1997). The other study, using data from eight annual interviews, found that oppositional defiant disorder was related to a trajectory of chronic obesity in a population of children who were 9–13 years at the time of the first assessment (Mustillo *et al.* 2003).

Different mechanisms may explain why conduct problems in childhood would result in obesity later in life. Binge eating and unhealthy eating may be manifestations of deviant behaviors in children with an antisocial problem (Thompson *et al.* 1999; Croll *et al.* 2002). Children with antisocial behaviors may avoid sports or other types of physical activity involving a prosocial component (Mahoney, 2000) and therefore exercise less than children without such problems. Conceivably, overeating behaviors and inactivity or sedentary habits would tend to become chronic, resulting in obesity later in life. Although childhood psychiatric conditions also tend to persist in adulthood (Cohen *et al.* 1993; Costello *et al.* 2003), they appear to be more transitory than childhood obesity (Freedman *et al.* 2001; Nader *et al.* 2006). Furthermore, common precursors, ranging from abnormalities in the serotonin system to impulsivity, ineffective parental discipline or neighborhood quality, could explain the observed association between conduct problems and obesity. The reverse causal pathway is also possible, with obesity resulting in conduct problems; for example, obese children may be stigmatized (Myers & Rosen, 1999) and react by developing conduct problems. The lack of a significant association between depression in childhood and obesity in young adulthood among males is consistent with other studies that detected such an association in females only (Richardson *et al.* 2003; Hasler *et al.* 2005; Anderson *et al.* 2006).

Epilepsy in young adulthood has also been associated with higher levels of emotional problems in childhood, and conduct problems have been linked to atopic eczema. Extensive clinical data exist linking

epilepsy and mental health problems (Bilgic *et al.* 2006; Spencer, 2007). However, the mechanism here is still unclear, as is the reason why atopic eczema would be related to conduct problems. Several studies have suggested that common prenatal factors, such as prenatal smoking, are associated with conduct problems in youth (Gatzke-Kopp & Beauchaine, 2007) and may be associated with atopic eczema, although this association is debated (Schafer *et al.* 1997; Strachan & Cook, 1998). Unfortunately, information on prenatal factors was not available in this study. The lack of a significant association between early mental health problems and the majority of physical disorders in early adulthood, in particular risk of diabetes and migraine, is somewhat surprising, given that extensive cross-sectional data from clinical samples of adults suggest strong links with mental disorders (Albanesi de Nasetta & Morales de Barbenza, 2006; Hamelsky & Lipton, 2006; Pravin *et al.* 2006).

It is possible that this disparity in results is due to differences in the sample used. For instance, previous investigations have been cross-sectional and, therefore, variation may occur in the nature of the relationships if the diseases are concurrent or if they occur during discrete distant periods of time across the life course.

There are some shortcomings in this study that limit the conclusions that can be drawn from our results. First, although we were able to control for parent-reported health problems in childhood, we did not have information on the specific health problems that were present during childhood, except for parent-reported asthma at age 8. Therefore, it cannot be concluded definitively that the onset of physical health problems occurred subsequent to mental health problems, nor that the relationship is causal. Second, as the sample was drawn from Finland, a Nordic welfare state, the diversity in socio-economic status (SES) is considerably narrower than in the USA and other countries. Therefore, future studies that include populations with a broader range of SES are needed to confirm the generalizability of these findings, given the frequently observed SES variability in several chronic diseases, such as asthma and obesity (Bloom & Dey, 2006; Wang & Zhang, 2006). In addition, only males were included in this study so the results cannot be generalized to females.

Our findings provide new evidence of an association between childhood mental health problems and increased likelihood of physical health problems, primarily obesity and asthma, in early adulthood. Future studies that can investigate mechanisms of these linkages are needed. From a clinical perspective, clinicians who see children with mental health problems in pediatric settings, especially those with other

risk factors for chronic health problems such as asthma and obesity, may benefit from extra attention to youth with mental health problems not only in their vulnerability to persistent mental health difficulties throughout development but also in their potential vulnerability to both physical and mental health problems into adulthood. Earlier identification of youth at risk for both asthma and obesity, which are among the most common and pressing public health problems worldwide, may result in the development of more effective prevention efforts.

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Declaration of Interest

None.

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