Cumulative adverse childhood experiences, school performance and psychiatric morbidity in young adults: a cohort study of 96 399 individuals in Stockholm County

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Abstract

Cumulative adverse childhood experiences (ACEs) increase the risk of psychiatric morbidity. Although school performance also has been linked with psychiatric outcome, limited research has considered school performance as a modulating factor. To address this gap in literature, the current register study examined whether school performance mediates and/or moderates the association between ACEs (experienced between birth and age 14 years) and psychiatric morbidity using a Swedish cohort of 96,399 individuals born 1987-1991. Estimates of risk of psychiatric morbidity (measured as in-patient, out-patient, and primary care) were calculated as hazard ratios (HR) with 95% confidence intervals (CI). A graded relationship was found whereby greater ACEs were linked with greater psychiatric morbidity risk, upwards of 2-fold risk (HR: 1.9 (95% CI: 1.8,2.0)) among individuals with 3+ ACEs. Highest risk was observed among individuals with 3+ ACEs and incomplete school grades (HR 7.5 (95% CI: 6.1,9.1)), after adjusting for demographic variables. Moreover, school performance both mediated and moderated the relationship between ACEs and psychiatric morbidity. Our findings suggest that future efforts to prevent or mitigate ACEs, in combination with efforts to improve school performance among vulnerable youth, may be of great importance for prevention programs aiming to improve mental health among young adults.

Introduction

Research strongly suggests that adverse childhood experiences (ACEs) increase the risk of psychiatric disorders[1, 4, 18, 24, 38, 39]. ACEs tend to occur in clusters, rather than as single events or experiences[2, 8]. Moreover, clustered risk factors in childhood have a strong graded relationship to psychiatric morbidity later in life, in terms of depression[11], substance abuse disorder[15], and psychotropic drug consumption[8].

Conceptually, ACEs may shape adult health through "direct" and "indirect" processes[32]. They may directly influence health outcomes through biological imprint processes, and early life stress is suggested to cause enduring brain dysfunction that affects health and quality of life throughout the lifespan[2]. Adverse health outcomes may also be the result of adult circumstances that indirectly have been set in motion by adverse childhood experiences. Psychological and psychosocial explanations suggest that childhood adversity may damage emotion regulation, and concept of self-worth, reducing the child's self-esteem[39].

One well-established and important indirect mechanism through which ACEs may adversely impact later health is educational attainment[32]. Poor school performance is a powerful predictor of psychiatric morbidity[7, 23, 25, 42], including for children with ACEs[6, 28]. One suggested etiologic pathway states that children who experience childhood adversity tend to have lower levels of education or lower grade point average (GPA), leading to poor adult health[32]. Despite these earlier findings, little emphasis has been placed on school performance as a possible link between cumulative adverse childhood experiences and the increased risk of later psychiatric morbidity.

In this register-based study, we used a large sample of approximately 96,000 adolescents born in the Stockholm County between 1987 and 1991, to test the hypotheses that:

- Cumulative ACEs increase the risk of psychiatric morbidity, in terms of psychiatric care utilization

- The studied association is mediated and moderated by school performance

Methods

Study population

The study population was defined as all individuals born in Stockholm County, Sweden between 1987 and 1991 (n=116 088), recorded in the Medical Birth Register. This register includes data on all deliveries in Sweden since 1973[13]. The selected study population and exclusion criteria are illustrated in Figure 1. Our target population comprised 96 399 individuals.

The unique Swedish personal identity number was used to link information from several population-based registers as follows:

The Causes of Death Register comprises information on all deaths of Swedish residents. The National Patient Register includes all individuals admitted to psychiatric or general hospitals, with complete coverage for all care since 1987[29]. In addition, the Swedish VAL database, containing individualized data on all public health care services in Stockholm County was used. The Total Enumeration Income Survey contains data on the income of and governmental benefits provided to all Swedish residents. The Total Population Register includes information on age, sex, place of residence, and other relevant demographic characteristics. The Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA) integrates existing data from the labor market, educational and social sectors. The Register of Court Convictions contains information on all court convictions in Sweden for persons 15 years of age or older. The Swedish National School Register holds information on individual educational performance (grade points by subjects) from all public and non-public schools.

Adverse childhood experiences

Indicators of ACEs were selected based upon prior research demonstrating them to have significant adverse health or social implications[1, 2, 10, 16, 33-37, 40, 41]. The eight ACEs

studied, as defined below, were each measured during a specific interval between birth and age 14. To assess accumulation of risk factors, the total number of ACEs was summed and grouped into: 0, 1, 2, and 3 or more ACEs.

Familial death: Death of at least one parent or a sibling.

Parental substance abuse: At least one parent hospitalized with a main diagnosis for alcohol and/or narcotic-related substance abuse, as defined by the International Classification of Disease (ICD-9): (291-292, 303-3050, 3570, 4255, 5353, 5710, 5711-5713, 6483, 6555, 9650, 9696-9697; ICD-10: E244, F10-F16, F18-F19, G312, G621, G721, I426, K292, K70, K852, K86, O354-355, P044, T40, T436, T51, Z502-503, Z714, Z721-Z722) or received an alcohol or narcotic-related drug conviction.

Severe parental psychiatric morbidity (excluding substance abuse related diagnoses): At least one parent hospitalized with a main diagnosis of mental disorder (ICD-9: 290-319; ICD10: F00-F99).

Parental severe somatic disease: At least one parent hospitalized for one or more of the following conditions: multiple sclerosis (ICD-9: 340; ICD-10: G35), chronic disease of the gastrointestinal tract (inflammatory bowel disease including Crohn's disease and Ulcerative colitis (ICD-9: 5550-2, 5559, 556, 558; ICD-10: K50-52)), meningitis (ICD-9: 320-323, 036, 054D, ICD-10: A39, B004, G00-G01, G04-G05), myocardial infarction including cardiac arrest (ICD-9: 410, 427F; ICD-10: I21-22, I46), haemorrhage (ICD-9: 430-434, 436-437; ICD-10: I60-I64), pulmonary embolism (ICD-9: 415B, 673; ICD-10: I260, I269, O88), and certain cancer types (ICD-9: 140-175, 179-194; ICD-10: C00-C26, C30-C41, C43-C75, C81-C97). The conditions were chosen on the basis of earlier research[35, 36].

Severe criminality among parents: At least one parent sentenced to prison, probation, or forensic psychiatric care.

Parental separation/single household: Measured when the child was between the ages of 3 and 14.

Household receiving social assistance: At least one parent having received social assistance during at least one year (when the child was between 3 and 14 years of age), in cases where more than 50 percent of the yearly income constituted social assistance.

Two or more changes in place of residency: Two or more changes when the child was between 6 and 14 years of age.

***Measure of school performance*:** This study focuses on child's performance in the final (ninth) year of compulsory school in Sweden, at age 15-16. The reported grade point average was based on the student's 16 best subjects. The child could earn 10-20 points per subject, yielding a total grade point of 320 points. The maximum number of points earned was used to create five categories. The first category included youth with incomplete grades or missing values on more than five subjects. The remaining four categories were quartiles based on the maximum grade points. The mean values in the first, second, third, and fourth quartiles were 173.8 (100-190), 212.2 (195-230), 249.7 (235-265), and 292.8 (270-320) respectively.

Indicators of psychiatric morbidity

The individuals were followed from age 18 (2005–2011) until at most December 31st 2011 to track psychiatric morbidity, in terms of at least one psychiatric diagnosis (ICD-10: F00-F99) during psychiatric inpatient care, psychiatric outpatient care, and/or primary care.

Potential confounders

Various demographic factors carry potential confounding effects. Thus, analyses adjusted for sex, parental socioeconomic position (SEP), and/or parental country of birth, as defined

below. First, people from disadvantaged family backgrounds are more likely to accumulate risk factors associated with disadvantage than those born in more privileged families[2, 19, 27]. We adjusted for parental SEP, in terms of education and income. Highest attained educational level among the parents was measured when the child was 15 years of age (i.e. between 2002 and 2006). Educational level was classified into three categories: 1) Nine years of compulsory school, 2) 10-12 years of education (equivalent to senior high school), and 3) ≥13 years of education (i.e. university). Second, disposable income when the child was 15 years was assessed using the individualized weighted average income, obtained by calculating the sum of all the family members' disposable incomes multiplied by the individual consumption weights, then divided by their aggregate consumption weight. This weight includes all earnings and income from self-employment for both spouses, all state cash benefits that the family receives (e.g. rental subsidies), and deductions to account for taxation. We categorized disposable income into quartiles.

Finally, we adjusted for parental country of birth, for which the following four categories were created: both parents born in Sweden, one parent born in Sweden and the other foreign-born, one/both parents born in another Nordic country, and one/both parents foreign-born elsewhere).

Statistical analysis

Multivariate analyses were performed using Cox hazards models of time to first contact with in- or outpatient care during which a psychiatric diagnosis was assigned. Time in the study was calculated with the entry date defined as the date of the 18th birthday and the exit date as the date of the first psychiatric contact, date of death from the Causes of Death Register, date of emigration from the Register of the Total Population or the end of follow-up (i.e.

December 31st 2011). Cluster robust standard errors were used in order to take potential family level clustering into account.

To assess whether GPA moderated the association of ACEs with psychiatric morbidity, mediator and moderator analyses were conducted. First, to analyze the mediating role of school performance in the association between ACE and psychiatric morbidity, linear regression analyses were conducted according to the recommendations of Baron and Kenny[3]. In addition, the Sobel test was used to measure the statistical reliability of the degree of mediation[3]. To assess a moderator model, linear regression analyses were conducted using ACEs, GPA, and the interaction term of ACEs by GPA as the independent variables, and psychiatric morbidity as the dependent variable.

Secondary analyses were conducted whereby parental psychiatric morbidity was excluded from the list of ACEs.

All statistical analyses were conducted with SAS v.9.4.

Results

Our cohort of 96,399 children was evenly distributed between the sexes (49 percent women and 51 percent men). Half of the cohort had been exposed to at least one ACE, and 23 percent had experienced two or more ACEs.

Table 1 shows cohort characteristics and prevalence of adverse childhood experiences by distribution of average school grades. Nearly 10 percent had incomplete grades (8 803 out of 96 399, and individuals in this group had been exposed to ACEs to a larger extent than all other grade groups. Parental separation/single household was the most common ACE (43 percent in the cohort had been exposed to this ACE, whereof 65 in the group "Incomplete grades" in comparison with only 30 percent in the group with highest grade points (quartile 4). Accumulation of ACEs was negatively associated with school grades, with higher rates in lower quartiles. A similar pattern was found for parental SEP (education and income): i.e., lower parental SEP was more common in lower school grade quartiles as was having parents born outside Nordic countries.

Nearly 15 percent had at least one psychiatric contact during the follow up period (table 2). In the entire cohort, 10 percent had used specialized psychiatric outpatient care, whereas 3 percent had been treated in inpatient care. Seven percent received their psychiatric diagnosis in primary care. Psychiatric morbidity rates (as indicated by utilization of psychiatric care), presented in table 2 show that individuals experiencing childhood adversity had higher rates for all measures of psychiatric morbidity. Results were graded with higher rates in lower grade groups for all outcome measures. Of those treated in psychiatric care, approximately 30 percent were treated in more than one form of care.

Exposure to ACEs was associated with an increased risk of psychiatric morbidity in a graded fashion (table 3), with risk increasing as the number of ACEs increased. Those with 3 or more ACEs had a 1.7-fold increase in risk of primary care (95% CI: 1.6, 1.8) and a 2.8-fold

increase in risk of inpatient care (95% CI: 2.5, 3.1) compared to those with no ACEs. Those with one ACE only had higher risk for all measures of psychiatric morbidity as compared to those with no ACEs (HR 1.2, 95% CI: 1.2, 1.3). Risk estimates were slightly attenuated when adjusting for GPA.

Tables 4-5 present crude and multi-adjusted HRs with 95% confidence intervals for risk of psychiatric morbidity by average school grade (in quartiles), and exposure to ACEs. Regardless of exposure to ACEs, school performance was associated with psychiatric morbidity (category 0+). The crude HRs (adjusted only for birth year and sex) displayed a gradual increase in the risk of psychiatric morbidity with decreasing levels of grades (table 4).

The risk of psychiatric morbidity was most pronounced among individuals with incomplete grades; e.g., a 4-fold risk of inpatient care (HR 4.1, 95% CI: 3.6, 4.6), and a 3-fold risk of specialized out-patient care (HR 3.2, 95% CI: 3.0, 3.4).

The highest risks of psychiatric morbidity were found mainly in individuals with incomplete grades, who had experienced multiple ACEs.

Adjustments for additional demographic variables including parental country of birth and parental SEP had little effect on the estimates (table 5). Lower school grades in combination with accumulation of ACEs were strongly associated with psychiatric morbidity (between 3 and 7 times higher risk compared to those in the highest grade group with no ACEs). The dose-response relationship between ACEs, school performance and risk of psychiatric morbidity was not as evident for primary care as for the other outcome measures.

Secondary analyses excluding severe parental psychiatric morbidity from the list of ACEs did not significantly alter the findings (data not shown). That is, the strength of the relation between ACEs and psychiatric morbidity remained.

To test the mediator model, linear regression analyses showed that ACEs were associated with GPA [standardized beta coefficients ranged from -0.22 (those with 3 or more ACEs had

0.22 lower units of GPA compared to those with no ACEs) to -0.11 (those with two ACEs had 0.11 lower units of GPA compared to those with no ACEs), all at p<0.0001]. These results indicated that the condition required at the first step of mediation was fulfilled. The association between GPA and psychiatric morbidity (for any outcome: HR 0.92, 95% CI: 0.92, 0.93, for in-patient care: HR 0.87, 95% CI: 0.86, 0.88, for specialized out-patient care: HR 0.91, 95% CI: 0.90, 0.92, and for primary care: HR 0.95, 95% CI: 0.94, 0.96) satisfied the requirements of the second criterion. After adjusting for GPA (step 4 of mediation) the risk estimates decreased indicating that school performance mediated the association between ACEs and psychiatric morbidity. The Sobel test confirmed that GPA significantly mediated the association between ACEs and psychiatric morbidity ($z = 23.5$, $p<0.0001$).

To test the moderator model, regression analyses demonstrated that GPA moderated the relationship between ACEs and psychiatric outcome such that the magnitude of the relationship between ACEs and psychiatric morbidity was changed significantly when including GPA (interaction term, $p=0.0086$).

Discussion

As hypothesized, and in line with prior research[2, 4, 8, 11, 15], our cohort study of almost 100,000 young individuals in Stockholm, Sweden, showed that accumulation of adverse childhood experiences was associated (in a dose response manner) with markedly increased risk of psychiatric morbidity in young adulthood. Moreover, the association of ACEs with psychiatric morbidity was both mediated and moderated by school performance.

Also, consistent with previous studies[4-6, 9, 28], there was a significant relationship between ACEs and school performance. Accordingly, the higher the number of ACEs, the lower the GPA. These findings fit with earlier findings suggesting that ACEs in combination with other adversities in the family[5, 9], rather than single ACEs in isolation, most often lead to poor school performance.

We found that each individual ACE served as a risk factor for psychiatric morbidity, which is in line with earlier studies using similar types of ACEs as we did[1, 2, 11, 15, 24, 38]. Further, the impact of ACEs appeared to be cumulative, with the risk of psychiatric morbidity increasing with number of ACEs incurred. Initial ACEs studies were undertaken in the US[2, 11], but consistent findings have been reported in different contexts and in different parts of the Western world[2, 4, 12, 15, 18, 24]. Earlier studies typically used cross-sectional survey data[4, 12, 18], whereas longitudinal studies such as the current study, have been warranted[4]. Our study provides strong evidence that the impact of ACEs is cumulative, as has been shown in other settings[18, 24].

Although there is extensive research investigating adverse childhood experiences and later morbidity[2, 11, 15, 18, 24], research specifically examining the role of school performance on the association between ACEs and psychiatric morbidity is scarce. One recent study from the US examined if childhood adversity, in terms of socioeconomic disadvantage, in combination with educational attainment predicted future health[32]. Findings revealed that,

because education had a larger impact on health than did childhood socioeconomic context, adults from disadvantaged childhoods who achieved high education levels often had better life expectancies than adults from advantaged childhoods who achieved low education levels[32]. The researchers, using the same procedure as we did to test education as a mediator and moderator[32], found educational attainment to mediate the association between childhood SEP and health[32]. These results are in line with findings from a Swedish study in which school performance strongly mediated the association between childhood SES and psychiatric morbidity in terms of suicidal behavior[22]. Even though these studies examine parental SES rather than ACEs, it is known that low parental SES is likely to be accompanied by psychosocial adversity related to alcohol misuse and family disruption[19].

We found school performance to moderate the association between ACEs and psychiatric morbidity. Similar findings were recently shown in a Canadian study on protective factors against depression in young adulthood, revealing that education level moderated the association between recent stressful events and future depression[14].

We found school performance to be an important mediator through which ACEs translate into a risk for psychiatric morbidity. Children accumulating adversities in childhood have higher risk of psychiatric morbidity, and perform worse in school than those without ACEs. Thus, the combination of cumulative ACEs and lower school grades seems to be particularly detrimental to health.

There are different possible explanations for the current findings. ACEs, and in particular cumulative ACEs may lead to lower self-esteem and self-worth, which it turn may increase the risk of psychiatric morbidity[15, 39]. This may also hold for poor school performance. It has been suggested that education promotes good health in part by moderating social stressors and strengthening individuals' social networks[17]. Education may improve health because it enhances a sense of personal control encouraging and enabling a healthy lifestyle[31]. Hence,

improving vulnerable children's school performance is of great importance[14]. Researchers have pointed out that the school performance of children experiencing ACEs can be improved with appropriate interventions[20]. Ongoing psychosocial problems could have a negative impact on both school performance and mental health. Some of the problems may be explained by individual factors, such as lower cognitive ability and the presence of behavioral problems[25, 37]. However, the fact that school performance was found to mediate the association between ACEs and psychiatric morbidity contributes to growing evidence that school performance may play an important role in the prediction of psychiatric morbidity[7, 23, 25].

The studied ACEs reflect to a great extent social disadvantage in childhood, though may also capture a degree of genetic susceptibility to morbidity. It is difficult to disentangle heredity to mental disorder from social disadvantage in childhood. It is also well-known that the presence of a family history of psychiatric morbidity is a predictor of offspring psychiatric morbidity[34]. In an attempt to take genetic factors into account, we excluded parental psychiatric inpatient care from the list of ACEs and considered it a potential confounder, which had little effect on the risk estimates. Likewise adjustments for parental education and income did not substantially alter the results.

Strengths and limitations

This study has several methodological strengths, including the population-based design, using nationwide registers with high completeness and no loss to follow up, and the large cohort. Earlier studies on ACEs as risk factors for morbidity in adulthood have often been retrospective and based on self-reported information with risk for recall bias in terms of underreporting of ACEs[21]. Another strength was adjustment for important parental

variables, in an attempt to disentangle the complicated associations between social factors, ACEs and parental psychiatric morbidity.

This study also includes methodological weaknesses. First, the use of only in- and outpatient care events to measure psychiatric morbidity limits the sample to only those actively seek care, though we were able to able to cover a broad spectrum of psychiatric morbidity. Second, duration or timing of ACEs was not captured. Future studies may benefit from examining whether the earlier in childhood the ACEs occur, the longer the child is likely to be exposed to the effects associated with the ACEs. Earlier research has stressed the importance of taking age at exposure into account when studying the association between childhood adversities and adult health, as exposure at a specific period in the life course is particularly damaging to the individual[26, 30]. Finally, the list of ACEs is not exhaustive. Future studies may consider additional ACEs, such as childhood abuse and neglect, which were not possible to capture with the use of our register data.

Conclusion

The results of this study show a strong association between accumulation of ACEs and later psychiatric morbidity, with important mediating and moderating effects of school performance. The potential role of school performance as a pathway between adverse childhood experiences and other health outcomes needs to be further investigated in future studies. Childhood education may offer a promising pathway for mental health prevention programs targeting children who have experienced multiple ACEs.

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Conflict of interest

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

Figures and tables

Figure 1. *Flow chart with exclusion criteria for the study population*

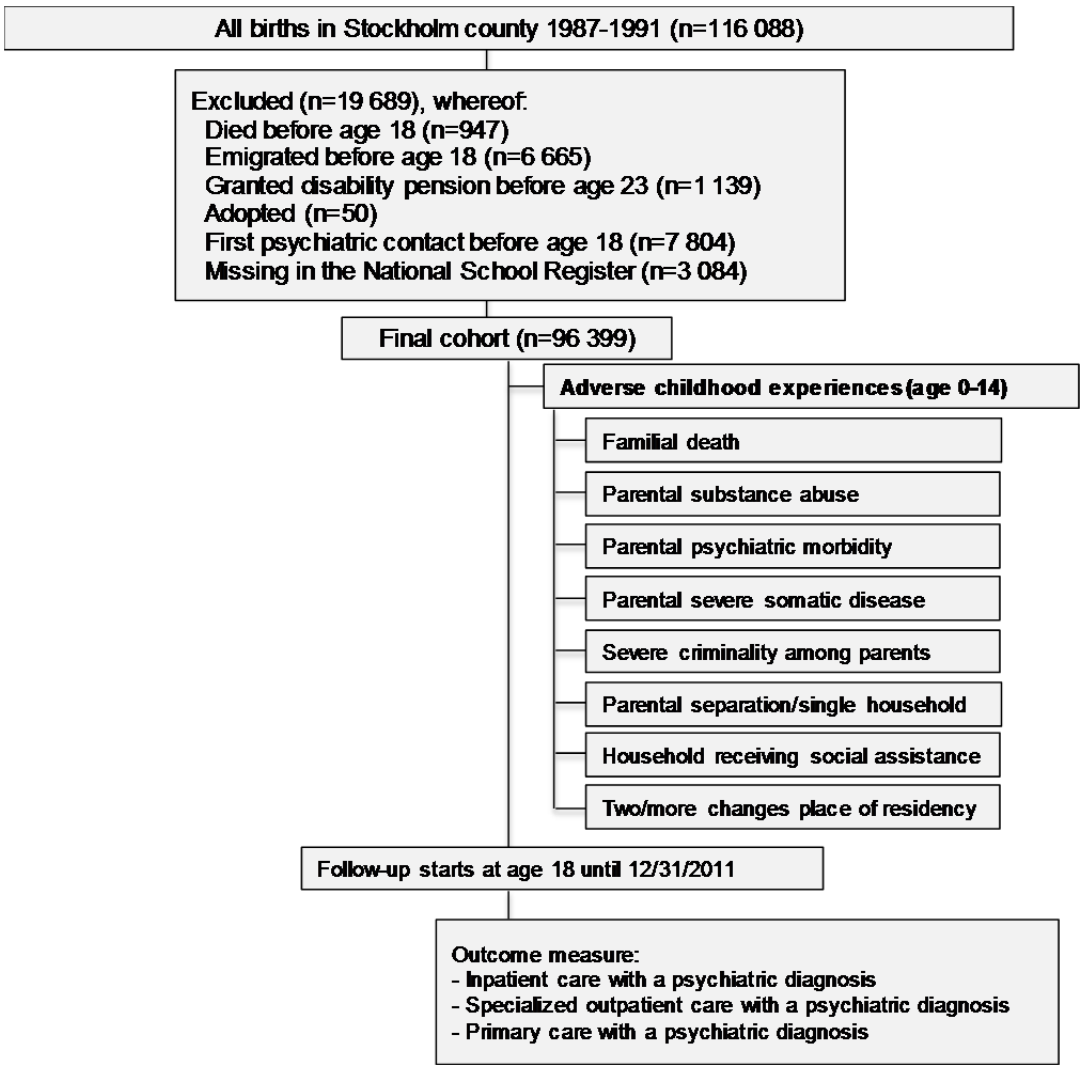

Table 1. *Cohort characteristics and prevalence of adverse childhood experiences by average school grade in quartiles*

	Incomplete grades	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Grade Point Average (SD)	Total
N	8,803	22,140	23,622	19,982	21,852	14.2 (2.9)	96,399
Women	3 655 (42)	8 098 (37)	10 671 (45)	10 539 (53)	13 861 (63)	14.8 (2.9)	46 824 (49)
Men	5 148 (58)	14 042 (63)	12 951 (55)	9 443 (47)	7 991 (37)	13.6 (2.7)	49 575 (51)
Adverse Childhood Experiences (ACEs)							
Familial death	423 (5)	783 (4)	733 (3)	529 (3)	510 (2)	13.6 (2.8)	2 978 (3)
Parental substance abuse	1 621 (18)	2 396 (11)	1 747 (7)	1 055 (5)	819 (4)	12.8 (2.7)	7 638 (8)
Parental psychiatric morbidity	719 (8)	1 243 (6)	1 108 (5)	681 (5)	728 (3)	13.4 (2.8)	4 479 (5)
Parental severe somatic disease	640 (7)	1 534 (7)	1 507 (6)	1 277 (6)	1 414 (6)	14.1 (2.9)	6 372 (7)
Severe criminality among parents	846 (10)	1 262 (6)	865 (4)	467 (2)	329 (2)	12.6 (2.6)	3 769 (4)
Parental separation and/or single household	5 710 (65)	11 389 (51)	10 158 (43)	7 175 (36)	6 661 (30)	13.5 (2.8)	41 093 (43)
Household receiving social assistance	3 788 (43)	5 683 (26)	3 985 (17)	2 238 (11)	1 634 (7)	12.7 (2.6)	17 328 (18)
Two or more changes in place of residence	649 (7)	1 115 (5)	896 (4)	558 (3)	484 (2)	13.1 (2.7)	3 702 (4)
Potential confounders							
Parental country of birth							
Both born in Sweden	5 450 (62)	15 727 (71)	17 236 (73)	15 106 (76)	16 882 (77)	14.3 (2.9)	70 401 (73)
One parent born in Sweden, other foreign-born	1 586 (18)	3 308 (15)	3 473 (15)	2 798 (14)	2 956 (14)	14.0 (2.9)	14 121 (15)
One/Both parents foreign-born (other Nordic country)	375 (4)	674 (3)	565 (2)	458 (2)	468 (2)	13.7 (2.9)	2 540 (3)
One/Both parents foreign-born (born elsewhere)	1 392 (16)	2 431 (11)	2 348 (10)	1 620 (8)	1 546 (7)	13.6 (2.8)	9 337 (10)
Parental educational level							
9 years of education	1 392 (16)	1 827 (8)	1 145 (5)	598 (3)	353 (2)	12.4 (2.4)	5 315 (6)
10 - 12 years of education	5 582 (63)	12 969 (59)	10 799 (46)	6 863 (34)	4 801 (22)	13.2 (2.6)	41 014 (43)
>12 years of education	1 809 (21)	7 322 (33)	11 652 (49)	12 512 (63)	16 690 (76)	15.2 (2.8)	49 985 (52)
Missing	20 (0)	22 (0)	26 (0)	9 (0)	8 (0)	12.7 (2.6)	85 (0)
Parental income							
Quartile 1	3 610 (41)	6 766 (31)	6 024 (26)	4 112 (21)	3 505 (16)	13.4 (2.7)	24 017 (25)
Quartile 2	2 659 (30)	6 538 (30)	6 114 (26)	4 532 (23)	4 147 (19)	13.7 (2.8)	23 990 (25)
Quartile 3	1 701 (19)	5 417 (24)	6 081 (26)	5 373 (27)	5 604 (26)	14.3 (2.8)	24 176 (25)
Quartile 4	833 (9)	3 419 (15)	5 403 (23)	5 965 (30)	8 596 (39)	15.3 (2.8)	24 216 (25)
Accumulation of adverse childhood experiences							
0	2 143 (24)	8 566 (39)	11 264 (48)	11 088 (55)	13 308 (61)	14.8 (2.9)	46 369 (48)
1	2 405 (27)	6 534 (30)	7 023 (30)	5 536 (28)	5 818 (27)	14.1 (2.9)	27 316 (28)
2	2 059 (23)	3 872 (17)	3 115 (13)	2 127 (11)	1 774 (8)	13.3 (2.7)	12 947 (13)
3+	2 196 (25)	3 168 (14)	2 220 (9)	1 231 (6)	952 (4)	12.7 (2.6)	9 767 (10)

Table 2. *Rates of psychiatric morbidity (at least one psychiatric contact) per 100,000 person years, by average school grade in quartiles and exposure to increasing number of adverse childhood experiences*

	n	Incomplete grades	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Total
			Any psychiatric care				
Number of adverse childhood experiences							
0	5,326	4,926.9	2,885.3	2,480.6	2,119.9	2,066.2	2,459.2
1	4,043	5,512.0	3,683.0	3,186.1	2,812.5	2,464.5	3,273.1
2	2,308	6,338.9	4,108.5	3,297.6	3,364.9	2,953.8	3,968.4
3+	2,032	6,648.1	4,574.1	4,131.9	3,135.3	3,781.4	4,658.2
Total	13,709	5,833.7	3,566.0	2,944.8	2,499.4	2,315.8	3,102.4
			Psychiatric inpatient care				
Number of adverse childhood experiences							
0	833	945.8	497.7	376.1	269.7	262.9	367.5
1	697	1,015.2	656.2	516.5	433.8	298.8	531.7
2	450	1,208.2	786.5	562.3	535.6	485.2	718.1
3+	482	1,653.2	983.0	799.5	597.8	687.3	1,014.7
Total	2,462	1,201.9	663.8	481.5	362.8	309.0	526.2
			Psychiatric outpatient care				
Number of adverse childhood experiences							
0	3,559	3,681.0	1,904.9	1,612.8	1,336.7	1,329.5	1,612.9
1	2,787	4,031.9	2,518.5	2,053.1	1,826.0	1,647.5	2,203.2
2	1,572	4,347.6	2,787.2	2,113.3	2,151.4	1,751.2	2,618.4
3+	1,469	4,980.9	3,192.4	2,623.7	2,219.0	2,475.7	3,258.8
Total	9,387	4,252.1	2,418.5	1,900.9	1,609.0	1,497.2	2,075.5
			Primary care				
Number of adverse childhood experiences							
0	2,688	2,025.6	1,336.6	1,227.6	1,081.4	1,064.8	1,203.7
1	2,021	2,236.3	1,704.5	1,582.4	1,424.6	1,264.5	1,570.7
2	1,116	2,621.5	1,761.4	1,645.7	1,621.1	1,544.8	1,818.2
3+	945	2,539.7	1,910.2	2,033.5	1,335.2	2,046.8	2,020.6
Total	6,770	2,349.2	1,600.2	1,461.7	1,247.3	1,199.0	1,471.3

Table 3. *Hazard ratios[a] (HR) with 95% confidence intervals (CI) for risk of psychiatric morbidity by exposure to adverse childhood experiences*

	Number of adverse childhood experiences					
	1		2		3+	
	HR	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Any psychiatric care						
Model I[b]	1.3	1.3, 1.4	1.6	1.5, 1.7	1.9	1.8, 2.0
Model II[c]	1.2	1.2, 1.3	1.4	1.3, 1.4	1.5	1.4, 1.6
Psychiatric inpatient care						
Model I[b]	1.4	1.3, 1.6	2.0	1.7, 2.2	2.8	2.5, 3.1
Model II[c]	1.3	1.2, 1.4	1.6	1.4, 1.8	2.1	1.8, 2.3
Psychiatric outpatient care						
Model I[b]	1.4	1.3, 1.4	1.6	1.5, 1.7	2.0	1.9, 2.2
Model II[c]	1.3	1.2, 1.3	1.4	1.3, 1.4	1.6	1.5, 1.7
Primary care						
Model I[b]	1.3	1.2, 1.4	1.5	1.4, 1.6	1.7	1.6, 1.8
Model II[c]	1.2	1.2, 1.3	1.3	1.2, 1.4	1.4	1.3, 1.5

[a] Reference group: Individuals with no adverse childhood experiences

[b] Adjusted for birth year and sex

[c] Adjusted for birth year, sex, and GPA

Table 4. *Crude[a] Hazard ratios (HR) with 95% confidence intervals (CI) for risk of psychiatric morbidity by average school grade (in quartiles), and exposure to adverse childhood experiences*

	Number of adverse childhood experiences (ACEs)									
	0+		0		1		2		3+	
	HR	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Any psychiatric care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.1, 1.3	1.4	1.2, 1.6	1.8	1.5, 2.1
Quartile 3	1.1	1.1, 1.2	1.1	1.0, 1.2	1.4	1.3, 1.5	1.7	1.5, 1.9	1.6	1.3, 1.8
Quartile 2	1.4	1.3, 1.5	1.3	1.2, 1.4	1.7	1.5, 1.8	1.7	1.5, 1.9	2.1	1.9, 2.4
Quartile 1	1.8	1.7, 1.9	1.6	1.5, 1.8	2.0	1.9, 2.2	2.2	2.1, 2.5	2.5	2.3, 2.7
Incomplete grades	2.9	2.7, 3.1	2.7	2.5, 3.0	3.0	2.8, 3.4	3.5	3.1, 3.8	3.6	3.3, 4.0
Psychiatric inpatient care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.1	0.9, 1.5	1.8	1.3, 2.6	2.6	1.8, 3.8
Quartile 3	1.2	1.0, 1.4	1.1	0.8, 1.3	1.7	1.3, 2.1	2.1	1.5, 2.8	2.3	1.6, 3.3
Quartile 2	1.6	1.4, 1.8	1.5	1.2, 1.8	2.0	1.6, 2.5	2.2	1.7, 2.8	3.1	2.4, 4.0
Quartile 1	2.3	2.0, 2.6	2.0	1.6, 2.4	2.6	2.1, 3.2	3.1	2.5, 3.9	3.9	3.1, 4.8
Incomplete grades	4.1	3.6, 4.6	3.8	2.9, 4.8	4.0	3.2, 5.1	4.8	3.8, 6.0	6.5	5.3, 8.1
Psychiatric outpatient care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.1, 1.4	1.3	1.1, 1.5	1.8	1.5, 2.2
Quartile 3	1.1	1.1, 1.2	1.1	1.0, 1.2	1.4	1.3, 1.6	1.7	1.4, 1.9	1.7	1.4, 2.1
Quartile 2	1.4	1.3, 1.5	1.3	1.2, 1.5	1.7	1.5, 1.8	1.7	1.5, 1.9	2.1	1.8, 2.3
Quartile 1	1.8	1.7, 2.0	1.6	1.5, 1.8	2.1	1.9, 2.3	2.3	2.1, 2.6	2.7	2.4, 3.0
Incomplete grades	3.2	3.0, 3.4	3.1	2.8, 3.5	3.4	3.0, 3.8	3.6	3.2, 4.1	4.2	3.7, 4.7
Primary care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.0, 1.3	1.4	1.2, 1.7	1.9	1.5, 2.3
Quartile 3	1.1	1.0, 1.2	1.1	1.0, 1.2	1.4	1.2, 1.6	1.6	1.3, 1.9	1.3	1.0, 1.6
Quartile 2	1.4	1.3, 1.5	1.3	1.2, 1.5	1.7	1.5, 1.9	1.7	1.5, 2.0	2.1	1.8, 2.4
Quartile 1	1.6	1.5, 1.7	1.5	1.4, 1.7	1.9	1.7, 2.1	1.9	1.7, 2.2	2.1	1.8, 2.4
Incomplete grades	2.3	2.1, 2.5	2.2	1.9, 2.6	2.5	2.1, 2.8	2.8	2.5, 3.3	2.7	2.5, 3.1

[a] Adjusted for birth year and sex

Table 5. *Multi-adjusted[b] Hazard ratios (HR) with 95% confidence intervals (CI) for risk of psychiatric morbidity by average school grade (in quartiles), and exposure to adverse childhood experiences*

	Number of adverse childhood experiences (ACEs)									
	0+		0		1		2		3+	
	HR	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Any psychiatric care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.1, 1.3	1.5	1.3, 1.7	1.9	1.6, 2.3
Quartile 3	1.2	1.1, 1.2	1.1	1.0, 1.2	1.5	1.3, 1.6	1.8	1.6, 2.0	1.7	1.4, 2.0
Quartile 2	1.4	1.4, 1.5	1.4	1.3, 1.5	1.8	1.6, 1.9	1.9	1.7, 2.1	2.3	2.1, 2.6
Quartile 1	1.8	1.7, 2.0	1.7	1.6, 1.9	2.2	2.0, 2.4	2.5	2.3, 2.8	2.8	2.5, 3.1
Incomplete grades	3.1	2.9, 3.3	3.0	2.7, 3.4	3.4	3.1, 3.8	4.0	3.6, 4.4	4.1	3.6, 4.7
Psychiatric inpatient care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.1	0.9, 1.5	1.9	1.4, 2.7	2.8	1.9, 4.1
Quartile 3	1.2	1.0, 1.4	1.1	0.9, 1.3	1.7	1.4, 2.2	2.2	1.7, 3.1	2.5	1.8, 3.6
Quartile 2	1.6	1.4, 1.9	1.5	1.3, 1.9	2.1	1.7, 2.7	2.4	1.9, 3.2	3.4	2.7, 4.2
Quartile 1	2.3	2.0, 2.7	2.1	1.7, 2.6	2.8	2.3, 3.5	3.5	2.8, 4.4	4	3.4, 5.5
Incomplete grades	4.2	3.6, 4.9	4.2	3.3, 5.4	4.5	3.6, 5.7	6	4.1, 7.3	7.5	6.1, 9.1
Psychiatric outpatient care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.1, 1.4	1.4	1.1, 1.6	2.0	1.6, 2.4
Quartile 3	1.2	1.1, 1.2	1.1	1.0, 1.2	1.5	1.3, 1.7	1.8	1.6, 2.1	1.9	1.6, 2.3
Quartile 2	1.4	1.3, 1.5	1.4	1.3, 1.5	1.8	1.6, 2.0	1.9	1.7, 2.2	2.4	2.1, 2.8
Quartile 1	2.0	1.8, 2.1	1.8	1.6, 2.0	2.4	2.1, 2.6	2.7	2.4, 3.0	3.1	2.8, 3.5
Incomplete grades	3.5	3.2, 3.9	3.6	3.1, 4.1	4.0	3.4, 4.5	4.3	3.8, 4.9	5.0	4.3, 5.7
Primary care										
Average school grade										
Quartile 4	1 (REF)		1 (REF)		1.2	1.0, 1.4	1.5	1.2, 1.8	1.9	1.6, 2.4
Quartile 3	1.1	1.0, 1.2	1.1	1.0, 1.2	1.4	1.3, 1.6	1.7	1.4, 2.0	1.3	1.0, 1.7
Quartile 2	1.4	1.3, 1.5	1.3	1.2, 1.5	1.7	1.5, 1.9	1.8	1.5, 2.1	2.2	1.9, 2.6
Quartile 1	1.6	1.5, 1.8	1.6	1.4, 1.8	2.0	1.8, 2.3	2.1	1.8, 2.4	2.2	1.9, 2.6
Incomplete grades	2.3	2.1, 2.5	2.3	2.0, 2.7	2.6	2.3, 3.1	3.1	2.6, 3.6	3.0	2.6, 3.5

[b] Adjusted for birth year, sex, parental country of birth and parental socioeconomic position (education and income)

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