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Parental academic involvement in adolescence, academic achievement over the life course and allostatic load in middle age: a prospective population-based cohort study

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ABSTRACT

Background Parental involvement in their children's studies, particularly in terms of academic socialisation, has been shown to predict academic achievement, and is thus a candidate modifiable factor influencing life course socioeconomic circumstances. Socioeconomic disadvantage is thought to impact on health over the life course partly by allostatic load, that is, cumulative biological risk. We sought to elucidate the role of parental involvement at age 16 on the life course development of allostatic load.

Methods In a population-based cohort (365 women and 352 men, 67% of the eligible participants), we examined the association between parental involvement in their offspring's studies, measured by teacher and pupil ratings at age 16 and an allostatic load index summarising 12 physiological risk markers at age 43. Mediation through life course academic and occupational achievement was assessed by entering school grades, adult educational achievement and socioeconomic position at age 43 in a linear regression analysis in a stepwise manner and testing for mediation.

Results Parental interest in their offspring's studies during the last year of compulsory school—rather than the parent's social class or availability of practical academic support—was found to predict adult allostatic load ($\beta = -0.12$, 95% CI -0.20 to -0.05). Further adjustments indicated that academic achievement over the life course mediated a large part of the effect of parental interest on allostatic load.

Conclusions Parental interest in their offspring's studies may have protective effects by decreasing the likelihood of a chain of risk involving low academic achievement, low socioeconomic position and high accumulated physiological stress.

INTRODUCTION

Most health conditions are more common in lower compared with higher socioeconomic strata.^{1–2} Socioeconomic conditions are thought to impact on health over the life course partly through sustained and repeated activation of multiple physiological systems. Excessive amounts of such repeated activation, labelled Allostatic Load (AL),^{3–4} is hypothesised to lead to physiological dysregulation, which in turn may increase the risk of manifest disease. Although early life socioeconomic disadvantage has shown small effects on adult AL independently of adult conditions, the accumulation of socioeconomic disadvantage over the life course is robustly related to adult

AL⁵ and to other forms of health outcomes, for example, cardiovascular health.⁶ Nevertheless, the hardship encountered across the life course may still be rooted in early life conditions which set individuals on unfavourable life course trajectories, so-called social chains of risk,⁷ which eventually impact on health. It is therefore important to identify modifiable conditions in early life that are starting points for such chains of risk.

Particular forms of parental involvement in their offspring's schooling have been highlighted as important determinants of academic achievement. Involvement in the form of academic socialisation, such as parental interest, appears to incite the offspring's own interest and motivation in the academic field and promote both academic achievement during school years^{8–9} and adult educational attainment, beyond other factors known to influence academic success or failure, such as childhood social class and cognitive ability.¹⁰ Other forms of parental involvement, such as practical help with homework, are less consistently, or even negatively, related to achievement—possibly because they are attempts to compensate for pre-existing lower achievement, or because they may interfere with the child's development of autonomy.^{8–9}

Parental interest in their offspring's schooling has also been shown to be an independent predictor of adult health; teacher-rated parental interest in the child's studies and parents reading to the child relate to better adult self-rated health in young adulthood,^{11–12} and also to a lower risk of obesity and indications of diabetes in middle-age.¹³ Parental academic interest has also been shown to partially explain the inverse association between cognitive ability in childhood and adult mortality.¹⁴ Although it has been suggested that parental academic involvement may bridge the span of the life course through a pathway of academic achievement,¹² this has not been specifically investigated.

We therefore sought to elucidate the role of parental involvement in their offspring's studies at age 16 on the life course development of physiological stress. Our main hypothesis was that academic socialisation, measured by teacher-rated parental interest in their offspring's schooling, but not practical support, measured by student-rated parental help with homework assignments, would contribute to lower AL in adulthood by preventing a social chain of risk related to low socioeconomic status by promoting good academic achievement both

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in compulsory school and in higher education. We furthermore hypothesised that parental involvement would be related to, but have an effect independent of, parental social class.

METHODS

Population

The sample was based on the Northern Swedish Cohort, a 27-year prospective study comprising all pupils in the ninth grade of compulsory school living in Luleå in 1981, when the participants were 16 years of age (N=1083; 506 girls and 577 boys).¹⁵ Follow-up surveys were conducted in 1983, 1986, 1995 and 2008. In this report, data from the 1981 and 2008 surveys are presented. Of the original cohort, 1071 subjects were still alive in 2008, of which 1003 (93.7%) agreed to participate. Owing to non-response on one or more key measures (see below), the effective sample size of the present report is 717 (67% of those cohort members who were still alive).

Participants completed a comprehensive questionnaire at all follow-ups covering health, social and socioeconomic conditions and school/working conditions. The majority of the items originated from the Swedish Survey of Living Conditions¹⁶ and the Low-Income Study.¹⁷ In 1983, a structured interview was performed with the participants' main teachers regarding the participants' school environment and achievements. In 2008, a health examination was conducted,⁵ which included blood pressure, anthropometrics and the collection of blood samples after an overnight fast. The participants also performed saliva sampling four times during one weekday (at awakening, 15 min later, before lunch and at bedtime) using Salivettes for the assessment of cortisol.

Measurements

Parental social class was assessed by two questions put to the participants at age 16: *What is/was your father's occupation?* and *What is/was your mother's occupation?* Responses were coded according to the Swedish classification of social classes into working (blue-collar) class, lower white-collar class and upper white-collar class. We defined parental social class as the highest of the father's and the mother's social class, with the highest value indicating upper class.

Parental interest in their offspring's studies was assessed with a question about *Knowledge about the parents' interest in the pupil's studies*, which was asked of the main teachers regarding each participant in 1981. There were five response options ranging from 'probably very small' to 'probably very large'.

Help with homework assignments was based on the question *Can you get help with homework assignments when you need it?* with five response options from 'no, never' through 'yes, always' asked in the questionnaire of the participants themselves at age 16.

Mean grades at exit from compulsory school at age 16 were obtained from school records with the participants' permission. Grades were given on a scale from 1 through 5 and by the design normally distributed. The mean grades were thus also normally distributed and vary between 1 (the lowest possible) and 5 (the best possible) with 3.00 as the national mean.

Educational achievement was assessed at age 43 by the question in the participant questionnaire: *What is your education? State your highest education.* with the response options 'compulsory school', coded as 1, '2 year upper secondary school', coded as 2, '3 or 4 years of upper secondary school', coded as 3, 'basic academic degree (eg, bachelor)', coded as 5, and 'other post upper secondary education', coded as 4.

Socio-economic position was derived from the occupations stated by the respondents at age 43 and coded according to the socioeconomic classification system of Statistics Sweden.¹⁸ For the purpose of this study, this was recoded into five categories: unskilled manual workers, skilled manual workers, non-manual workers, technical/lower management and professionals/higher managers.

AL at age 43 was operationalised as an index used previously and described in detail by our research group,⁵ based on the following 12 biological parameters: systolic and diastolic blood pressure, body mass index (BMI), waist circumference, fasting glucose, total cholesterol, high-density lipoprotein cholesterol (HDL-C), triglycerides, apolipoprotein A1, apolipoprotein B, C reactive protein and cortisol area under the curve (AUC). Each parameter was divided into tertiles separately for women and men (coded 0, 1, 2), except for cortisol AUC, which was divided into sextiles and coded symmetrically (sextile 1 and 6=2, 2 and 5=1, 3 and 4=0). HDL-C was coded inversely (2, 1, 0). Subsequently, mean scores of the parameters were calculated within six physiological systems: cardiovascular regulation, body fat deposition, lipid metabolism, glucose metabolism, inflammation and neuroendocrine regulation. Pharmacological treatment was coded as 2 on the affected physiological system categories. Since most dropout on biological parameters was due to the failure to complete saliva cortisol sampling (n=130), those without valid cortisol data were assigned the value 1 on the neuroendocrine category, which was taken into account when forming the tertiles. Finally, the allostatic contributions of the physiological systems were summed up into an approximately normally distributed index (range 0–12), yielding the final measure of AL.

Statistical analysis

Sex differences were tested with Pearson χ^2 test and Student t test. Bivariate Pearson product moment correlation coefficients were calculated for all pairs of variables in the study. To examine if parental involvement was related to AL, we used hierarchical linear regression based on Z-transformed variables in order to obtain 95% CIs for standardised β coefficients. Since the outcome had been standardised separately for men and women, sex was not included in the analyses (after confirmation that there was no association between sex and AL). To test if parental involvement influences AL through academic achievement and employment grade, we entered the mediators in the hypothesised order of causality. If a variable reflecting a condition later in the life course predicts AL and attenuates the association between parental interest and the outcome, this is seen as evidence of mediation, a hypothesis we tested by the Sobel test of mediation. To investigate if there are differences in the patterns of association between women and men, we additionally performed sex stratified analyses. All analyses were carried out in IBM SPSS for Windows, V20.0.0, and all significance tests are based on two-sided tests.

RESULTS

There were 717 participants in the analytic sample, with approximately the same number of women and men (table 1). In total, 79% had parents whose interest in their offspring's education was rated as high or very high, and 55% had often or most of the time been able to get help with their homework assignment from their parent, again with no sex difference. Girls had significantly higher school grades than boys, whose average matched the national average. Women had significantly

Table 1 Descriptive statistics for the sample

Total N	Total 717	Women 365	Men 352	Test of sex difference
Parental social class N (%)				p=0.141
Upper class	70 (11)	36 (10)	43 (12)	
Middle class	379 (53)	206 (56)	173 (49)	
Working class	259 (36)	123 (34)	136 (39)	
Parental interest in offspring's studies, N (%)				p=0.921
Probably very large	306 (43)	154 (42)	152 (43)	
Probably large	260 (36)	136 (37)	124 (35)	
Probably neither particularly large nor particularly small	108 (15)	54 (15)	54 (15)	
Probably small	34 (5)	17 (5)	17 (5)	
Probably very small	9 (1)	4 (1)	5 (1)	
Help with homework assignment possible, N (%)				p=0.499
Yes, always	201 (28)	111 (30)	90 (26)	
Yes, often	192 (27)	94 (26)	98 (28)	
Sometimes	221 (31)	111 (34)	110 (31)	
No, seldom	64 (9)	33 (9)	31 (9)	
No, never	39 (5)	16 (4)	23 (6)	
Mean grade on leaving compulsory school, mean (SD)	3.14 (0.72)	3.29 (0.69)	3.00 (0.71)	p<0.0001
Educational achievement at age 43, N (%)				p<0.0001
Compulsory school, 9 years	48 (7)	21 (6)	27 (8)	
2-Year upper secondary school, 10–11 years	182 (25)	78 (21)	104 (30)	
3 or 4-Year upper secondary school, 12–13 years	137 (19)	53 (14)	84 (24)	
Other post upper secondary education	199 (28)	113 (31)	86 (24)	
Basic academic degree (eg, bachelor)	151 (21)	100 (27)	51 (14)	
Socioeconomic position at age 43				p<0.001
Unskilled manual	139 (19)	67 (18)	72 (20)	
Skilled manual	124 (17)	45 (12)	79 (22)	
Non-manual	103 (14)	67 (18)	36 (10)	
Technical, lower management	236 (33)	131 (36)	105 (30)	
Professionals and higher managers	115 (16)	55 (15)	60 (17)	

higher education and higher grade jobs, although slightly more men were professionals and higher managers.

Bivariate correlations between all studied variables (table 2) revealed a particularly strong association between parental interest in their offspring's studies and school grades when leaving compulsory school at age 16 ($r=0.53$). In univariate regression analyses on the whole sample (table 3, top panel), parental social class, parental interest in their offspring's studies at age 16, school grades when leaving compulsory school at 16, as well as educational achievement and socioeconomic position at age 43, were all significantly related to lower AL at age 43, whereas the possibilities of getting help with homework assignments were unrelated to the outcome (table 3). When parental interest in their offspring's studies was entered in model 1,

parental social class was rendered non-significant. Entering school grades in model 2 yielded a significant association with AL and also rendered parental interest non-significant. The Sobel test indicates highly significant mediation of the effect of parental interest through school grades (test statistic= -5.232 , $SE=0.020$, $p<0.0001$). Entering highest educational achievement at age 43 in model 3 also resulted in a significant association with AL and substantially attenuated the association between school grades and the outcome. The Sobel test indicates highly significant mediation both of the effect of school grades through educational achievement (test statistic= -4.673 , $SE=0.019$, $p<0.0001$) and of parental interest through educational achievement (test statistic= -4.301 , $SE=0.013$, $p<0.0001$). Entering socioeconomic position at age 43 in

Table 2 Bivariate Pearson correlations between all variables in the studies; women above the diagonal and men below

	SC	IS	HA	GR	ED	SEP	AL
Parental social class (SC)	1	0.28**	0.12*	0.23**	0.14**	0.15**	-0.10
Parental interest in offspring's studies (IS)	0.17**	1	0.08	0.53**	0.33**	0.30**	-0.11*
Help with homework assignments (HA)	0.20**	0.02	1	0.03	0.08	0.02	-0.05
Mean grade on leaving compulsory school (GR)	0.25**	0.53**	0.06	1	0.52**	0.50**	-0.22**
Educational achievement at age 43 (ED)	0.32**	0.31**	0.04	0.43**	1	0.58**	-0.13*
Socioeconomic position at age 43 (SEP)	0.31**	0.31**	0.10*	0.53**	0.63*	1	-0.15**
Allostatic load at age 43 (AL)	-0.06	-0.15**	-0.01	-0.19**	-0.24**	-0.20**	1

* $p<0.05$; ** $p<0.01$

Table 3 Linear regression relating factors influencing the socioeconomic life course at different ages to allostatic load at age 43

	Univariate	Model 1	Model 2	Model 3	Model 4
Whole sample					
Parental social class	-0.07 (-0.15 to -0.00)	-0.04 (-0.12 to 0.03)	-0.02 (-0.10 to 0.05)	-0.01 (-0.09 to 0.06)	-0.01 (-0.08 to 0.07)
Parents' interest in their offspring's studies at age 16 according to the teacher	-0.13 (-0.20 to -0.06)	-0.12 (-0.20 to -0.05)	-0.03 (-0.12 to 0.05)	-0.03 (-0.11 to 0.06)	-0.03 (-0.11 to 0.06)
Help with homework assignments at age 16 according to the student	-0.03 (-0.10 to 0.05)	-0.01 (-0.09 to 0.06)	-0.01 (-0.08 to 0.06)	-0.01 (-0.08 to 0.06)	-0.01 (-0.08 to 0.06)
Total school grade at age 16	-0.20 (-0.27 to -0.13)		-0.18 (-0.26 to -0.09)	-0.13 (-0.23 to -0.04)	-0.12 (-0.22 to -0.02)
Own highest education at age 43	-0.18 (-0.25 to -0.11)			-0.10 (-0.19 to -0.02)	-0.08 (-0.17 to 0.01)
Socioeconomic position at age 43	-0.17 (-0.25 to -0.10)				-0.05 (-0.15 to 0.04)
Adjusted R ²		0.016	0.037	0.044	0.044
Women					
Parental social class	-0.09 (-0.20 to 0.01)	-0.06 (-0.17 to 0.04)	-0.05 (-0.16 to 0.06)	-0.05 (-0.16 to 0.06)	-0.05 (-0.16 to 0.06)
Parents' interest in their offspring's studies at age 16 according to the teacher	-0.11 (-0.21 to -0.01)	-0.09 (-0.20 to 0.02)	0.00 (-0.12 to 0.12)	0.01 (-0.12 to 0.13)	0.01 (-0.12 to 0.13)
Help with homework assignments at age 16 according to the student	-0.05 (-0.15 to 0.05)	-0.04 (-0.14 to 0.07)	-0.04 (-0.14 to 0.06)	-0.04 (-0.14 to 0.09)	-0.04 (-0.14 to 0.07)
Total school grade at age 16	-0.19 (-0.29 to -0.08)		-0.18 (-0.30 to -0.05)	-0.16 (-0.28 to -0.03)	-0.14 (-0.23 to -0.00)
Own highest education at age 43	-0.12 (-0.22 to -0.02)			-0.05 (-0.16 to 0.07)	-0.02 (-0.15 to 0.10)
Socioeconomic position at age 43	-0.15 (-0.25 to -0.05)				-0.06 (-0.19 to 0.10)
Adjusted R ²		0.009	0.028	0.028	0.027
Men					
Parental social class	-0.06 (-0.16 to 0.05)	-0.03 (-0.14 to 0.08)	0.00 (-0.11 to 0.11)	0.04 (-0.07 to 0.15)	0.04 (-0.07 to 0.15)
Parents' interest in their offspring's studies at age 16 according to the teacher	-0.16 (-0.26 to -0.06)	-0.15 (-0.26 to -0.05)	-0.06 (-0.18 to 0.06)	-0.05 (-0.17 to 0.07)	-0.05 (-0.17 to 0.07)
Help with homework assignments at age 16 according to the student	-0.00 (-0.11 to 0.10)	0.01 (-0.10 to 0.12)	0.01 (-0.10 to 0.12)	0.01 (-0.10 to 0.11)	0.01 (-0.10 to 0.11)
Total school grade at age 16	-0.22 (-0.33 to -0.12)		-0.19 (-0.32 to -0.07)	-0.11 (-0.25 to 0.02)	-0.10 (-0.24 to 0.04)
Own highest education at age 43	-0.24 (-0.35 to -0.14)			-0.18 (-0.31 to -0.06)	-0.16 (-0.30 to -0.02)
Socioeconomic position at age 43	-0.20 (-0.30 to -0.10)				-0.05 (-0.18 to 0.09)
Adjusted R ²		0.018	0.041	0.062	0.061

All values are standardised regression coefficients (β) with 95% CIs.
 Bold characters signify a statistically significant ($p < 0.05$) result.

model 4 resulted in little attenuation of the association between school grades and AL, but yielded non-significant estimates for both socioeconomic measures.

Stratification by sex (table 3, middle and lower panels) showed that the main findings were consistent between women and men, but that the main effect of parental interest may have been somewhat stronger among boys. In women, the effect seems mainly to have been mediated through final school grades from compulsory school, whereas own educational achievement in adulthood seems to have been more important in men.

DISCUSSION

In this prospective, community-based cohort study, parental interest in their offspring's studies during the last year of compulsory school—rather than the parent's social class or availability of practical academic support—was found to predict adult AL, indicating a potential effect on physiological stress over the life course. Adjustment for school grades at graduation from compulsory school and adult educational achievement indicates that academic achievement over the life course mediates a large part of the effect of parental interest on AL. This confirms our hypotheses and suggests that parental interest in their offspring's studies, as an indicator of academic socialisation, may have long-term protective effects by preventing a chain of risk involving low academic achievement, low socioeconomic position and physiological dysregulation.

Parental involvement in their offspring's schooling has previously been a topic of interest mostly within educational and developmental psychology, as a determinant of academic achievement in childhood and adolescence,^{8–9} and only a few studies have examined prospective associations with adult educational attainment¹⁰ or of adult health.^{11–14} Our results mirror those of the psychological literature in that parental interest, signifying academic socialisation, but not help with homework, relating to practical involvement, is positively related to academic achievement in adolescence.⁹ Our findings extend these observations by illustrating how parental interest is reflected on the subsequent life course, by preventing a social chain of risk involving later low academic and occupational attainment and, in the end, cumulative biological risk in adulthood.

The virtually non-existent correlation between parental interest and help with homework might seem counterintuitive, but although it is impossible to know exactly what the teachers and students were thinking of when answering the respective questions, it could be due to several factors influencing the rating of homework help in different directions: On the one hand, parents who are interested in their offspring's studies should be more motivated to give practical help if needed compared with parents who are less interested, and it may also be that those who are interested are also more able as they may have pursued a more academic course in their own lives. On the other hand, parental help might be triggered by academic problems that the student has, and thus actually be negatively correlated with academic achievement in some cases, and as suggested by the literature, practical involvement of the parents is not necessarily a part of academic socialisation but can also negatively influence the child's autonomy and academic development.^{8–9} It should also be pointed out that help with homework assignments could also be offered by others than the parents, such as peers, teachers and older relatives, further diluting any correlation between help with homework assignments and teacher-rated parental interest. The latter is more likely to be influenced by the parents' direct interactions with the teacher, which may reflect the parents' attitudes towards education and the priority that they give to it.

Social chains of risk have been conceptualised as acting by trigger effects, that is, that the last link in the chain is necessary for health effects to manifest, and/or through additive effects, that is, that all links in the chain contribute to health effects, which is reminiscent of a cumulative risk model.⁷ Our results suggest that achievement in adolescence acts as a trigger for the health impact of parental involvement. Achievement in adolescence, in turn, seems to act both through triggering by setting an individual on an unfavourable academic trajectory, as well as through additive effects, possibly involving, for example, health behaviours or stressor exposure, which together impact on adult physiological functioning. Associations between parental academic involvement and adult health have generally been found to be partially explained by childhood factors, including academic test scores,¹¹ and completely explained by childhood and adult factors,^{12–13} with educational attainment regarded as the most important explanatory factor.¹² Previous findings are thus generally consistent with our results, but the lack of analyses in the literature explicitly examining an academic pathway makes it impossible to gauge whether the findings correspond in detail.

Previous studies of social chains of risk and adult health have mostly focused on the cascades set off by early life socioeconomic disadvantage.^{19–20} The observation that our results were not explained by early socioeconomic disadvantage emphasises that academic socialisation, for example, parents providing a stimulating environment and promoting academic motivation and aspiration, might be a means to set an individual on a favourable academic track and thereby counteract the health consequences of sustained socioeconomic disadvantage over the life course,⁵ even in the face of early disadvantage.

A major strength of this prospective study is that it is based on a stable cohort with very low attrition over the 27 years of follow-up. The cohort is population based and has in various comparisons been found to be representative of this age cohort of the Swedish population.¹⁵ Another strength is that three different types of data are used, decreasing the risk of common method variance: Parental interest in their offspring's studies was based on an interview with the main teacher at age 16. Availability of home assignment help in school was self-reported. Education and socioeconomic position were self-reported 27 years later. AL was operationalised as an index of clinically measured biological parameters which had first been divided into tertiles, thus emphasising variation within the asymptomatic spectrum, making reverse causality unlikely. Our study also has some limitations. Despite a very high overall response rate, a relatively large number of participants did not complete the medical screenings at age 43, which could lead to biased results. However, earlier analyses have shown that those with incomplete data were largely similar in both the history of adversity and SES across the life course,²¹ in blood pressure and BMI in adolescence, as well as in adult health behaviours.²² Using teacher evaluations of parental interest in their offspring's studies has the advantage of avoiding some of the social desirability effects that could have been expected if the question had been asked of the parents or the students, and has the further benefit of utilising the teachers' ability to compare parental interest between pupils. However, despite regular scheduled contacts between teachers and parents, teachers may not know exactly how interested the parents actually are, and their ratings could thus be confounded by, for instance, the student's social background, socially conditioned behaviour or actual academic achievements. In addition, we cannot rule out that the observed associations could partly be due to third variables rather than be causal. It is possible, for instance, that more intelligent children,

who are likely to do better in school, also motivate their parents to become more interested in their studies, creating a spurious association between parental interest and academic achievement. However, as earlier studies have found parental interest to predict academic achievement,^{11 12} it seems reasonable to assume that there is an effect. Imprecision would tend to attenuate the relationship with the outcome, whereas confounding could either attenuate or strengthen it. Further studies are needed to investigate the generalisability as the importance of both parental interest and education may vary substantially depending on the context.

What is already known on this subject

- Parental involvement in their children's studies, particularly in terms of academic socialisation, has been shown to predict academic achievement, a key factor for later socioeconomic circumstances. Socioeconomic disadvantage, in turn, is thought to impact on health over the life course partly by allostatic load, that is, sustained and repeated activation of multiple physiological systems.

What this study adds

- Parental interest in their offspring's studies—rather than parental social class or availability of practical academic support—was found to predict adult allostatic load, largely mediated by academic achievement over the life course. This suggests that early academic socialisation may prevent a chain of risk leading from low socioeconomic status in the family of origin to later life health problems.

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Contributors AH is the originator of the cohort used in this study. She collected the data together with UJ. HW had the original idea for this paper and developed the analyses together with PEG. HW ran the statistical analyses, and wrote the first and consecutive drafts of the paper together with PEG. PEG constructed the allostatic load index and reviewed the literature. All authors commented on and contributed to each version of the paper and approved the final version.

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Competing interests None.

Ethics approval This study was conducted with the approval of the Regional Ethical Review Board in Umeå and has conformed to the principles embodied in the Declaration of Helsinki.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The Northern Swedish Cohort is conducted at Umeå University. This longitudinal dataset has substantial potential for secondary analysis. These data are not freely available but collaborative ideas are welcome. Professor Anne Hammarström is the main contact person. The website with documentation for the cohort and detailed information about variables and publications is available at http://www.medfak.umu.se/english/research/research-projects/lulea_cohort_project/.

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