

Material deprivation and self-rated health: a multilevel study of adolescents from 22 European and North American countries

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Abstract

This cross-sectional study examined the combined and interactive effects of material deprivation and area deprivation on adolescent self-rated health, using data from the World Health Organization collaborative study 'Health Behaviour in School-aged Children 1997/1998'. Included in the present study were 94,915 11–15-year-old students from a total of 22 European and North American countries. Multilevel logistic regression analyses revealed significant additive main effects of individual material deprivation and area deprivation, but not interactive effects. The most deprived students had an odds ratio for self-rated poor health almost three times higher than the least deprived students. Area deprivation effects were stronger at the country level than at the school level, and stronger among 11-year-olds than among 13- and 15-year-olds. A combined 'individual and area deprivation' model predicted that the most disadvantaged 11-year-old students were eight times more likely to have poor self-rated health compared to the least disadvantaged student (OR (95% CI) = 7.96 (3.38, 18.75)). The findings highlight the multilevel effects of deprivation at the individual, local, and national level.

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Introduction

Social inequalities in mortality and morbidity are well established for both children (DiLiberti, 2000; Nelson, 1992; Singh & Yu, 1996) and adults (Mackenbach, Kunst, Cavelaars, Groenhof, & Geurts, 1997; Marmot et al., 1991). By contrast, the evidence for social inequalities in adolescent health is much less consistent.

Some studies have found social inequalities in adolescent health (Goodman, 1999; Halldorsson, Kunst, Kohler, & Mackenbach, 2000; Vanderlucht & Groothoff, 1995), whereas other studies have reported weak or non-existent inequalities (Macintyre & West, 1991; West, 1997; West, Macintyre, Annandale, & Hunt, 1990). The lack of consistent findings has led researchers to hypothesise that adolescence is a period of *social equalisation* in health (West, 1997). The assumption is that as young people increasingly earn independence, the influence of parental socio-economic status is reduced, and peers become a more important reference group.

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Equalisation is but one of several plausible explanations for the lack of consistent socio-economic differences in adolescent health. Methodological factors may also play an important role. Conventionally, socio-economic status in adolescence is classified according to the status of the head of the household, in terms of parental income, material deprivation, level of education, or occupation. Studies suggest that adolescent self-reports of parental occupation and education in a survey setting may be inaccurate (Currie, Elton, Todd, & Platt, 1997; Goodman et al., 2000). Self-report surveys reporting on parental education or occupation are characterised by high levels of missing data (Currie et al., 1997; Ensminger et al., 2000), indicating that a significant proportion of adolescents may lack knowledge about their parents' socio-economic status (SES), or do not wish to report on these indicators. From this perspective, inconsistent findings may reflect a low reliability and validity of conventional SES indicators, rather than social equalisation. In studies that have used *parental* reports of occupation, education, or income, relatively robust social inequalities in adolescents have been reported (Goodman, 1999; Halldorsson et al., 2000).

The lack of consistent findings of social inequalities in studies on adolescents may also be attributed to cross-national variations in the relationship between SES and health. Research on inequalities in adolescent health has largely been confined to samples for single countries (Vanderlucht & Groothoff, 1995; West, 1997), or a limited number of countries (Halldorsson et al., 2000). It is difficult to establish from these adolescent studies whether findings can be generalised to adolescent populations from other countries. For example, the fact that social inequalities have been present in studies of North American populations (Goodman, 1999; Starfield, Riley, Witt, & Robertson, 2002) and Nordic populations (Halldorsson et al., 2000) but not in populations from the UK (West, 1997) may reflect the fact that the magnitude of individual inequalities varies between countries. However, owing to the use of different indicators of socio-economic status across countries, and the different age compositions of samples, empirical studies of cross-national differences in adolescent inequalities have been difficult to conduct.

A third factor contributing to the relative absence of health inequalities in adolescent studies relates to the level of analysis. Owing to the fact that most studies have only focused on inequalities at the individual level, potentially important community level sources of inequalities in adolescent health may have been overlooked. The level of material wealth varies significantly between communities, which affects the general quality of housing, access to health care, and education. A recent review of such area deprivation effects on health found statistically significant effects in 23 of the 25

reviewed studies (Pickett & Pearl, 2001). However, none of the studies examined these effects within the transitional period from childhood to adolescence, leaving the issue of area deprivation in adolescence unresolved. Such area deprivation effects could occur at local and national levels. For example, in terms of child poverty, industrialised countries show substantial cross-national differences (Bradbury & Jäntti, 2001). These social differences suggest the need for investigations of how community level socio-economic differences affect adolescent health, not only at a local level but also at a national level.

The present study examined individual and community sources of inequalities in adolescent health through the use of a recently developed indicator of family affluence. The family affluence scale (FAS) (Currie et al., 1997) is a composite indicator of self-reported socio-economic status comprising three material indicators: number of holidays taken during the last year, family car ownership, and having one's own bedroom (Currie, 1998, 2001). Previous research suggests that this formative index, and similar indexes, are less subject to non-response than conventional protocols for adolescent reporting of parental occupational status or income (Currie et al., 1997; Wardle, Robb, & Johnson, 2002). In a survey setting, SES indicators that do not require adolescent reports of parental occupation, education, or income represent an interesting alternative approach to the study of socio-economic gradients in adolescent health, because such indicators may be less vulnerable to inaccurate reporting and missing data.

The family affluence scale is conceptually related to common indices of material deprivation (Carstairs & Morris, 1991) and home affluence (Wardle et al., 2002). A valuable property of this type of indicator is that it can be applied at multiple levels of analysis, enabling tests for both individual material deprivation and area deprivation effects. At the individual level, a low score indicates a materially deprived family, whereas a high score indicates family access to valued goods and services. In longitudinal studies, parental material wealth in early adolescence has been associated with self-rated good health as adults (Lundberg, 1997; Power, Matthews, & Manor, 1998). In a cross-sectional study on North American adolescent populations, the family material wealth dimension showed the most consistent association with indicators of morbidity (Goodman, 1999), including self-rated fair or poor health, depression, and obesity. These studies provide evidence that material wealth may be a subcomponent of SES with concurrent and prospective relationships with health.

In previous studies, scales that are highly similar to the FAS, such as the Carstairs Index and the Home Affluence Scale (Wardle et al., 2002), have been aggregated in order to indicate the level of area affluence or area deprivation. The external validity of such area

aggregation has been supported by reports of moderate to strong correlations between aggregate index scores and independent measures of area income and deprivation (McLoone & Ellaway, 1999; Wardle et al., 2002). In the present study, individual FAS scores were aggregated to the level of school and country, as indicators of area deprivation at these levels.

The present study examined the following research issues:

- (a) the relationship between individual material deprivation and self-rated health;
- (b) the cross-national variation and consistency of relationships between individual material deprivation and self-rated health;
- (c) the relationships between area deprivation and individual self-rated health; and finally,
- (d) the interactive effects of individual material deprivation and area deprivation on self-rated health.

Method

Sample

The study was undertaken in the context of the World Health Organization (WHO) collaborative study 'Health Behaviour in School-aged Children 1997/1998' (Currie, 1998; Currie, Hurrelmann, Settertobulte, Smith, & Todd, 2000), in which adolescents from 29 European and North American countries participated. The overriding goal of the 'Health Behaviour in School-aged Children 1997/1998' survey was to increase the understanding of the social context of health and health behaviour in young people. The target populations for the HBSC study are young people attending school in their 12th (11-year-olds), 14th (13-year-olds) and 16th (15-year-olds) year of life. A common research protocol describing sampling procedures was developed (Currie, 1998) prior to the data collection (Table 1)

The 'Health Behaviour in School-aged Children 1997/1998' data included 125,732 adolescents from 29 countries and regions. A total of 100,700 adolescents from 22 of these countries were included in the present study. Not included in the present study were the surveys from France, Germany, and the Russian Federation, where only subregional sampling was conducted. Similarly the survey from Greenland, was not included because the social structure and population size is highly different than the rest of the samples. The surveys from Poland and Estonia did not provide sufficient school identifiers to enable estimation of random school effects for these countries. As the research questions partly address school-level inequal-

ities, surveys from these countries were also excluded from the study. The survey in the Czech Republic did not include all indicators of the family affluence scale, and could not be included in the present study.

The sample was obtained through a complex multi-stage sampling procedure. The prescribed primary unit was the school class, with self-selection of students from these classes. However, owing to variations in the school systems between countries, national adaptations had to be made. For the majority of countries, the desired age group coincided with school entry, resulting in a homogeneous age composition within school classes. The strategy followed in these countries was to select one class per school within each age group to be covered. In a small number of samples (Flemish-speaking Belgium, French-speaking Belgium, England, Republic of Ireland, Switzerland, and the USA), the age composition of school classes was more heterogeneous, because some students repeated grades, and due to different standard ages for school entry. In this group of countries, school classes were deliberately over-sampled, and students matching the desired age range within these classes were selected. More detailed information about the sample and the sampling frame can be obtained elsewhere (Currie et al., 2000; NSD, 2000).

Given the multistage sampling procedure, non-response occurred at several levels, including school, school class, and student. The available documentation (NSD, 2000) provides detailed information on non-response at the level of school and student. The response rate (RR) at the school level was generally high, with a majority of countries being above 80%. The response rate at the individual level was generally higher, with a majority of countries being 85% or higher. Across the 22 countries, the average response rate was 80% at the school level, and 87% at the student level.

Due to missing data on key study variables, the final available study sample consisted of 94,915 students (51.7% girls), including 32831 11-year-olds, 32297 13-year-olds, and 29787 15-year-olds.

Procedure

Data were collected in accordance with a standardised protocol (Currie, 1998). Teachers received instructions on how to administer the survey. Questionnaires were distributed during ordinary class hours. Pupils were informed that their participation was voluntary, and that responses were treated as anonymous. Each student was allowed 45 min to complete the survey.

Measurements

The family affluence scale was a composite of three indicators:

Table 1
Sample details

Sample	Data collection	11-year-olds	13-year-olds	15-year-olds
Austria	March 1998	1421	1518	1376
Belgium-Flemish	March 1998	1730	1535	1559
Belgium-French	January 1998	982	883	640
Canada	October 1997	1856	2308	2403
Denmark	March 1998	1713	1807	1546
England	Nov 1997	2279	2222	1872
Finland	March 1998	1691	1628	1545
Greece	March 1998	1662	1315	1322
Hungary	Nov 1997	1435	1356	818
Israel	May 1998	2299	1370	1385
Latvia	Nov 1997	1311	1199	1265
Lithuania	March 1998	1566	1512	1435
Northern Ireland	Feb 1998	1068	1197	1081
Norway	Dec 1997	1733	1623	1670
Portugal	March 1998	1217	1259	1245
Republic of Ireland	Feb 1998	1495	1442	1457
Scotland	March 1998	2092	1813	1727
Slovakia	Jan 1998	1403	1543	843
Sweden	Nov 1997	1294	1357	1151
Switzerland	March 1998	1668	2020	1832
USA	April 1998	1558	1803	1808
Wales	Feb 1998	1539	1571	1427
Total sample	Oct 97–May 98	35012	34281	31407

- ‘Does your family have a car or a van?’ [‘No’ (0), ‘Yes’ (1), ‘Yes, two or more’ (2)];
- ‘Do you have your own bedroom?’ [‘Yes’ (1), ‘No’ (0)]; and
- ‘During the past year, how many times did you travel away on holiday (vacation) with your family?’ [‘Not at all’ (0), ‘Once’ (1), ‘Twice’ (2), ‘More than twice’ (3)].

When the three indicators are combined to produce a linear composite score, the family affluence scale ranges from 0 (lowest affluence) to 6 (highest affluence).

Self-rated health was measured by the single item: ‘How healthy do you think you are?’ The response options were ‘Very healthy’ (1), ‘Quite Healthy’ (2), and ‘Not very Healthy’ (3). In the present study, self-rated poor health was defined as a response of ‘Not very healthy’ (coded 1).

Perceived Affluence was measured by the single item: ‘How well off do you think your family is?’ Response options were ‘Very well off’ (1), ‘Quite well off’ (2), ‘Average’ (3), ‘Not very well off’ (4), and ‘Not at all well off’ (5).

Parental support was measured by two composite scores of parental communication and parental involvement. The parental communication composite was the sum of two items: ‘How easy is it for you to talk to the

following persons about things that really bother you? (a) Father, (b) Mother. Response options were: ‘Very easy’ (1), ‘Easy’ (2), ‘Difficult’ (3), and ‘Very difficult’ (4). Parental involvement was measured by a composite of three items: ‘If I have problems at school, my parents are ready to help’, ‘My parents are willing to come to school to talk to teachers’, and ‘My parents encourage me to do well at school’. Response options were as follows: ‘Always’ (1), ‘Often’ (2), ‘Sometimes’ (3), ‘Rarely’ (4), and ‘Never’ (5).

Family structure was derived from responses to the item ‘I live with (a) Mother, (b) Father, (c) Stepmother, (d) Stepfather’. Response options were ‘Yes’ (1) and ‘No’ (2).

Three separate health behaviours were measured: physical exercise, daily smoking, and alcohol use. Physical exercise: ‘Outside school hours, how often do you usually exercise in your free time, so much that you get out of breath or sweat?’ ‘Every day’ (1), ‘4–6 times a week’ (2), ‘2–3 times a week’ (3), ‘Once a week’ (4), ‘Once a month’ (5), ‘Less than once a month’ (6), and ‘Never’ (7). Alcohol use: At present, how often do you drink anything alcoholic such as beer, wine or spirits?’ ‘Every day’ (1), ‘Every week’ (2), ‘Every month’ (3), ‘Rarely’ (4), ‘Never’ (5). Smoking: ‘How often do you smoke at present?’ ‘Every day’ (1); ‘At least once a week, but not every day’ (2), ‘Less than once a week’ (3), and ‘I do not smoke’ (4).

Statistical analyses

The software MlwiN ver. 1.10.07 (Rasbash et al., 2000) was used in the modelling of individual material deprivation and area deprivation effects on self-rated health. In the present study, individuals are clustered within schools within countries, suggesting that a three-level model including variances at the level of pupil, school, and country may adequately reflect the data structure. By performing a multilevel analysis, the clustered structure of the data is taken into account, and accurate estimates of individual standard errors are obtained. Since the dependent variable in the present study was dichotomised, a logistic multilevel model with second-order penalised quasi-likelihood (PQL2) estimation was used. Compared to marginalised first-order estimation, the PQL2 method provide more accurate variance estimates when the number of higher level units (i.e. countries) is small relative to the number of lower level units, in this case students and school classes (Rasbash et al., 2000). Walds chi-square test was used for tests of statistical significance, since the $-2 \log$ likelihood test statistic is inconsistent for multilevel logistic models.

Transformation of variables. A central assumption of the present study is that the family affluence scale has at least ordinal measurement properties, and that the scores of the scale can be used to rank individuals and groups along a latent continuum of material wealth. Ridit transformation is a widely used approach to SES scales with ordinal measurement (Mackenbach & Kunst, 1997; Manor, Matthews, & Power, 1997). In ridit transformation, ordered categorical responses are converted to cumulative probabilities. In the present study, the family affluence scale was ridit transformed to yield a continuous material deprivation score ranging between 0 and 1, with a whole sample mean of 0.5. The material deprivation score reflects the proportion of adolescents with a higher level of family affluence. A student with a material deprivation score of 1 is at the bottom of the material hierarchy (100% of the students have a higher level of affluence), whereas a student with a score of 0 is at the top of the material hierarchy (no students have a higher level of affluence). In a prediction model with self-rated health as a dependent variable, the regression coefficient of the material deprivation score can be directly interpreted as the predicted health difference between the least deprived individual and the most deprived individual. This valuable property has been exploited in a series of studies using ordinal SES ratings (Cavelaars et al., 1998; Mackenbach & Kunst, 1997; Manor et al., 1997).

The above regression-based measures rest on the assumption of linear relationships. Tests of non-linearity between material deprivation and self-rated health were performed for the whole sample, and separately for each

country. For all age groups, there was a small, but statistically significant quadratic non-linearity in the relationship between material deprivation scores and self-rated poor health. The non-linearity was characterised by a slightly higher than expected probability of self-rated poor health in adolescents at extremely high levels of material deprivation. The observed non-linearity represents a violation of the linear assumption. However, a visual inspection of the predicted logits revealed only minor departures from that of a linear relationship. This suggests that the statistically significant non-linearity is partly a reflection of the high statistical power of the present study. Adding to this conclusion, when linearity was tested separately for each country, non-linear terms did not achieve statistical significance in any of the countries. Overall, the tests of non-linearity suggest that the pooled analysis may involve a small bias in the linear regression estimates. This needs to be considered when interpreting the data. For practical purposes, however, the linear approximation should not severely bias the findings.

Weighting of data. Several kinds of weighting may be relevant in multilevel analyses of cross-national data, including equal weighting, weighting by the inverse of sample size, and weighting by population size. The present study used equal weights for all units within each level. Using equal weights is statistically more efficient than inverse sample weighted analysis, and when the sample sizes per country are homogenous, equal weighting introduces essentially no bias.

Weighting by population size was considered to be inappropriate in the present context. First, the primary goal of the present study was to provide a theoretical model of deprivation effects, and not to provide a population estimate. Second, the population sizes of the sampled countries are highly heterogeneous. For example, in the USA, the eligible population surpassed nine million students. By contrast, the comparable population in Norway was 150,000 students. Weighting by country population would thus allow very little influence on data from countries with small populations.

Results

Descriptive statistics

Table 2 shows the frequency of self-rated poor health and mean relative family affluence across demographic subgroups. For the total sample, 6.7% rated their health as poor. Self-rated poor health was more frequently reported by girls across all age groups. Self-rated health showed minor differences across family structure, but students not living with their parents were more likely to report self-rated poor health (11.4%). The material deprivation score showed only minor differences across

Table 2
Descriptive statistics for study variables

	<i>N</i>	Self-rated poor health (%)	Material deprivation score (mean)
Total sample	94,915	6.7	0.5
<i>Gender</i>			
Boys	45,901	4.9	0.49
Girls	49,014	8.4	0.51
<i>Age group</i>			
11-year-olds	32,831	4.9	0.49
13-year-olds	32,297	6.3	0.49
15-year-olds	29,787	9.2	0.52
<i>Family structure</i>			
Intact	71,576	6.2	0.48
Reconstituted	8189	8.0	0.51
Single parent	12,863	8.2	0.59
Two families	890	8.9	0.49
Not living with parents	739	11.4	0.54
Non-classifiable	658	7.1	0.53

gender and age group, but stronger variation across family structure. Adolescents from single-parent families had the highest material deprivation score, whereas adolescents from intact two-parent families had the lowest material deprivation score.

Multilevel variation in self-rated health

To examine the scope for multilevel modelling, a three-level logistic random intercept model was carried out for self-rated health, with separate variance terms for individuals, schools, and countries. As shown in Table 3, self-rated poor health differed significantly between individuals, between schools, and between countries. Expressed as intraclass correlations (ICC), the contextual variation was comparatively stronger for the country level (ICC = 0.08–0.10) than for the school level (ICC = 0.03–0.06). Overall, the magnitude of school-level and country-level differences indicated scope for multilevel modelling of self-rated health, in particular for the country-level effects.

Individual material deprivation and self-rated health

The results of a saturated model including all main effects—two- and three-way interaction between age group, gender and material deprivation—revealed a statistically significant material deprivation by age group interaction, with decreasing effects across age groups. Based on these results, it was decided to run all subsequent models separately by age group.

The relationship between material deprivation and self-rated poor health could reflect a number of structural, behavioural, and psychosocial confounding factors. To examine the robustness and nature of the relationship between material deprivation and self-rated health, a series of nested multilevel logistic models was carried out, in which adjustment was made for an increasing number of family related structural, behavioural, and psychosocial confounding or mediating variables. As a baseline model, the first model (M1) controlled for family structure, and gender.

The second model (M2) included additional control for the potential mediating role of smoking, alcohol use and physical exercise in self-rated health, in line with previous research indicating a relationship between parental socio-economic status and adolescent health behaviours (Tuinstra, Groothoff, VandenHeuvel, & Post, 1998). As shown in Table 4, the magnitude of the relationship between material deprivation and self-rated poor health was further reduced when health behaviours were controlled for.

Model 3 (M3) further adjusted for the role of parental support, as previous research have indicated a role for psychosocial family functioning in the relationship between material deprivation and health (Beiser, Hou, Hyman, & Tousignant, 2002). It can be seen from Table 4 that when parental support was adjusted for, the odds ratios of material deprivation became further reduced compared to the previous models.

In the last model (M4), adjustment was also made for perceived affluence, as the association between material deprivation and self-rated health to some extent could reflect the stressful experience of perceiving oneself as being non-affluent in adolescence. The adjustment for perceived affluence resulted in a further reduction of the odds ratio between material deprivation and self-rated poor health. Controlling for perceived affluence led to a further reduction in the odds ratio of self-rated poor health. Notably, among the group of 15-year-olds, the OR of self-rated poor health was not significant.

Cross-national consistency of material deprivation effects

To test whether the individual relationship between material deprivation and self-rated poor health varied systematically across countries, a random coefficient model was estimated for each age group. In the random coefficient model, the regression coefficient of material deprivation was allowed to vary between countries. The results from the statistical test of a random coefficient model are shown in Table 5. It can be seen that the random coefficient variance of material deprivation did not achieve statistical significance for any of the age groups, suggesting no evidence for cross-national variation in the relationship. Fig. 1 shows the predicted slope for individual material deprivation on self-rated health

Table 3
Logistic random intercepts variance component model for the log odds of self-rated poor health

Age group	Intercept (SE)	Random intercept variance			Intraclass correlation	
		Individual	School (SE)	Country (SE)	School	Country
11-year-olds	−3.22 (0.14)	1 —	0.24 (0.05)	0.37 (0.11)	0.06	0.09
13-year-olds	−2.95 (0.13)	1 —	0.23 (0.04)	0.37 (0.12)	0.06	0.10
15-year-olds	−2.46 (0.12)	1 —	0.10 (0.03)	0.30 (0.10)	0.03	0.08

Table 4
Odds ratios of self-rated poor health by level of individual material deprivation (range 0–1), with adjustment for confounding variables

Age group	M1 gender and family structure	M2 M1 + health behaviours	M3 M2 + parental support	M4 M3 + perceived affluence
	OR 95% CI	OR 95% CI	OR 95% CI	OR 95% CI
11-year-olds	2.66 (2.19, 3.23)	2.41 (1.98, 2.94)	2.00 (1.64, 2.45)	1.68 (1.37, 2.06)
13 year-olds	2.52 (2.10, 3.01)	2.31(1.92, 2.77)	1.92 (1.60, 2.32)	1.47 (1.21,1.78)
15-year-olds	2.10 (1.79, 2.46)	1.78 (1.51, 2.10)	1.49 (1.27,1.76)	1.15 (0.97, 1.37)

Table 5
Model summary for the random part of random intercepts and coefficient model of material deprivation on self-rated health, with Walds test of significance for random coefficient variance at country level

Age group	Random country level variance components			Wald ₍₂₎	P
	Intercept (SE)	Coefficient (SE)	Covariance (SE)		
11-year-olds	0.33 (0.11)	0.08 (0.09)	0.01 (0.07)	0.854	NS
13-year-olds	0.34 (0.11)	0.01 (0.05)	0.02 (0.06)	0.115	NS
15-year-olds	0.31 (0.10)	0.01 (0.04)	−0.09 (0.05)	4.521	NS

NS—Not significant at the 0.05 level of significance.

for a model allowing for random coefficient variation. Each line represents the prediction line for a country. The almost parallel lines demonstrate that although countries differed substantially in their log odds of self-rated poor health, the relationship between material deprivation and self-rated health was highly uniform across countries.

Cross-level effects of area deprivation

To investigate the scope for modelling of area deprivation effects, a multilevel random intercept model

was run for the material deprivation score. In results not reported here, the random intercept model of material deprivation revealed a significant variation in material deprivation scores across schools and countries, with intraclass correlations at 0.06 and 0.09 for the school and country levels, respectively.

The fact that material deprivation scores differed not only between students, but also between schools and between countries, indicated that the material deprivation score to some extent reflected the area deprivation in a school or in a country. To examine potential area deprivation effects, the residual scores from the variance

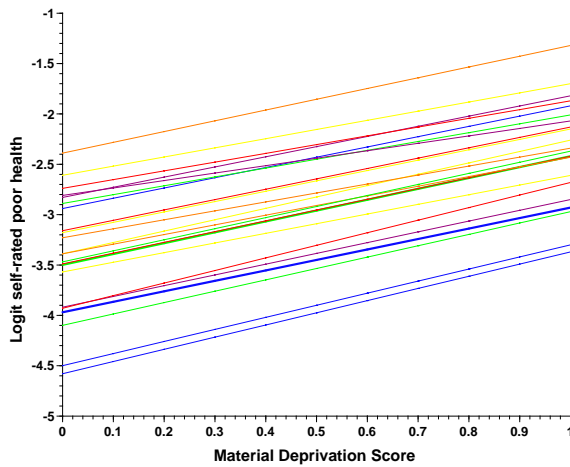


Fig. 1. Random coefficient model of material deprivation and log odds self-rated poor health from random coefficient model, with separate prediction lines for each country.

component model were used as indicators of area deprivation at the school and country level, respectively. Importantly, the residuals are decomposed, and not correlated across levels. By contrast, a simple aggregation of raw scores may confound variation across levels.

To fix the school- and country-level residuals to a common scale, ridit transformation was used, to preserve rank-order measurement level. For the schools, an area deprivation score of 1 indicated the most deprived school area, with a whole sample expected average score of 0.5. Conversely, a school with a score of 0 would represent the least deprived school area. The same scoring was applied for countries, with scores ranging from 0 (least deprived country) to 1 (most deprived country).

Table 6 shows the results of a multilevel logistic regression analysis, with area deprivation at the country and the school level as predictors of self-rated poor health. Two regression models were tested. The first model estimated the unadjusted OR of area deprivation on self-rated health. In the second model, adjustment was made for individual compositional effects such as health behaviours and parental support, and individual material deprivation. The adjustment was motivated by the argument that area deprivation effects on individual health outcomes may result artifactually from pure aggregation of individual level relationships. It can be seen from Table 6 that an 11-year-old student from a country with the highest area deprivation had a risk of self-rated poor health more than three times higher than students from the least materially deprived country. The higher risk for students from countries ranked as having the highest area deprivation was maintained after controlling for individual level of family affluence,

Table 6

Odds ratios (OR) of self-rated poor health by level of area deprivation (range 0–1) at country and school level

Area deprivation	M1 unadjusted	M2 adj. For individual material deprivation and compositional effects
	OR 95% CI	OR 95% CI
<i>Country deprivation</i>		
11-year-olds	3.12 (1.44, 6.76)	2.42 (1.12, 5.23)
13-year-olds	2.35 (1.01, 5.47)	1.87 (0.77, 4.50)
15-year-olds	1.55 (0.69, 3.49)	1.37 (0.57, 3.30)
<i>School deprivation</i>		
11-year-olds	1.31 (1.07, 1.60)	1.19 (0.97, 1.45)
13-year-olds	0.99 (0.82, 1.20)	0.92 (0.76, 1.11)
15-year-olds	1.14 (0.98, 1.32)	1.02 (0.88, 1.19)

health behaviours, parental support, and perceived affluence. This indicates that the area deprivation effects were not simply aggregates of individual level relationships.

To test whether the impact of individual affluence was moderated by area deprivation, a model including cross-level interaction terms of individual affluence by area deprivation was specified. In results not reported here, none of these cross-level interaction terms achieved statistical significance. These results were consistent with results from the random coefficient model, in that the relationship between individual affluence and self-rated health were highly consistent across countries, including countries with different levels of area deprivation.

To cross-validate the area deprivation effects at the country level, an ecological analysis was performed at the country level, including gross domestic product (GDP) per capita of 1997 as an independent cross-validation criterion. The result from the ecological analysis is shown in Table 7. It can be seen that countries' area deprivation score was highly correlated with countries' GDP per capita, in both nominal and ranked versions. Further, the magnitude and pattern of relationships with self-rated health were highly consistent across the different socio-economic indicators, with strong correlations between GDP and country level of self-rated poor health among 11-year-olds, and substantially weaker correlations with country level of self-rated poor health among 13- and 15-year-olds.

Joint individual and area deprivation effects

The previous multilevel analysis suggested that the effects of individual material deprivation and area

Table 7
Ecological analysis of relationships (Pearson-r) between country level indicators of material wealth and self-rated poor health ($n = 22$)

	1	2	3	4	5
1 Area deprivation score (FAS)					
2 Gross domestic product 1997 ^a	−0.70***				
3 Rank GDP 1997	−0.70***	0.98***			
4 Self-rated poor health 11-year-olds ^b	0.58**	−0.67***	−0.69***		
5 Self-rated poor health 13-year-olds ^b	0.42*	−0.50*	−0.57**	0.84***	
6 Self-rated poor health 15-year-olds ^b	0.25 ns	−0.31 ns	−0.39 ns	0.71***	0.94***

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Note: ns—non-significant at the 0.05 level of significance.

^aSource UNDP.

^bLogit scale.

Table 8

Odds ratio of self-rated poor health for joint effects of highest material deprivation vs. lowest material deprivation, with predicted probability of self-rated poor health for each extreme group

Age group	% Self-rated poor health in extreme subgroup (95% CI)		Combined effects of deprivation OR 95 CI%
	Least deprived ^a	Most deprived ^b	
11-year-olds	1.4 (0.9, 2.3)	10.0 (6.5, 14.9)	7.96 (3.38, 18.75)
13-year-olds	2.3 (1.4, 3.6)	9.1 (6.0, 13.7)	4.33 (1.81, 10.35)
15-year-olds	4.3 (2.7, 6.7)	11.5 (7.5, 17.3)	2.93 (1.28, 6.70)

^aPredicted probability of self-rated poor health in least-deprived student, in least-deprived school, in least-deprived country.

^bPredicted probability for the most-deprived student, in the most-deprived school, in the most-deprived country.

deprivation were additive. To demonstrate the combined prediction of individual and area deprivation the joint odds ratio of self-rated poor health was computed through the exponential of the joint log odds. The result from this computation represents the odds ratio of self-rated poor health of the most deprived student (score 1) in the most deprived school (score 1) in the most deprived country (score 1), as compared to the least deprived student (score 0) in the least deprived school (score 0) in the least deprived country (score 0). As can be seen in Table 8, among 11-year-olds, the most deprived student had a risk of self-rated poor health almost eight times higher than the least deprived student. For the other age groups, the predicted differences between the two groups were substantially weaker, but even for 15-year-olds, the most deprived would have a risk for self-rated poor health almost three times higher than the least deprived.

Discussion

The present study extends previous research in several major ways. First, by addressing both individual and contextual sources of adolescent health inequalities, the present study provides a more comprehensive account of such inequalities than previous adolescent research,

which has typically focused on individual sources of inequality. Second, the study demonstrates the usefulness of a new self-report indicator of family affluence that enables both within- and between-community analysis of material deprivation. Finally, the results of the study are highly relevant to previous hypotheses on equalisation in adolescence.

According to the social equalisation hypothesis, social inequalities should largely disappear or weaken in the transition from childhood to adolescence, only to re-emerge in late adolescence (West, 1997). In partial consistency with the social equalisation hypothesis, the results did suggest a developmental pattern in health inequalities, at both the individual and the community level. However, the pattern was more gradual across age groups, indicating a slower and more long-term process. It seems more appropriate to label the developmental pattern in the present study as 'reduction of inequalities' rather than 'equalisation'.

In general, social inequalities at the individual level were remarkably consistent across countries, suggesting that individual inequalities in adolescent health may be the result of processes that are relatively independent of the absolute economic conditions in a country. Material deprivation was just as strongly related to self-rated poor health in countries historically known to be wealthy, such as the Nordic countries, than in other

countries. This pattern is consistent with other studies that have indicated social inequalities in adolescent self-rated health, and also in the Nordic countries (Hall-dorsson et al., 2000). The cross-national consistency found in the present study suggests that the inconsistent findings of previous studies to some extent reflect method variance. When data collection procedures, sampling, and measurement are standardised, the SES-health relationships are highly uniform across countries.

Social inequalities in self-rated health were demonstrated for age groups that were in developmental transition. Although young people increase their level of autonomy and become more independent from their family during adolescence, the present findings indicate a very persistent impact of individual material deprivation. These findings support previous cross-sectional work, in that family material wealth may be an important subcomponent of SES (Goodman, 1999). Parental reports of family income have shown consistent association with indicators of adolescent self-rated health, obesity, and depression (Goodman, 1999). Also, indicators of family material wealth in early adolescence have been associated with long-term social inequality in self-rated health at both 23 and 33 years of age (Power et al., 1998). In this context, family affluence could be regarded as an important marker of social reproduction of inequalities in health.

The present study identified some of the pathways that could mediate the impact of individual material deprivation. Relationships between material deprivation and self-rated health were significantly reduced after taking into account psychosocial factors, health behaviours, and perceived affluence. Although these factors may be regarded as confounders of the relationship between material deprivation and self-rated health, it is also possible to regard these factors as potential mediators of the relationship. Material deprivation may not directly cause self-rated poor health, but may serve as an important stratification mechanism for a matrix of processes that are of importance to health, including health behaviours and parental support.

One of the major findings of the present study was that even when individual levels of material deprivation and other compositional differences were taken into account, adolescents living in relatively deprived countries had a higher risk of self-rated poor health during early adolescence than those in less-deprived countries. Area deprivation effects have been studied in previous research as a local area phenomenon, defined by postcode sectors, electoral ward, and census tracts, but the present study indicates that such community effects may also occur in larger geographical units. In fact, the evidence for area deprivation effects was most consistent at the country level, where the same pattern was found using multiple indicators of area deprivation and wealth. In the group of 11-year-olds, these cross-level effects

remained after controlling for compositional effects and individual differences in family affluence, indicating that the cross-level effects were more than simple aggregates of individual relationships.

The comparatively weak evidence for area deprivation effects at the school level is consistent with previous studies on local level area deprivation in adults. These studies have in general found weak effect sizes of area deprivation after controlling for individual SES (Pickett & Pearl, 2001). In addition, methodological factors may also have contributed to the relatively weak effects at the school level. Importantly, the sampling scheme of the present study was not designed to be representative of schools, since single classes for each age group were sampled. As such, the present aggregate school indicators may not provide sufficiently accurate estimates of area deprivation at the school level.

The present findings are highly relevant for the measurement of SES in adolescent self-report surveys. At an individual level, previous work has demonstrated that adolescent self-reports of parental educational, occupational level or social class may be unreliable (Ensminger et al., 2000; Goodman et al., 2000), thus underscoring the need for age-appropriate measures of SES in adolescent self-report studies. The high consistency of relationships between the FAS and self-rated poor health across countries provides evidence that the family affluence scale may be particularly valuable in cross-national research and multilevel research, where comparability is essential.

The findings also suggest that the family affluence scale may be used at an aggregate level as an indicator of area deprivation. The validity of such an approach to measurement was more convincing at the country level, for which the results obtained with the aggregation of the FAS paralleled those obtained with the countries' GDP. When interpreting the magnitude of effects, it is important to consider that the area deprivation effects were achieved through indicators with rank order properties. Rank level measurement restricts the range of variation and is associated with less statistical power than analysis with indicators having interval or ratio properties. As such, the observed magnitude of area deprivation effects may represent a conservative estimate of the real population value. Future validation studies should address whether the family affluence scale also exhibits interval properties of measurement.

In conclusion, the present study highlights the strong combined effects of material deprivation at individual, local, and national level on early adolescents' self-rated health. European and North American adolescents show substantial health inequalities, related to their material standards at home, in their school, and in their country. The multilevel sources of these health inequalities strongly indicate that public health policies need to

incorporate individual, local, and national political targets for intervention.

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References

- Beiser, M., Hou, F., Hyman, I., & Tousignant, M. (2002). Poverty, family process, and the mental health of immigrant children in Canada. *American Journal of Public Health, 92*(2), 220–227.
- Bradbury, B., & Jäntti, M. (2001). Child poverty across the industrialised world: Evidence from the Luxembourg Income Study. In K. Vleminckx, & T. Smeeding (Eds.), *Child well-being, child poverty, and child policy in modern nations*. Bristol: The Policy Press.
- Carstairs, V., & Morris, R. (1991). *Deprivation and health in Scotland*. Aberdeen: Aberdeen University Press.
- Cavalaars, A. E. J. M., Kunst, A. E., Geurts, J. J. M., Crialesi, R., Grotvedt, L., Helmert, U., Lahelma, E., Lundberg, O., Matheson, J., Mielck, A., Mizrahi, A., Mizrahi, A., Rasmussen, N. K., Regidor, E., Spuhler, T., & Mackenbach, J. P. (1998). Differences in self-reported morbidity by educational level: A comparison of 11 Western European countries. *Journal of Epidemiology and Community Health, 52*(4), 219–227.
- Currie, C. (1998). *Health behaviour in school-aged children. A WHO cross-national survey (HBSC). Research protocol for the 1997–1998 study*. Edinburgh: University of Edinburgh.
- Currie, C. (2001). Socioeconomic circumstances among school-aged children in Europe and North America. In K. Vleminckx, & T. Smeeding (Eds.), *Child well-being, child poverty and child policy in Modern Nations: What do we know?* (pp. 347–364). Bristol: The Policy Press.
- Currie, C. E., Elton, R. A., Todd, J., & Platt, S. (1997). Indicators of socioeconomic status for adolescents: The WHO health behaviour in school-aged children survey. *Health Education Research, 12*(3), 385–397.
- Currie, C., Hurrelmann, K., Settertobulte, W., Smith, R., Todd, J. (Eds.) (2000). *Health and health behaviour among young people*, WHO Copenhagen.
- DiLiberti, J.H. (2000). The relationship between social stratification and all-cause mortality among children in the United States: 1968–1992. *Pediatrics, 105*(1), art. no.–e2.
- Ensminger, M. E., Forrest, C. B., Riley, A. W., Kang, M. S., Green, B. F., Starfield, B., & Ryan, S. A. (2000). The validity of measures of socioeconomic status of adolescents. *Journal of Adolescent Research, 15*(3), 392–419.
- Goodman, E. (1999). The role of socioeconomic status gradients in explaining differences in US adolescent's health. *American Journal of Public Health, 89*(10), 1522–1528.
- Goodman, E., Amick, B. C., Rezendes, M. O., Levine, S., Kagan, J., Rogers, W. H., & Tarlov, A. R. (2000). Adolescent's understanding of social class: A comparison of white upper middle class and working class youth. *Journal of Adolescent Health, 27*(2), 80–83.
- Halldorsson, M., Kunst, A. E., Kohler, L., & Mackenbach, J. P. (2000). Socioeconomic inequalities in the health of children and adolescents—a comparative study of the five Nordic countries. *European Journal of Public Health, 10*(4), 281–288.
- Lundberg, O. (1997). Childhood conditions, sense of coherence, social class and adult ill health: Exploring their theoretical and empirical relations. *Social Science & Medicine, 44*(6), 821–831.
- Macintyre, S., & West, P. (1991). Lack of class variation in health in adolescence: An artefact of an occupational measure of social class? *Social Science & Medicine, 32*(4), 395–402.
- Mackenbach, J. P., & Kunst, A. E. (1997). Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Social Science & Medicine, 44*(6), 757–771.
- Mackenbach, J. P., Kunst, A. E., Cavelaars, A. E., Groenof, F., & Geurts, J. J. (1997). Socioeconomic inequalities in morbidity and mortality in western Europe. The EU Working Group on socioeconomic inequalities in health. *Lancet, 349*(9066), 1655–1659.
- Manor, O., Matthews, S., & Power, C. (1997). Comparing measures of health inequality. *Social Science & Medicine, 45*(5), 761–771.
- Marmot, M. G., Smith, G. D., Stansfeld, S., Patel, C., North, F., Head, J., White, I., Brunner, E., & Feeney, A. (1991). Health inequalities among British civil servants: The Whitehall II study. *Lancet, 337*(8754), 1387–1393.
- McLoone, P., & Ellaway, A. (1999). Postcodes don't indicate individuals' social class. *British Medical Journal, 319*(7215), 1003–1004.
- Nelson, M. D. (1992). Socioeconomic-status and childhood mortality in North-Carolina. *American Journal of Public Health, 82*(8), 1131–1133.
- NSD (2000). *Health Behaviour in schoolaged children 1997/98. Technical Report*. Bergen: University of Bergen.
- Pickett, K. E., & Pearl, M. (2001). Multilevel analyses of neighbourhood socioeconomic context and health outcomes: A critical review. *Journal of Epidemiology and Community Health, 55*(2), 111–122.

- Power, C., Matthews, S., & Manor, O. (1998). Inequalities in self-rated health: Explanations from different stages of life. *Lancet*, *351*(9108), 1009–1014.
- Rasbash, J., Browne, W., Goldstein, H., Yang, M., Plewis, I., Healey, M., Woodhouse, G., Draper, D., Langford, I., Lewis, T. (2000). *A user's guide to MLwiN, Version, 2.1*. London: University of London.
- Singh, G. K., & Yu, S. M. (1996). US childhood mortality, 1950 through 1993: Trends and socioeconomic differentials. *American Journal of Public Health*, *86*(4), 505–512.
- Starfield, B., Riley, A. W., Witt, W. P., & Robertson, J. (2002). Social class gradients in health during adolescence. *Journal of Epidemiology and Community Health*, *56*(5), 354–361.
- Tuinstra, J., Groothoff, J. W., VandenHeuvel, W. J. A., & Post, D. (1998). Socio-economic differences in health risk behavior in adolescence: Do they exist? *Social Science & Medicine*, *47*(1), 67–74.
- Vanderlucht, F., & Groothoff, J. (1995). Social inequalities and health among children aged 10–11 in the Netherlands-causes and consequences. *Social Science & Medicine*, *40*(9), 1305–1311.
- Wardle, J., Robb, K., & Johnson, F. (2002). Assessing socioeconomic status in adolescents: The validity of a home affluence scale. *Journal of Epidemiology and Community Health*, *56*(8), 595–599.
- West, P. (1997). Health inequalities in the early years: Is there equalisation in youth? *Social Science & Medicine*, *44*(6), 833–858.
- West, P., Macintyre, S., Annandale, E., & Hunt, K. (1990). Social class and health in youth: Findings from the west of Scotland twenty-07 study. *Social Science & Medicine*, *30*(6), 665–673.