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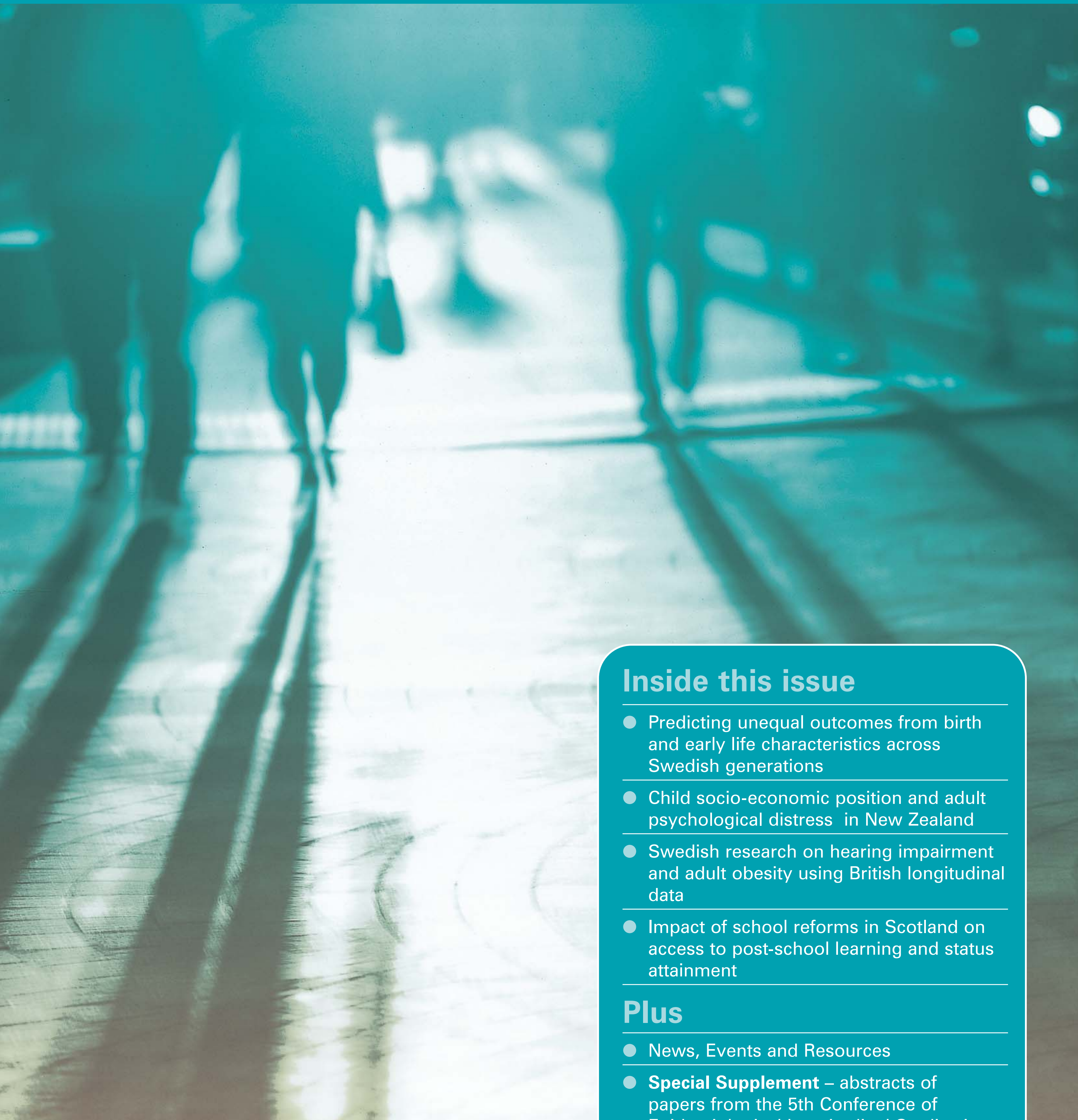
# Longitudinal and Life Course Studies: International Journal



## Inside this issue

- Predicting unequal outcomes from birth and early life characteristics across Swedish generations
- Child socio-economic position and adult psychological distress in New Zealand
- Swedish research on hearing impairment and adult obesity using British longitudinal data
- Impact of school reforms in Scotland on access to post-school learning and status attainment

## Plus

- News, Events and Resources
- **Special Supplement** – abstracts of papers from the 5th Conference of Epidemiological Longitudinal Studies in Europe (CELSE2010, Paphos, Cyprus)

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# CONTENTS






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# EDITORIAL

**John Bynner – *Executive Editor***

At a time when investment in longitudinal and life course research is threatened by cutbacks due to the economic downturn, the findings have never been more necessary. Polarising pressures coupled with accelerating technological change, face each new generation with challenges in the direction the life course is going to take. These demand increasing personal, family and community resources as protection. But the dependency that this may engender is also seen as problematic - sometimes part of the problem rather than the solution.

The impact of these economic, social and policy shifts cascades through communities, enabling those who can undertake the necessary life course investment through education, to take advantage of new opportunities as they arise, while poverty, social exclusion and reduced physical and psychological well-being is experienced by others. Only through monitoring not just population change, but the lives of individuals and groups under new conditions, can we learn how the life course is changing. Countries need the evidence as a basis for the prescriptions that are needed for moderating and ameliorating the worst effects, while identifying indicators for boosting positive outcomes. Longitudinal and life course studies build the knowledge base from which the evidence comes.

This issue of *LCCS* demonstrates some of the range of disciplinary interest that the field of life course study embraces, with this time generally more of a health focus. The four papers span physical and psychological health, education and economics. Two have a major historical component in making comparisons between cohorts inter-generationally across time. And one uses longitudinal studies conducted from 1936 to 1963 with children in Scotland, as offering a 'quasi experimental' opportunity to assess the effect on engagement in post-school education and later occupational status, of earlier education reforms. This underlines the point that history that makes up the life course studies discipline set.

Topics addressed in this issue are: prediction of unequal educational outcomes from birth and early social characteristics; childhood socio-economic position and adult psychological stress; sex difference in the relationship between childhood hearing impairment and adult obesity; post-school education and social class destinations. The issue has a significant international flavour, with Sweden, New Zealand, England and Scotland all represented by authors. One study uses longitudinal data resources from another country to pursue the scientific questions of interest.

A novel feature this time is the publication (as a separate supplement) of the abstracts of papers and posters presented at this year's 5th Conference of Epidemiological Longitudinal Studies in Europe (CELSE2010), held in Paphos, Cyprus in October. In supplying an overview of the uses of longitudinal studies in scientific and related areas, the 400 abstracts included are not only a testament to the organisation and productivity of the conference, but comprise a lasting resource of much value to longitudinal and life course researchers everywhere.

All these matters are pertinent to an important event referred to in the "News, Notes and Resources" section. The September 2010 conference of the Society for Longitudinal and Life Course Studies (SLLS) held in Cambridge was its first, and offered the opportunity to hold the first General Meeting, at which the Society was formally established and its constitution ratified. The significance of this development for the *LLCS* journal is that, during 2011, when the grant from the Nuffield Foundation, which 'pump-primed' the development of *LLCS*, comes to an end, the Society will take over full responsibility. Policies for revenue-raising are underway, including increasing the membership of the Society, which now includes corporate membership. A major recruitment drive will shortly be underway.

The range of the Society's remit will be evident from the abstracts of the papers and posters presented in Cambridge, to be published as a supplement with the next *LLCS* issue early in the new year. So, all told, longitudinal and life course research has never been more needed while the infrastructure and communications machinery needed to support it is steadily being put in place.

The invitation to *LLCS* readers is to participate in this exciting venture by joining SLLS, if you have not yet done so, and to encourage your colleagues to follow suit. This goes hand in hand with expanding the journal readership, through which major recruitment to SLLS, and hence benefit to the journal, will continue to come. Content for future issues, some stimulated by the CELSE and SLLS conferences, is steadily building. Make sure you and your colleagues are in the lead by adding to it!

# Birth characteristics and early-life social characteristics predict unequal educational outcomes across the life course and across generations

## Data from a Swedish cohort born 1915-1929 and their grandchildren born 1973-1980

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## Abstract

*We investigated the effects of adverse birth characteristics and social disadvantage upon educational outcomes over the lifecourse and across generations. Our subjects were 12,674 Swedish infants born 1915-1929 and 9,706 of their grandchildren born 1973-1980. Within both cohorts, better school achievement (schoolmarks in elementary school) was predicted by: heavier birthweight, lower birth order, older mother, married mother and higher family social class. These effects persisted after mutual-adjustment, and birth characteristics and family composition did not play a major role in explaining social class effects. There were no independent effects of pre-term or twin status, but weak evidence of a disadvantage to post-term infants. The predictors of education continuation (secondary school attendance and entrance to tertiary education) were very similar, with family composition and social class effects persisting even after adjusting for school achievement. In cross-generational analyses, better educational outcomes in the grandchildren were predicted by heavier birthweight, lower birth order and higher social class in the grandparents. These associations became non-significant and/or were substantially attenuated after adjusting for grandchild socio-economic position in childhood, suggesting that this was the major mechanism for this effect. We conclude that multiple early-life characteristics predict educational outcomes across the lifecourse and across generations. This includes birth characteristics and family composition effects which typically receive far less attention than socio-economic influences. Most effects were remarkably stable across the half-century separating our cohorts, suggesting their potential relevance for understanding educational inequalities in populations around the world.*

**Keywords**: Birth characteristics; early-life characteristics; education continuation; educational inequalities; inter-generational effects; school achievement; social characteristics; socio-economic position

## Introduction

Social inequalities create inequities within societies in health, employment and living conditions, and may also decrease well-being in society as a whole (World Health Organization, 2008). Educational level is a major route whereby social inequalities are recreated across generations – indeed, in Sweden it appears to be the dominant mechanism (Jonsson 2004). Equalising educational opportunities and outcomes was therefore a major political goal in Sweden during the twentieth century, motivating many of the school reforms which occurred since 1945 (Husén and Boalt 1967, Björklund et al 2003).

Inequalities in adult educational outcomes may reflect differences in academic achievement in school and/or differences in the probability that a student continues to higher education (Boudon 1974). There is accumulating evidence that adverse birth characteristics and early-life social disadvantage impact negatively upon cognitive development and educational attainment, and growing interest in the role of these early-life characteristics in explaining educational inequalities. This paper examines this issue across the lifecourse and across generations, using two Swedish birth cohorts. The first cohort comprises infants born 1915-1929 in Uppsala, Sweden, whom we refer to as 'G1s' (Generation 1s). The second cohort is drawn from their Swedish-born grandchildren born 1973-1980, whom we call 'G3s' (Generation 3s).

### Historical context

Sweden experienced substantial changes in the years separating our cohorts. Living standards rose dramatically, a comprehensive social support system was established and infant mortality fell from 64/1,000 in the G1s to 7/1,000 in the G3s. Average family size remained around two, but both childlessness and very large families became rarer (Eckstein et al 1999; Modin 2002b). Simultaneously, childbearing outside of marriage became more common and substantially more socially acceptable. By contrast, unmarried mothers in the G1 cohort faced considerable stigma, and this may partly explain the poorer birth outcomes and higher mortality of their offspring (Modin 2003).

### Existing evidence on early-life characteristics and educational outcomes

***Birth characteristics.*** During the past decade, strong evidence has accumulated that pre-term or low birthweight infants are more likely to experience cognitive impairment and difficulties in school (Bhutta et al 2002). More recently, researchers have turned their attention to the effects of birth characteristics within the normal range. The protective effect of higher birthweight appears to extend across the normal range, with heavier infants having progressively better cognitive and educational outcomes (Shenkin et al 2004). By contrast, a smaller number of studies suggest that an intermediate gestational age is optimal, with poorer childhood outcomes in post-term infants (Record et al 1969b; Yang et al 2010).

More modest disadvantages from adverse birth characteristics may also persist into later adolescence (Breslau et al 2004; Boardman et al 2002; Eide et al 2007) and be reflected in lower completion of secondary school or university (Jefferis et al 2002; Conley and Bennett 2000). These effects upon education continuation are most plausibly mediated by earlier inequalities in school achievement, but to our knowledge no studies examine this explicitly.

***Birth order, mother's age and mother's marital status.*** Studies from around the world report poorer educational outcomes in children with many siblings, probably reflecting a 'dilution' of parental investments of time and money (Steelman et al 2002). Most large studies also find an independent disadvantage to later-born children (Bjerkedal et al 2007). For example, birth order had a greater effect than family size or social class when predicting school achievement and continuation among 11,000 children born in Stockholm in 1953 (Walldén 1990; Walldén 1992).

Fewer studies examine maternal age, but these generally report better cognitive or educational outcomes for children of older mothers (Lawlor et al 2005; Lawlor et al 2006; Record et al 1969a; Eide et al 2007). Findings are less consistent for children of unmarried mothers; some studies find a marked disadvantage (Lawlor et al 2005; Eide et al 2007), others find no difference or a difference only in some groups (Boardman et al 2002; Desai et al 1989). This inconsistency may be because the effects of mother's marital status are particularly likely to be context-specific.

***Family socio-economic position.*** In societies around the world, low family socio-economic position predicts poorer school achievement and lower education continuation (Bradley and Corwyn 2002). In Sweden, strong social gradients in schoolmarks and/or education continuation were demonstrated in longitudinal studies of 1,549 children in the 1930s (Husén et al 1969) and 5,306 children in the 1950s (Husén and Boalt 1967). Socio-economic position likewise affects both school achievement (Björklund et al 2003) and education continuation net of school performance (Berggren 2006) among Swedish students born at the same time as the G3s.

These socio-economic inequalities appear to reflect multiple factors, including early cognitive development, parental aspirations and the child's own perceptions of the benefits of education (Erikson and Jonsson 1996; Guo 1998). It is also plausible that socio-economic inequalities may partly reflect systematic differences in birth characteristics or family composition, although relatively few studies address this question directly (Shenkin et al 2004).

**Contribution of the present paper**

Thus many early-life characteristics predict educational outcomes. Few studies examine multiple factors simultaneously, however, making it hard to assess which effects are independent or which are strongest. Similarly, few studies investigate both school achievement and education continuation, preventing ready assessment of how far the former may explain any differences in the latter. Finally, although education plays a major role in recreating social inequalities across generations (Jonsson 2004), no previous study has examined whether individuals' early-life characteristics predict educational outcomes in their descendants.

These limitations also apply to published evidence on the G1s and G3s. Among the G1s, Modin (2002a) has demonstrated that low birthweight, higher birth order, unmarried mother and lower social class predict failing to complete three years of secondary school. Modin also showed similar trends for schoolmarks in a small subset (N=720), though mostly not statistically significant. Among the G3s, male gender, pre-term birth and higher birth order predict schoolmarks in Swedish, with the effect of pre-term birth being confined to less well-educated parents (Gisselmann et al 2010). No previous analysis, however, has used all these early-life characteristics, has presented adequately-powered analyses of both school achievement and education continuation, or has examined cross-generational effects.

This paper redresses these limitations through a comprehensive investigation of which early-life characteristics predict school achievement and education continuation. First, we present analyses of each cohort separately, testing the hypotheses that 1) any association between family social class and school achievement is explained by birth characteristics and family composition, and 2) any association between early-life characteristics and education continuation is explained by earlier school achievement. We then present cross-generational analyses, testing the hypotheses that 3) early-life characteristics of the G1s predict educational outcomes in their G3 grandchildren, and 4) any such associations are explained by G3 childhood socio-economic position. In testing these hypotheses, this paper presents the first analysis of how and why birth characteristics and early-life social characteristics may affect educational outcomes across generations. It also presents the first direct comparison of early-life determinants in the G1 and G3 cohorts, thereby shedding light on how far Sweden has achieved its long-standing political goal of equalising educational opportunities.

## Methods

**Study populations**

Our study populations come from the Uppsala Multigenerational Birth Cohort Study (Koupil 2007). The G1s are drawn from the 14,192 live births between 1915 and 1929 at the Uppsala University Hospital. Of these, 13,811 (97.3%) were traced through parish archives until death, emigration or until their unique personal registration number was assigned, usually in 1947. For the 12,168 G1s assigned personal numbers and still alive in Sweden in 1960, record linkage provided information across their adult lives. This included identifying all registered descendents in the Swedish Multigenerational registry. Our G3 cohort is drawn from their 10,036 grandchildren born in Sweden between 1973 and 1980.

In this paper, we excluded the 1,518 G1s and 239 G3s who died or emigrated before the spring of the year when they turned 20, this being the age necessary to attain the educational outcomes of interest. We likewise excluded the 91 adopted G3s – this data was not available for G1s. Our study populations therefore consisted of the remaining 12,674 G1s (6,560 male, 6,114 female) and 9,706 G3s (4,924 male, 4,782 female).

The G1s Uppsala Birth Cohort has previously been demonstrated to be broadly representative of Sweden in 1915–1929 (Rajaleid et al 2008). To assess the representativeness of our G3 cohort, we used register data to compare their characteristics to those of all births in Sweden 1973-1980.

**Early-life characteristics**

For the G1s, archived obstetric records provided data on their gender; birthweight; gestational age; birth multiplicity; birth order; mother's age; mother's marital status; and family social class (see Table 1). The Swedish medical birth register (established 1973) provided the corresponding G3 information, with the exception of family social class which came from the 1980 Swedish census. These registers also provided the data we used to assess the representativeness of our G3 cohort relative to all Swedish births in 1973-1980.

Family social class was coded using the Swedish socio-economic classification scheme (SEI: Statistics Sweden 1989). We assigned G1 social class using father's occupation if recorded (80.1%) or mother's occupation if not (19.9%). G1 social class categories included 'housedaughters', namely mothers living with their parents. We assigned G3 social class using the occupation of the head of household - i.e. the resident adult with the highest occupational social class (Erikson 1984); in 23.1 % of households this was the mother, in 55.4% the mother's partner and in 21.6% both parents had the same social class. We were unable to use this 'head of household' method for the G1s because the mother's occupation was usually missing if the father's occupation was recorded. In practice, however, this will have made very little difference because women at this time faced substantial disadvantages in the labour market, and very rarely had a higher occupational social class than their partners.

Finally, for the G3s we additionally calculated total family size, operationalised as the number of children recorded for the mother in the Multigenerational Registry up to 2002; and mother's and father's educational level in the 1990 census. These characteristics were not available for the G1s.

**School achievement, G1s**

Our G1 measure of school achievement was their mean schoolmark in the spring term of the third grade. At this age all children were schooled together, whereas from the fifth grade children were streamed to different schools. Furthermore, third grade schoolmarks had meaningful consequences for children, being one determinant of subsequent streaming (Husén and Boalt 1967). In theory children complete the third grade in the year they turn 10, although (as was common at this time) this applied to only 79.9% of G1s.

Using archived school records, we obtained schoolmarks for 10,336/12,674 (81.6%) of the G1s eligible for inclusion in this study. We recorded marks for 10 standard school subjects, with a mean of 9.1 subjects per child (range 6-10). We scored the marks from 0 (Grade C) to 18 (Grade A), as suggested by the education department in 1942 (SOU 1942). Factor analyses indicated a single latent factor explaining much of the observed variation in all 10 marks (first Eigenvalue 4.26, second 0.99). We therefore combined all 10 schoolmarks into a single average, first standardising each subject individually because of differences in their means.

**School achievement, G3s**

Our G3 measure of school achievement was their grade average in the ninth (and final) grade of elementary school, obtained from the Swedish National Board for Education. In theory, children complete the ninth grade in the calendar year when they turn 16, and this applied to 95.6% of G3s.

Ninth grade schoolmark averages are calculated for all students by their schools. These averages are based on 16 to 18 standard subjects, and are important in determining admission chances for different secondary schools. Thus as for the G1s, our G3 measure of school achievement was a composite across many subjects with personally meaningful consequences. Moreover, again as for the G1s, the component subjects of the ninth grade average loaded strongly onto a single factor (first Eigenvalue 11.21, second 0.99).

**Table 1: Early-life characteristics of study subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and their grandchildren (G3s, born 1973-1980).**

| Early-life characteristics | Range/categories | Percent in G1 (N=12,674) | Percent in G3 (N=9,706) |
|---|---|---|---|
| **Gender** | Male | 51.8 | 50.7 |
| | Female | 48.2 | 49.3 |
| **Birthweight** | <2,500g | 4.4 | 3.5 |
| | 2,500-3,000g | 14.3 | 13.0 |
| | 3,000-3,500g | 36.1 | 34.2 |
| | 3,500-4,000g | 32.7 | 33.8 |
| | ≥4,000g | 12.5 | 15.6 |
| **Gestational age** | Pre-term (≤36 weeks) | 7.3 | 4.5 |
| | Term (37-41 weeks) | 80.6 | 81.4 |
| | Post-term (≥42 weeks) | 12.0 | 14.0 |
| **Birth multiplicity** | Singleton | 97.3 | 98.4 |
| | Twin/triplet | 2.7 | 1.6 |
| **Birth order** | 1 | 39.2 | 47.2 |
| | 2-3 | 36.8 | 49.6 |
| | 4-5 | 13.5 | 3.0 |
| | 6-16 [G1] / 6-7 [G3] | 10.5 | 0.2 |
| **Mother's age at birth** | 15-19 years | 5.7 | 5.6 |
| | 20-24 years | 26.7 | 35.0 |
| | 25-29 years | 28.1 | 42.8 |
| | 30-34 years | 20.3 | 14.7 |
| | 35-39 years | 13.2 | 1.9 |
| | 40-49 [G1] / 40-42 years [G3] | 6.0 | 0.1 |
| **Mother's marital status** | Married | 79.6 | 59.4 |
| | Unmarried | 19.6 | 39.0 |
| | Widowed/divorced | 0.8 | 1.6 |
| **Family social class** | High/mediate non-manual | 8.7 | 38.0 |
| | Low non-manual | 6.8 | 13.3 |
| | Skilled manual | 14.3 | 19.1 |
| | Semi/unskilled manual | 47.1 | 16.7 |
| | Self-employed | 3.2 | 7.2 |
| | Farmer | 14.5 | 2.2 |
| | Housedaughter | 5.5 | [not used] |
| | Retired, student, other | [not used] | 3.6 |

*For numbers of G1s and G3s in each category see the Supplementary Material. The Supplementary Material also presents a comparison of the G3 characteristics with those of all births in Sweden 1973-1980.*

**Education continuation**

Our primary measure of educational continuation was entering tertiary education, defined as completing at least one year of a university degree or equivalent. As a secondary measure we examined secondary school attendance, defined as completing at least two years at *gymnasium* (secondary school) or equivalent. This secondary measure was particularly valuable for analyses of the G1s, amongst whom tertiary education was rare.

For the G1s, we obtained this education continuation data from the 1960 Swedish census (i.e. at ages 31-45 years), or from the 1970 and 1990 census if this information was missing (N=112). For secondary school attendance, the 1960 census categorised all people who did not complete three years of secondary school as having only elementary education. The 1970 census included the additional, intermediate response option '2 or fewer years of secondary school'. This was assigned to 2,179 G1s with 'elementary' education in the 1960 census and we decided to count these individuals as having attended secondary school. For the G3s we obtained our information from the Longitudinal database for Education, Income and Occupation (LOUISE database) held by Statistics Sweden. The last year from which we had data was 2001, providing good coverage for those born in 1980 or earlier. This determined 1980 as the upper birthyear for our G3 cohort. Where LOUISE 2001 data was missing, we used the most recent year in which the individual was aged at least 20 (N=139).

**Statistical methods**

Our statistical analyses were guided by our hypotheses that birth characteristics and family composition may explain the effects of family social class upon an individual's educational outcomes; that schoolmarks may explain effects of early-life characteristics upon an individual's education continuation; and that G3 childhood socio-economic position may explain the effects of early-life G1 characteristics upon G3 educational outcomes. We examined these hypotheses by fitting a series of multivariable regression models using a hierarchical approach, beginning with models including only the most distal variables and then proceeding to models additionally including hypothesised mediators (Victora et al 1997). We used linear regression when predicting to schoolmarks, and logistic regression when predicting to secondary school attendance/entrance to tertiary education. All standard errors were calculated with clustering by the subject's mother, in order to allow for potential correlations due to similarity between siblings (26.4% of G1 cohort and 28.1% of G3 cohort). All models adjust for sex and for birthyear by one-year age band, and were performed in Stata 11.1.

We determined *a priori* to examine whether any early-life characteristics modified the relationship between school achievement and education continuation and/or had differential effects by gender or social class. We therefore tested for interactions between each early-life characteristic and 1) schoolmarks, 2) gender and 3) social class, predicting to each educational outcome in turn and adjusting only for birthyear.

The frequency of missing data was 0-6.0% for all early-life characteristics and educational outcomes, except for G1 schoolmarks where the frequency of missing data was 18.4%. We used multiple imputation (five imputations) to impute missing values under an assumption of missing at random. To facilitate comparisons between the G1s and G3s, we categorised our three continuous variables (birthweight, birth order and mother's age) in main effects models and present *p*-values for heterogeneity. This did not affect substantive conclusions regarding associations with any educational outcome. By contrast, we kept these variables as continuous when testing for interactions, to avoid underpowered tests involving categorical variables with many levels.

When performing cross-generational effects, we used the G3s as our units of analysis and assigned to each G3 the early-life characteristics of their G1 grandparent. For the 1,312 G3s (13.5%) with more than one grandparent from the Uppsala Birth Cohort, we selected one G1 grandparent at random. We examined whether G3 childhood socio-economic position explained any cross-generational effects by additionally adjusting for G3 family social class, mother's educational levels and father's educational levels.

## Results

### Early-life characteristics

There were noticeable differences in the early-life social characteristics of our two cohorts (Table 1). Compared to the G1s, the G3s had fewer large families (3% at birth order ≥4 vs. 24% in G1s); fewer older mothers (17% aged over 30 years vs. 40% in G1s); more unmarried mothers (39% vs. 20% in G1s); and higher social class (e.g. 38% high/mediate non-manual vs. 9% in G1s). Comparisons with all Swedish births 1973-1980 indicated that this largely reflected real changes in Swedish society; in general the early-life characteristics of the G3s were very similar to those of the total population (see Supplementary Material). Nevertheless, the maternal age difference between the two cohorts was exaggerated by an under-representation of older mothers in the G3s (17% aged over 30 years in the G3s vs. 26% in the total population). This is because, for example, 40-year old G3 mothers must have been born between 1933 and 1940, years when most G1s (i.e. their own parents) would not have started childbearing (Goodman and Koupil 2009).

### Early-life predictors across the lifecourse (1): School achievement

Schoolmarks were approximately normally distributed in both cohorts. The raw mean of the G3s was 3.23, very similar to the Swedish national average of 3.21 in 1991-1996; no national data exists from the time of the G1 schoolmarks. To facilitate interpretation of effect sizes, the remainder of this paper uses standardised schoolmark means. All findings were unchanged after restricting to children of the correct age for their school year.

Multivariable analyses revealed striking similarity between the G1s and the G3s in the predictors of schoolmarks (Table 2; unadjusted mean scores in Supplementary Material). In both cohorts, females achieved better schoolmarks as did infants with heavier birthweight. This birthweight effect was evident across the full range in the G3s, but was strongest in the bottom half of the distribution in the G1s. Minimally-adjusted analyses provided some evidence that full-term infants were advantaged over pre-term infants (p=0.01), but this became non-significant after adjusting for other early-life characteristics. By contrast, the advantage of full-term infants over post-term infants remained weakly significant even in fully-adjusted analyses (p=0.08 in G1s, p=0.02 in G3s). In neither cohort was there any effect of twin status.

In both cohorts, there were large independent advantages to children of lower birth order and older mothers (although only in the G3s did this include a particularly large disadvantage for children of mothers aged 15-19). There were also large independent advantages to children of married vs. unmarried mothers in both cohorts and to children of married vs. widowed/divorced mothers in the G3s.

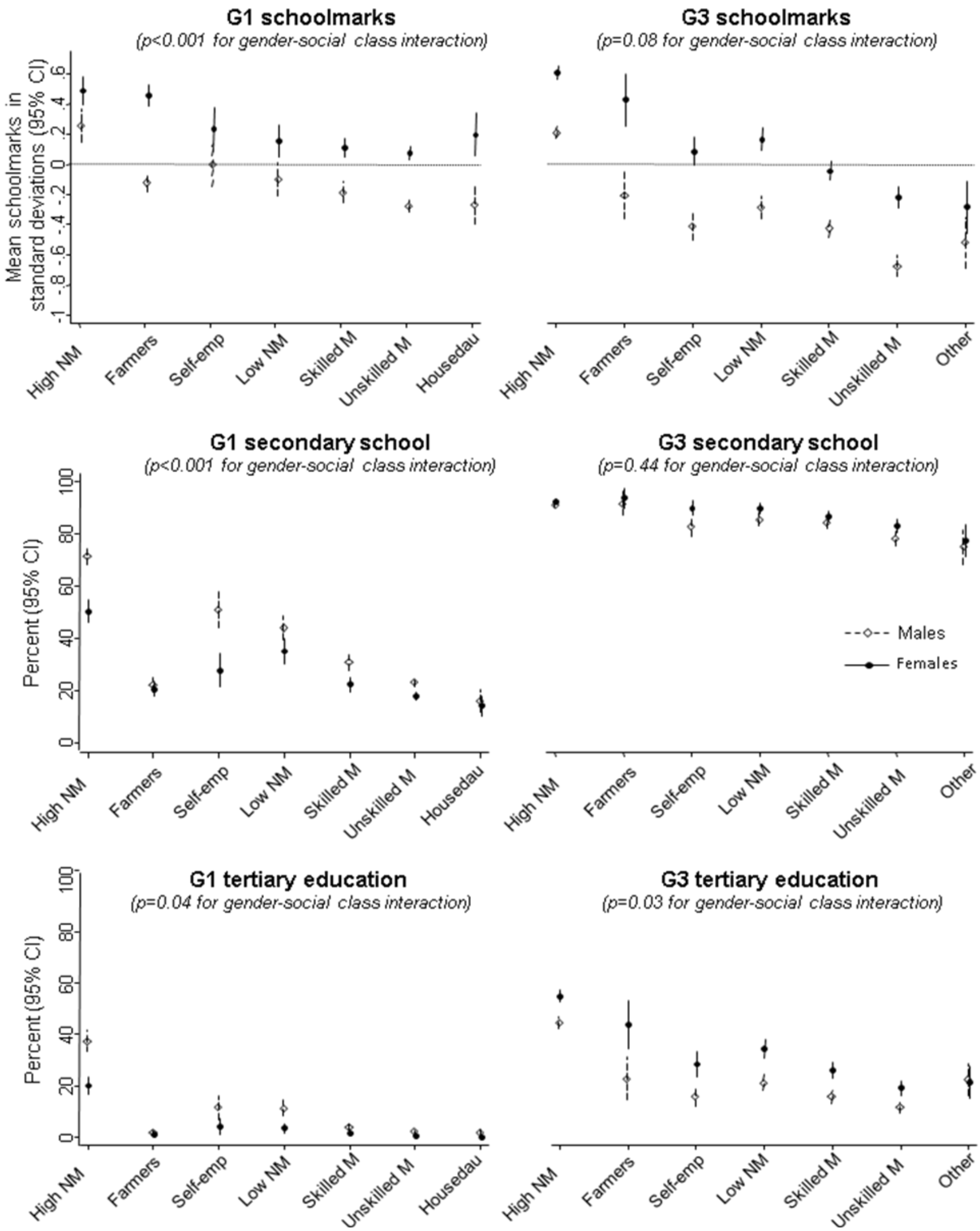
Finally, both cohorts showed large social class differences in school achievement. These included very large advantages to high/mediate non-manual children, and a very similar ordering of the remaining shared social classes (see Figure 1). In both cohorts, these social class effects showed only modest attenuation after adjusting for the other early-life characteristics presented in Table 2. Moreover, this attenuation was entirely driven by adjustment for the family composition variables; adjusting for birth characteristics alone left the effect estimates virtually unchanged (see Supplementary Material). The same was true of all further analyses presented below. Thus in contradiction of our first hypothesis, social class differences seemed to be only slightly explained by family composition effects and not at all explained by adverse birth characteristics.

**Table 2: Early-life characteristics and school achievement among subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and their grandchildren (G3s, born 1973-1980)**

| | | G1 characteristics predicting G1 schoolmarks: linear regression, regression coefficients and 95% CI | | G3 characteristics predicting G3 schoolmarks: linear regression, regression coefficients and 95% CI | |
|---|---|---|---|---|---|
| | | Minimally adjusted† | Multivariable: all early-life characteristics | Minimally adjusted† | Multivariable: all early-life characteristics |
| **N** | | 12,674 | 12,674 | 9,706 | 9,706 |
| **Gender** | Male | 0*** | 0*** | 0*** | 0*** |
| | Female | 0.35 (0.30, 0.41) | 0.37 (0.32, 0.43) | 0.42 (0.38, 0.46) | 0.43 (0.39, 0.47) |
| **Birth-** | <2,500g | -0.13 (-0.22, -0.04) | -0.13 (-0.23, -0.04) | -0.22 (-0.35, -0.10) | -0.22 (-0.34, -0.09) |
| **weight** | 2,500-3,000g | -0.09 (-0.17, -0.01) | -0.09 (-0.17, -0.02) | -0.10 (-0.17, -0.04) | -0.10 (-0.17, -0.04) |
| | 3,000-3,500g | 0** | 0** | 0*** | 0*** |
| | 3,500-4,000g | 0.01 (-0.04, 0.05) | 0.02 (-0.03, 0.07) | 0.10 (0.05, 0.15) | 0.08 (0.04, 0.12) |
| | ≥4,000g | 0.01 (-0.06, 0.08) | 0.04 (-0.04, 0.11) | 0.11 (0.05, 0.17) | 0.12 (0.06, 0.18) |
| **Gesta-** | Pre-term | -0.10 (-0.17, -0.02) | -0.02 (-0.09, 0.05) | -0.09 (-0.20, 0.02) | 0.10 (-0.01, 0.22) |
| **-tional** | Term | 0** | 0 | 0 | 0* |
| **age** | Post-term | -0.06 (-0.11, 0.00) | -0.05 (-0.10, 0.01) | -0.04 (-0.10, 0.02) | -0.06 (-0.12, -0.01) |
| **Birth** | Singleton | 0 | 0 | 0 | 0 |
| **multiplicity** | Twin/triplet | -0.10 (-0.24, 0.05) | -0.02 (-0.17, 0.13) | -0.02 (-0.21, 0.17) | 0.12 (-0.04, 0.29) |
| **Birth** | 1 | 0*** | 0*** | 0*** | 0*** |
| **order** | 2-3 | -0.12 (-0.16, -0.07) | -0.20 (-0.25, -0.15) | -0.18 (-0.21, -0.14) | -0.30 (-0.34, -0.26) |
| | 4-5 | -0.18 (-0.24, -0.12) | -0.31 (-0.38, -0.24) | -0.55 (-0.68, -0.41) | -0.65 (-0.77, -0.52) |
| | ≥6 | -0.21 (-0.28, -0.14) | -0.39 (-0.48, -0.30) | -0.66 (-1.13, -0.20) | -0.74 (-1.19, -0.30) |
| **Mother's** | 15-19 years | 0.04 (-0.04, 0.13) | 0.06 (-0.03, 0.15) | -0.29 (-0.38, -0.20) | -0.20 (-0.29, -0.11) |
| **age** | 20-24 years | 0* | 0** | 0*** | 0*** |
| **at birth** | 25-29 years | 0.08 (0.02, 0.13) | 0.07 (0.01, 0.13) | 0.25 (0.20, 0.30) | 0.16 (0.11, 0.21) |
| | 30-34 years | 0.09 (0.02, 0.15) | 0.11 (0.03, 0.19) | 0.32 (0.26, 0.39) | 0.25 (0.18, 0.31) |
| | 35-39 years | 0.04 (-0.02, 0.10) | 0.11 (0.03, 0.18) | 0.32 (0.17, 0.47) | 0.33 (0.19, 0.48) |
| | ≥40 years | 0.07 (-0.02, 0.15) | 0.19 (0.09, 0.29) | [too few cases] | [too few cases] |
| **Mother's** | Married | 0*** | 0*** | 0*** | 0*** |
| **marital** | Unmarried | -0.15 (-0.20, -0.10) | -0.14 (-0.21, -0.08) | -0.27 (-0.32, -0.23) | -0.15 (-0.19, -0.11) |
| **status** | Widow/divorced | -0.21 (-0.41, -0.01) | -0.09 (-0.29, 0.11) | -0.73 (-0.90, -0.56) | -0.54 (-0.70, -0.39) |
| **Family** | High/med non- | 0*** | 0*** | 0*** | 0*** |
| **social** | Low non-manual | -0.34 (-0.47, -0.21) | -0.30 (-0.42, -0.17) | -0.47 (-0.53, -0.40) | -0.39 (-0.45, -0.32) |
| **class** | Skilled manual | -0.42 (-0.52, -0.32) | -0.36 (-0.46, -0.26) | -0.64 (-0.70, -0.58) | -0.51 (-0.57, -0.45) |
| | Semi/unskilled | -0.48 (-0.56, -0.39) | -0.40 (-0.48, -0.31) | -0.86 (-0.92, -0.79) | -0.69 (-0.76, -0.62) |
| | Self-employed | -0.26 (-0.38, -0.13) | -0.22 (-0.35, -0.09) | -0.57 (-0.65, -0.48) | -0.46 (-0.54, -0.38) |
| | Farmers | -0.22 (-0.32, -0.12) | -0.15 (-0.25, -0.05) | -0.29 (-0.43, -0.16) | -0.23 (-0.36, -0.10) |
| | Housedaughter | -0.41 (-0.51, -0.31) | -0.32 (-0.44, -0.21) | [not used] | [not used] |
| | Retired, student, | [not used] | [not used] | -0.81 (-0.95, -0.67) | -0.63 (-0.77, -0.50) |

**p<0.05, **p<0.01, ***p<0.001. †Minimally adjusted: variables entered separately, adjusting only for gender and birthyear. Results not presented for G3 children of mothers aged 40 or more because of the very small sample size (N=6). See Supplementary Material for intermediate multivariable models adjusting A) only for birth characteristics and social class, and B) only for family composition and social class.*

**Figure 1: School achievement and education continuation stratified by gender and family social class in subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and their grandchildren (G3s, born 1973-1980)**

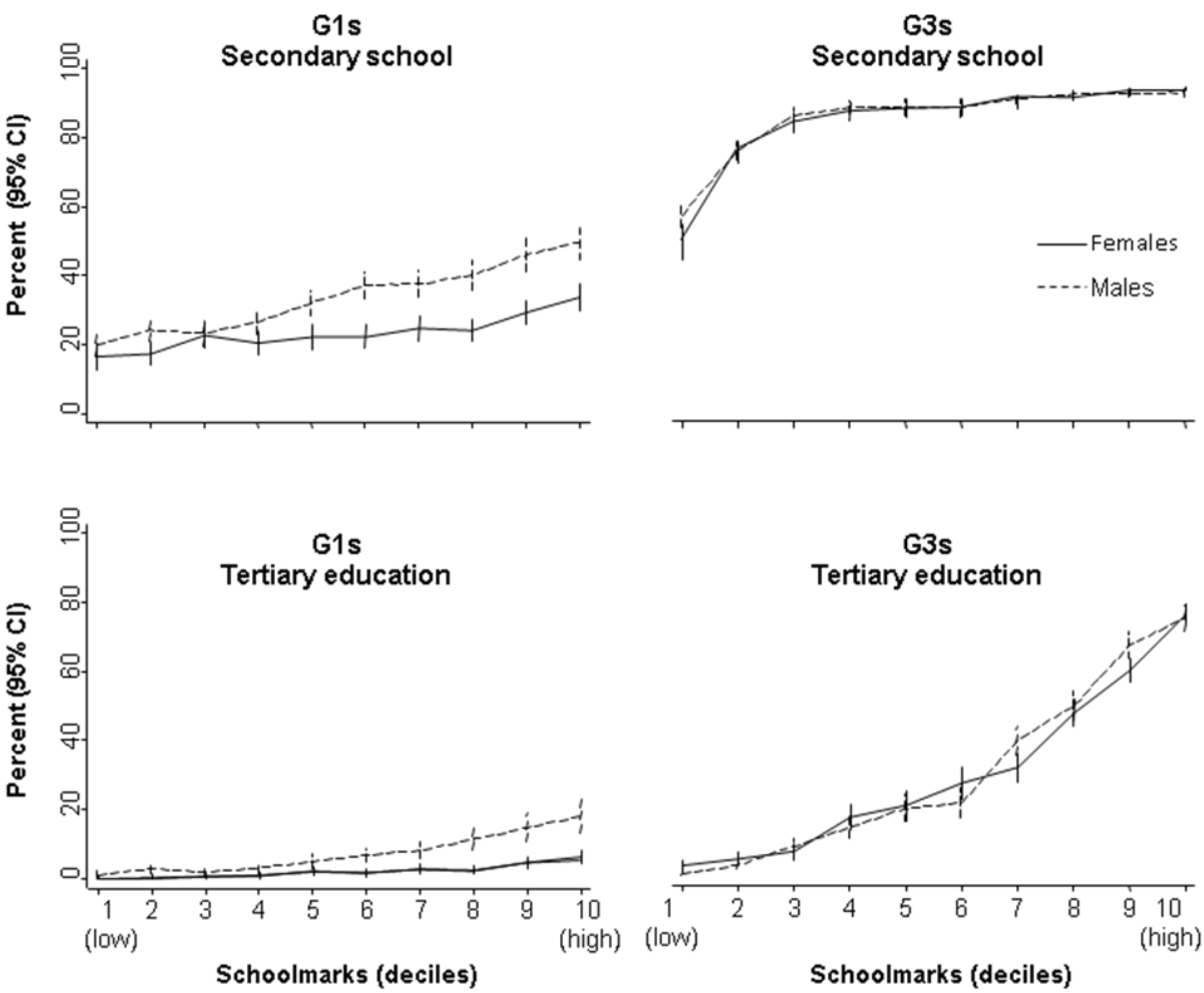



*95% CI = 95% confidence intervals. High NM = high/mediate non-manual, Self-emp=self-employed, Low NM=low non-manual, Skilled M=skilled manual, Unskilled M=semi/unskilled manual, Housedau=housedaughters, Other=retired/student/other. Shared social classes are presented in order of school achievement in G1 females.*

**Early-life predictors across the lifecourse (2): Education continuation**

Secondary school attendance was far more common in the G3s (90% vs. 28% in the G1s), with even G3s in the bottom schoolmark decile attending more often than top-decile G1s (Figure 2). Entering tertiary education was likewise substantially more common for the G3s (32% vs. 5%), despite the G3s being younger when educational level was ascertained and therefore not including mature students.

**Figure 2: Education continuation by school achievement and gender in subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and their grandchildren (G3s, born 1973-1980)**




*95% CI = 95% confidence intervals.*

**Table 3: Early-life characteristics and entrance to tertiary education among subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and their grandchildren (G3s, born 1973-1980)**

| | | **G1 characteristics predicting G1 entrance to tertiary education: logistic regression, odds ratios and 95% CI** | | | **G3 characteristics predicting G3 entrance to tertiary education: logistic regression, odds ratios and 95% CI** | | |
|---|---|---|---|---|---|---|---|
| | | Minimally adjusted† | Multivariable: all early-life characteristics | Multivariable: all early-life characteristics plus schoolmarks | Minimally adjusted† | Multivariable: all early-life characteristics | Multivariable: all early-life characteristics plus schoolmarks |
| **N** | | 12,674 | 12,674 | 12,674 | 9,706 | 9,706 | 9,706 |
| **Gender** | Male | 1*** | 1*** | 1*** | 1*** | 1*** | 1 |
| | Female | 0.38 (0.32, 0.46) | 0.35 (0.29, 0.43) | 0.28 (0.23, 0.35) | 1.62 (1.48, 1.77) | 1.74 (1.58, 1.91) | 1.00 (0.89, 1.12) |
| **Birth-weight** | <2,500g | 0.84 (0.52, 1.38) | 0.82 (0.47, 1.43) | 0.84 (0.46, 1.56) | 0.87 (0.67, 1.13) | 0.82 (0.61, 1.12) | 1.14 (0.79, 1.65) |
| | 2,500-3,000g | 0.83 (0.62, 1.11) | 0.79 (0.57, 1.11) | 0.82 (0.59, 1.15) | 0.92 (0.80, 1.06) | 0.90 (0.77, 1.05) | 1.04 (0.87, 1.25) |
| | 3,000-3,500g | 1 | 1* | 1 | 1** | 1** | 1 |
| | 3,500-4,000g | 0.89 (0.72, 1.10) | 0.91 (0.72, 1.15) | 0.91 (0.71, 1.16) | 1.16 (1.05, 1.29) | 1.14 (1.02, 1.28) | 1.06 (0.93, 1.21) |
| | ≥4,000g | 1.14 (0.88, 1.47) | 1.34 (1.00, 1.80) | 1.32 (0.97, 1.81) | 1.18 (1.03, 1.36) | 1.25 (1.08, 1.44) | 1.10 (0.93, 1.32) |
| **Gesta--tional age** | Pre-term | 0.83 (0.58, 1.18) | 1.07 (0.70, 1.62) | 1.12 (0.72, 1.73) | 1.03 (0.82, 1.28) | 1.30 (0.99, 1.70) | 1.15 (0.85, 1.56) |
| | Term | 1* | 1* | 1* | 1 | 1 | 1 |
| | Post-term | 0.63 (0.46, 0.86) | 0.62 (0.44, 0.86) | 0.62 (0.44, 0.89) | 0.96 (0.85, 1.09) | 0.94 (0.81, 1.08) | 1.03 (0.87, 1.22) |
| **Birth multiplicity** | Singleton | 1 | 1 | 1 | 1 | 1 | 1 |
| | Twin/triplet | 1.04 (0.56, 1.94) | 1.19 (0.67, 2.10) | 1.25 (0.69, 2.28) | 1.30 (0.85, 1.96) | 1.53 (0.99, 2.34) | 1.59 (0.98, 2.58) |
| **Birth order** | 1 | 1*** | 1*** | 1*** | 1*** | 1*** | 1*** |
| | 2-3 | 0.86 (0.71, 1.04) | 0.65 (0.52, 0.81) | 0.73 (0.59, 0.91) | 0.71 (0.65, 0.77) | 0.53 (0.47, 0.58) | 0.71 (0.63, 0.80) |
| | 4-5 | 0.54 (0.40, 0.74) | 0.42 (0.30, 0.60) | 0.49 (0.34, 0.71) | 0.45 (0.33, 0.61) | 0.31 (0.22, 0.43) | 0.58 (0.38, 0.87) |
| | ≥6 | 0.17 (0.10, 0.31) | 0.12 (0.07, 0.23) | 0.15 (0.08, 0.29) | 0.40 (0.13, 1.20) | 0.26 (0.09, 0.75) | 0.58 (0.16, 2.12) |

*(Table 3 cont'd)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Mother's age at birth** | 15-19 years | 0.38 (0.19, 0.76) | 0.65 (0.32, 1.31) | 0.63 (0.30, 1.29) | 0.52 (0.41, 0.66) | 0.62 (0.48, 0.80) | 0.70 (0.52, 0.95) |
| | 20-24 years | 1*** | 1*** | 1** | 1*** | 1*** | 1*** |
| | 25-29 years | 1.74 (1.35, 2.24) | 1.32 (1.00, 1.74) | 1.26 (0.94, 1.70) | 1.58 (1.43, 1.75) | 1.35 (1.20, 1.52) | 1.14 (0.99, 1.31) |
| | 30-34 years | 1.86 (1.41, 2.45) | 1.48 (1.08, 2.02) | 1.39 (0.98, 1.96) | 2.03 (1.77, 2.34) | 1.80 (1.53, 2.12) | 1.44 (1.19, 1.75) |
| | 35-39 years | 1.97 (1.45, 2.67) | 2.00 (1.38, 2.90) | 1.89 (1.28, 2.78) | 2.34 (1.66, 3.30) | 2.48 (1.70, 3.61) | 1.94 (1.30, 2.87) |
| | ≥40 years | 1.16 (0.74, 1.83) | 2.10 (1.24, 3.58) | 1.92 (1.11, 3.31) | [too few cases] | [too few cases] | [too few cases] |
| **Mother's marital status** | Married | 1*** | 1 [p=0.05] | 1 | 1*** | 1*** | 1** |
| | Unmarried | 0.18 (0.12, 0.28) | 0.54 (0.30, 0.98) | 0.60 (0.34, 1.07) | 0.58 (0.53, 0.65) | 0.72 (0.65, 0.81) | 0.84 (0.73, 0.96) |
| | Widow/divorced | 0.18 (0.02, 1.33) | 0.30 (0.03, 2.85) | 0.32 (0.03, 3.25) | 0.23 (0.14, 0.37) | 0.28 (0.16, 0.46) | 0.42 (0.23, 0.78) |
| **Family social class** | High/med non-manual | 1*** | 1*** | 1*** | 1*** | 1*** | 1*** |
| | Low non-manual | 0.19 (0.14, 0.27) | 0.21 (0.16, 0.30) | 0.24 (0.17, 0.34) | 0.37 (0.32, 0.43) | 0.43 (0.37, 0.50) | 0.58 (0.49, 0.69) |
| | Skilled manual | 0.06 (0.05, 0.09) | 0.08 (0.05, 0.11) | 0.09 (0.06, 0.12) | 0.25 (0.22, 0.29) | 0.32 (0.28, 0.37) | 0.50 (0.42, 0.59) |
| | Semi/unskilled manual | 0.03 (0.02, 0.04) | 0.04 (0.03, 0.06) | 0.05 (0.04, 0.07) | 0.17 (0.15, 0.20) | 0.23 (0.19, 0.27) | 0.43 (0.35, 0.52) |
| | Self-employed | 0.20 (0.13, 0.31) | 0.21 (0.14, 0.33) | 0.22 (0.14, 0.35) | 0.27 (0.22, 0.33) | 0.32 (0.26, 0.39) | 0.47 (0.37, 0.60) |
| | Farmers | 0.03 (0.02, 0.05) | 0.04 (0.02, 0.06) | 0.04 (0.02, 0.06) | 0.49 (0.35, 0.68) | 0.55 (0.39, 0.77) | 0.67 (0.44, 1.00) |
| | Housedaughter | 0.02 (0.01, 0.05) | 0.05 (0.02, 0.13) | 0.05 (0.02, 0.15) | [not used] | [not used] | [not used] |
| | Retired, student, other | [not used] | [not used] | [not used] | 0.27 (0.20, 0.36) | 0.36 (0.26, 0.49) | 0.66 (0.45, 0.94) |

**p<0.05, **p<0.01, ***p<0.001. †Minimally adjusted: variables entered separately, adjusting only for gender and birthyear. Results not presented for G3 children of mothers aged 40 or more because of the very small sample size (N=6)*

In general, these two measures of education continuation yielded similar or identical substantive findings regarding the importance of early-life characteristics. We therefore describe the results together below, with Table 3 presenting logistic regression models for tertiary education (our primary measure of education continuation). Raw proportions and regression models for secondary school attendance are presented in the Supplementary Material.

G3 females were advantaged with respect to education continuation, while among the G1s it was males who were substantially advantaged (see also Figure 2). The G3 female advantage disappeared after adjusting for schoolmarks, suggesting that school achievement explained the gender difference in this cohort. By contrast the G1 gender inequality grew still more pronounced after adjusting for females' better school achievement. In both cohorts there was some evidence of an advantage to infants of heavier birthweight in analyses adjusting for all early-life characteristics, but these effects became non-significant after adjusting for previous school achievement. As for schoolmarks, there was no independent effect of pre-term or twin status in either cohort. However, full-term G1s (but not G3s) did have an advantage relative to post-term infants, and this persisted even after adjusting for schoolmarks (p=0.008 for secondary school attendance; p=0.009 for entrance to tertiary education).

In both cohorts, lower birth order, older mother, married mother and higher family social class carried large independent advantages for education continuation. The social class differences were particularly striking; for example, 30% of high/mediate non-manual G1s entered tertiary education versus 1% of semi/unskilled manuals. The corresponding G3 figures were 50% and 15%. It was also interesting to note that G1 children of farmers and housedaughters were among the social classes least likely to continue their education, despite average or above-average schoolmarks (see Figure 1). For the most part, however, the predictors of education continuation were very similar to the predictors of school achievement. Nevertheless, prior school achievement only partially explained these differences – despite some attenuation after adjusting for schoolmarks, most effect sizes remained large and highly significant (Table 3, columns 3 and 6). The major exception was that most G3 early-life characteristics ceased to predict secondary school attendance after adjusting for school achievement in the final year of elementary school (i.e. immediately before the transition to secondary school; results in the Supplementary Material).

To summarise, these analyses only partially supported our second hypothesis that school achievement would explain the effects of early-life characteristics upon education continuation. This did seem to be the case for the greater education continuation for G3 females and G1 and G3 infants of heavier birthweight. By contrast, schoolmarks only explained some of the effects of family composition and social class, with these variables having a direct effect on education continuation over and above their previous influence on school achievement.

**Early-life predictors across the lifecourse (3): Interactions and sensitivity analyses**

We tested for interactions between all early-life characteristics and 1) schoolmarks, 2) gender and 3) social class. In the G1s, three sets of interactions were significant at p<0.01. First, not only were G1 males much more likely to attend secondary school than females, but good schoolmarks played a greater role in determining which males got that opportunity (p<0.001 for interaction; see also Figure 2). Second, there was a gender-social class interaction for schoolmarks (p<0.001), secondary school attendance (p<0.001) and entrance to tertiary education (p=0.04). For school achievement this interaction reflected a particularly large female advantage in farming families, while for education continuation it reflected a particularly large male advantage in non-manual and self-employed families (see Figure 1). Third, there was a birth order-social class interaction for school achievement (p=0.03) and secondary school attendance (p=0.003), reflecting particularly strong birth order effects in non-manual families. No interactions were significant at p<0.01 in the G3s.

We also conducted sensitivity analyses in the G3s, repeating the analyses in Table 2 and Table 3 after additionally adjusting for total family size, mother's education and father's education. The effect of family social class attenuated somewhat after adjusting for parental education, but otherwise the results were almost unchanged. This included only a very small attenuation of the effect of birth order after adjusting for total family size.

**Early-life predictors across generations**

In line with our third hypothesis, educational outcomes in the G3s were predicted by several of the early-life characteristics of their G1 grandparents (Table 4). There was no evidence in univariable analyses that these effects differed by type of grandparent (mother's mother vs. mother's father vs. father's mother vs. father's father: p>0.05 for interaction with all G1 early-life characteristics). In models adjusting for all early-life G1 characteristics, better G3 schoolmarks were predicted by higher G1 birthweight; G1 full-term vs. post-term birth; lower G1 birth order; and higher G1 family social class. The same factors predicted G3 entrance to tertiary education, with the exceptions that G1 term vs. post-term birth was no longer significant, but there was weak evidence of an effect of the G1 being born to an unmarried mother. As in previous analyses the social class effects were particularly striking. For example, the proportion of G3 grandchildren entering tertiary education was 44% for G1s from high/mediate non-manual families vs. 29% for G1s from semi/unskilled manual families (for all schoolmark means and education continuation proportions, see the Supplementary Material).

To assess whether these effects were explained by G3 childhood socio-economic position, we additionally adjusted for G3 family social class at birth, mother's educational level and father's educational level (Table 4, columns 3 and 6). This caused all effect sizes to attenuate substantially towards the null, and almost all variables to become highly non-significant (p>0.1). The only exception was that effect of G1 social class upon G3 schoolmarks remained significant (p=0.002), but even here the effect sizes decreased by a factor of at least four. These results therefore supported our fourth hypothesis that G3 childhood socio-economic position largely explained the effects of G1 early-life characteristics upon G3 educational outcomes.

**Table 4: Early-life characteristics in subjects from the Uppsala Birth Cohort (G1s, born 1915-1929) and the educational outcomes of their grandchildren (G3s, born 1973-1980)**

| | | G1 characteristics predicting G3 standardized schoolmarks: linear regression, regression coefficients & 95% CI | | | G1 characteristics predicting G3 entrance to tertiary education: logistic regression, odds ratios & 95% CI | | |
|---|---|---|---|---|---|---|---|
| | | Minimally adjusted† | Multivariable: all G1 early-life characteristics | Multivariable: all G1 early-life characteristics & G3 childhood socio-economic position†† | Minimally adjusted† | Multivariable: all G1 early-life characteristics | Multivariable: all G1 early-life characteristics & G3 childhood socio-economic position†† |
| N | | 9,706 | 9,706 | 9,706 | 9,706 | 9,706 | 9,706 |
| **Gender** | Male | 0 | 0* | 0 | 1 | 1 | 1 |
| | Female | 0.03 (-0.02, 0.07) | 0.05 (0.00, 0.09) | 0.00 (-0.04, 0.04) | 1.06 (0.96, 1.16) | 1.09 (0.99, 1.20) | 0.98 (0.88, 1.08) |
| **Birthweight** | <2,500g | -0.09 (-0.20, 0.03) | -0.09 (-0.22, 0.05) | -0.02 (-0.15, 0.10) | 0.96 (0.75, 1.22) | 0.94 (0.71, 1.24) | 1.07 (0.79, 1.46) |
| | 2,500-3,000g | -0.02 (-0.09, 0.05) | -0.01 (-0.08, 0.06) | -0.03 (-0.09, 0.04) | 1.10 (0.95, 1.28) | 1.12 (0.95, 1.31) | 1.09 (0.93, 1.28) |
| | 3,000-3,500g | 0 [p=0.08] | 0* | 0 | 1 | 1* | 1 |
| | 3,500-4,000g | -0.01 (-0.06, 0.04) | 0.01 (-0.05, 0.06) | -0.02 (-0.06, 0.03) | 1.06 (0.95, 1.19) | 1.11 (0.98, 1.24) | 1.06 (0.94, 1.20) |
| | ≥4,000g | 0.07 (0.00, 0.14) | 0.11 (0.03, 0.18) | 0.04 (-0.03, 0.11) | 1.18 (1.01, 1.37) | 1.25 (1.07, 1.45) | 1.10 (0.94, 1.30) |
| **Gestational age** | Pre-term | -0.08 (-0.16, 0.01) | -0.01 (-0.11, 0.08) | -0.01 (-0.09, 0.08) | 0.90 (0.75, 1.08) | 0.95 (0.78, 1.16) | 0.95 (0.77, 1.18) |
| | Term | 0*** | 0** | 0 | 1 | 1 | 1 |
| | Post-term | -0.13 (-0.20, -0.06) | -0.13 (-0.20, -0.05) | -0.07 (-0.13, 0.00) | 0.93 (0.79, 1.09) | 0.95 (0.81, 1.11) | 1.08 (0.92, 1.28) |
| **Birth multiplicity** | Singleton | 0 | 0 | 0 | 1 | 1 | 1 |
| | Twin/triplet | -0.10 (-0.23, 0.04) | -0.07 (-0.21, 0.08) | -0.01 (-0.14, 0.12) | 0.98 (0.72, 1.33) | 1.01 (0.72, 1.41) | 1.18 (0.82, 1.68) |
| **Birth order** | 1 | 0* | 0*** | 0 | 1* | 1*** | 1 |
| | 2-3 | 0.00 (-0.05, 0.05) | -0.08 (-0.14, -0.02) | -0.03 (-0.08, 0.02) | 0.98 (0.88, 1.10) | 0.83 (0.73, 0.94) | 0.92 (0.80, 1.04) |
| | 4-5 | -0.08 (-0.15, -0.01) | -0.19 (-0.27, -0.11) | -0.07 (-0.14, 0.00) | 0.85 (0.74, 0.99) | 0.66 (0.56, 0.79) | 0.83 (0.69, 0.99) |
| | ≥6 | -0.07 (-0.14, 0.00) | -0.17 (-0.27, -0.07) | 0.01 (-0.08, 0.09) | 0.83 (0.71, 0.96) | 0.62 (0.51, 0.76) | 0.88 (0.71, 1.09) |

*(Table 4 cont'd)*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Mother's age at birth** | 15-19 years | 0.00 (-0.11, 0.08) | 0.04 (-0.06, 0.14) | 0.02 (-0.07, 0.11) | 0.98 (0.79, 1.21) | 1.10 (0.88, 1.37) | 1.07 (0.85, 1.35) |
| | 20-24 years | 0** | 0 | 0 | 1* | 1 | 1 |
| | 25-29 years | 0.08 (0.02, 0.14) | 0.06 (-0.01, 0.12) | 0.02 (-0.04, 0.08) | 1.14 (1.00, 1.29) | 1.10 (0.96, 1.26) | 1.02 (0.88, 1.18) |
| | 30-34 years | 0.12 (0.06, 0.19) | 0.10 (0.03, 0.18) | 0.03 (-0.04, 0.10) | 1.24 (1.08, 1.42) | 1.23 (1.06, 1.44) | 1.08 (0.91, 1.27) |
| | 35-39 years | 0.09 (0.01, 0.16) | 0.09 (0.00, 0.18) | 0.00 (-0.08, 0.08) | 1.20 (1.03, 1.41) | 1.31 (1.09, 1.59) | 1.10 (0.90, 1.35) |
| | ≥40 years | 0.01 (-0.09, 0.10) | 0.03 (-0.08, 0.15) | -0.03 (-0.13, 0.07) | 1.07 (0.87, 1.31) | 1.27 (0.99, 1.63) | 1.13 (0.87, 1.48) |
| **Mother's marital status** | Married | 0*** | 0 | 0 | 1*** | 1* | 1 |
| | Unmarried | -0.14 (-0.20, -0.09) | -0.06 (-0.14, 0.02) | 0.00 (-0.07, 0.07) | 0.74 (0.65, 0.83) | 0.80 (0.67, 0.94) | 0.88 (0.74, 1.05) |
| | Widowed/divorced | 0.11 (-0.12, 0.35) | 0.14 (-0.09, 0.38) | 0.02 (-0.20, 0.23) | 1.18 (0.72, 1.91) | 1.26 (0.75, 2.12) | 0.98 (0.58, 1.67) |
| **Family social class** | High/med non-manual | 0*** | 0*** | 0** | 1*** | 1*** | 1 |
| | Lower non-manual | -0.17 (-0.28, -0.05) | -0.15 (-0.27, -0.03) | -0.04 (-0.14, 0.06) | 0.85 (0.67, 1.07) | 0.89 (0.70, 1.13) | 1.13 (0.87, 1.48) |
| | Skilled manual | -0.33 (-0.43, -0.23) | -0.29 (-0.39, -0.19) | -0.04 (-0.13, 0.05) | 0.62 (0.51, 0.76) | 0.67 (0.55, 0.83) | 1.12 (0.90, 1.41) |
| | Semi/unskilled manual | -0.40 (-0.49, -0.32) | -0.36 (-0.45, -0.27) | -0.07 (-0.15, 0.01) | 0.50 (0.42, 0.59) | 0.56 (0.47, 0.68) | 0.99 (0.81, 1.21) |
| | Self-employed | -0.02 (-0.16, 0.11) | -0.01 (-0.14, 0.13) | 0.08 (-0.04, 0.20) | 0.96 (0.71, 1.30) | 0.97 (0.71, 1.31) | 1.17 (0.85, 1.61) |
| | Farmers | -0.26 (-0.35, -0.16) | -0.22 (-0.32, -0.12) | 0.05 (-0.04, 0.14) | 0.56 (0.45, 0.68) | 0.60 (0.48, 0.74) | 1.03 (0.82, 1.29) |
| | Housedaughter | -0.47 (-0.59, -0.35) | -0.42 (-0.56, -0.28) | -0.09 (-0.22, 0.04) | 0.46 (0.35, 0.59) | 0.55 (0.41, 0.74) | 1.10 (0.80, 1.52) |

**p<0.05, **p<0.01, ***p<0.001. †Minimally adjusted: variables entered separately, adjusting only for G3 gender and birthyear. ††G3 childhood socio-economic position: G3 family social class at birth, G3 mother's educational level and G3 father's educational level.*

## Discussion

This paper has examined the early-life characteristics predicting educational outcomes across the lifecourse and across generations, using data from 12,674 Swedish infants born 1915-1929 ('G1s') and 9,706 of their grandchildren born 1973-1980 ('G3s'). The predictors of school achievement and educational continuation were very similar in the two cohorts. The independent predictors of better schoolmarks were: female gender, heavier birthweight, lower birth order, older mother, married mother and higher family social class. Here and in all subsequent analyses, the social class effects were particularly large and were also largely independent of the effects of birth characteristics or family composition. There was no evidence of an independent effect of pre-term or twin status, but weak evidence of a disadvantage to post-term infants. The predictors of education continuation were very similar, the main exception being a marked male advantage in the G1s. The higher probability of education continuation among heavier birthweight individuals seemed to be explained by their better school achievement. By contrast, even after adjusting for school achievement, entrance to tertiary education was still predicted in both cohorts by lower birth order, older mother, married mother and higher family social class. In cross-generational analyses, higher G3 school achievement and education continuation were predicted by higher G1 birthweight; lower G1 birth order; and higher G1 family social class. These associations became non-significant and/or substantially attenuated after adjusting for G3 socio-economic position at birth, suggesting that intervening socio-economic position was the major mechanism underlying these cross-generational effects.

### Study limitations

In interpreting these findings, it is important to bear in mind our study's limitations. By definition, our G3 cohort consisted of infants with at least one grandparent born in Uppsala between 1915 and 1929. The G3s were therefore not fully representative of all Swedish births in 1973-1980; births to older parents were somewhat underrepresented and, by excluding all children with four foreign-born grandparents, our G3 cohort will also underrepresent the descendents of immigrants. Nevertheless, the close similarity between most G3 characteristics and total population data leads us to believe that many of our findings will generalise to all Swedish births from this time period. Moreover, although the G3s are not representative in the *distribution* of some early-life characteristics, we know of no reason to hypothesise that this will bias the *associations* between those characteristics and subsequent educational outcomes.

Perhaps a more important limitation is that our educational outcomes are not fully comparable between the two cohorts. Schoolmarks were awarded at around age 10 in the G1s but at age 16 in the G3s. This is important because both social and biological characteristics may vary in the strength of their effects upon educational outcomes according to the age at which educational outcomes are assessed (Boardman et al 2002; Bradley and Corwyn 2002). Other possible sources of non-comparability between the cohorts include differences in the criteria applied by teachers when grading students, or differences in the degree of measurement error when assigning schoolmarks. We therefore believe it is not advisable to make direct comparisons of the magnitude of the schoolmark effect sizes between the two cohorts. Similarly, although we used the same measures of education continuation in both cohorts, their frequencies differ greatly – for example, 5% entering tertiary education in the G1s vs. 32% in the G3s. We partly addressed this issue by demonstrating that our substantive findings were generally unchanged when we used secondary school attendance as an alternative measure of education continuation, which had a G1 frequency which was comparable to the G3 frequency of tertiary education (28% vs. 32%). Nevertheless, the different frequency of educational continuation in the two cohorts again complicates direct comparisons of effect sizes. Thus while we have certainly demonstrated that large educational inequalities exist in both cohorts, we do not feel that we can comment with confidence how the *magnitude* of these inequalities has changed in Sweden over the twentieth century. It is for this reason that we have focused instead upon comparing the pattern of relative advantage and disadvantage between the two cohorts.

### Implications of study for understanding educational inequalities.

Bearing these limitations in mind, what do our results reveal about the early-life predictors of educational outcomes? For birth characteristics, we did not find an independent effect of pre-term birth upon our educational outcomes but, in accordance with previous findings (Record et al 1969b; Yang et al 2010; Eide et al 2007), we did find some evidence of a disadvantage to post-term infants. We also showed that the effect of birthweight upon school achievement was not confined to low birthweight infants (<2,500g); rather it extended until at least the middle of the distribution in the G1s and right across the distribution in the G3s. This replicates a recent systematic review (Shenkin et al 2004) and extends it by including more evidence from study populations born pre-1945 and post-1965. The persistence of marked birthweight effects in the G3s highlights that birth outcomes are an important public health issue even in low mortality settings. This conclusion is reinforced by the fact that in both cohorts the poorer school achievement of lighter infants was translated into a lower probability of education continuation, thereby potentially having adverse implications for adult life chances. Indeed, these deleterious effects even seemed to extend across generations, with some evidence that the grandchildren of post-term and lighter birthweight G1s had poorer school achievement and/or lower entrance to tertiary education. To our knowledge, ours is the first paper to suggest such inter-generational effects of birth characteristics upon educational outcomes.

With regard to family composition, the similarity between the two cohorts was striking, and included a continued marked disadvantage to G3 children of unmarried mothers. This may seem somewhat surprising given the substantially lower stigma attached to unmarried parenthood when the G3s were born. Moreover, our results plausibly underestimate the disadvantage to truly single G3 mothers, since many unmarried G3 mothers will have been living in stable partnerships with the child's father. Our results are, however, in line with British findings which likewise show that the negative effect of parental divorce upon educational attainment did not decrease over the twentieth century despite divorce becoming substantially more common (Ely et al 1999). One interpretation is that a major mechanism of this disadvantage is not external stigma, but rather a reduction in the total amount of cognitive stimulation children get from their parents if they live with one parent rather than two. Reduced parent stimulation is known to be associated with adverse effects across a range of cognitive outcomes, and has also been suggested as the key mechanism underlying the disadvantage to children of higher birth order and/or from larger families (Steelman et al 2002; Price, 2008). Indeed, while the G3 children of unmarried mothers may have benefitted from reduced stigma, it is plausible that for them, reduced parental stimulation was an even more important source of relative disadvantage than in the less gender-egalitarian G1 society – perhaps for the G1s even 'present' fathers played a relatively small role in child-rearing. Speculatively, large amounts of contact time with mothers and grandparents may partly explain why the school achievement of G1 children of housedaughters was no worse than average, despite this being the most disadvantaged group for education continuation.

The extremely low probability of education continuation among G1 children of housedaughters contrasts with the large advantages to the highest social class; of all the early-life characteristics, high/mediate non-manual social class was the single strongest predictor of educational advantage for all three outcomes in both cohorts. In the G1s, social class also interacted with birth order and gender, highlighting a constellation of particular advantage to first-born, male children of non-manual families.

That family social class affects educational outcomes is well-documented, including in Swedish populations born at similar times to our study samples (Husén et al 1969; Husén and Boalt 1967; Björklund et al 2003; Berggren 2006; Erikson and Jonsson 1993; Erikson and Jonsson 1996). There is also some evidence of narrowing socio-economic inequalities in recent decades, particularly with respect to education continuation (Erikson and Jonsson 1996; Erikson and Jonsson 1993). Nevertheless, it was striking how little change there was in the pattern of social class differences between our two cohorts. This highlights the continued policy imperative to seek to narrow these socio-economic inequalities, particularly given our demonstration that strong social class effects persist after adjusting for multiple plausible mediators or confounders such as birth characteristics or family composition. By including these other biological and social characteristics, our study also permits some comparison of the magnitude of their different effects. We believe that one contribution of this paper is to demonstrate that socio-economic differences form only one important axis of inequality. In particular, there were substantial educational disparities by birth order, mother's age and mother's marital status, despite these receiving far less attention from academics and policy-makers than socio-economic differences.

A further contribution of this paper has been to assess how far these early-life effects upon educational continuation could be explained by prior school achievement. In the G3s, schoolmarks explained almost all differences in secondary school attendance, which was also near-universal among those who achieved schoolmarks above the bottom fifth. This probably reflects the fact that G3s had few alternative occupational pathways at this age, and attending secondary school was therefore standard for those with adequate school achievement. By contrast, schoolmarks only partly explained the effects of family composition and social class upon G3 continuation to tertiary education. The same was true of G1 continuation to both secondary school and tertiary education. Previous Swedish studies have documented such effects for low social class (Erikson and Jonsson 1993; Erikson and Jonsson 1996; Husén and Boalt 1967), but to our knowledge this is the first demonstration that children with higher birth order, younger mothers or unmarried mothers are less likely to continue their education even after controlling for their school achievement. This suggests a 'two-stage' process in creating educational inequalities, with disadvantages in school achievement being compounded by a lower probability of education continuation net of school achievement (Boudon 1974). This again highlights the greater attention which family composition deserves as a source of educational inequalities across the lifecourse.

A final, unique contribution of our paper is to demonstrate that birth characteristics, family composition and family social class may all have effects upon educational outcomes which extend across multiple generations. Specifically, we showed that both the school achievement and the education continuation of Swedes born in 1973-1980 were predicted by their grandparents' birthweight, birth order and family social class at birth – that is, the social class of their great-grandparents four generations before. We also showed that these effects seemed to be largely or entirely explained by the intervening educational attainment and social class of the parents of the G3s. This indicates the ongoing importance of education as a mechanism whereby early-life disadvantage is translated into social inequalities across the lifecourse, social inequalities which may then be recreated across generations to create a long-term legacy of social disadvantage.

## Conclusion

The Swedish education system underwent major reforms between the births of our two cohorts, many of which were explicitly designed to extend and democratise educational opportunities (Erikson and Jonsson 1993; Husén and Boalt 1967). This paper demonstrates Sweden's success in increasing the proportion of young people entering secondary and tertiary education, and also in equalising participation by gender. Nevertheless, for most early-life characteristics the pattern of relative advantage and disadvantage changed little over the twentieth century. Moreover, early-life disadvantage was not only associated with educational inequalities across the lifecourse but was also found to predict educational inequalities over three generations, as mediated by intervening socio-economic position. These findings therefore indicate the persistent importance of multiple axes of educational inequality in Sweden, and suggest the continued need for policies which seek to equalise opportunities across children. The consistency of these findings across our two cohorts also suggests their potential relevance for understanding educational inequalities in populations around the world. Greater understanding of educational inequalities would, in turn, shed light onto a major mechanism whereby health inequalities are created and recreated across generations.

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# The association of childhood socio-economic position and psychological distress in adulthood: is it mediated by adult socio-economic position?

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## Abstract

*There is substantial evidence that lower socio-economic position (SEP) is associated with poorer mental health outcomes. However, uncertainties exist about the origins of socio-economic gradients in mental health problems and the relative contributions of both childhood and adult SEP. In this study we assess the association of childhood SEP with psychological distress in adulthood and investigate how much of this association is mediated by adult SEP. Data for this cross-sectional analysis came from Wave 3 of the Survey of Family, Income and Employment (SoFIE) in New Zealand (n=14,470). Childhood SEP was measured using parental occupation recalled at age 10. Non-specific psychological distress was assessed using the Kessler 10 scale (K10). Adult SEP was measured using five socio-economic indicators (area deprivation, household income, wealth, labour market activity, education). The association of childhood SEP with psychological distress before and after controlling for confounders and adult SEP indicators was determined using logistic regression, with the K10 dichotomised at low/moderate versus high/very high. Sensitivity analyses included birth cohort and sex. There was a weak inverse relationship between increasing proportion of psychological distress with lower childhood SEP. Adjusted for age, sex and ethnicity, respondents with low compared to high childhood SEP had 1.35 greater odds of reporting high psychological distress (95% CI 1.13-1.60). Adjustment for adult mediating SEP variables led to a 77% reduction in the excess odds ratio to 1.08 (95% CI 0.90-1.29). The relationship did not significantly differ by birth cohort or sex. This finding is consistent with the current evidence that socio-economic circumstances in adulthood are important determinants of inequalities in adult mental health and mediate much of the association of childhood SEP with adult psychological distress.*

**Keywords***:* psychological distress, mental health, Kessler 10, childhood socio-economic position, adulthood socio-economic position

## Introduction

The literature on the existence of adult socio-economic gradients in mental health is extensive (Dohrenwend, Levav et al 1992; Weich and Lewis 1998; Miech, Caspi et al 1999; Fryers, Melzer et al 2003; Lorant, Deliege et al 2003; Stansfeld, Head et al 2003; Muntaner, Eaton et al 2004; Skapinakis, Weich et al 2006; Butterworth, Rodgers et al 2009). Socio-economic disparities in adult mental health have been shown in a number of populations (Dohrenwend, Levav et al 1992; Weich and Lewis 1998; Weich and Lewis 1998; Miech, Caspi et al 1999; Fryers, Melzer et al 2003; Skapinakis, Weich et al 2006; Carter, Blakely et al 2009) and across a range of mental disorders, including schizophrenia, anti-social personality disorder and affective disorders (Power, Stansfeld et al 2002). However, for the more common mental disorders and general psychological distress, which make up the majority of the burden of mental illness in the community, the findings are inconsistent. Most studies have, however, shown significantly higher rates of specific disorders, such as depression, anxiety or a combination of both among lower socio-economic groups (Stansfeld, Head et al 1998; Miech, Caspi et al 1999; Lorant, Deliege et al 2003; Stansfeld, Head et al 2003; Lorant, Croux et al 2007). Those groups with less education, more unemployment and lower income or material assets, tend to have higher prevalence rates of the common mental disorders (Fryers, Melzer et al 2003).

Despite this, the origins of the socio-economic differences observed in inequalities in adult mental health remain under investigated, particularly the association and relative contributions of earlier and later SEP conditions. A key question from the life course perspective is whether the higher rates of adult ill health, observed in the lower socio-economic groups, reflect influences that took place earlier in the life course, in adolescence or earlier stages of adulthood, or whether they reflect more recent influences. The identification of socio-economic pathways that link early life experiences to social inequalities in adult mental health is therefore an important line of enquiry within the life course framework.

Previous investigations of the effects of childhood and adult SEP on health have tended to focus exclusively on physical health outcomes such as coronary heart disease (Singh-Manoux, Ferrie et al 2004), self-rated health (Laaksonen, Rahkonen et al 2005), biological risk factors such as blood pressure, body mass index and cholesterol (Melchior, Moffitt et al 2007; Power, Atherton et al 2007), cause-specific mortality (Davey Smith, Hart et al 1998; Galobardes, Lynch et al 2008) and all-cause mortality (Kuh, Hardy et al 2002). These studies comprise a growing body of literature showing that whilst poor socio-economic circumstances during childhood are associated with adverse health outcomes in adulthood, adjusting for measures of current adult SEP can explain some or all of the association (i.e. much if not all of the association of childhood socio-economic position with adult health is mediated by adult socio-economic position). Similar studies, exploring the contributions of both early and later life SEP to adult mental health, are not as common and their findings inconsistent. Some have demonstrated a significant association between adverse childhood SEP and poorer mental health independently of adult SEP, concluding that socio-economic differences, certainly for depression, originate early in life and do not appear to be fully mediated by adult socio-economic position (Gilman, Kawachi et al 2002; Luo and Waite 2005; Power, Atherton et al 2007). However, other studies have shown that poor mental health is more strongly associated with adult than childhood SEP (Harper, Lynch et al 2002; Poulton, Caspi et al 2002). It is unclear whether these effects are due to direct effects from childhood SEP on adult mental health or whether they are due to an indirect effect through adult SEP.

We might expect a direct effect of childhood SEP on adult mental health as hypothesised by the 'critical periods model'. According to this model, an exposure acting during a specific period of development (such as childhood SEP) may have lasting or lifelong effects on the structure or function of organs, tissues and body systems that are not modified in any dramatic way by later life experience (Kuh and Ben-Shlomo 2004). Also known as 'biological programming', this is the basis of the 'fetal origins of adult disease' hypotheses (Barker 1998). The socio-economic environment in childhood could affect exposure during gestation, infancy, and childhood to adverse causal factors which are part of long-term biological processes. These factors are generally associated with various aspects of childhood development and wellbeing such as social competence, emotion processing; cognitive development; psychosocial behaviours; and the development of biological stress-responses (Bradley and Corwyn 2002; Repetti, Taylor et al 2002). Children from low socio-economic families are more likely to begin life in poor health, experience more biological and psychosocial risk factors; more stress; more fetal and birth complications and have elevated rates of emotional and behavioural problems than those born into higher socio-economic groups (Power and Matthews 1997; Poulton, Caspi et al 2002; Graham and Power 2004).

We might also expect an indirect effect of childhood SEP on adult psychological distress as hypothesised by the 'chain of risk' or the 'pathways model' (Kuh and Ben-Shlomo 2004). According to these models a sequence of linked exposures leads to impaired function and increased risk of ill health because one bad experience or exposure leads to another and so on. Each exposure in the chain of risk may not only increase the risk of subsequent exposure, but may also have an independent 'additive effect 'on later function or disease (Kuh and Ben-Shlomo 2004). It is also argued that there is continuity of family socio-economic circumstances or social class (including grandparent social class) during childhood and adolescence through to adulthood. The socio-economic circumstances of the family are responsible for influencing children's access to social and economic resources, and relate strongly to the child's opportunities for education and learning experiences (Kuh, Power et al 2004). There is also substantial evidence from cohort studies that education is an important determinant of subsequent occupational career, and thus opportunities for ensuring income and favourable living conditions in adulthood (Kuh and Wadsworth 1991; Kuh, Head et al 1997; Graham 2007). Adult socio-economic circumstances have in turn been shown to affect mental health status through factors such as unemployment, deprivation, or poor social networks and support (Power and Manor 1992; Lorant, Deliege et al 2003). The influence of the early socio-economic environment on adult socio-economic trajectories therefore is a hypothesised major indirect pathway through which childhood SEP may exert an effect on adult health (Kuh, Power et al 2004; Singh-Manoux, Ferrie et al 2004). Adult SEP is argued to act as a mediating variable, as not only is it heavily influenced by childhood SEP, but is itself also predictive of later health outcomes.

Our study uses data from a survey in New Zealand (NZ) to address the following research questions (i) Is there a direct association between a retrospective measure of childhood SEP and psychological distress in adulthood? and if so (ii) How much of the association is mediated by adult SEP through an indirect pathway? (childhood SEP → adult SEP → psychological distress). We also examine whether this association differs by sex or birth cohort.

## Methods

This study is a cross-sectional analysis utilising data from the Survey of Families, Income and Employment (SoFIE) conducted by Statistics New Zealand (Wave 1 to 4 version 6) (Carter, Cronin et al 2009). SoFIE is New Zealand's first national survey designed to study income, family type and employment and how they change over a period of 8 years. It is a nationally representative fixed-panel longitudinal survey of the usually resident population living in private dwellings in New Zealand in 2002. SoFIE used the standard Statistics New Zealand sampling frame used for other household surveys (Carter, Cronin et al 2009). In SoFIE, face to face interviews are used to collect information annually on income levels, sources and changes; and on major influences on income such as employment and education experiences, household and family status and changes, demographic factors and health status. Information on assets and liabilities is collected every two years (Waves 2, 4, 6 and 8). At Waves 3, 5 and 7 an array of health questions, collecting information of health-related quality of life, psychological distress, co-morbidities (e.g. stroke, diabetes, and injury), lifestyle factors, perceived stress and primary care usage are asked. In this analysis, data were restricted to adults (15 years or older) who answered questions at Wave 3, as this wave also included questions about parental occupation.

The quality of longitudinal data through time is heavily affected by attrition as it occurs at each wave of the survey, resulting in fewer and fewer people who have complete records over the course of the survey. The initial SoFIE sample comprised approximately 11,500 randomly-selected responding private households (response rate of 77%) with data collected from 22,165 individuals aged 15 and over at Wave 1. All individuals who were asked and responded to the Wave 1 interview were original sample members (OSMs). Children under the age of 15 at Wave 1 were interviewed as OSMs from Wave 2 onwards once they had turned 15. All household members over the age of 15 were eligible to take part. By Wave 2 the sample had reduced to just over 20,000 responding OSMs (89%) and by Wave 3 (2004), 18,955 responding adults answered the SoFIE Health questionnaire (82% of Wave 1 adult OSMs) (Statistics New Zealand 2008). The highest attrition rates between wave 1 and 3 were observed in respondents living in the most deprived areas (26.6%), with no qualifications (20.3%), in the lowest income group (29%), lowest quintile for wealth (17.6%) , unemployed (31.4%) and in the minority ethnic groups (Asian 38.4%, Maori 30.9% and Pacific 29.4%).

Of the 18,955 adults who answered the health questionnaire at Wave 3, parental occupation was missing for 4,090 respondents. When the sample was further restricted by excluding those adults with missing information on psychological distress (n = 125) the final sample size reduced to 14,740. Respondents in the final sample were more likely to be aged over 35 years, identify as New Zealand/European (70.4%), report higher educational qualifications, income and wealth and be less likely to report living in a deprived area compared to the original Wave 1 sample.

## Measures

### Childhood socio-economic position

As part of the health module (Wave 3) of SoFIE, respondents were asked to recall the occupation of both parents when they were aged 10. These occupations were coded using the 1999 version of the *New Zealand Standard Classification of Occupations* (NZSCO99) which provides a standardised framework for classifying occupational data (Statistics New Zealand 2001). Our measure of childhood SEP was derived by mapping the highest occupational code of both parents to the *New Zealand Socio-economic Index of Occupational Status (*NZSEI 1996) (Davis, McLeod et al 1997) thereby creating a measure of childhood socio-economic status for each respondent. The NZSEI is a census-derived, occupation based measure of SES based on a 'return to human capital' model of social stratification (Davis, McLeod et al 1997; Davis, McLeod et al 1999; Davis, Jenkin et al 2003; Davis, Jenkin et al 2004). NZSEI is a linear scale of ranked occupation, produced using an algorithm involving age, income and education. Thus, variations in occupational orders translate into variations in social stratification and differentiation in lifestyles and life chances (Davis, McLeod et al 1997; Davis, McLeod et al 1999). The socio-economic scores are scaled from 10 (representing the occupational group at the lowest) to 90 (the occupational group at the highest ends of the socio-economic hierarchy). For our analysis, NZSEI scores were split into three discrete socio-economic groups using cutpoints based on the 33$^{rd}$ and 66$^{th}$ percentile splits of the distribution of scores in our sample, creating similar score ranges to previous work by Davis et al. The distribution of childhood SEP groups over NZSEI-96 were as follows: low (10-30), medium (31-46) and high (47-90) childhood SEP groups. Sensitivity analyses for our final modelling strategy conducted using the NZSEI-scores continuously, rather than in tertiles, produced similar results.

### Psychological distress

Mental health was assessed at Wave 3 using the 10-item Kessler psychological distress Scale (K10). This scale has been developed specifically for assessing the prevalence of general psychological distress symptoms at the community level, and is increasingly being used in population mental health research. It has been validated in multiple settings (Andrews and Slade 2001) and has sound psychometric properties (Kessler, Andrews et al 2002). In SoFIE, respondents were asked how often they had experienced each of the 10 states elicited by the K10 (mainly anxiety and depressive symptoms) in the four weeks prior to interview. The frequency with which each of the 10 items was experienced was recorded using a five-point Likert scale ranging from 1 (none of the time) to 5 (all the time). This score was then summed with increasing scores reflecting an increasing degree of psychological distress. As there is no agreed standard for determining cut-off points for levels of psychological distress, and various interpretations of scoring have been used to date, the scores in our study were grouped according to the criteria developed by Andrews and Slade (2001) into four levels of psychological distress: low (10-15); moderate (16-21); high (22-29); very high distress (≥30). For the current analysis, the K10 was dichotomised at low to moderate levels of distress (K10 ≤21) versus high to very high levels of psychological distress (K10≥22) (Phongsavan, Chey et al 2006). High to very high levels of psychological distress have been shown to be associated with clinical diagnoses of anxiety and affective disorders (Andrews and Slade 2001; Oakley Browne, Wells et al 2010). Using alternative K10 cutpoints, or multichotomous logistic regression, did not substantially alter our findings and how much of the relationship was mediated by adult SEP.

**Adult socio-economic position**

We used five measures of the participant's current SEP at the time of the Wave 3 interview to reflect different aspects of both material and social resources in adulthood (Galobardes, Shaw et al 2006). For our research questions, it is important that we adjust as completely as possible for adult socio-economic position; hence including multiple measures of adult socio-economic position is desirable. These include area deprivation, education, household income and labour market activity. The NZ deprivation (NZDep2001) index provides a small area deprivation score composed of census variables which reflect aspects of material and social deprivation (Salmond and Crampton 2002). NZDep2001 information was divided into quintiles where NZDepQ1 is the least deprived and NZDepQ5 is the most deprived. Education, which captures early- to mid-life adult socio-economic position, was measured using the respondent's maximum educational qualification over the three waves and categorised as nil, high school, post-school vocational (diploma/certificate) or, bachelor degree or higher qualification(s). Equivalised household income (CPI adjusted to 2002), a measure of material resources at the household level, was divided into quintiles using the mean household income across the first three waves. Labour market activity was used as a measure of workforce status, as these conditions are associated with material resources, for example those who are unemployed may have a lack of resources. Labour market activity was defined as employed, not employed but seeking work, or not employed and not seeking work at the interview date. Wealth is a measure of total assets and can include financial and physical assets such as housing, investments or pensions. Net worth (taken from Wave 2 of SoFIE) was calculated by subtracting the total value of all liabilities from the total value of all assets for individuals and couples, and categorised into quintiles (Carter, Hayward et al 2008).

**Covariates**

Respondents' sex and age was asked at the initial interview and then checked with the respondents at subsequent waves. At each wave, every adult was also asked their self-identified ethnicity. Participants were asked to '*choose as many responses as you need to say which ethnic groups you belong to',* from a list of fifteen possible groups. For analyses we used prioritised ethnicity where each respondent was allocated to a single ethnic group using the priority recording system (Allan 2001). Ethnicity was defined as New Zealand/European (those primarily of European descent), Māori (the indigenous people of New Zealand), Pacific (those of Pacific Island descent e.g. Samoan, Cook Island, Fijian), Asian (those of Southeast Asia, China or Indian descent) and other (non NZ/European, non-Maori, non-Pacific and non-Asian).

**Statistical methods**

Associations between childhood SEP and adult psychological distress were investigated using multiple logistic regression models to calculate odds ratios (OR) and 95% confidence intervals (CI). Firstly, the odds of experiencing high to very high psychological distress (score of 22+) in the low and medium childhood SEP groups, as compared with the high childhood SEP group, were calculated with adjustment for the confounders sex, age and ethnicity (model 1). Secondly, respondent's own NZDep2001 score, education, income, labour market activity and wealth were added to the confounder adjusted model, one at a time (model 2). Finally the model was fully adjusted for confounders and all five adult SEP indicators simultaneously (model 3). The fully adjusted ORs (from model 3) were compared with those from model 1 by calculating the percentage change in the excess OR $(OR_{Model\ 2}-OR_{Model\ 1})/(OR_{Model\ 1}-1)$ in the low compared to high childhood SEP group. As a test of whether the change in strength of the association of low childhood SEP with psychological distress was statistically significant, we conducted a Hausman test (Hausman 1978; Greenland 2008). This involved calculating the difference in the beta coefficients and constructing 95% confidence intervals before (model 1) and after adjusting for mediating variables (model 3).

**Sensitivity analyses**

It is argued that the association between childhood SEP and psychological distress could, potentially, vary by sex, as the determinants of mental health differ between males and females (Piccinelli and Wilkinson 2000; Artazcoz, Benach et al 2004). It could also vary by birth cohort, which, given the cross-sectional nature of our data, would be equivalent to variation by age in this study (Kuh, Ben-Shlomo et al 2003). This could possibly be due to increasing measurement error of parental occupation with older subjects, or perhaps more substantively, due to true cohort variation in effects. Thus, to account for these possible influences, or effect modification, three birth cohorts were created covering three time periods (1920-1950,1950-1970,1970-1990) using the respondent's age at Wave 3. Models 1 (age, sex, ethnicity adjusted) and 3 (fully adjusted) were re-run, stratified by sex and birth cohort, and the Wald Statistic test was applied to test for heterogeneity between the sex and age strata.

All data were analysed on unit-level data in the Statistics New Zealand data laboratory using SAS 8.2. All tabular numbers of respondents presented in this paper are random rounded to the nearest multiple of five as per Statistics New Zealand confidentiality protocol. Analyses were run both with and without longitudinal weights (taking into account attrition and weighting to the New Zealand population at 2002); there was no difference in the results so we present the unweighted results.

## Results

The demographic and socio-economic characteristics of the study sample in relation to categories of psychological distress (K10) are presented in Table 1. Overall, 79% of the study sample reported low levels of psychological distress (K10 score between 10 and 15). This distribution is heavily skewed but is the same as found in the recent NZ Health Survey 2006/07 and the NZ Mental Health Survey (Oakley Browne, Wells et al 2006; Ministry of Health 2008). There was a slightly higher proportion of high to very high psychological distress present in the low childhood SEP group as compared to the high childhood SEP group. Females made up a little more than half of the sample (54.1%) and reported higher levels of psychological distress. The majority of the sample identified as NZ/European ethnicity, with Pacific respondents reporting higher levels of psychological distress than any other ethnic group. All adult SEP indicators illustrated a linear relationship with psychological distress, i.e. more respondents in poorer income and wealth quintiles, or living in more deprived areas, reported high to very high levels of psychological distress.

**Table 1. Characteristics of SoFIE Health respondents by psychological distress (K10) at Wave 3 (n= 14,740)**

| | | Category of psychological distress (total K10 score) (row %) | | | |
|---|---|---|---|---|---|
| **Childhood SEP** | **n** | **Low 10-15 (%)** | **Moderate 16-21 (%)** | **High 22-29 (%)** | **Very high ≥ 30 (%)** |
| Low | 6,520 | 78.5 | 14.7 | 5.1 | 1.6 |
| Medium | 3,610 | 79.2 | 14.3 | 5.0 | 1.5 |
| High | 4,610 | 80.7 | 14.1 | 4.1 | 1.1 |
| **Sex** | | | | | |
| Female | 7,975 | 77.5 | 15.4 | 5.2 | 1.9 |
| Male | 6,765 | 81.5 | 13.2 | 4.2 | 1.0 |
| **Ethnicity** | | | | | |
| NZ/European | 11,980 | 80.7 | 13.8 | 4.2 | 1.3 |
| Maori | 1,340 | 74.3 | 16.8 | 7.1 | 2.2 |
| Asian | 725 | 75.9 | 17.2 | 4.8 | 2.1 |
| Pacific | 450 | 70.0 | 18.9 | 10.0 | 2.2 |
| Other | 245 | 71.4 | 16.3 | 8.2 | 4.1 |
| **Age** | | | | | |
| 15-24 | 2,035 | 74.0 | 18.7 | 6.1 | 1.5 |
| 25-34 | 2,015 | 76.9 | 16.9 | 4.5 | 1.7 |
| 35-44 | 3,030 | 78.5 | 14.4 | 5.3 | 1.7 |
| 45-54 | 2,925 | 82.1 | 12.5 | 4.3 | 1.4 |
| 55-64 | 2,230 | 83.2 | 11.4 | 4.0 | 1.8 |
| 65+ | 2,495 | 80.4 | 14.2 | 4.6 | 0.8 |
| **Highest educational qualification** | | | | | |
| Degree or higher | 2,235 | 83.9 | 12.8 | 2.7 | 0.7 |
| Post school vocational | 5,170 | 80.5 | 14.0 | 4.1 | 1.5 |
| School qualification | 3,920 | 78.2 | 15.7 | 5.1 | 1.1 |
| No qualification | 3,415 | 76.1 | 14.6 | 6.9 | 2.3 |
| **NZDeprivation** | | | | | |
| NZDepQ1(least) | 3,215 | 86.3 | 10.6 | 2.3 | 0.6 |
| NZDepQ2 | 3,150 | 81.9 | 12.7 | 4.3 | 1.0 |
| NZDepQ3 | 2,745 | 79.6 | 14.4 | 4.9 | 1.6 |
| NZDepQ4 | 3,100 | 75.2 | 17.4 | 5.3 | 1.8 |
| NZDepQ5(most) | 2,520 | 72.2 | 17.5 | 7.7 | 2.6 |
| **Household income** | | | | | |
| q1: low -< $21,080 | 1,485 | 71.4 | 17.5 | 8.4 | 3.0 |
| q2: $21,080 -< $34,010 | 3,265 | 74.0 | 17.8 | 6.0 | 2.5 |
| q3: $34,010 -< $49,380 | 2,825 | 77.2 | 15.6 | 6.0 | 1.4 |
| q4: $49,380 -< $72,280 | 3,290 | 83.1 | 12.5 | 3.5 | 0.8 |
| q5: $72,280 -< high | 3,865 | 85.6 | 11.3 | 2.7 | 0.5 |
| **Labour market activity** | | | | | |
| Not employed, looking for work | 235 | 63.8 | 19.1 | 12.8 | 4.3 |
| Not employed, not looking for work | 4,595 | 73.6 | 16.9 | 7.1 | 2.2 |
| Working | 9,910 | 82.4 | 13.1 | 3.5 | 1.1 |
| **Wealth** | | | | | |
| Q1: low -< $25,590 | 3,860 | 72.7 | 17.9 | 7.0 | 2.3 |
| Q2: $25,590 -< $70,315 | 2,515 | 76.1 | 16.1 | 5.8 | 2.2 |
| Q3: $70,315 -< $128,090 | 2,545 | 81.1 | 13.4 | 4.3 | 1.2 |
| Q4: $128,090 -< $232,935 | 2,635 | 83.5 | 12.5 | 3.2 | 0.6 |
| Q5: $232,935 - high | 2,675 | 87.7 | 9.9 | 2.2 | 0.4 |

**Table 2. Description of respondent's socio-economic position in childhood and adulthood**

| | | Childhood socioeconomic position | | | |
|---|---|---|---|---|---|
| **Adult socioeconomic indicators** | **n** | **Low (%)** | **Medium (%)** | **High (%)** | **Pearson correlation coefficients** |
| **Highest educational qualification** | | | | | |
| Degree or higher | 2,230 | 27.1 | 20.4 | 52.5 | |
| Post school vocational qualification | 5,165 | 42.8 | 27.0 | 30.2 | |
| School qualification | 3,915 | 41.5 | 24.1 | 34.4 | |
| No qualification | 3,420 | 60.7 | 23.8 | 15.5 | 0.19* |
| **NZ Deprivation** | | | | | |
| NZDepQ1(least) | 3,215 | 37.6 | 23.6 | 38.7 | |
| NZDepQ2 | 3,145 | 42.3 | 24.0 | 33.7 | |
| NZDepQ3 | 2,750 | 43.3 | 25.5 | 31.3 | |
| NZDepQ4 | 3,095 | 46.8 | 24.7 | 28.4 | |
| NZDepQ5(most) | 2,520 | 52.8 | 25.2 | 22.0 | 0.12* |
| **Household income** | | | | | |
| q1: low -< $21,080 | 1,485 | 48.8 | 24.9 | 26.3 | |
| q2: $21,080 -< $34,010 | 3,275 | 51.8 | 24.6 | 23.7 | |
| q3: $34,010 -< $49,380 | 2,825 | 46.0 | 25.3 | 28.7 | |
| q4: $49,380 -< $72,280 | 3,290 | 42.6 | 25.1 | 32.4 | |
| q5: $72,280 -< high | 3,870 | 36.2 | 23.3 | 40.6 | 0.10* |
| **Labour market activity** | | | | | |
| Not employed, looking for work | 235 | 42.6 | 27.7 | 29.8 | |
| Not employed, not looking for work | 4,595 | 47.9 | 24.6 | 27.5 | |
| Working | 9,905 | 42.6 | 24.4 | 33.0 | 0.06* |
| **Wealth** | | | | | |
| Q1: low -< $25,590 | 3,865 | 40.4 | 23.7 | 36.0 | |
| Q2: $25,590 -< $70,315 | 2,520 | 45.6 | 25.0 | 29.4 | |
| Q3: $70,315 -< $128,090 | 2,540 | 47.2 | 25.8 | 27.0 | |
| Q4: $128,090 -< 232,935 | 2,625 | 46.1 | 26.7 | 27.2 | |
| Q5: $232,935 - high | 2,680 | 44.4 | 22.4 | 33.2 | 0.01 |

* P<0.0001
All dollar values are NZ dollars

Table 2 shows the distribution of childhood and adult SEP measures for the study sample. Respondents reporting low childhood SEP were more likely to reside in the most deprived areas (NZDepQ5), have no educational qualifications, report lower household income and lower wealth and be not employed/ not looking for work, in comparison to those reporting higher childhood SEP. Childhood SEP was most strongly graded with educational qualifications. 27.1% of those from a low childhood SEP reported a degree or higher, whereas 60.7% reported no qualification. This was in contrast to the weaker grading observed for NZDep, household income, wealth and labour market activity. A potential problem is collinearity between the measures of SEP across the life course. Pearson correlation coefficients between childhood SEP and all five adult SEP indicators in our sample were low, and ranged from 0.01 to 0.19 with all, except wealth, being statistically significantly correlated ($p < 0.0001$).

Table 3 presents results from logistic regression analyses. In model 1 (adjusted for confounders) both low and medium childhood SEP groups were significantly associated with high levels of psychological distress. The relative odds of reporting high psychological distress among those with low compared to high childhood SEP was 1.35 (95% CI 1.13-1.60). The odds comparing moderate to high childhood SEP were similar to low SEP. The association between childhood SEP and psychological distress persisted after separately adjusting for each adult SEP indicators individually except education (Model 2). All measures except labour market activity attenuated the excess odds ratios. Both education and income were the strongest mediators of the association, reducing the OR independently by 63% and 40% respectively. Adjustment for all five adult SEP indicators simultaneously in addition to confounders, (Model 3) led to a 77% reduction in the excess OR from 1.35 to 1.08 (95% CI 0.90 to 1.29). The Hausman test showed the reduction in the beta coefficients before and after adjusting for adult SEP measures was statistically significant indicating that the change in strength of the association of low childhood SEP with psychological distress after adjustment was statistically significant.

The results of our sensitivity analyses investigating whether there is effect modification by birth cohort and sex are shown in Table 4. There was no statistically significant difference between the relationship of childhood SEP on psychological distress by birth cohort or by sex.

**Table 3. Odds ratios (OR) and confidence intervals (CI) for logistic regression modelling of childhood SEP on adult psychological distress***

| | Model 1 adjusted for respondents age, sex and ethnicity | | Model 2 adjusted for individual adult SEP indicators: education | | NZDeprivation | | income | | labour market activity | | wealth | | Model 3 adjusted for respondents age, sex, ethnicity and all measures of adult SEP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OR (95% CI) | | OR (95% CI) | | OR (95% CI) | | OR (95% CI) | | OR (95% CI) | | OR (95% CI) | | OR (95% CI) | |
| **Childhood SEP** | | | | | | | | | | | | | | |
| Low | 1.35 | (1.13-1.60) | 1.13 | (0.95-1.35) | 1.25 | (1.05-1.49) | 1.21 | (1.02-1.44) | 1.35 | (1.13-1.60) | 1.27 | (1.07-1.51) | 1.08 | (0.90-1.29) |
| Medium | 1.36 | (1.12-1.65) | 1.21 | (1.00-1.47) | 1.28 | (1.06-1.56) | 1.26 | (1.04-1.53) | 1.36 | (1.12-1.65) | 1.31 | (1.08-1.59) | 1.15 | (0.95-1.41) |
| High (ref) | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| **Age** | | | | | | | | | | | | | | |
| 15-24 (ref) | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| 25-34 | 0.78 | (0.60-1.02) | 0.87 | (0.67-1.13) | 0.75 | (0.58-0.98) | 0.78 | (0.60-1.02) | 0.93 | (0.72-1.22) | 1.00 | (0.77-1.31) | 1.03 | (0.78-1.37) |
| 35-44 | 0.91 | (0.72-1.15) | 0.96 | (0.76-1.21) | 0.93 | (0.74-1.17) | 0.93 | (0.74-1.17) | 1.16 | (0.91-1.47) | 1.56 | (1.21-2.02) | 1.52 | (1.16-1.99) |
| 45-54 | 0.73 | (0.48-0.94) | 0.74 | (0.57-0.95) | 0.74 | (0.58-0.95) | 0.82 | (0.65-1.05) | 0.96 | (0.75-1.23) | 1.55 | (1.18-2.04) | 1.42 | (1.07-1.90) |
| 55-64 | 0.74 | (0.58-0.96) | 0.66 | (0.51-0.87) | 0.74 | (0.57-0.96) | 0.76 | (0.58-0.99) | 0.79 | (0.61-1.03) | 1.72 | (1.28-2.32) | 1.21 | (0.88-1.65) |
| 65+ | 0.75 | (0.58-0.97 | 0.62 | (0.48-0.82) | 0.71 | (0.55-0.92) | 0.60 | (0.46-0.79) | 0.46 | (0.35-0.61) | 1.66 | (1.24-2.22) | 0.70 | (0.50-0.98) |
| **Sex** | | | | | | | | | | | | | | |
| Male (ref) | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Female | 1.40 | (1.21-1.61) | 1.39 | (1.20-1.60) | 1.39 | (1.20-1.60) | 1.32 | (1.14-1.52) | 1.21 | (1.04-1.39) | 1.41 | (1.23-1.63) | 1.24 | (1.07-1.44) |
| **Ethnicity** | | | | | | | | | | | | | | |
| NZ/European (ref) | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Maori | 1.66 | (1.35-2.06) | 1.49 | (1.20-1.85) | 1.31 | (1.06-1.64) | 1.45 | (1.17-1.79) | 1.47 | (1.18-1.82) | 1.29 | (1.04-1.60) | 1.03 | (0.82-1.30) |
| Pacific | 1.93 | (1.39-2.68) | 1.80 | (1.30-2.51) | 1.44 | (1.03-2.02) | 1.60 | (1.15-2.23) | 1.67 | (1.19-2.32) | 1.36 | (0.97-1.89) | 1.10 | (0.78-1.55) |
| Asian | 1.33 | (0.98-1.81) | 1.52 | (1.12-2.07) | 1.20 | (0.88-1.64) | 1.07 | (0.78-1.46) | 1.10 | (0.81-1.51) | 1.15 | (0.84-1.57) | 1.02 | (0.74-1.40) |
| Other | 2.62 | (1.75-3.90) | 2.94 | (1.96-4.41) | 2.55 | (1.7-3.81) | 2.33 | (1.55-3.49) | 2.34 | (1.56-3.52) | 2.14 | (1.42-3.21) | 2.09 | (1.37-3.18) |
| **Highest education qualification** | | | | | | | | | | | | | | |
| Degree or Higher (ref) | | | 1.00 | | | | | | | | | | 1.00 | |
| Post school vocational | | | 1.89 | (1.44-2.48) | | | | | | | | | 1.51 | (1.14-2.00) |
| School qualification | | | 1.83 | (1.38-2.43) | | | | | | | | | 1.39 | (1.04-1.86) |
| No qualification | | | 3.36 | (2.53-4.47) | | | | | | | | | 2.00 | (1.48-2.68) |

*(Table 3 cont'd)*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **NZ Deprivation** | | | | | | | | | | |
| NZDepQ1(least) (ref) | 1.00 | | | | | | | | 1.00 | |
| NZDepQ2 | 1.76 | (1.36-2.28) | | | | | | | 1.57 | (1.20-2.04) |
| NZDepQ3 | 1.99 | (1.53-2.58) | | | | | | | 1.54 | (1.18-2.01) |
| NZDepQ4 | 2.31 | (1.80-2.96) | | | | | | | 1.59 | (1.22-2.06) |
| NZDepQ5(most) | 3.04 | (2.36-3.93) | | | | | | | 1.70 | (1.30-2.23) |
| **Household income** | | | | | | | | | | |
| q1: low -< $21,080 | | | 3.45 | (2.67-4.46) | | | | | 1.70 | (1.30-2.24) |
| q2: $21,080 -< $34,010 | | | 2.81 | (2.22-3.56) | | | | | 1.49 | (1.15-1.92) |
| q3: $34,010 -< $49,380 | | | 2.33 | (1.84-2.96) | | | | | 1.50 | (1.20-1.97) |
| q4: $49,380 -< $72,280 | | | 1.36 | (1.06-1.76) | | | | | 1.08 | (0.83-1.40) |
| q5: $72,280 -< high (ref) | | | 1.00 | | | | | | 1.00 | |
| **Labour market activity** | | | | | | | | | | |
| Working (ref) | | | | | 1.00 | | | | 1.00 | |
| Not employed, not looking for work | | | | | 2.84 | (2.41-3.35) | | | 2.11 | (1.77-2.51) |
| Not employed, looking for work | | | | | 3.10 | (2.09-4.59) | | | 2.16 | (1.44-3.23) |
| **Wealth** | | | | | | | | | | |
| Q1: low -< $25,590 | | | | | | | 4.90 | (3.67-6.57) | 2.74 | (2.01-3.74) |
| Q2: $25,590 -< $70,315 | | | | | | | 3.43 | (2.57-4.57) | 2.26 | (1.67-3.05) |
| Q3: $70,315 -< $128,090 | | | | | | | 2.15 | (1.60-2.90) | 1.56 | (1.14-2.11) |
| Q4: $128,090 -< $232,935 | | | | | | | 1.49 | (1.09-2.03) | 1.21 | (0.88-1.67) |
| Q5: $232,935 - high (ref) | | | | | | | 1.00 | | 1.00 | |

* Due to missing values on some covariates, all logistic regression was on n=14,220 respondents

**Table 4. Sensitivity analyses of potential effect modifiers sex and birth cohort**

| | **Model 1** adjusted for age and ethnicity OR (95% CI) | | **Model 3** adjusted for age, ethnicity and all measures of adult SEP OR (95% CI) | |
|---|---|---|---|---|
| **Stratified by sex** | | | | |
| **Male (n=6,530)** | | | | |
| Low | 1.31 | (0.99-1.73) | 1.08 | (0.81-1.45) |
| Medium | 1.44 | (1.06-1.95) | 1.29 | (0.94-1.77) |
| High (ref) | 1.00 | | 1.00 | |
| **Female (n=7,690)** | | | | |
| Low | 1.37 | (1.10-1.71) | 1.09 | (0.86-1.37) |
| Medium | 1.31 | (1.02-1.71) | 1.10 | (0.85-1.42) |
| High (ref) | 1.00 | | 1.00 | |
| **Wald Test for interaction ( p-value)** | | | | |
| Low childhood SEP | 0.0009 | | 0.4144 | |
| Medium childhood SEP | 0.0018 | | 0.0946 | |

| | **Model 1** adjusted for age and ethnicity OR (95% CI) | | **Model 3** adjusted for age, ethnicity and all measures of adult SEP OR (95% CI) | |
|---|---|---|---|---|
| **Stratified by birth cohort** | | | | |
| **1970-1990 (n= 3,715)** | | | | |
| Low | 1.39 | (1.02-1.88) | 1.13 | (0.82-1.56) |
| Medium | 1.26 | (0.89-1.77) | 1.07 | (0.75-1.52) |
| High (ref) | 1.00 | | 1.00 | |
| **1950-1970 (n= 5,865)** | | | | |
| Low | 1.38 | (1.06-1.80) | 1.10 | (0.83-1.45) |
| Medium | 1.27 | (0.94-1.71) | 1.03 | (0.75-1.41) |
| High (ref) | 1.00 | | 1.00 | |
| **1920-1950 (n=4,635)** | | | | |
| Low | 1.29 | (0.90-1.84) | 1.01 | (0.69-1.46) |
| Medium | 1.63 | (1.11-2.39) | 1.35 | (0.90-2.01) |
| High (ref) | 1.00 | | 1.00 | |
| **Wald Test for interaction ( p-value)** | | | | |
| Low childhood SEP | 0.0465 | | 0.7706 | |
| Medium childhood SEP | 0.0226 | | 0.3344 | |

## Discussion

Our study shows that individuals from the lowest childhood socio-economic backgrounds have 35% greater odds of reporting high to very high psychological distress compared to those individuals from the highest childhood socio-economic backgrounds. Furthermore, more than two-thirds (77%) of the association of childhood SEP with current psychological distress in adulthood is explained by adult SEP. This is noteworthy as it is a larger proportion mediated (explained by) adult SEP than found in other studies exploring life course SEP and mental health (Gilman, Kawachi et al 2002; Harper, Lynch et al 2002; Luo and Waite 2005; Power, Atherton et al 2007). The association between childhood SEP and psychological distress was largely explained by educational attainment, accounting for 63% of the association of low childhood SEP on high to very high levels of psychological distress. The proportion mediated by education was greater than for the other adult measures of SEP, suggesting that educational achievement which is influenced by childhood socio-economic position, is the key gateway to socio-economic trajectories that link early life SEP and adult mental health. This is not to say that other socio-economic factors are unimportant. For example, income entered alone explains 40% of the association. But if education is entered first, the additional contribution of income is small, due to the pathways from childhood socio-economic position to income (presumably), largely going via education. This importance of education is plausible, given it is heavily influenced by parental characteristics such as parental education, income, social class and other household characteristics (Kuh, Power et al 2004).

Additionally, sensitivity analyses showed no interaction of sex or birth cohort in the association and using alternative K10 cutpoints, or multichotomous logistic regression, did not substantially alter our findings and how much of the relationship was mediated by adult SEP.

**Strengths and weaknesses**

This study used data from a large nationally representative population in NZ, with the availability of a wide range of measures of adult SEP and a retrospective measure of childhood SEP. Despite these strengths, potential limitations include information bias, unmeasured confounding, selection bias or the possibility of chance findings.

Firstly, the small association observed to start with (OR of 1.35) and the possibility of statistical imprecision in the association of childhood SEP with psychological distress warrants caution. Using the upper and lower confidence limits of Model 1's OR for low childhood SEP (95% CI 1.13-1.60) but assuming a constant 0.17 reduction in the OR due to adjustment for adult SEP, then the proportion mediated by adult SEP might range from 28% (0.17/0.60) to at least 100% (0.17/0.13).

Secondly, there is potential for measurement error. It is important to consider measurement errors in the exposure (childhood SEP), mediators (adult SEP) and outcome (psychological distress).

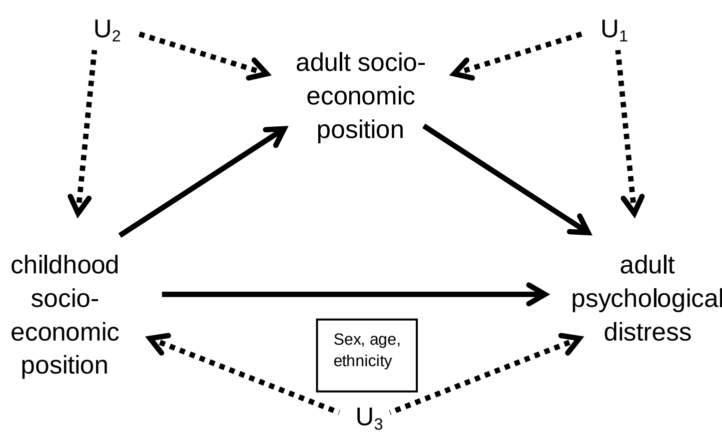
We consider first the impact of measurement error on the exposure-outcome association, without introducing mediators. The use of parental occupation at a single age has been argued to be a weak proxy for more complete information on socio-economic position spanning the entire childhood period (Glymour 2007). Thus, we have mis-measured our exposure. (Due to the design of the SoFIE study it was not possible to use prospective repeated measures of childhood SEP over time.) Nevertheless, this methodological shortcoming is common to many studies, and does not preclude useful causal inference (Mckenzie and Carter 2009). Additionally, the coding of parental occupation and subsequent assignment to the NZSEI-96 (which meant enforcing socio-economic status levels ascertained in the 1990s on older respondents' parental occupations, which date back to the 1930s) would have introduced further measurement error. This may have led to mis-classification of childhood SEP that is greater for older respondents compared to younger respondents. However, as our analysis used a trichotomous measure of childhood SEP, and found no difference by birth cohort, any historical changes in "status" of occupations would need to be substantial enough to cross the two thresholds used to categorise childhood SEP. The critical issue in the mis-measurement of parental SEP is whether it is non-differential and independent of the outcome psychological distress (and the mediator adult SEP). We argue that recall of parental occupation, when the adult respondent was aged 10, is a fairly 'concrete' and 'objective' measure. We assume, therefore, that any recall error is not too substantial and neither differential by, nor dependent on, measurement errors on other variables. The subsequent coding and classification to a class may introduce more error, but this too is probably non-differential and independent of other covariates. Assuming our arguments are correct, we have therefore underestimated the total association of childhood SEP with psychological distress, i.e. the OR of 1.35 is an underestimate.

Consider now measurement error of our mediator, adult SEP, ascertained at the time of interview, using multiple comprehensive measures. We argue that adult SEP is a complex multifaceted construct, and that multiple measures (as we have) are preferable to few in fully adjusting for this construct, and hence this mediation pathway. Put another way, we have more fully adjusted for adult SEP than previous research that has been confined to a single adult SEP indicator such as occupation or education (Lynch, Kaplan et al 1997; Gilman, Kawachi et al 2002; Poulton, Caspi et al 2002; Power, Stansfeld et al 2002; Gilman, Kawachi et al 2003; Singh-Manoux, Ferrie et al 2004; Melchior, Moffitt et al 2007; Power, Atherton et al 2007). This may explain why we found a greater proportion of the effect of childhood SEP on mental health was mediated by adult SEP, than did other studies, i.e. we simply measured adult SEP more fully than did other studies.

Consider now the joint effect of measurement error of exposure and the mediator. If the target parameter of interest is the *proportion* of the relationship mediated by adult SEP, and measurement error of both the exposure and mediator are independent and non-differential with respect to the outcome, the proportion of mediation is *unchanged* with measurement error of the childhood exposure (although the actual ORs are all reduced). However if the mediator is mis-measured, the proportion due to mediation is underestimated *(workings available from authors on request)*. For example, if better measurement of childhood SEP occurred, we might have observed a total OR of 1.70, but (assuming non-differential and non-dependent measurement errors of adult SEP with respect to both childhood SEP and psychological distress) the OR adjusted for adult SEP would have reduced by 77% to 1.26. Thus, to answer the research question in this paper, it is more important to have an accurate assessment of the adult SEP variables than childhood SEP (assuming non-differential and independence of measurement error).

Thirdly, it is important to note the difficulty with data such as in this study to reliably quantify direct and indirect effects due to unmeasured confounding (Blakely 2002; Cole and Hernan 2002; Hernan and Cole 2009). This is depicted in the following directed acyclic graph (Figure 1).

**Figure 1. Directed acyclic graph of the association between childhood SEP, adult SEP and psychological distress**



When we adjust for our mediator, adult SEP, it may be that there is unadjusted confounding of the adult SEP-distress association (labelled '$U_1$' )(Glymour and Greenland 2008). Furthermore, there are also a number of life course measures which can be classed as confounders of the association between childhood SEP and adult mental health status ($U_3$) and of the association of childhood SEP with adult SEP ($U_2$), such as childhood health, family history of mental illness and single-parent status. The absence of this information in our study may lead to some bias, probably in the direction to initial overestimation of the total association of childhood SEP with psychological distress; and perhaps some over-adjustment for adult SEP when determining indirect effects (if there is strong collider-bias on adult SEP from both $U_1$ and $U_2$). If this were the case, it might be that adult SEP mediates even more (proportionately) of the association – but it is beyond the scope of this paper to empirically model this possibility. We believe in most cases that the magnitude of these confounding biases will not be too severe. For example, it has been shown elsewhere that there needs to be very strong associations of posited additional variables (i.e. $U_2$ and $U_3$ in the diagram) with both the mediator and outcome of interest, before substantial bias will occur (Greenland 2003; Rothman, Greenland et al 2008).

A limitation of our graph and analysis is that it does not take into account the possible reverse causation of adult psychological distress on adult SEP, where those with pre-existing mental illness drift down the social scale i.e. health selection. In this study we cannot discount the possibility that the association of adult SEP with K10 is overestimated due to health selection, and subsequently, that the proportionate contribution of adult SEP to the childhood SEP and K10 association is also slightly overestimated. We would posit however that some of the adult SEP measures are less subject to selection effects than others. Most formal education, for example, is completed by young adulthood and is predictive of subsequent occupational career. Arguably therefore it is more robust to selection effects (in particular "downward drift") and thereby strengthens our conclusion regarding the mediating effects of education.

The final limitation relates to the selection and attrition of the sample used in our study. Our analysis was restricted to respondents with no missing data on the exposure and outcome at Wave 3 (49% of the original SoFIE study sample) leading to a sample which was older and potentially more homogenous than the original Wave 1 study population. There is a risk of not being able to obtain information about childhood SEP from a substantial fraction of the very people who are most at risk of poor health. Selection bias could arise if those adults from the lower childhood SEP group who are lost to follow-up, or have missing exposure data, have a different total indirect and direct set of associations between childhood, adult SEP and distress (within strata of covariates). For example, if those adults from the lower childhood SEP group who are lost to follow up or have missing exposure data are also those whom are at the highest risk of psychological distress, then the study will have underestimated the effect of low childhood SEP on the risk of psychological distress. However, for selection bias to arise requires the association of childhood SEP, adult SEP and K10 to differ among those included in the final analyses, compared to those excluded. We do not have any direct evidence whether this is the case or not, as it was not possible to directly estimate the extent and the pattern of 'missingness' on the associations of childhood SEP, adult SEP and K10, as we did not have information on those individuals who were lost to follow-up. Moreover, for the results of our analysis to be pushed towards the null, we would need to see the opposite associations of childhood SEP, adult SEP and psychological distress in the other 50% of the original study sample who were missing; this seems implausible.

## Conclusion

This research addresses an important life course issue regarding the pathways between childhood socio-economic position and mental health in adulthood. Our results suggest that disadvantaged social environments during childhood may have particularly adverse consequences for adult mental health status, because of their effects on educational achievement and subsequent socio-economic status. A possible explanation for our finding is that the direct effects of early socio-economic environment via pathways other than adult SEP are less important for psychological distress than that of the later adult SEP pathway, and hence after adjustment for adult SEP the effect of childhood SEP is no longer significant. This does not refute the early origins argument per se. Rather this finding is most consistent with a "pathways" interpretation within the life course framework, which views the early or distal childhood socio-economic environment as being important mainly through its influence on proximal socio-economic circumstances, in this case adult SEP (especially education), which in turn influences mental health status.

In other words the indirect or mediated pathway is stronger than the direct pathway, and is consistent with the substantial existing evidence that socio-economic circumstances in adulthood are important determinants of inequalities in adult mental health. Finally, causal mechanisms (nature and strength) are likely to vary by context, including time and place. Therefore, generalising our findings to other countries and comparing to other studies should be done cautiously.

In terms of policy, population-based research such as ours is important in providing evidence as to whether intervention programs, which aim to reduce the negative influence of serious economic adversity on adult mental health, should target their influences earlier or later in the life course. Our findings suggest that the short-term influences operating in adulthood such as unemployment and poverty are likely to be able to "circuit-break" the longer-term effects of early SEP. Nevertheless, the long-term influences, which are rooted in previous life stages, are still important as they influence mental health indirectly through current adult SEP.

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# Sex differences in childhood hearing impairment and adult obesity

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## Abstract

*Some adult neurological complications of obesity may have early-life origins. Here, we examine associations of childhood hearing impairment with childhood and adult obesity, among 3288 male and 3527 female members of a longitudinal cohort born in Great Britain in 1970. Height and weight were measured at age 10 years and self-reported at 34 years. Audiometry was conducted at age 10 years. The dependent variable in logistic regression was minor bilateral hearing impairment as a marker of systemic effects, while BMI at age 10 or 34 years were modelled as independent variables with adjustment for potential confounding factors including social class, maternal education and pubertal development at age 10 years. Among females, the adjusted odds ratios (and 95% confidence intervals) for hearing impairment at age 10 years were 2.33 (1.36-3.98) for overweight/obesity; and at age 34 years they were 1.71 (1.00-2.92) for overweight and 2.73 (1.58-4.71) for obesity and the associations were not explained by Childhood BMI at age 10 years. There were no consistent associations among males and interaction testing revealed statistically significant effect modification by sex. The dose-dependent associations among females are consistent with childhood origins for some obesity-associated impaired neurological function and the possible existence of a 'pre-obese syndrome'. The accumulation of risks for poorer health among those who become obese in later life begins in childhood. Childhood exposures associated with bilateral hearing impairment are risks for obesity in later life among females.*

**Keywords**: hearing impairment; cohort; obesity; audiometry; sex-difference

## Introduction

Obesity is linked with adverse health sequelae, including type 2 diabetes mellitus and excess mortality. Obesity and type 2 diabetes are linked with neurological complications including more rapid cognitive decline and dementia in later life (Yaffe et al, 2004a). While obesity and diabetes can result in neurological damage, there may be a more complex pattern of cause and effect. There is evidence of impaired childhood neurological function among otherwise healthy children, who go on to develop obesity or diabetes in adulthood (Olsson et al, 2008, Osika and Montgomery, 2008, Chandola et al, 2006). These associations were independent of childhood body mass index (BMI), so contemporaneous obesity or overweight in childhood does not appear to be the explanation for poorer function. It is not clear if the neurological 'impairments' reflect genuine biological phenomena or are confounded by social factors, and if the subtle neurological impairments are themselves causally related with subsequent obesity; or if they result from early-life exposures increasing the risk of both childhood impairments and later obesity risk. This paper is concerned with the hypothesis that childhood exposures impair neurological development and also increase subsequent obesity risk.

The association of poorer childhood cognitive function with obesity and type 2 diabetes (Chandola et al, 2006, Olsson et al, 2008) might be explained by social confounding, as performance in tests of cognition is influenced by social and cultural factors (Tong et al, 2007). These factors could also increase obesity risk. For this reason, we then used physical control and coordination to indicate neurological function (Osika and Montgomery, 2008) and focused on hand control. The association of poorer coordination and greater clumsiness at ages 7 and 11 years, with later obesity, is consistent with the hypothesis that early exposures increase the risk of both impaired neurological development and subsequent obesity risk. However, it could be argued that poorer physical control and coordination could *cause* subsequent obesity by discouraging participation in sport and exercise.

There may be several non-mutually exclusive explanations for associations of impaired neurological function with obesity. More evidence is required to demonstrate that there is a biological basis for impaired neurological development in those who will be subsequently obese. Here we examine the association of adult BMI with another marker of childhood function, hearing impairment. Objective testing of hearing function may be less confounded by social factors than cognitive function testing, so is arguably a better marker of a biological mechanism. Unlike physical control and coordination, we hypothesise that hearing impairment is less likely to be a direct influence on physical exercise and unlikely to *cause* later obesity. However, there is some evidence of causation in the opposite direction: physical exercise may improve hearing ability (Cristell et al, 1998) suggesting that exercise may be a common pathway relevant both to obesity risk and hearing ability. By examining bilateral hearing impairment, we increase the likelihood of identifying a systemic phenomenon, which may involve neurological function. The aetiology of bilateral sensorineural hearing impairment in children is heterogeneous, and the cause can be unknown in over 40% of children with less severe hearing loss (Das, 1996). Over a third of children can have genetic or syndromal abnormalities, while other causes include infections and complications associated with premature birth (Das, 1996). Socioeconomic disadvantage is associated with a higher rate of hearing impairment (Egbuonu and Starfield, 1982) indicating a role for socially mediated exposures.

Although little is known about childhood hearing impairment and *subsequent* adult-onset obesity or diabetes, there is cross-sectional evidence from studies of adults. Hearing impairment in adults has been associated with contemporaneous adult waist circumference (Hwang et al, 2009), type 2 diabetes and impaired fasting glucose (Bainbridge et al, 2008). The latter study identified the most notable associations with minor hearing impairment in young adults (Bainbridge et al, 2008). The former study identified sex differences in associations with waist circumference (Hwang et al, 2009). Therefore, in this study, we examined minimal hearing impairment in children and stratified by sex.

Here, we examine whether bilateral hearing impairment at age 10 years is associated with BMI at ages 10 and 34 years among a general population-based British birth cohort. This study is concerned with establishing whether an association exists between hearing and both contemporaneous and future BMI, rather than identifying specific causal processes. For this reason, the dependent variable in our statistical models (hearing impairment) should not necessarily be considered to be a direct *consequence* of, or temporally subsequent to, independent measures such as BMI. Our previous studies of physical control and coordination associated with adult obesity (Osika and Montgomery, 2008) and cognitive function with type 2 diabetes, were both performed using data from a 158 British birth cohort. To avoid a cohort-specific cluster of associations, this study uses a different birth cohort, following people who were born in 1970.

## Methods

The 1970 British Cohort Study (BCS70) is following the lives of all residents in Great Britain born during one week in 1970 (CLS, 2009). The study collected information on all birth events in the target week with subsequent data collection follow-ups. Here, data from follow-ups at age 10 and 34 years are used for the main analysis. The original longitudinal sample consisted of 16,571, and 13,135 participated at age 10 years, with 9,316 at 34 years (CLS, 2009). Some 6,815 had complete data from the 10 and 34-year follow-ups. As this study was concerned with minor bilateral hearing impairment, cohort members with other types of hearing impairment were excluded, reducing the sample to 6,548. The 10-year follow-up was described as nationally representative (CLS, 2009). In the reduced sample analysed here, there was some loss of the most disadvantaged families compared with the broader group of responders. Compared with the entire population available at age 10 years, the proportion in parental social class V (the most disadvantaged class based on occupation) dropped from 4.0% to 3.6%. The most notable loss was from the relatively small group who could not be assigned a social class, from 11.1% to 2.5% (n=175 among those included in the analysed sample).

Community medical officers and school nurses conducted an examination and medical record review at age 10 years. This included measurement of height and weight, which was used to calculate BMI, classified using the age- and sex-standardised Cole criteria (Cole et al, 2000). The overweight and obese categories at age 10 years were combined due to small numbers. Sweep and pure-tone audiometry identified minimal, moderate or marked hearing impairment. A pubertal development score was based on the summed total number of pubertal signs identified during the examination among: breast development, pubic hair, axillary hair, testicular enlargement, menarche, penile enlargement and a final category, 'other signs of puberty'. All chronic illnesses and disabilities were recorded from examination and medical record review and parents reported childhood infections. Parents' occupations were used to estimate the Registrar General's social class. Father's occupation was used, but where no father was present, mother's occupation was used to estimate social class. Mothers reported their educational qualifications. At age 34 years, cohort members reported their height and weight and the resulting BMI was categorised (table 1) using the 1995 WHO criteria (WHO, 1995).

A subset of the cohort members included in the analysis also had complete information on gestational age and birth weight (n=5,141). This information was recorded by midwives at the time of the birth.

**Statistical analysis**

Minor bilateral hearing impairment at age 10 years (our marker of systemic influences on function) was the dependent variable in logistic regression analysis. Although temporally preceding adult BMI, this model was chosen so that BMI at ages 10 and 34 years could be modelled simultaneously as independent variables, with the possibility to assess patterns of association across BMI categories. The minority of cohort members with more severe and unilateral hearing impairments were excluded from the analysis. Associations of hearing impairment with BMI at ages 10 and 34 years were examined with and without mutual adjustment for each other, and with adjustment for the puberty score, parental social class, whether mother and father lived in the household and highest maternal educational qualification. All measures were modelled as a series of binary dummy variables.

As there were fewer valid data for the measures of gestational age and birth weight, and also because these measures may have a complex pattern of association with obesity, a separate set of models was adjusted for these factors and for the puberty score, parental social class, whether mother and father lived in the household and highest maternal educational qualification. These measures were modelled as continuous and categorical variables, but neither strategy was markedly more effective than the other in altering the association of BMI with hearing.

The analyses were stratified by sex. Interaction testing (including an interaction term and the main effects in the model) estimated effect modification.
To ensure that the results were not due to childhood chronic illness or disability, the analyses were repeated excluding cohort members who had relevant conditions identified by the examination and medical record review conducted at age 10 years: these were syndromes or conditions defined in the examination as resulting in mental/development retardation, as well as epilepsy and diabetes mellitus.

Further models were adjusted for history of mumps, measles, chickenpox, meningitis and recurrent ear infections.

SPSS version 15 and PASW Statistics version 18 (PASW, 2009) software packages were used.

## Results

Table 1 shows the characteristics of the sample by sex. Girls were more likely to be overweight or obese at age 10 years, but more men had a BMI above the normal category at age 34 years. There were no other sex differences, except for a larger number of pubertal development signs by age 10 years among girls.

**Table 1. Study population characteristics by sex**

| | Males n (%) | Females n (%) |
|---|---|---|
| BMI at age 10 years | | |
| Underweight (<14.64 for boys, <14.61 for girls) | 330 (10.0) | 393 (11.1) |
| Normal (14.64 to 19.84 for boys, 14.61 to 19.86 for girls) | 2730 (83.0) | 2730 (77.4) |
| Overweight or obese (>19.84 for boys, >19.86 for girls) | 228 (6.9) | 404 (11.5) |
| BMI at age 34 years | | |
| Underweight (<18.5) | 23 (0.7) | 83 (2.4) |
| Normal (18.5 to <25) | 1294 (39.4) | 2025 (57.4) |
| Overweight (25 to <30) | 1425 (43.3) | 883 (25.0) |
| Obese (>30) | 546 (16.6) | 536 (15.2) |
| Signs of puberty at age 10 years | | |
| None | 3148 (95.7) | 2608 (73.9) |
| One | 125 (3.8) | 673 (19.1) |
| Two or more | 15 (0.5) | 246 (7.0) |
| Parental social class (Registrar General's) | | |
| I | 231 (7.0) | 220 (6.2) |
| II | 830 (25.2) | 892 (25.3) |
| III non-manual | 368 (11.2) | 390 (11.1) |
| III manual | 1295 (39.4) | 1374 (39.0) |
| IV | 378 (11.5) | 418 (11.9) |
| V | 115 (3.5) | 129 (3.7) |
| Not employed | 71 (2.2) | 104 (2.9) |
| Highest level of maternal qualifications | | |
| None | 1588 (48.3) | 1743 (49.4) |
| O level or equivalent | 346 (10.5) | 359 (10.2) |
| A level or equivalent | 76 (2.3) | 83 (2.4) |
| University degree or equivalent | 63 (1.9) | 61 (1.7) |
| Other qualifications | 1215 (37.0) | 1281 (36.3) |
| Hearing impairment at age 10 years | | |
| None | 3086 (93.8) | 3306 (93.7) |
| Minimal bilateral | 109 (3.3) | 119 (3.4) |
| Moderate or marked bilateral | 77 (2.3) | 82 (2.3) |
| Unilateral | 19 (0.6) | 20 (0.6) |
| Total | 3288 | 3527 |

Associations of the potential confounding factors with minor bilateral hearing impairment are presented in table 2. Among the childhood factors, only parental social class is weakly associated with hearing loss in girls, not boys, and this association was further attenuated in the adjusted model. Among the prenatal measures, low birth weight and premature birth were both associated with higher risk of hearing loss in boys but not girls.

Table 3 shows the association of BMI at ages 10 and 34 years with minor hearing impairment at age 10 years. Among males there is no evidence of an association with BMI at age 10 years. There was no consistent pattern of association between hearing impairment at age 10 years and BMI at age 34 years among males. A statistically significant inverse association was observed with the overweight category at age 34 years and this remained in the adjusted models. This isolated association may be due to chance, as there is no consistency in the pattern of association.

Among females there are statistically significant dose-dependent positive associations of hearing impairment at age 10 years with higher BMI at ages 10 and most notably 34 years, independent of the potential confounding factors (table 3). The associations remain after mutual simultaneous adjustment for BMI at both ages. There is no association with the underweight category.

The magnitude of the statistically significant associations between BMI and hearing impairment among females was not attenuated by additional adjustment for birth weight and gestational age. The adjusted odds ratios are 2.81 (1.45-5.47) for obesity at 34 years and 3.18 (1.74-5.82) for overweight/obesity at age 10 years. There was no notable change for the results among males.

Stratification by sex revealed that the magnitude of association between obesity and hearing impairment was much greater among women than men (table 3). This sex difference was quantified through the interaction of sex with BMI at age 34 years for associations with hearing impairment. Interaction testing produced statistically significant odds ratios of 3.72 (1.75–7.92) for overweight and 2.87 (1.30–6.31) for obesity. The interaction of sex with BMI at age 10 years for the association with hearing impairment also produced a statistically significant odds ratio of 3.36 (1.07–10.50) for the combined overweight/obesity category in children.

Exclusion of childhood chronic illness and disability at age 10 years, or adjustment for the infections, did not alter the main findings notably. The models were additionally adjusted for region of residence, and there was nothing to suggest that regional variation accounted for the findings. Exclusion of the minority of cohort members with an ethnic background other than the indigenous British population did not alter the findings notably (data not shown).

## Discussion

Minor bilateral hearing impairment at age 10 years was positively associated with overweight and obesity, both contemporaneously at age 10 years and subsequently at age 34 years in female cohort members, but not males. The associations were independent of markers of family circumstances in childhood and pubertal development, as well as birth weight and gestational age. BMI at age 10 years did not appear to explain the association of childhood hearing with future overweight and obesity. The lack of positive associations among males was unexpected. The study benefited from detailed prospectively collected measures at birth and age 10 years, although measures at age 34 years were self-reported. The study used bilateral hearing impairment in childhood as a marker of a systemic, possibly neurological, impairment to examine the hypothesis that early life exposures may impair neurological function in those who will subsequently become obese. Previous studies of contemporaneous hearing impairment and suboptimal insulin signalling, or obesity in adulthood, identified associations with minor rather than more severe hearing impairment (Bainbridge et al, 2008), so this study also focused on minor impairment.

The number of male cohort members with minor hearing impairment was relatively small, so it is possible that the observed sex difference is a chance finding. It is less likely that the findings among females are due to chance, as dose-dependent associations were observed for both childhood and adult BMI. Also, interaction testing identified statistically significant effect modification of the association between hearing and BMI (both in childhood and adulthood) by sex. Differential reporting bias by sex for the self-reported anthropometric data at age 34 years is unlikely to account for the results, as statistically significant associations with *measured* BMI at age 10 years among females were also observed. It is notable that, while the majority of women were in the 'normal' BMI category at age 34 years, a slightly higher proportion of males were in the overweight compared with the 'normal' category. Thus, overweight and obesity in women may represent a more extreme phenomenon with stronger links to adverse exposures such as those associated with childhood hearing impairment.

## Table 2. Potential confounding factors and bilateral hearing impairment at age 10

| | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | Hearing impairment | | Unadjusted | | Hearing impairment | | Unadjusted | |
| | No n (%) | Yes n (%) | Odds ratio (95% CI) | p-value[II] | No n (%) | Yes n (%) | Odds ratio (95% CI) | p-value[II] |
| **Social class (Registrar General's)** | | | | 0.106 | | | | 0.366 |
| I | 210 (6.4) | 1 (1.2) | 0.17 (0.02 1.21) | | 216 (7.0) | 4 (5.2) | 0.94 (0.32 2.75) | |
| II | 841 (25.4) | 21 (25.6) | 0.87 (0.50 1.49) | | 776 (25.2) | 20 (26.0) | 1.31 (0.72 2.39) | |
| III non-manual | 374 (11.3) | 3 (3.7) | 0.28 (0.09 0.91) | | 342 (11.1) | 12 (15.6) | 1.79 (0.89 3.61) | |
| III manual | 1284 (38.8) | 37 (45.1) | ref. | | 1223 (40.0) | 24 (31.2) | ref. | |
| IV | 387 (11.7) | 12 (14.6) | 1.08 (0.56 2.08) | | 354 (11.5) | 9 (11.7) | 1.30 (0.60 2.81) | |
| V | 115 (3.5) | 6 (7.3) | 1.81 (0.75 4.38) | | 105 (3.4) | 4 (5.2) | 1.94 (0.66 5.70) | |
| Not employed | 95 (2.9) | 2 (2.4) | 0.73 (0.17 3.08) | | 67 (2.2) | 4 (5.2) | 3.04 (1.03 9.02) | |
| **Social class based on occupation of** | | | | 0.302 | | | | 0.205 |
| Father | 2982 (90.2) | 78 (95.1) | ref. | | 2851 (92.5) | 70 (90.9) | ref. | |
| Mother | 229 (6.9) | 2 (2.4) | 0.33 (0.08 1.37) | | 165 (5.4) | 3 (3.9) | 0.74 (0.23 2.38) | |
| Not stated | 95 (2.9) | 2 (2.4) | 0.81 (0.20 3.32) | | 67 (2.2) | 4 (5.2) | 2.43 (0.86 6.85) | |
| **Maternal education** | | | | 0.89 | | | | 0.725 |
| No education | 1625 (49.2) | 45 (54.9) | ref. | | 1485 (48.2) | 36 (46.8) | ref. | |
| O level or equivalent | 331 (10.0) | 9 (11.0) | 0.98 (0.48 2.03) | | 324 (10.5) | 7 (9.1) | 0.89 (0.39 2.02) | |
| A level or equivalent | 76 (2.3) | 2 (2.4) | 0.95 (0.23 3.99) | | 74 (2.4) | 1 (1.3) | 0.56 (0.08 4.12) | |
| Higher degree or equivalent | 58 (1.8) | 0 (0.0) | * | | 59 (1.9) | 3 (3.9) | 2.10 (0.62 7.01) | |
| Other education | 1216 (36.8) | 26 (31.7) | 0.77 (0.47 1.26) | | 1141 (37.0) | 30 (39.0) | 1.09 (0.66 1.77) | |
| **Signs of puberty** | | | | 0.178 | | | | 0.523 |
| None | 2453 (74.2) | 54 (65.9) | ref. | | 2953 (95.8) | 74 (96.1) | ref. | |
| One | 620 (18.8) | 22 (26.8) | 1.61 (0.97 2.67) | | 116 (3.8) | 2 (2.6) | 0.69 (0.17 2.84) | |
| Two or more | 233 (7.0) | 6 (7.3) | 1.17 (0.45 2.75) | | 14 (0.5) | 1 (1.3) | 2.85 (0.37 21.96) | |
| **Total** | 3306 | 82 | | | 3083 | 77 | | |
| **Birth weight**[I] | | | | 0.578 | | | | 0.038 |
| Below 2500g | 121 (4.6) | 1 (1.8) | 0.36 (0.05 2.61) | | 110 (4.6) | 7 (10.4) | 2.08 (0.91 4.78) | |
| 2500g to 3500g | 1632 (62.6) | 38 (66.7) | ref. | | 1244 (51.6) | 38 (56.7) | ref. | |
| More than 3500g | 852 (32.7) | 18 (31.6) | 0.91 (0.52 1.60) | | 1058 (43.9) | 22 (32.8) | 0.68 (0.40 1.16) | |
| **Gestational age**[I] | | | | * | | | | 0.022 |
| Preterm | 92 (3.5) | 0 (0.0) | * | | 107 (4.4) | 8 (11.9) | 2.91 (1.35 6.25) | |
| Term | 2454 (94.2) | 57 (100.0) | ref. | | 2256 (83.5) | 58 (86.6) | ref. | |
| Post mature | 59 (2.3) | 0 (0.0) | * | | 49 (2.0) | 1 (1.5) | 0.79 (0.11 5.85) | |

[I] Fewer cohort members have complete data for birth weight and gestational age; [II] p-value for trend; * Not estimated due to empty cells

**Table 3. Bilateral hearing impairment at age 10 years and BMI**

| **MALES** | **Hearing impairment** | | **Unadjusted** | | **Adjusted[I]** | | **Adjusted[II]** | |
|---|---|---|---|---|---|---|---|---|
| | No, n (%) | Yes, n (%) | Odds ratio (95% CI) | p-value[III] | Odds ratio (95% CI) | p-value[III] | Odds ratio (95% CI) | p-value[III] |
| BMI at age 34 years | | | | 0.041 | | 0.051 | | 0.049 |
| Underweight | 22 (0.7) | 1 (1.3) | 1.44 (0.19 10.98) | | 1.26 (0.16 9.80) | | 1.13 (0.14 9.08) | |
| Normal | 1206 (39.1) | 38 (49.4) | ref. | | ref. | | ref. | |
| Overweight | 1352 (43.9) | 21 (27.3) | 0.49 (0.29 0.84) | | 0.50 (0.29 0.86) | | 0.52 (0.30 0.90) | |
| Obese | 503 (16.3) | 17 (22.1) | 1.07 (0.60 1.92) | | 1.08 (0.60 1.95) | | 1.19 (0.64 2.21) | |
| BMI at age 10 years | | | | 0.605 | | 0.595 | | 0.621 |
| Underweight | 307 (10.0) | 10 (13.0) | 1.33 (0.67 2.61) | | 1.32 (0.67 2.60) | | 1.21 (0.60 2.46) | |
| Normal | 2564 (83.2) | 63 (81.8) | Ref | | Ref. | | ref. | |
| Overweight/Obese | 212 (6.9) | 4 (5.2) | 0.77 (0.28 2.13) | | 0.74 (0.27 2.07) | | 0.65 (0.23 1.87) | |
| Total | 3083 | 77 | | | | | | |
| | | | | | | | | |
| **FEMALES** | | | | | | | | |
| BMI at age 34 years | | | | 0.001 | | 0.004 | | 0.033 |
| Underweight | 79 (2.4) | 0 (0.0) | * | | * | | * | |
| Normal | 1921 (58.1) | 32 (39.0) | ref. | | ref. | | ref. | |
| Overweight | 818 (24.7) | 25 (30.5) | 1.83 (1.08 3.12) | | 1.71 (1.00 2.92) | | 1.65 (0.96 2.83) | |
| Obese | 488 (14.8) | 25 (30.5) | 3.08 (1.81 5.24) | | 2.73 (1.58 4.71) | | 2.37 (1.33 4.24) | |
| BMI at age 10 years | | | | 0.002 | | 0.008 | | 0.116 |
| Underweight | 371 (11.2) | 8 (9.8) | 1.03 (0.48 2.17) | | 1.08 (0.51 2.30) | | 1.31 (0.61 2.81) | |
| Normal | 2567 (77.6) | 54 (65.9) | ref. | | ref. | | ref. | |
| Overweight/Obese | 368 (11.1) | 20 (24.4) | 2.58 (1.53 4.37) | | 2.33 (1.36 3.99) | | 1.79 (1.02 3.14) | |
| Total | 3306 | 82 | | | | | | |

[I.] Adjusted for pubertal development score, parental social class, father figure resident in the household and mother's highest qualification, *but BMI at ages 10 and 34 years are not adjusted for each other.*

[II.] Mutual adjustment for BMI at ages 10 and 34 years, as well as adjustment for the other potential confounding factors.

[III.] P value for trend

* Not estimated due to empty cells.

Although not an *a priori* hypothesis, the sex difference in association with hearing impairment is consistent with previously observed greater female-specific susceptibility to early life socio-economic risks for metabolic syndrome (Chichlowska et al, 2009) and obesity (Khlat et al, 2009). Do such socially mediated exposures increase the risk of both hearing impairment and obesity in females? Disadvantage is certainly associated with hearing impairment (Egbuonu and Starfield, 1982) and although we identified a weak association with social class among girls, this measure could not explain associations between hearing and BMI. The sex difference could lie in greater weight gain susceptibility among females exposed to risks for hearing impairment. A possible alternative explanation for the sex difference is selection bias: a higher proportion of disadvantaged males than females (with greater obesity and hearing loss risk) could have been lost to follow-up. This might help to explain the inconsistency of our findings with studies showing cross-sectional associations of hearing loss with obesity among adult males (Hwang et al, 2009).

We can only speculate about the specific mechanisms underlying hearing loss. This may be sensorineural hearing impairment, involving abnormalities of the central nervous or auditory systems. These findings add to the earlier evidence of poorer neurological function associated with subsequent obesity (Olsson et al, 2008, Osika and Montgomery, 2008, Chandola et al, 2006). Influences on neurological function could include hormones such as oestrogen, which may be implicated as indicated by menstrual fluctuation in auditory perception (Haggard and Gaston, 1978), perhaps acting through inner-ear oestrogen receptors (Stenberg et al, 2001). Perhaps hormonal effects on hearing could be reversible. Growth hormones could also be relevant, as IGF1 is implicated in the development of childhood hearing (Welch and Dawes, 2007). However, this study did not reveal any evidence of hormonal involvement, as neither height at age 10 years, nor pubertal development among girls, explained the associations of BMI with hearing impairment.

We speculate that one relevant exposure may be psychosocial stress in girls. Significant exposure (or susceptibility) to stress, results in chronic activation of glucocorticoid receptors, and this may damage hearing through detrimental effects on the central nervous system: the influence of the hypothalamic-pituitary-adrenal (HPA) axis – which is central to the stress response - on the auditory system has been demonstrated (Welch and Dawes, 2007). Psychosocial stress is also associated with childhood obesity (Dockray et al, 2009), adult type 2 diabetes (Eriksson et al, 2008) and weight gain (Fowler-Brown et al, 2009). We recently demonstrated that maternal stress, likely to be a potent source of chronic stress for young children, is associated with overweight in three-year-olds; and this association was independent of markers of socio-economic circumstances (Stenhammar et al, 2010). Some of the putative effects of stress on weight gain could be through metabolic and behavioural influences, as suggested by animal models (Alsio et al, 2009). Another aspect of the influence of maternal stress could operate through maternal behaviour, as mothers with higher stress levels, on average left their three-year-olds watching television for notably longer periods each day (Stenhammar et al, 2010). This will influence physical activity, but might also represent inadequate stimulation relevant to neurological development and function. The beneficial effect of exercise on hearing ability (Cristell et al, 1998) may also be relevant in this context. While exposures other than stress will be important influences on weight gain in children, associations with another measure lend support to a causal role for stress. In the earlier study, some forms of non-secure parental attachment style were also associated with overweight in offspring. Attachment style indicates personal characteristics relevant to interpersonal interactions, and is thought to be stable over time. Some non-secure attachment styles in parents could result in stressful exposures among offspring, and in our earlier study, influences on children's weight associated with parental attachment style appeared to operate through stress. There may be sex-specific physiological responses to some types of stress with greater susceptibility among girls (Osika et al, 2009), although the lack of disparity by sex in proportion with hearing impairment suggests that the difference lies in susceptibility to risks for weight gain.

It has been suggested that developmental coordination disorder (DCD) could explain the association of obesity with poorer physical control and coordination, signalling impaired neurological function, as poorer coordination may limit participation in physical exercise and thus increase obesity risk (Cairney et al, 2010). DCD is associated with impaired foetal development, indicated by markers such as low birth weight (Holsti et al, 2002). As hearing impairment can also have early life origins signalled by low birth weight (Cristobal and Oghalai, 2008) and premature birth (Leversen et al, 2010), exposures in utero may be relevant to poorer neurological development, hearing impairment and obesity risk. For this reason we additionally adjusted for birth weight and gestational age, but limited this to sub-analyses for two reasons. The first reason is that not all of the subjects included in the main analyses had full data for birth weight and gestational age, and we wished to include the maximum number. The second reason is that associations of birth weight with DCD and obesity may be contradictory, making interpretation of the results potential problematic: DCD is associated with low birth weight (Holsti et al, 2002), while higher birth weight is a significant risk for subsequent obesity even though this may be due to confounding (The et al, 2010). Only a minority of people with poorer physical control and coordination coupled with obesity are likely to also have DCD (Montgomery, 2010).

Potential limitations of this study include the lack of glycaemic status measurements and the use of BMI, rather than more precise measures of adipose tissue distribution relevant to metabolic influences, as these measures were not available. The adult anthropometric measures were self-reported so possibly imprecise, introducing error and possibly bias. The loss of participants from the most disadvantaged families may have biased the results, and have excluded a notable proportion that became obese. Hearing was only measured in childhood, so it is not known if the hearing impairment in females persists into adulthood, nor whether males develop impairments at later ages. Hearing impairment was precisely measured in childhood but the causes may be somewhat heterogeneous. To tackle this, we only considered minor hearing impairment, as previous studies found this was most notably associated with contemporaneous obesity and related measures. We only considered bilateral hearing loss to identify systemic problems, but in a proportion of those with bilateral impairment, there may be non-systemic influences that affect both ears. Such considerations could reduce the observed associations or may conceivably inflate them.

Confounding in a study such as this is a possibility, so we adjusted for parental social class (and if based on father's or mother's occupation), which indicates cultural and material circumstances in childhood; and is relevant both to obesity and hearing loss risk (Khlat et al, 2009, Egbuonu and Starfield, 1982). We also adjusted for maternal education as this is another marker of factors relevant to obesity risk (Stenhammar et al, 2010). A measure of pubertal signs was included, as development at age 10 years is likely to be relevant to childhood BMI and potentially to other aspects of development. We additionally adjusted for birth weight and gestational age, as markers of foetal development potentially relevant to weight gain and neurological development. However, the association of hearing impairment with obesity in women over 20 years later is independent of these markers of family circumstances and foetal development; and it could not be explained by childhood chronic illness or disability. We also adjusted for childhood BMI, which clearly represents over-adjustment, but also provides useful information. Adjustment for childhood BMI not only indicates that childhood body mass is associated with contemporaneous hearing impairment, but also that the association of hearing with adult BMI is not explained by childhood BMI itself. Adjustment for childhood BMI also represents indirect adjustment for a variety of factors, such as physical activity, that are plausible confounding factors. However, BMI may be too crude a measure to identify specific types of adipose tissue in childhood that indicate exposures or produce bioactive compounds (Knecht et al, 2008, Yaffe et al, 2004b) relevant to neurological function.

Minor hearing impairment in girls is added to the measures of poorer childhood function associated with obesity in adulthood. This association provides more evidence of poorer neurological function among those who will subsequently become obese or develop type 2 diabetes, indicating that some neurological complications, or susceptibility to them, that are associated with these diseases have their origins in early life. As poorer childhood function and development predicts poorer adult function (Kuh et al, 2006a, Kuh et al, 2006b) this is also likely to be associated with more rapid limitation with decline in old age and thus poorer health. Early life exposures impairing development and function are associated with accumulation of later risks: those with poorer childhood function are also more likely to be exposed to the risks coupled with adult obesity. Accumulation of risks could occur through a variety of mechanisms that are not mutually exclusive. These include lower-level educational attainment associated with poorer cognitive function leading to labour market disadvantage and behavioural risks; lower levels of physical activity due to poorer physical control and coordination (Olsson et al, 2008, Osika and Montgomery, 2008, Chandola et al, 2006). It should be stressed that the previous study of neurological function indicated by physical control and coordination associated with later obesity, found that the association could not be explained by lower cognitive function, indicating that the problems described are not due to lower intelligence.

Further research should identify relevant risks, mechanisms and whether a 'pre-obese syndrome' associated with a range of impairments exists. While the childhood impairments pre-dating obesity may be relatively minor, they are worthy of further investigation and could signal other developmental effects and susceptibility to more rapid functional decline in later life, further accelerated by adult obesity. Understanding the accumulation of risks over life is likely to be key in identifying how early exposures impairing childhood function are related to more severe adverse outcomes in later life. *When sorrows come, they come not as single spies, but in battalions - Hamlet, Act IV scene V.*

## Acknowledgement

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# Post-school education and social class destinations in Scotland in the 1950s

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## Abstract

*Data from the 1947 Scottish Mental Survey are used to investigate the relationship between type of secondary school attended and both post-school education up to age 27 and also occupational status by age 27, controlling for social background (social class, parental education, gender), intelligence at age 12, and attitude to school work. The survey was based on a representative sample of all children born in Scotland in 1936. They were first surveyed in 1947 and then almost annually to 1963. The focus of the paper is on the legacies of several waves of reform to secondary education in the first half of the twentieth century. The main research questions are whether the reforms extended access to educational attainment up to age 27 and thus widened access to high-status occupations. These questions are investigated using mainly multiple linear regression. The conclusions are that access was extended, but that people who had attended the older-established secondaries that pre-dated the reforms were more successful educationally and occupationally than people who attended newer foundations, even controlling for social background and intelligence. This effect was especially pronounced for pupils of above-average intelligence, the old schools providing them with particularly pronounced opportunities in adulthood.*

## Key Words

Scottish Mental Survey; selective secondary schooling; post-school education; occupational attainment; intelligence.

## Introduction

The main purpose of this paper is to investigate whether reforms to secondary schooling in Scotland in the first part of the twentieth century influenced people's post-school learning and status attainment in the 1950s and early 1960s. The general reason why this question matters is the importance of knowing whether school reform can have an effect beyond the point at which young people leave full-time education. The historically specific reason is to gain some insight into the effects of the 1950s school system on adult opportunities. Much has been written about the ways in which the selective secondary system of the time did or did not promote opportunity within formal education (Halsey, Heath and Ridge 1980; Gray, McPherson and Raffe 1983; Kerckhoff et al 1988; Paterson, Pattie and Deary forthcoming). Some of that work used data from the same survey as we use here (Hope 1984; Macpherson 1958; Paterson, Pattie and Deary forthcoming). Our analysis goes further than this, tracing the effects of school reform on young people's lives up to their late twenties.

There has been some re-assessment recently of the transition to adulthood in Britain in the couple of decades after the end of the Second World War. The tendency of this research has been to counter the belief that people proceeded smoothly and swiftly from school to work (Vickerstaff 2003, 2005, 2007; Goodwin and O'Connor 2007; O'Connor and Goodwin 2005; Richardson 2007). A large majority left school at the first opportunity (age 15 from 1947) without formally certificated attainment, but subsequent training for boys was always regarded as important (Goodwin and O'Connor 2007, p. 361). Girls entering the labour force did expect to spend time out of it when they married (Wadsworth 1991, pp. 144-149), but there is evidence that in some regions of England most of them expected also to return to paid work once their children had started school (O'Connor and Goodwin 2005). In Scotland, at age 18, girls were no less willing than boys to express a preference for a kind of job (Macpherson 1958, p. 113), but their paid employment was much more likely to be curtailed by marriage than was men's (Maxwell 1969, pp. 81-2). Therefore, acquiring skills that might improve their prospects of employment mattered for both genders, but probably for a shorter period of time for girls than for boys. Apprenticeship was expanding during the 1950s, though remaining far more common for boys than for girls (Ryrie and Weir 1978). Its form was changing, however, shifting towards day release and away from evening classes (Butt 2000, pp. 186-7; Raffe 1977; Scotland 1969, pp. 237-8); this in turn was encouraged by the large investment in technical colleges that governments made at that time. Commercial and secretarial courses in these colleges were as important for girls as the technical courses were for boys.

This expansion was common to the whole of Britain (Richardson 2007, p. 387), but its effects interacted with inherited structures of provision in different ways, as was noted by Raffe (1977). Whereas in England the changes largely took the form of converting colleges into higher-status polytechnics or universities, in Scotland the main change was the transfer of non-advanced courses to the colleges from Central Institutions, the government-funded institutes that had been emerging as a distinct sector of technological higher education since the early years of the century. Examples of these Central Institutions were the Royal College of Science and Technology in Glasgow, Heriot-Watt College in Edinburgh, and Robert Gordon's Technical College in Aberdeen (Silver 2007; Paterson 2003, pp. 85, 90-92). The Central Institutions themselves were thus joining the four ancient universities in a slowly expanding system of higher education. Transition to adulthood for the minority who went through higher education in this sense had always lasted into their early twenties.

The system of post-school education came increasingly to be questioned during the late 1950s, culminating in various attempts to reform it from the 1960s onwards (Sheldrake and Vickerstaff 1987). There was a belief that not enough attention was given to proper training rather than time-serving, that training was restricted to only a few trades (and in particular therefore was not properly available to girls), and that young people's general education was not being catered for if they left school at age 15, and received thereafter at best only courses in technical skills. Nevertheless, we might still ask in long retrospect whether the immediately post-war system really was as restricted in the opportunities it offered as its contemporary critics claimed. To do so, we need to have data that allow us to look beyond the immediate effects of schooling, and thus allow us to take account of delayed educational attainment and delayed entry to stable employment.

None of these debates of the time, nor any since, has had anything to say, moreover, about the interaction between school reform and the opportunities which young people had in the decade or so after they might leave school. Yet how best to prepare young people for life after school, and how best to match them to the needs of the economy, had dominated discussion and reform of post-primary education since the beginning of the century. By the 1930s, the main structure of Scottish secondary schooling had settled into a pattern of three-year 'junior secondary' and five-year 'senior secondary' courses. The former were intended to prepare people for training and work, and the latter were supposed to lead to the professions either directly or through university. Allocation of pupils between these courses was mainly on the basis of tests of intelligence and of attainment (in English, arithmetic and mathematics) taken in the final year of primary school. Within the types of course, there was also a hierarchy of status and of intellectual demand according to whether they were general or narrowly technical and, within the five-year courses, according to the number of non-English languages that were studied. Tests of intelligence were as important for allocating pupils to these finely differentiated courses as to the decisions between three years and five years. The details are described fully elsewhere (Anderson 1983, 1985a, 1985b; Gray, McPherson and Raffe 1983; McPherson 1992; Osborne 1966; Paterson 2004, forthcoming). What matters for present purposes is the mapping of the length and type of course onto the sectors of secondary school, defined by their origins in these debates and reforms since the beginning of the century.

The oldest schools (of which there were about 50) were secondaries providing mainly five-year courses. They served geographical communities that were predominantly middle-class and thus had a long record of sending people into professional careers; from 1888, the route was increasingly likely to be through the rapidly expanding Scottish Leaving Certificate. The second sector (about 100 schools) had been raised to the same full-secondary status as these old schools by government regulations and funding between 1902 and 1924, during which period they had been called 'Higher Grade schools'. They were intended to widen opportunity to take the Leaving Certificate to much broader social groups than the old schools reached, and they were located in predominantly lower-middle-class and upper-working-class areas. In most cases they were founded by upgrading primary schools that, in the nineteenth century, had regularly sent a few boys to university. By the 1950s, these schools had had over three decades of preparing pupils for entry to professional careers. Serving the same social groups was the third sector consisting of some 40 schools that were either founded as secondaries or upgraded to secondaries after 1924. By the 1930s these first three sectors, providing five-year as well as three-year courses, were referred to informally as 'senior-secondary schools'. The remaining two sectors provided only three-year courses, and were described informally as 'junior-secondary schools'. The distinction here lay between schools that had or had not previously presented some pupils for the Leaving Certificate. Those which had done so – approximately 130 in number, about half of them formerly Higher Grade schools – retained a certain academic emphasis, but their relegation to junior-secondary status was controversial and was perceived by critics of government as restricting opportunity (Paterson 2003, p. 135). The remaining approximately 430 junior-secondary schools had no such tradition.

Thus we may summarise the inherited structure of secondary schooling in the 1950s as consisting of five types of institution: old senior secondaries, senior secondaries that were formerly Higher Grade schools, senior secondaries that were founded after 1924, academic junior secondaries, and other junior secondaries. The allocation of pupils to them was based mainly on measured intelligence at age 12, although other social factors had a strong influence, notably social class, largely through the influence of the area in which the child lived (Douglas et al 1966; Paterson, Pattie and Deary forthcoming). There was also some differentiation by religion (about one in five pupils attended Roman Catholic schools) and, in both the Catholic and the independent sectors, some single-sex schools (Paterson forthcoming); further brief comment on these factors is made later.

Although the immediate purpose of the expansion was to offer pupils better opportunities during their period at school, the ultimate aim, expressed at its most idealistic, was to assign people to work that would suit them and to give them the capacity to keep learning throughout life. On the other hand, the most radical critics of the system that divided secondary schooling between five-year and three-year courses described it as a way of perpetuating inequality, at best only siphoning off into professional careers a small minority of able working-class pupils, and consigning the rest to occupational as well as educational mediocrity (for these debates, see McPherson and Raab 1988, pp. 347-72; Paterson 2003, pp. 129-54). This claim that the system (and its analogues in other countries) achieved no more than a reproduction of social inequality then became the premise on which much sociological debate proceeded in the 1960s and after (as evidenced in, for example, the three volumes edited by Halsey and associates: Halsey et al (1997), Karabel and Halsey (1978) and Halsey, Floud and Anderson (1961)). Recent comparative analysis of social mobility between countries has also concluded that education plays a central role in the transmission of social inequality between generations (Breen and Luijkx 2004). Some of this work has used Scottish longitudinal surveys from the same period as the data used here (Johnson, Brett and Deary 2010; von Stumm et al 2010).

The present study thus has two broad research questions, and answers them using data from people born in 1936 and attending schools in Scotland:

(1) What contribution did the recent history of secondary schools make to young people's learning beyond school?
(2) What contribution did that learning and these schools make to young people's opportunities to attain high-status occupations?

## Data and Methods

We investigate these questions using a unique longitudinal data set – a survey conducted by the Scottish Council for Research in Education of 1208 people born in Scotland in 1936, who were first contacted in 1947 as they were about to enter secondary school. They were followed up almost annually with structured interviews until 1963. This sample was nearly every child in Scotland born on the first day of the even-numbered months of 1936 and attending schools in Scotland in 1947; they were called the Six Day Sample of the Scottish Mental Survey 1947. Full details of the survey methods and the representativeness of the achieved sample are provided by Macpherson (1958), Maxwell (1969), Scottish Council for Research in Education (1953, 1958), and Deary, Whalley and Starr (2009); a short summary is given by Paterson, Pattie and Deary (forthcoming). Analysis is confined to those sample members who had no missing data on any of the variables defined below and for whom the recorded secondary school was in Scotland: this gave a usable sample of 1028 (85% of the original 1208).

The variables which we use are, in summary: an IQ measure (based on form L of the Terman-Merrill revision of the Stanford Binet test, taken at age 12, and standardised herein to have a mean of 0 and a standard deviation of 1 in the sample); gender; father's occupation; the ages at which each parent left full-time education (which we made into an index by taking the arithmetic mean), secondary school category entered at age 12; and secondary school course entered at age 12. Four of these need some further explanation:

- The intelligence test was administered by the original researchers, and was therefore different from the tests that were used as part of the process of allocation of pupils to courses. In particular, the IQ measure used in the present analysis has not been adjusted for gender.
- Social class was based on the 1951 Classification of Occupations and has five categories: class I is professionals, II is intermediate, III is skilled (both non-manual and manual), IV is semi-skilled and V is unskilled. Because class I has only 17 members in the sample, it is grouped with II, and so we use four categories in the analysis.
- The five categories of school are as explained above (with their summary labels in parenthesis): junior secondary schools with no pre-war history of presenting pupils for certificate examinations ('junior secondaries'); junior secondaries with some such history ('academic junior secondaries'); senior secondary schools created or upgraded in 1924 or later ('senior secondary founded after 1924'); senior secondaries that had their origins in the Higher Grade schools, 1903-1923 ('senior secondary: former Higher Grade'); and senior secondaries that had their origins in the nineteenth century or earlier ('old senior secondary').
- The secondary courses were classified according to length and difficulty as explained above (based on Macpherson (1958, pp. 29-34)): five years with two languages; five years with no or one language; three years, general; three years, technical, domestic or commercial; three years, other.

We mentioned above that there was some further differentiation of schools by gender and – more extensively – by religion. Information on the full extent of single-sex provision in Scottish schools is not in fact accurately known. (Paterson (forthcoming) has information only on the schools that presented some pupils for the Leaving Certificate, drawn from data in the National Archives of Scotland; thus further investigation in the archives would be required to extend that to those junior secondary schools that had never presented any pupils for the Leaving Certificate.) So we are not able to analyse its effects further here, although we do include the gender of the individual.

We do have a note in the data set of whether or not each school was Catholic, but the survey did not ask for the individual or family religion of the respondents. Fuller analysis of this question requires a study of its own, but we did try adding the school-denomination indicator to each of the regressions shown later. In none of the models was it close to being statistically significant, and so its absence from the models as shown cannot have distorted the results.

Education taken after leaving school and up to age 27 was summarised according to the highest level achieved, in the manner shown in Table 1. Achievement was recorded either by specific reports from respondents of having completed a course, or else by inference from their later occupation that they had completed it: for example, if a respondent reported attending a non-graduate course of teacher training, and later reported being a school teacher, then it was inferred that that person had completed the course. In the case of 11% of respondents, there was a report of having attended a course but no evidence as to whether they had completed it. The analysis below includes these people as if they had completed the course, on the grounds that the skills gained on even a partly completed course may have contributed to the respondent's employment chances: 70% of that 11% were following low-level courses or trade or secretarial courses, and so some vocational benefit is likely to have been acquired. Nevertheless, all the main regression models were re-run excluding these people, and the results of the models were affected very little.

The value of this data set is that it provides information on post-school education for at least a decade after the sample had left school, and thus is able to take into account the protracted length of the transition from school to work that the research summarised above has shown was common in this period. Ninety percent of the sample members had no formally certificated attainment when they left school, and of the 102 who did, all but 9 (0.9% of the whole sample) had formal attainment in addition to that achieved at school; we use post-school attainment as our measure of eventual educational achievement, and we capture the school experience through the courses followed.

The occupational social class achieved by age 27 was derived from the latest measure of the respondent's occupation (classified in the same way as for fathers, but retaining all five categories): this allows for the length of time that it might take for a respondent to settle into a stable line of work. Because the data collection came to an end at that age, we are unable to investigate respondents' development beyond it.

In the early waves of the follow-up between ages 11 and 27, information was also collected on various measures of personality traits and of home circumstances; the first two in the following list were assessed by the home visitor and the remainder by the headteacher:

(1) the emotional atmosphere of the home (three-point scale from 'happy' to 'unhappy');
(2) the cultural interests of the home (three-point scale from 'above average' to 'below average');
(3) home circumstances judged to affect education (three-point scale from 'good' to 'poor');
(4) pupil's confidence (five-point scale from 'very self-confident' to 'marked lack of self-confidence');
(5) pupil's perseverance (five-point scale from 'very great perseverance' to 'marked lack of perseverance');
(6) pupil's stability of mood (five-point scale from 'very stable moods' to 'very unchangeable moods');
(7) pupil's conscientiousness (five-point scale from 'very conscientiousness' to 'marked absence of conscientiousness');
(8) pupil's originality (five-point scale from 'very original and inventive' to 'marked lack of originality');
(9) pupil's desire to excel (five-point scale from 'very marked desire to excel' to 'marked lack of ambition').

These were reduced to three dimensions by principal-components analysis, with varimax rotation, which were given the following names:

*dependability*: mean of (3) home circumstances, (5) perseverance, (6) mood and (7) conscientiousness;
*engagement*: mean of (4) confidence, (8) originality and (9) desire to excel;
*family environment*: mean of (1) emotional atmosphere and (2) cultural interests.

These three accounted for 67% of the variance of the nine measures. A fourth would have taken this to 75%, a trivial additional amount, and although the scree diagram might also have indicated a need to retain four (eigenvalues of 3.5, 1.3, 1.2 and then a gentler decline from 0.7) that fourth would have indicated a component accounting for less variance than one item. In any case, the fourth simply separated the two components of 'family environment', and so in the interests of parsimony (and because we have separate indirect measures of cultural resources in the measure of parental education) we retained three dimensions.

The allocation of 'home circumstances' to 'dependability' rather than 'family environment' perhaps requires comment. The respective loadings on the unrotated components (0.69 and 0.26) clearly favoured allocating this item to the first. The loadings on the rotated components were equal (each about 0.5), but the strongest correlations of 'home circumstances' with individual items were with 'perseverance' and 'conscientiousness' (0.46 each), each on the first rotated component ('dependability'), and the correlation with 'mood' (the third item to load strongly on 'dependability'), at 0.33, was only slightly lower than the higher of its correlations with the two items in the 'family environment' component (0.39 with 'cultural interests'). Its correlation with the other item in 'family environment' was only 0.29. On balance, these considerations point towards including the assessment of home circumstances in the 'dependability' component. Note further that 'home circumstances' were assessed by the school headteacher, whereas the two items that contribute here to 'family environment' were assessed by the home visitor. It is likely that the headteacher's assessment will have been reflecting, not home circumstances directly, but their observed effect on the pupil's motivation and behaviour; it would then not be surprising that such an item would correlate quite strongly with measures of perseverance etc, also observed directly by the school.

Our main statistical technique is regression, with the measures of post-school qualifications or of class attainment as the dependent variable. To allow for non-linearity in attained class, we re-do the analysis of it by logistic regression, dichotomising it at various points, and we further re-analyse it as an ordered logistic regression across all its categories. The explanatory variables are continuous, except for school sector (four categories compared to a reference category of 'old senior secondary'), social class of father (three categories compared to a reference category of classes I and II combined), and secondary course followed (four categories compared to a reference category of five years with two languages). The inter-relationships of the character variables and the other explanatory variables were explored using path analysis. The main regression analysis was carried out in R (using the packages 'lm' and 'glm'), the path analysis by AMOS and the ordinal regression analysis by PASW. To test whether the grouping of pupils in schools ought to be allowed to modify the standard errors of estimation, the main regression models (Tables 4, 6 and 10 below) were re-run in a multi-level framework using the software MLwiN (Rasbash et al 2009); none of the results was affected by this, and so we do not comment further on the clustering.

Specific research questions are therefore:

(1) What was the relationship between attending a particular type of secondary-school and post-school attainment?

(2) Might any such relationship be explained by:

- (2a) intelligence measured upon entry to secondary school, or by social characteristics of the respondent (class, parental education, gender)?
- (2b) secondary course followed?
- (2c) the measures of dependability, engagement or family environment?

(3) Then repeat all the above for social-class attainment by age 27, adding the measure of post-school educational attainment as an extra explanatory variable.

## Results

### Post-School Educational Attainment

Table 1 shows the distribution of the variable recording attainment after people had left school up to age 27. The first point to note is how much education there was: 46% had at least some, rather greater among men than women (respectively 55% and 39%; chi-squared value for gender difference: 317 on 11 df, p<0.001). However, around two thirds of the attainment was at no higher a level than trade-certificate or secretarial. Beyond this, one in eight men had a higher level of technical training, and one in ten women had the certificates required to be a nurse or a primary-school teacher. Six per cent of the whole sample had a university degree or a higher-professional certificate (such as being a qualified accountant), and this was twice as common among men as among women. People continued to take courses for many years after they had left school (details not shown in the table): approximately one quarter of the latest ages at which respondents reported having done so was in each of the ranges 18-20, 21-22, 23-25 and 26-27. Therefore the present study's long-term follow-up was necessary. There is an interesting similarity between this and (for Britain as a whole) the delayed achievement of qualifications by respondents to the cohort that was born in 1946, the evidence on which is summarised by Wadsworth (1991, pp. 144-8): for example, one third of men there who had left school (in the early 1960s) with no qualifications had acquired some by age 26; as in the present analysis, moreover, women were less likely than men to have acquired qualifications after leaving school.

There was a clear gradient in attainment across the categories of secondary school, as is shown in Table 2 (now using a grouped version of the attainment variable): the numbers there show row percentages, and thus show the distribution of attainment within sector. Two thirds of people who had attended one of the oldest secondary schools had some sort of post-school qualification, in contrast to one half of those who had attended the newest sector of senior-secondary school, and only just over a quarter among those who had attended a non-academic junior-secondary school. At the other end of the scale, whereas one fifth of people who had attended an old secondary had a degree or higher professional qualification, at most one tenth of those who had attended the newer senior secondaries attained this level of qualification. Despite these differences, Table 2 shows that there were possible paths from any type of secondary school to the highest post-school attainment, with one exception: no-one from a non-academic junior secondary went on, by age 27, to have a higher professional qualification or degree.

**Table 1. Post-School Attainment, by Gender**

| | | Male | Female | All |
|---|---|---|---|---|
| Level of attainment: | | % | % | % |
| 1 | None | 45 | 61 | 54 |
| 2 | Low | 4 | 2 | 3 |
| 3 | Trade certificate | 28 | 3 | 15 |
| 4 | Secretarial certificate | 2 | 21 | 12 |
| 5 | City and Guilds | 8 | 0 | 4 |
| 6 | Ordinary National Certificate etc | 3 | 0 | 1 |
| 7 | Higher National Certificate | 2 | 0 | 1 |
| 8 | Nursing qualification | 0 | 6 | 3 |
| 9 | Non-graduate teaching qualification | 1 | 4 | 2 |
| 10 | Non-degree professional qualification | 2 | 1 | 2 |
| 11 | Degree | 6 | 2 | 4 |
| *Sample size* | | *491 (=100%)* | *537 (=100%)* | *1028 (=100%)* |

**Table 2. Grouped post-school attainment, by school sector**

| | Level of attainment (levels grouped from Table 1) Percentages in rows | | | | | Sample size (=100%) |
|---|---|---|---|---|---|---|
| | None or low (1,2) | Trade and secretarial (3,4) | City and Guilds etc (5,6,7) | Nursing and teaching (8,9) | High professional and degree (10,11) | |
| **School sector**: | | | | | | |
| Old senior secondary | 32 | 27 | 7 | 14 | 21 | 111 |
| Senior secondary: former Higher Grade | 38 | 34 | 10 | 10 | 9 | 248 |
| Senior secondary founded after 1924 | 48 | 32 | 7 | 6 | 7 | 98 |
| Academic junior secondary | 65 | 25 | 5 | 4 | 1 | 147 |
| Junior secondary | 72 | 22 | 5 | 1 | 0 | 424 |

The attainment difference between the senior-secondary and junior-secondary sectors reflects in part the difference in intelligence between them caused by the initial selection of pupils into them (as explained in the Introduction): among people in the lowest quintile of intelligence, only 10% had any post-school qualification; this rose to one half in the middle quintile and to 77% in the top quintile. Part of the explanation for attainment differences could lie in the measures of personality: the product-moment correlation of attainment with the measure of dependability was 0.29, and with the measure of engagement was 0.30; these associations were partly but not wholly due to effects of intelligence (with which dependability and engagement were significantly correlated), because the partial correlations, adjusting for intelligence, were respectively 0.12 and 0.10. Social class is also a potential explanation for attainment differences, because the older school sectors continued to reflect their origins serving relatively high-status groups (Paterson, Pattie and Deary forthcoming). Thus the row percentages in Table 3 show that, whereas 59% of people whose origins were in social classes I or II had some post-school qualifications, only 26% had any among those with origins in class V. The proportions with a degree or higher-professional qualification for classes I/II and V were, respectively, 18% and 2%. The class gradient was evident even controlling for intelligence, and so was not due only to the class contribution to intelligence: thus, in the top quintile of intelligence, the proportions with no post-school qualifications were 14% in classes I and II but 39% in class V; the proportions with a degree were respectively 41% and 17%. Nevertheless, despite these strong correlations, the association of attainment with social origin is not perfect: there were routes for able people from the lowest class even to the high professions.

**Table 3. Grouped post-school attainment, by social class of father**

| | Level of attainment (levels grouped from Table 1) Percentages in rows | | | | | Sample size (=100%) |
|---|---|---|---|---|---|---|
| | None or low (1,2) | Trade and secretarial (3,4) | City and Guilds etc (5,6,7) | Nursing and teaching (8,9) | High profession al and degree (10,11) | |
| Father's social class: | | | | | | |
| I and II | 41 | 26 | 4 | 11 | 18 | 114 |
| III | 51 | 33 | 8 | 5 | 4 | 555 |
| IV | 66 | 19 | 8 | 4 | 3 | 180 |
| V | 74 | 16 | 4 | 4 | 2 | 179 |

**Table 4. Regression models of post-school attainment**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Coefficient | Standard error | Coefficient | Standard error | Coefficient | Standard error |
| Intercept | 4.5** | 0.26 | 3.4** | 0.25 | 0.40 | 0.21 |
| School sector (ref. old senior secondary) | | | | | | |
| Senior secondary: former Higher Grade | -1.3** | 0.32 | -0.85** | 0.29 | -0.59** | 0.29 |
| Senior secondary founded after 1924 | -2.0** | 0.38 | -1.4** | 0.35 | -1.1** | 0.35 |
| Academic junior secondary | -3.1** | 0.35 | -1.7** | 0.33 | -1.4** | 0.33 |
| Junior secondary | -3.6** | 0.30 | -2.0** | 0.29 | -1.6** | 0.30 |
| Intelligence at age 12 | | | 1.4** | 0.088 | 1.3** | 0.090 |
| Gender (ref. male) | | | | | -0.13 | 0.16 |
| Father's social class (ref. I and II) | | | | | | |
| III | | | | | -0.70** | 0.27 |
| IV | | | | | -0.60(*) | 0.31 |
| V | | | | | -0.82* | 0.32 |
| Parental education | | | | | 0.24** | 0.078 |
| $R^2$ | 0.18 | | 0.33 | | 0.34 | |

*For model-fitting statistics, see Table 5.*

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

**Table 5. Analysis of variance of regression models of post-school attainment for Model 3 in Table 4**

| | Degrees of freedom | Sum of squares | Mean square | F-value | Significance (p value) | cumulative $R^2$ |
|---|---|---|---|---|---|---|
| Model term added in this order: | | | | | | |
| School sector | 4 | 1682 | 420 | 68 | <0.001 | 0.176 |
| Intelligence | 1 | 1471 | 1471 | 239 | <0.001 | 0.330 |
| Gender | 1 | 4.4 | 4.5 | 0.72 | 0.40 | 0.330 |
| Father's class | 3 | 76 | 25 | 4.1 | 0.007 | 0.338 |
| Parental education | 1 | 57 | 57 | 9.2 | 0.002 | 0.344 |
| Residual | 1017 | 6264.2 | 6.2 | | | |

*For regression coefficients, see Table 4.*

To disentangle these several potential explanations of the school-sector differences in post-school attainment, we use multiple regression. A series of multiple linear regressions is shown in Tables 4 to 6. The dependent variable is the full version of the measure of attainment, as an 11-point ascending scale from 1 (no attainment) to 11 (a degree) (as in Table 1). The regression coefficients of the first three models are in Table 4, and the analysis of variance is in Table 5. The first model reproduces the simple description of the differences among the historical school sectors in Table 2. The following models add control variables in order to assess whether the sector differences may be explained by these. (We checked the residuals of the final model 3 and found them to be approximately Normally distributed, presumably because the dependent variable has as many as 11 categories and because the measure of intelligence is a strong predictor of it.)

The summary point of the whole sequence of models may be stated quite simply before going through them in detail: although the variation among historical categories is weakened by some of these control variables, it is not entirely explained by any of them, and so there seems to be something about having attended a particular type of secondary school that encouraged or discouraged post-school learning and that is not captured in the measured control variables.

The second model in Table 4 adds what we find to be the most powerful control, the measure of intelligence. This does explain a large part of the sector variation. Thus the $R^2$ due to sector is 0.18 before adding intelligence, but the change in $R^2$ due to sector after intelligence is only 0.037. Nevertheless, sector remains strongly associated with post-school attainment, and the gradient from the oldest senior-secondary sector (the reference category) to the non-academic junior secondaries remains clear.

The third model in Table 4 adds gender and family circumstances. (The effect of adding these together is in Table 4; the effect of adding each singly is shown in Tables A1 and A2 in the Appendix.) When they are included together, after intelligence, there is no effect of gender: the male advantage is explained by intelligence (which, recall, had not been adjusted for gender). Social class and parental education, however, both have direct influences on post-school education despite the other variables in the model. That is, people with well-educated parents, or with a father who was in a professional occupation, tended to have higher post-school attainment than those without these advantages, even when we hold constant their intelligence and the kind of school they attended: schooling did not mediate all the effects of social reproduction. There is also no interactive effect of sector with either father's class or parental education. (Compared to Model 3, the interactive effect with sector for father's class had F-value of 1.66 on 12 and 1005 df, and for parental education had F-value of 1.90 on 4 and 1013 df). The absence of such an interactive effect means that there is no evidence that the social-class inequality in post-school attainment was exacerbated or diminished by any of the sectors, and thus in particular no evidence that the oldest sector was especially responsible for social reproduction.

The school-sector effects were attenuated by each of these additions to the model: on its own, as we have noted, sector had an $R^2$ of 0.18; after intelligence, it added only 0.037 to $R^2$, and after gender and family circumstances it added 0.026. Nevertheless, for our main purpose, the most important point is that the sector effects persist after all these additions, with the same gradient as before. Thus the differences among sectors cannot be fully explained by, for example, the higher proportion of brighter children or children of professional parents in the older than in the newer senior-secondary schools.

The sector effects could also not be explained by the organisation of the courses in them. This was tested by adding a further categorical variable to Model 3 in Table 4 (results not shown), with reference category being five-year courses with two or more languages and the other four categories being as noted earlier. The highest post-school attainment was by people who had been on courses in the reference category. Those on five-year courses with one or no languages came next, and then the three kinds of three-year course were similar to each other. Such a gradient is not surprising; the main point for us is that it did not explain the gradient across the categories of school sector, although it did render the post-1924 senior secondaries indistinguishable from the junior secondaries. That is, these most recently founded senior secondaries seem to have had their beneficial effect on post-school attainment mainly through their course structure, whereas the effects of the two older sectors of senior secondaries were not wholly explained by course structure.

Nevertheless, that is not the whole story, because there is an interactive effect of intelligence and school sector. The relevant coefficients are shown in the first column of Table 6, where it may be seen that the interaction takes the form of a steady decrease in the effect of intelligence on post-school attainment across the sectors, from the oldest kind of senior-secondary school to the non-academic junior secondaries.

Another way of looking at this is to calculate the predicted values of post-school attainment from the model in Table 6, at one standard deviationabove and below the mean of intelligence. (Note that this is well within the range of intelligence found in each sector, the mean values of which are shown in the final column of Table 7). The first column of Table 7 shows, for each school sector, the predicted value at one standard deviation below the sample mean of intelligence, setting all other variables to their reference category or mean; the third column shows the same for one standard deviation above the sample mean of intelligence. At the lower of these two values of intelligence, the five sectors are indistinguishable from each other: pupils with lower intelligence attained, on average, about the same educational qualifications by age 27 no matter the school sector they had attended. At the higher value of intelligence, however, there is a gradient across all sectors; pupils with higher intelligence attained, on average, higher educational qualifications by attending the historically more academic schools.

**Table 6. Interactive effect[1] of school sector and intelligence on post-school attainment[2]**

| | Coefficient | Standard error |
|---|---|---|
| Intercept | 0.29 | 1.2 |
| School sector (ref. old senior secondary) | | |
| Senior secondary: former Higher Grade | -0.28 | 0.33 |
| Senior secondary founded after 1924 | -0.67(*) | 0.39 |
| Academic junior secondary | -1.1** | 0.36 |
| Junior secondary | -1.5** | 0.32 |
| Intelligence at age 12 | 1.9** | 0.21 |
| Interactive effect of intelligence and sector: | | |
| Intelligence BY senior secondary: former Higher Grade | -0.37 | 0.26 |
| Intelligence BY senior secondary founded after 1924 | -0.66* | 0.33 |
| Intelligence BY academic junior secondary | -0.86** | 0.32 |
| Intelligence BY junior secondary | -1.1** | 0.27 |

*[1] The interactive effect (added to Model 3 in Table 4) had a Sum of Squares of 124 on 4 degrees of freedom, and the Residual Sum of Squares became 6141 on 1013 degrees of freedom, yielding an F-value of 5.1 (p<0.001). The $R^2$ value was 0.36.*
*[2] Shows only the part of the model relating to these terms; the other terms were as in Model 3 in Table 4.*
*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

**Table 7. Predicted post-school attainment from model with interactive effect of school sector and intelligence**

| | Predicted mean value at one standard deviation below mean[2] intelligence | Standard error of predicted mean | Predicted mean value at one standard deviation above mean[2] intelligence | Standard error of predicted mean | Mean value of intelligence |
|---|---|---|---|---|---|
| Old senior secondary | 1.5 | 0.49 | 5.3 | 0.31 | 0.76 |
| Senior secondary: former Higher Grade | 1.6 | 0.37 | 4.6 | 0.30 | 0.46 |
| Senior secondary founded after 1924 | 1.5 | 0.49 | 3.9 | 0.40 | 0.35 |
| Academic junior secondary | 1.3 | 0.37 | 3.3 | 0.45 | -0.26 |
| Junior secondary | 1.2 | 0.31 | 2.7 | 0.38 | -0.46 |

*[1] That is, from the model summarised in Table 6, using the R function 'predict.lm'. All the other variables in the model are set to their mean (for continuous variables) or their reference category (for categorical variables) for these predictions.*

*[2] That is, the mean intelligence for the sample as a whole, which has been set to be 0.*

Moreover, much of this interactive effect may be explained in a statistical sense by the personality variable which we called 'engagement'. (The variables 'dependability' and 'family environment' had something of this explanatory power for the interactive effect of intelligence and sector, but not as markedly as 'engagement'). Thus when 'engagement' and the interactive effect of it and sector are also added to the model, the only sector difference in the slope of intelligence is in the non-academic junior-secondary schools, where the slope remains shallower.

Some insight into what is happening here may be obtained by calculating separately for the five sectors the estimates of regression weights and correlations from path diagrams involving post-school qualifications, intelligence and engagement; this is shown in Table 8. The first column shows the unstandardised regression weight from intelligence to post-school qualifications, and so reflects the different slopes noted from Table 6; that is, the older school sectors are better at converting intelligence into educational attainments. The third column shows that for engagement, too, there is a gradient in the association with qualifications, more erratic than but not dissimilar to that for intelligence; the old senior secondaries stand out as being particularly effective in converting engagement into educational attainment. The fifth column shows that the strongest association between engagement and intelligence is in the old senior-secondary schools: there is a gradient in covariance across all five sectors, although the absence of such a gradient in the correlations in the seventh column (except to a limited extent with respect to the old senior secondaries) shows that the covariances in the junior secondaries are low partly because of the low variability of the intelligence variable there.

The broad similarity of correlations in all but the old senior-secondary sector does, however, allow us to say that the different association of engagement and attainment cannot be due solely to teachers' being the source of the measures that contribute to our variable 'engagement'. Without that similarity, it would in theory be possible that teachers might have under-estimated the educational engagement of pupils in the junior secondary schools, perhaps because of holding low expectations of them; but that under-estimation would be likely to have resulted in an attenuated correlation between intelligence and the measure of engagement in these schools. Thus the measure of engagement is not wholly an effect of intelligence, and so probably does reflect something educationally meaningful about the ethos of the different kinds of school.

**Table 8. Path coefficients connecting post-school attainment, intelligence and engagement, by school sector**

| | Intelligence to attainment | | Engagement to attainment | | Intelligence and engagement | | |
|---|---|---|---|---|---|---|---|
| | Unstandardised weight | Standard error | Unstandardised weight | Standard error | Covariance | Standard error | Correlation |
| Old senior secondary | 1.6 | 0.33 | 1.8 | 0.60 | 0.35 | 0.076 | 0.49 |
| Senior secondary: former Higher Grade | 1.4 | 0.21 | 0.41 | 0.35 | 0.27 | 0.045 | 0.41 |
| Senior secondary founded after 1924 | 1.0 | 0.34 | 0.66 | 0.49 | 0.26 | 0.072 | 0.40 |
| Academic junior secondary | 0.84 | 0.22 | 0.74 | 0.29 | 0.20 | 0.045 | 0.39 |
| Junior secondary | 0.68 | 0.11 | 0.29 | 0.12 | 0.16 | 0.022 | 0.38 |

## Social Class Attainment

The second broad area of analysis is to investigate the association between type of school attended and the respondents' eventual social-class destinations at age 27. As in all other studies of social mobility, this data set shows a strong association of respondent's class with father's class: see the top part of Table 9, which displays, for each origin class, the percentage in each destination class. Thus 40% of people who grew up in classes I or II were in these classes at age 27, in contrast to only 7% of those who grew up in class V. That there was less stability at the bottom end of the distribution (only 19% remaining in class V) is partly because of another familiar feature of mid-twentieth-century social mobility: the occupational structure as a whole was shifting upwards with, for example, a decline from 35% to 25% in the proportion in classes IV and V, and a rise from 11% to 18% in the proportion in classes I and II. Thus 36% of the whole sample moved upwards and only 19% moved down. These figures were not strongly differentiated by gender (for example, 17% of women and 19% of men were in classes I or II at age 27), mainly perhaps because the largest differentiating effect of gender on occupational attainment occurred after women had married, which for this cohort would tend to be in their mid twenties (Paterson, Bechhofer and McCrone 2004, p. 14).

There is also a very strong bivariate association of school sector and attained class, as is shown by the percentage distribution of attained class for each sector in the lower part of Table 9. The gradient across school sector in the proportion reaching classes I or II is in fact similar to that across categories of father's class, as is, in the reverse direction, the gradient in the proportion reaching class V. So, as with post-school attainment, the main question for the regression modelling is whether the sector effect is explained by the differential distribution of the pupils' paternal social classes into the sectors.

The two other most promising potential explanations of sector effects are intelligence measured upon entry to secondary school and post-school qualifications (details not shown in the tables): in the top quintile of intelligence, 45% entered classes I or II; in the bottom quintile, the proportion was 4%; among those with degrees or professional qualifications, 79% entered classes I or II, whereas among those with no or only very low qualifications the proportion was 8%. In a process of class allocation that operated fully meritocratically, post-school attainment might be expected to explain the whole of social-class attainment.

Table 10 shows the relevant regression models (with the analysis of variance in Table 11); the effect of adding each explanatory variable separately is in the Appendix Tables A3 and A4. The dependent variable is the social class attained by the respondent by age 27, treated for the time being as a continuous measure. The first model reproduces the descriptive statistics. The second shows that controlling for intelligence at age 12 reduces but does not eliminate the sector differences, and does leave the academic junior secondaries indistinguishable from the oldest senior secondaries (the reference category); in other words, the difference in the class destination of the people who passed through them may be explained by intelligence alone. Most of the school-sector effect has been explained by intelligence: the change in $R^2$ associated with sector is only 0.019 after intelligence is in the model, in contrast to 0.11 in Table 11.

**Table 9. Social class at age 27, by father's class and by school sector**

| | Class at age 27 (percentage in rows) | | | | Sample size (=100%) | Column percentage |
|---|---|---|---|---|---|---|
| | I and II | III | IV | V | | |
| Father's class: | | | | | | |
| I and II | 40 | 44 | 11 | 4 | 114 | 11 |
| III | 16 | 64 | 12 | 8 | 555 | 54 |
| IV | 18 | 55 | 20 | 7 | 180 | 18 |
| V | 7 | 50 | 24 | 19 | 179 | 17 |
| All | 18 | 58 | 16 | 9 | 1028 | |
| School sector: | | | | | | |
| Old senior secondary | 42 | 47 | 9 | 2 | 111 | |
| Senior secondary: former Higher Grade | 23 | 60 | 11 | 5 | 248 | |
| Senior secondary founded after 1924 | 21 | 62 | 13 | 3 | 98 | |
| Academic junior secondary | 18 | 61 | 13 | 8 | 147 | |
| Junior secondary | 7 | 57 | 21 | 15 | 424 | |

The third model in Table 10, controlling in addition for gender, paternal social class and parental education, reduces the differences among sectors still further, now leaving also the newest senior secondaries indistinguishable from the oldest senior secondaries. The final model, controlling further for post-school attainment, shows almost no differences among sectors at all: there are none when compared to the oldest senior secondaries (as shown in the table), but there is still a difference between the former Higher Grade schools that became senior secondaries and the academic junior secondaries (not shown in the table): the split in 1924 seems to have had a long-term effect on the opportunities offered to pupils in the latter. A further model (not shown in the table) found no interactive effect of post-school attainment and sector: attainment is related to class destination independently of sector.

**Table 10. Regression models of social class at age 27**

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. |
| Intercept | 2.6** | 0.079 | 2.88** | 0.075 | 3.66** | 0.37 | 3.7** | 0.35 |
| School sector (ref. old senior secondary) | | | | | | | | |
| Senior secondary: former Higher Grade | 0.36** | 0.095 | 0.24** | 0.087 | 0.18* | 0.088 | 0.12 | 0.083 |
| Senior secondary founded after 1924 | 0.35** | 0.12 | 0.19(*) | 0.11 | 0.11 | 0.11 | -0.0023 | 0.10 |
| Academic junior secondary | 0.53** | 0.11 | 0.12 | 0.099 | 0.060 | 0.10 | -0.084 | 0.096 |
| Junior secondary | 0.86** | 0.089 | 0.38** | 0.087 | 0.30** | 0.089 | 0.13 | 0.086 |
| Intelligence at age 12 | | | -0.39** | 0.027 | -0.37** | 0.027 | -0.24** | 0.028 |
| Gender (ref. male) | | | | | 0.11* | 0.047 | 0.091* | 0.045 |
| Father's social class (ref. I and II) | | | | | | | | |
| III | | | | | 0.12 | 0.081 | 0.055 | 0.077 |
| IV | | | | | 0.044 | 0.094 | -0.016 | 0.089 |
| V | | | | | 0.35** | 0.096 | 0.27** | 0.091 |
| Parental education | | | | | 0.057* | 0.024 | -0.034 | 0.022 |
| Post-school attainment | | | | | | | -0.099* | 0.0089 |
| $R^2$ | 0.11 | | 0.26 | | 0.29 | | 0.36 | |

*For model-fitting statistics, see Table 11.*

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.Table 11*

**Table 11. Analysis of variance of regression models of social class at age 27**

| Model term added in this order: | Degrees of freedom | Sum of squares | Mean square | F-value | Significance (p value) | cumulative $R^2$ |
|---|---|---|---|---|---|---|
| School sector | 4 | 87 | 22 | 44 | <0.001 | 0.109 |
| Intelligence | 1 | 124 | 124 | 248 | <0.001 | 0.264 |
| Gender | 1 | 2.6 | 2.6 | 4.6 | 0.03 | 0.268 |
| Father's class | 3 | 13 | 4.4 | 7.8 | <0.001 | 0.284 |
| Parental education | 1 | 3.3 | 3.3 | 5.9 | 0.02 | 0.288 |
| Post-school attainment | 1 | 61.6 | 62 | 123 | <0.001 | 0.365 |
| Residual | 1016 | 509 | 0.50 | | | |

*For regression coefficients, see Table 10.*

As in the model of attainment, we checked the residuals here and found them to be approximately Normally distributed. We further checked the conclusions by examining whether there was any evidence of non-linearity in the relationships between attained class and the explanatory variables. For example, modelling by logistic regression the probability of entering classes I or II, we found a strongly negative effect of the non-academic junior secondaries, but again this was explained by post-school attainment. Likewise, modelling entry to classes IV or V, we found no difference even before adding the educational-attainment variable: the sector differences were explained by intelligence. A final check of non-linearity was obtained by ordinal regression of attained class on the series of explanatory variables shown in Table 10. The conclusions concerning the school-history variable were the same as we have drawn from Table 10. In the ordinal regression, moreover, there was no evidence that the relationship between school category and attained class differed by category of attained class.

We may summarise this sequence of models by saying that the link between school sector and occupational-social-status attainment by age 27 is mostly explained by post-school qualifications, but only when both class of origin and intelligence are in the model too. Thus, for a person of given origin class and given intelligence, school sector had no effect on attained class other than through post-school qualifications.

## Discussion

The analysis has used a rich longitudinal data source that provides detailed information on the transition to adulthood of a nationally representative sample of people born in Scotland in 1936. No better source exists for understanding the operation and effects of the secondary-school system of the 1950s, nor the legacies embodied in it of educational reforms and arguments about reform during the previous half century.

There are two main conclusions. The first is that the type of school to which children were assigned at age 12 had lasting effects well into adulthood, effects that were not merely a reflection of intelligence, gender, paternal social class or parental education. Being allocated to a junior-secondary school depressed people's post-school attainment and also their attainment of social status through the kind of occupation they could enter. In summary illustration of this, we can calculate the equivalent in increments of intelligence of being placed in a (non-academic) junior-secondary school compared to being placed in an old senior-secondary school. For predicted post-school attainment from Model 3 in Table 4, we find that the attainment in the junior-secondary category of a person whose intelligence was at the mean for the whole sample (attainment of 1.5, with standard error 0.13) would, in the old senior secondaries, be the expected attainment of people as much as 1.4 standard deviations below the whole-sample mean of intelligence. Likewise, for predicted social class at age 27, in Model 3 of Table 10 (that is, the model without post-school qualifications), the average attained class of people in the junior-secondary category (3.05, with standard error 0.088) would, in the old senior secondaries, be the expected attained class of people 0.8 of a standard deviation below the mean of intelligence. In short, the difference in outcomes between the sectors – controlling for intelligence, gender, father's social class and parental education – was the equivalent of between 0.8 and 1.4 standard deviations in intelligence.

The effect of school also reflected history. Within the category of senior-secondary school, the oldest led to the highest post-school attainment and the highest-status occupations, even for people of given intelligence, gender, social-class background and parental education. The newer senior secondaries that had started life as Higher Grade schools were in that sense not able fully to match in quality the achievements of their long-standing predecessors. However, the success of educational reform in creating these new secondaries was also evident, because they enabled their former pupils to achieve higher attainment and better occupations than did pupils in the junior-secondary schools, even those junior secondaries which had an academic history similar to that in the schools which became the new senior secondaries.

This advantage was not wholly explained by the kinds of course which the different kinds of school provided. So there appeared to be something about the ethos or culture of the oldest schools that had an impact on their pupils' capacity to succeed. We were able to offer only a tentative explanation, based on the further point that the gap in post-school attainment between pupils of high and low intelligence was greatest in the oldest schools. In that sense, these were the most internally selective, followed by the two categories of newer senior secondaries, with all these differentiating more thoroughly by intelligence than the junior secondaries. The result was that, for pupils of above-average intelligence, the school attended mattered more for post-school educational achievement than it did for pupils of below-average intelligence. Indeed, for the above-average pupils, there was a gradient across all five sectors, and thus in particular a difference between the academic and non-academic junior secondaries: if an able pupil did not enter a senior-secondary school, then their prospects were better if they could attend a school that had some history of academic work than if they could not.

It appeared that one reason for this differentiation was that pupils in the older schools were more confident in their school work, more original in their thinking and more committed to excelling (summarised in the variable that we have called ‘engagement’, although we offer the caveat that teachers reporting the traits that made up this dimension could, to some extent, have been reporting pupils’ intelligence differences). Whether the schools created these attitudes or merely channelled pre-existing inclinations could not be determined from the data available, but the effect was to create a declining gradient in the strength of meritocratic ethos from the older senior secondaries to the non-academic junior secondaries. This finding demonstrates an effect of school ethos, interacting with school history, and demonstrable even after quite strong controls for pupil characteristics. ‘Ethos’ has often been an elusive quality in research on school effects, and so to have found a case where it does seem to be measurable is interesting (Rutter and Maughan 2002).

This differentiation of school sectors was evident for post-school attainment and through it for occupational destination. However, that was more or less the only way that the school sector influenced destination, and in that sense the structure of secondary schooling did operate meritocratically so far as the allocation of former pupils to occupational status was concerned. For a pupil of given intelligence and given social characteristics, the only way in which the school attended had an effect on their eventual occupational status in adulthood was through their attainment in post-school education. If the older schools made it more likely that such a pupil would attain highly, that advantage was the only advantage conferred in the labour market. In that sense, hidden networks of social capital did not seem to be operating, or, if they did, they operated only in ways that were concordant with measured attainment. So there is some evidence here that, in the middle of the twentieth century, opportunity in Scotland remained somewhat based on the ‘contest’ as opposed to ‘sponsorship’ model, the distinction which Turner (1960) drew between mobility in the USA and in England, and which Hope (1984) and McPherson and Raab (1988) also saw as marking Scotland from England. That is, opportunity continued to be based on a combination of intelligence and attainment to a much greater extent than on social capital; if it remained partly based also on parental social class, that was channelled only through attainment, not through direct influence.

These are important conclusions because they say something about the scope and limitations of educational reform aimed at widening opportunity. The extension of full secondary schooling in the first part of the twentieth century did, by the middle of the century, offer new educational opportunities to pupils of middling social classes (Paterson, Pattie and Deary forthcoming). We have seen here that the effect of that lasted into the sometimes lengthy transition into adult life, giving them access to educational opportunities after leaving school. The resulting opportunities to enter worthwhile occupations were then the same in the new as in the old secondaries in the sense that what mattered after leaving school was the publicly verifiable route of post-school educational attainment rather than any exercise of influence based on the kind of school attended.

Schools and school reform were less responsible for social-class destination than for educational attainment itself. The main effect of the selective system, especially the oldest parts of the senior-secondary sector, may have been in the encouragement of people of above-average ability. Whatever the effects of schools, however, there continued to be direct influences from class of origin on post-school education and on type of occupation entered, even among people of similar measured intelligence: ascriptive criteria still had an effect. These persisting and independent effects on young people’s learning and opportunities show the limits of merely institutional reform. Nevertheless, we may conclude from our analysis that, on the whole, the school system that resulted from the reforms was not responsible for social reproduction, and that it did achieve some measure of success in mitigating its effects.

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## Appendix

**Table A1. Regression models of post-school attainment: effect of adding family-circumstances variables singly (without intelligence).**

| | Gender | | Class | | Parental education | |
|---|---|---|---|---|---|---|
| | Coefficient | Standard error | Coefficient | Standard error | Coefficient | Standard error |
| Intercept | 4.3** | 0.28 | 5.1** | 0.32 | -2.2(*) | 1.2 |
| School sector (ref. old senior secondary) | | | | | | |
| Senior secondary: former Higher Grade | -1.3** | 0.32 | -1.0** | 0.32 | -1.0** | 0.32 |
| Senior secondary founded after 1924 | -1.9** | 0.38 | -1.7** | 0.39 | -1.7** | 0.38 |
| Academic junior secondary | -3.1** | 0.35 | -2.8** | 0.35 | -2.8** | 0.35 |
| Junior secondary | -3.6** | 0.30 | -3.2** | 0.31 | -3.2** | 0.30 |
| Gender (ref. male) | -0.34* | 0.17 | | | | |
| Father's social class (ref. I and II) | | | | | | |
| III | | | -0.92** | 0.29 | | |
| IV | | | -1.1** | 0.34 | | |
| V | | | -1.5** | 0.34 | | |
| Parental education | | | | | 0.46** | 0.083 |
| $R^2$ | 0.18 | | 0.19 | | 0.20 | |

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

**Table A2. Regression models of post-school attainment: effect of adding family-circumstances variables singly (with intelligence).**

| | Gender | | Class | | Parental education | |
|---|---|---|---|---|---|---|
| | Coefficient | Standard error | Coefficient | Standard error | Coefficient | Standard error |
| Intercept | 3.4** | 0.26 | 4.0** | 0.30 | -0.70 | 1.1 |
| School sector (ref. old senior secondary) | | | | | | |
| Senior secondary: former Higher Grade | -0.86** | 0.29 | -0.67* | 0.29 | -0.72* | 0.29 |
| Senior secondary founded after 1924 | -1.4** | 0.35 | -1.2** | 0.35 | -1.3** | 0.35 |
| Academic junior secondary | -1.7** | 0.33 | -1.6** | 0.33 | -1.6** | 0.33 |
| Junior secondary | -2.0** | 0.29 | -1.7** | 0.30 | -1.8** | 0.29 |
| Intelligence at age 12 | 1.3** | 0.089 | 1.3** | 0.089 | | |

*Table A2 (cont'd)*

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender (ref. male) | -0.13 | 0.16 | | | | |
| Father's social class (ref. I and II) | | | | | | |
| III | | | -0.86** | 0.26 | | |
| IV | | | -0.75* | 0.31 | | |
| V | | | -1.0** | 0.31 | | |
| Parental education | | | | | 0.28** | 0.076 |
| $R^2$ | 0.33 | | 0.34 | | 0.34 | |

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

**Table A3. Regression models of social class at age 27: effect of adding family-circumstances variables and post-school attainment singly (without intelligence).**

| | Gender | | Class | | Parental education | | Post-school attainment | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. |
| Intercept | 2.7** | 0.084 | 2.4** | 0.096 | 4.4** | 0.38 | 3.2** | 0.080 |
| School sector (ref. old senior secondary) | | | | | | | | |
| Senior secondary: former Higher Grade | 0.36** | 0.095 | 0.30** | 0.096 | 0.30** | 0.095 | 0.19* | 0.085 |
| Senior secondary founded after 1924 | 0.33** | 0.12 | 0.27* | 0.12 | 0.28* | 0.12 | 0.080 | 0.10 |
| Academic junior secondary | 0.51** | 0.10 | 0.45** | 0.11 | 0.43** | 0.11 | 0.094 | 0.097 |
| Junior secondary | 0.85** | 0.089 | 0.75** | 0.092 | 0.76** | 0.095 | 0.36** | 0.085 |
| Gender (ref. male) | 0.16** | 0.052 | | | | | | |
| Father's social class (ref. I and II) | | | | | | | | |
| III | | | 0.18* | 0.087 | | | | |
| IV | | | 0.18(*) | 0.10 | | | | |
| V | | | 0.54** | 0.10 | | | | |
| Parental education | | | | | -0.12** | 0.025 | | |
| Post-school qualifications | | | | | | | -0.14** | 0.0084 |
| $R^2$ | 0.12 | | 0.14 | | 0.13 | | 0.30 | |

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

**Table A4. Regression models of social class at age 27: effect of adding family-circumstances variables and post-school attainment singly (with intelligence).**

| | Gender | | Class | | Parental education | | Post-school attainment | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. | Coeff. | s.e. |
| Intercept | 2.9** | 0.078 | 2.8** | 0.091 | 3.9** | 0.35 | 3.2** | 0.077 |
| School sector (ref. old senior secondary) | | | | | | | | |
| Senior secondary: former Higher Grade | 0.24** | 0.087 | 0.20* | 0.088 | 0.21* | 0.087 | 0.16(*) | 0.082 |
| Senior secondary founded after 1924 | 0.18(*) | 0.11 | 0.14 | 0.11 | 0.15 | 0.11 | 0.046 | 0.10 |
| Academic junior secondary | 0.12 | 0.099 | 0.090 | 0.10 | 0.081 | 0.10 | -0.056 | 0.095 |
| Junior secondary | 0.38** | 0.087 | 0.32** | 0.089 | 0.34** | 0.088 | 0.18* | 0.084 |
| Intelligence at age 12 | -0.39** | 0.027 | -0.38** | 0.027 | - 0.38** | 0.027 | -0.25** | 0.028 |
| Gender (ref. male) | 0.10* | 0.048 | | | | | | |
| Father's social class (ref. I and II) | | | | | | | | |
| III | | | 0.16* | 0.080 | | | | |
| IV | | | 0.077 | 0.093 | | | | |
| V | | | 0.39** | 0.095 | | | | |
| Parental education | | | | | - 0.071** | 0.023 | | |
| Post-school qualifications | | | | | | | -0.10** | 0.0089 |
| 89$R^2$ | 0.27 | | 0.28 | | 0.27 | | 0.35 | |

*Key for statistical significance levels: ** p<0.01; * 0.01<p<0.05; (*) 0.05<p<0.10.*

## News

### Millennium Cohort Study publishes Fourth Survey User's Guide

The Millennium Cohort Study (MCS) is the fourth national birth cohort study in Britain. It has so far followed up the 'Children of the New Century' four times, and is set to track them through their teenage years and into adulthood. The fourth survey (MCS4) collected information from some 14,000 children born in 2000–02 across the UK. The survey was conducted when most of the children were aged 7, in 2008, following previous sweeps at 9 months, age 3 and age 5. This report is a first look at the MCS4 data. It offers mainly simple snapshots of the nation's 7-year-olds and their families but paves the way for more complex analysis of the longitudinal data accumulated so far.

The Guide, edited by Kirstine Hansen, Elizabeth Jones, Heather Joshi and David Budge, covers the following topics:

- Family demographics
- Parenting
- Child self-report
- Education, schooling and childcare
- Cognitive development
- Child behaviour
- Child health
- Parental health
- Parents' employment and education
- Income and poverty
- Housing, neighbourhood and residential mobility

The full report is available at: www.cls.ioe.ac.uk/MCSFindings

### SLLS and EUCCONET Conference Report

"Developments and Challenges in Longitudinal Studies from Childhood" took place 22-24 September 2010, in Clare College, Cambridge, supported by co-funding arrangements between the European Science Foundation (ESF) through the European Child Cohort Network (EUCCONET) www.esf.org/index.php?id=4796 and Longview www.longviewuk.com. The conference aims were, raising the visibility of birth cohort studies, enhancing their quality and initiating new and in-depth collaboration to share expertise. Experts in longitudinal enquiry from across the developmental, health, social and statistical sciences presented papers focussing on the long-term impact of early childhood circumstances and experience, and on the methodology and practice of longitudinal study.

The meeting was organised jointly with the newly-established international *Society for Longitudinal and Life Course Studies (SLLS)* www.longstudies.longviewuk.com for which the conference was the inaugural meeting. One hundred and sixty eight longitudinal and life course researchers participated, of which 96 were from the UK, 45 from other European countries and 27 from countries outside Europe. A third of participants were early career researchers under the age of 35; 58% were women.

The conference was organised in terms of plenary sessions, 4 streams of parallel group sessions and two poster sessions, and also included three keynote talks:

- *Professor Karl Ulrich-Mayer* (Yale University, Director of the German Life History study and the newly-appointed Director of the Leibnitz Institute), "Life Course and Social Policy".
- *Professor Carol Dezateux* (Institute of Child Health, University College London, and Principal Investigator of the potential UK 2012 birth cohort study) "Developments and Challenges of Longitudinal Studies in Childhood".
- *Professor Bren Neale* (University of Leeds and Director of the UK "Timescapes" project) "Journeys through Time: time as a concept category and methodological strategy in qualitative Longitudinal Research".

There were sixteen symposia on a wide range of topics and 10 themed individual paper sessions, at which a 104 papers in total were presented. Of the two poster sessions, one was devoted to EUCCONET affiliated projects, - 34 in total. *The conference abstracts will be published in the next Issue of LCCS*.

At the conference dinner held in the 'Great Hall' of the college, the newly appointed Chief Executive of the UK 'Economic and Social Research Council' (ESRC), Professor Paul Boyle, a founder (and now retiring) member of the SLLS Executive Committee, gave a rousing and amusing after-dinner talk, stressing the importance of international collaboration in the next phase of longitudinal research, and its public value.

Feedback from the conference participants was supplied through completion of a short questionnaire and gave a most positive appraisal. There was acclaim for the range of disciplinary interests and experience represented, the generally high quality of the papers, and the networking and collaborative opportunities the conference provided.

The conference was a memorable and highly significant event in the development of the field of longitudinal and life course studies, to which the ESF through EUCCONET has now made a major contribution.

## Events 2011

**SRCD** - (Society for Research in Child Development) Biennial Meeting **March 31st – April 2nd**, Montreal, Canada. http://www.srcd.org
Volunteer Reviewer website http://www.srcd.org/submissions2011/volunteers.

**SLLS** - (Society for Longitudinal and Life Course Studies) Summer School, **July 4th – 8th,** University of Antwerp, Belgium, particularly for research post-graduates and post-doctoral fellows. Other sponsors include the European Association of Population Studies and CELLO (Centrum voor Longitudinaal en Levensloop Onderzoek - Research Centre for Longitudinal and Life Course Studies), University of Antwerp. Registration opens on 1 Sept 2010 at www.ua.ac.be/cello/summerschool.

## Resources

### The Neville Butler Memorial Prize

**Longview's trustees are calling for applications for the 3rd Neville Butler Memorial Prize**. This prestigious annual award, supported by the Economic and Social Research Council (ESRC), is **open to *early-career researchers whose work involves longitudinal and/or life course research and analysis*.**

The prize comprises an award ***up to £5000*** for research dissemination and networking activities, together with significant support for promoting the winner's research and its implications for policy or practice.

The award is a collaboration between Longview, an independent thinktank which exists to promote longitudinal and life course studies, and the ESRC, which is the UK's leading research and training agency addressing economic and social concerns. The award was established in honour of Neville Butler, who was both a distinguished paediatrician and professor of child health, and an outstanding international pioneer of longitudinal and life course studies.

***The aims of the prize are***:

- to promote the understanding and importance of longitudinal and life course research within the public domain.
- to reward publically relevant new work, grounded in empirical analysis of longitudinal data.
- to enhance the capacity of early career researchers to communicate their findings to a wider audience.

***The research should***:

- be in the broad field of the economic or social sciences, including interdisciplinary work.
- make an original contribution involving empirical investigation and using longitudinal data.
- have demonstrable social value and public relevance.

Longitudinal research involves gathering data on the same individuals or groups at repeated points in time. The studies may be large-scale cohort or panel studies, but are not restricted to these. Life course research focuses on the trajectories and transitions of individual lives and how these unfold in particular contexts.

***The award panel would like to see applications from a wide range of disciplines and fields***. These include (but are not restricted to) health, economics, education, business, psychology, sociology and law. Particular encouragement is given to research which spans more than one discipline and field, and demonstrates breadth of outlook. We are looking for individuals who demonstrate intellectual rigour, an imaginative approach to the design and execution of research and a keen awareness of the particular value of longitudinal research.

Applicants are asked to submit a report fulfilling these criteria, of 5-7000 words. The report should be accessible to non-academic audiences. The prize-winner will be required to submit a revised version for publication in the international journal *Longitudinal and Life Course Studies.*

***The prize is open to all longitudinal researchers at the early stage of their career***. Eligible applicants must fulfil the following criteria:

- have completed a PhD, or an equivalent professional qualification or experience within the last five years
- be currently engaged in longitudinal\life course research in the UK, or have a strong current associations with a longitudinal research centre or project in the UK

Exceptions may be considered if an applicant has had a formal career break taken for family care responsibilities, health or other reasons. Any academic or policy field interdisciplinary research within the ESRC remit is eligible (see application form).

Winners will be expected to make themselves available for both the prize-giving event, to be held in April/May 2011, and media opportunities that may arise following the announcement of the prize. The ESRC will provide media training as part of the promotional platform.