PERMANENT PARENTAL INCOME DATASET

Aims of the study

The current data set was derived during the course of a project funded by the Economic and Social Research Council's Health Variations Programme, titled 'Income dynamics and health inequalities: an analysis of cohort and panel data' (grant number L128251018) . One of the major aims of the project was to explore the role of income in generating health inequalities within a life course perspective. The influence of family income in childhood on later health outcomes, therefore, became one of the central focuses of the study.

Why permanent parental income?

The data set selected as most appropriate for analysis of the relationship between childhood circumstances and adult health was the National Child Development Study (NCDS), a cohort survey of individuals born during one week in March 1958, originating in the Perinatal Mortality Survey. There have been five follow-up waves of the survey to data, when respondents were age 7 (1965), 11 (1969), 16 (1974), 23 (1981) and 33 (1991). The original sample contained 17,414 births, with just over 11,000 respondents interviewed in the latest wave.

The NCDS contains detailed information on family circumstances and health status at each wave of the survey, which makes it invaluable for the purposes of identifying life course determinants of adult health inequalities. However, the information collected by NCDS on family income in childhood was deemed inappropriate for our purposes, for a number of reasons. For example, the NCDS only collects family income information when respondents were aged 16, which might not be an accurate reflection of living standards in earlier childhood. Also, there is good reason to believe that persistent poverty, rather than a single-year measure, is more important in terms of its effect on health outcomes. If parents' experience of low income was only temporary, this is likely to have much less impact on the child than if family income was permanently low. With only one measure of parental income observed at a single point in time it is impossible to distinguish between transitory and permanent poverty. Moreover, any measure of income reported at a single point in time will be subject to measurement error. As such, the relationship between reported family income in childhood and later health outcomes may be understated.

In order to overcome some of these problems, a prediction of permanent total parental income was obtained using information on parental characteristics, in an attempt to capture average living standards in childhood. We experimented with a number of different assumptions in generating an estimate of permanent parental income, but the general pattern of results in the main study were generally not affected by alternative specifications. The data

set includes one particular version of predicted permanent income, used for example in Taylor (1999), and the derivation of this variable is detailed in the following section.

Methodology

The methodological approach to obtaining a prediction of permanent parental income follows closely the procedure employed by Dearden et al (1997), who used information on individual characteristics to predict permanent wages for a sample of NCDS respondents and their fathers. In the current study, a prediction of permanent *total* parental income was obtained using information on parental characteristics.

Estimation with banded income information

Family income in NCDS is reported in banded form separately for father's earnings, mother's earnings and 'other' sources of family income. The banded nature of this income information means that using the standard ordinary least squares approach to estimation will generate inconsistent estimates, as the dependent variable will tend to be left, right or interval censored. The approach taken here is to sum together the lower and upper band limit of each separate source of family income, and estimate a total (log) family income equation, using grouped dependent variable techniques developed by Stewart (1983)[1].

The explanatory variables included in the model are:

mother's and father's years of education (derived from information on age left full-time education collected in wave 3 of the survey), including missing dummies

mother's and father's occupational class dummies (reference group is skilled manual for men, not working for women)

dummy variables for whether or not a mother or father figure was ever absent during childhood

mother's and father's age (and age squared)

region dummies (reference group is London and the South East)

Exclusions

The following cases are excluded from the analysis:

fathers and working mothers with missing occupational class information at wave 3 of the survey

respondents with neither natural parent at wave 3 of the survey.

[1] The current study made use of a STATA programme developed by researchers at the Institute for Fiscal Studies that automates the GDV estimation process.

The reason behind the second imposed exclusion condition is that information on mother's and father's age is only available in the birth survey. This potentially restricts the sample on which family income can be predicted to NCDS respondents with both natural parents (or only one natural parent if only one parent figure) at the time of the income observation. However, we have expanded our sample by imputing the age of non-natural parents – conditional on there being one natural parent in the household – using information on the mean difference in reported mother's and father's age at birth. This approach makes the implicit assumption that non-natural parents present at wave 3 have very similar characteristics to those of the natural parent they might have replaced.

Obtaining a prediction

Using the results from the estimated income equation, permanent parental income is derived as follows. The estimated coefficients on the variables deemed to have a *permanent* impact on family income levels (parental education and occupational class, and the absence of either parent at any point in childhood) are used to predict average or permanent family income in childhood, while holding constant parents' age and region (assumed to be the time-varying transitory components of parental income determination).

Identifying assumption

This prediction of permanent income was then used in the main analysis of the childhood determinants of adult health status, which required an identifying assumption to be made. For the particular measure of permanent income described here, we assume that father's and mother's occupational class only affect a child's health development indirectly via income, once parents' education and other childhood circumstances are controlled for. While this might be deemed a rather strong assumption, imposing alternative identifying assumptions did not alter the general pattern of results.

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INCOME DYNAMICS AND HEALTH INEQUALITIES: AN ANALYSIS OF COHORT AND PANEL DATA END OF AWARD RESEARCH REPORT

Michaela Benzeval, Andrew Dilnot, Ken Judge and Jayne Taylor

BACKGROUND

It is a truism that poverty is bad for health. However, the precise links between various definitions and perceptions of financial circumstances and different measures of health status are not clearly understood. Moreover, much of the evidence about the association between income and health is based on cross-sectional data where the direction of causation cannot be known with any certainty. In addition, recent research findings make it increasingly clear that poverty is a dynamic not a static concept. Such dynamics may be particularly relevant to the debate about the relationship between poverty and health, as Walker and Ashworth argue:

> *. . . a brief spell of poverty is not the same as a lifetime spent with resources outstripped by need and . . . neither is* [it] *the same as repeated bouts of poverty separated by time that may allow for some financial and emotional repair.* [For example,] *. . . during spells of poverty psychological well-being may reflect a complex interplay between factors that change with time: frustrated expectations and stress caused by the need to budget on an exceptionally low income for long periods, contrasting with growing expertise in what may be relatively stable financial circumstances* (1994, pp. 139; 39).

The overall objective of this project therefore has been to investigate the relationship between income and health over time both to shed more light on the issue of causation and to take account of income dynamics. It explores the association between income measured at different points in time, income measured over time and fluctuations in income, and a range of health outcomes. There are three general reasons why a dynamic approach to examining the income and health relationship is important to the scientific understanding of health inequalities and to developing policies to tackle them.

- First, the direction of causation between income and health can be investigated by exploring the association between income and health where the income measure

precedes health or by undertaking dynamic analyses. In addition, measuring income over time facilitates an investigation of the effect of fluctuations in income on health.

- Secondly, there is a growing recognition of the importance of examining people's current health in light of their lifecourse experience (Kuh *et al*, 1997). The early identification of lifecourse issues as a key theme within the Health Variations Programme has made this a more central focus of the project than was indicated in the original proposal.
- Finally, there is a growing recognition that it is vital to understand the dynamics of people's experiences in order to design effective policies (Ellwood, 1998; Jenkins, 1999).

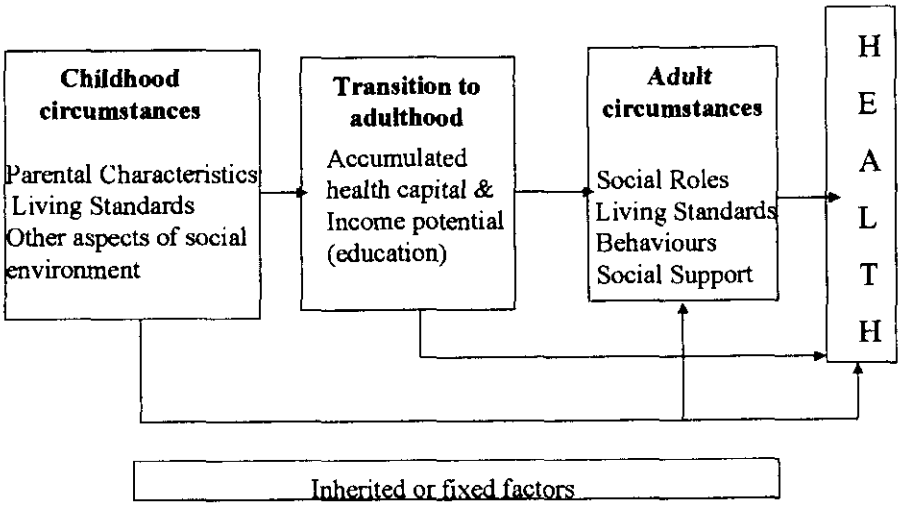
We have reviewed the existing literature relevant to each of these issues, and summaries are contained in specific papers. Here we highlight the main research questions derived from the literature that are explored in this study.

Drawing on the literature on the first of these issues we identified four broad issues to investigate.

- To what extent can the cross-sectional association between income and health be explained by reverse causation or health selection?
- Does the point of time at which income is measured affect the association between income and health? Is persistent poverty more harmful for health than occasional episodes?
- Do income fluctuations or volatility have an effect on health over and above income levels?
- Does the association between financial circumstances and health vary depending on whether objective monetary measures of income are considered or more subjective perceptions of financial difficulties?

The second main empirical area of research within the project considered the role of income within a lifecourse perspective. We have developed a conceptual framework that focuses on the role that income in childhood and adulthood plays in shaping health both directly and indirectly through important mediators such as educational attainment. This is illustrated in Figure 1.

Figure 1 Income and health a lifecourse perspective



First, an individual has certain characteristics that are fixed - such as genetic makeup, age and sex - which may also affect their health and socioeconomic status throughout their life.

In childhood, we are particularly interested in the effect of the financial resources available to households on the development of health and educational capital. However, other childhood circumstances are also likely to be important factors.

Two dimensions of an individual's transition to adulthood that we define as "income potential" and "health capital" are of particular relevance to the project.

- Income potential is the accumulation of abilities, skills and educational experiences in childhood that are important determinants of adult employability and income capacity. Education is seen as the key mediator in this association (Kuh *et al.*, 1997), being strongly influenced by family circumstances in childhood and a central determinant of an individual's income in adulthood.
- Health capital is the accumulation of health resources, both physical and psychosocial, 'inherited and acquired during the early stages of life which determine current health and future health potential' (Kuh *et al.*, 1997, p. 173).

Finally, in adulthood an individual's living standards, health-related behaviours, social networks and health are determined partly by their accumulated lifecourse experience and partly by the social roles – in terms of marital status, employment and parenthood – that they assume.

The conceptual framework is a fundamental foundation of the project, providing a theoretical structure within which to explore issues about the direction of causation and to investigate the complex inter-relations between income, other determinants - such as employment, education and family circumstances - and health.

By reorientating some of the general questions derived from the lifecourse literature to focus on the role of income, the project explored the following issues.

- What role do financial circumstances in childhood play in shaping educational outcomes and the acquisition of health capital?
- What contribution do education and health capital make to adult health?
- What role does recent experience of income play in determining adult health after having taken account of accumulated human capital and risk?
- How does adult income interact with other adult circumstances to affect health?

The third main area of the project explores the policy implications of the empirical findings. Drawing on the Government's own accounts of its strategy to tackle health inequalities and various critiques of New Labour's first two years in office we addressed three questions.

- What policy areas need to be addressed to tackle the causes of health inequalities identified in the study?
- To what extent does the current Government's social policy agenda address these issues?
- How successful will their strategy be in tackling poverty and reducing health inequalities?

OBJECTIVES

1. *The main aim of this proposal is to increase scientific understanding of the relationship between income distribution and health variations in ways that directly contribute to the formulation of more appropriate economic and fiscal policies.*

This project has focused on the role of income across the lifecourse and its relationship with health. In addition to investigating the association between long term income at different stages of life and adult health, a number of other issues pertinent to the income and health relationship have been explored. These include: the joint . determination of income and health; the association between different aspects of income dynamics and health; alternative measures of financial circumstances and their relationship with health; and, some of the inter-relationships between the causes of poverty and falls in income, income itself and health. Based on the results of these analyses, we identified key areas for policy development and considered the extent to which New Labour's agenda will address them.

A range of other activities, although not specifically funded by this grant, have also contributed to this aim. For example, Michaela Benzeval and Ken Judge have undertaken a detailed investigation of the cross-sectional association between income and health using the GHS (Benzeval *et al.,* 1999) and a review of the relationship between income inequalities and health at the national level (Judge *et al.* 1998). In relation to policy, we have published relevant critiques of New Labour's anti-poverty strategy (Benzeval, 1999; Judge, 1999; Gregg *et al.*, 1999; Dilnot and McCrae, forthcoming) and contributed to policy development. For example, Michaela Benzeval produced an input paper for the *Acheson Inquiry into Health Inequalities* and Andrew Dilnot made a presentation to the Committee and provided a number of analyses; and, Ken Judge has acted as a key resource in the early development of Health Action Zones.

2. *The specific empirical objective is to investigate the relationships between levels of and changes in family and individual income and various measures of health status, after controlling for other determinants of health, using data obtained from the British Household Panel Survey and the National Child Development Study. We will try to supplement this by using data from the American National Longitudinal Survey of Youth.*

This project focused on exploiting two British datasets: the *British Household Panel Survey* (BHPS) and the *National Child Development Study* (NCDS). For example, the BHPS was employed to investigate the complex interactions between income levels, fluctuations and volatility and adult health, while the NCDS was used to examine the

role of financial circumstances in childhood for health. Bringing the two datasets together within a common conceptual framework has enabled us to produce a more comprehensive analysis of the role of income alongside other factors at different stages of the lifecourse. To disseminate the findings, 14 conference presentations have been given, two more are planned together with an IFS Policy seminar. In addition, eight papers have been produced and three more are in preparation.

We also explored the potential of the American *National Longitudinal Survey of Youth* to address some of the questions that are central to this project. Unfortunately, the health variables were not suitable for our purposes and consequently we decided to concentrate on the two British studies.

3. *An associated objective is to develop appropriate econometric methods to explore the complex pathways between income histories and health experiences and to advance theoretical understanding of the ways in which relative deprivation can generate adverse health outcomes.*

As the project developed, the importance of the lifecourse approach to evaluating the determinants of health inequalities was identified as a central theme of the Health Variations Programme. Consequently, an important theoretical aim of this study became the development of a conceptual framework to aid understanding of the role of income in determining health inequalities within a lifecourse perspective. This developed the project in a slightly different direction to that suggested in the application. However, this enabled us to make a much stronger contribution to the Programme. As described above, this theoretical framework emphasises the potential joint determination of income and health, as well as exploring the impact of income levels and income fluctuations at different points of life.

In general, we employed existing econometric techniques, rather than developing new ones, to analyse the complex relationships between income and health controlling for confounders as appropriate. We decided that we could make the most effective contribution to health inequalities debate within the framework of the Health Variations Programme by prioritising the development of complementary models from each dataset in order to identify clear conclusions to take forward into the policy analysis component of the project. However, we did make new and innovative use of advanced econometric techniques in order to obtain a much more sophisticated

measure of average financial circumstances in childhood than is normally available in survey data.

4. *Finally, we expect that sufficiently significant findings will emerge from the analysis to contribute to discussions that address the possible ways in which new fiscal policies could form part of any concerted attempt to reduce health inequalities.*

This project was undertaken against the background of a very fast moving policy agenda. It was designed and commenced under a Conservative Government that paid little attention to the problem of health inequalities. By the time the empirical analyses had been conducted New Labour had been in office for nearly two years with a strong commitment to tackling health inequalities (DH, 1999), poverty and social exclusion (Cm 4445, 1999). We, therefore, took a slightly different approach to meeting this objective than we originally intended. Having identified the particular policy areas associated with the empirical findings, we assessed the extent to which New Labour's policies addressed these issues, and how successful they might expect to be. It was enormously helpful that, following Paul Johnson's departure from the project, Andrew Dilnot, Director of IFS, worked with us on the policy analysis component. Given the increased interest in developing policies to tackle health inequalities, members of the team have been in considerable demand to contribute policy advice, and have drawn on the work of the project in doing so. In addition, a number of our presentations have been specifically aimed at policy audiences and an IFS Policy Seminar will be held in November.

METHODS

The core of this project is based on the secondary analysis of two British longitudinal datasets: the BHPS and the NCDS. In the early stages of the project considerable time was spent acquainting ourselves with the details of the two rather complex longitudinal datasets; developing appropriate samples of respondents with relevant information; and, constructing variables with which to conduct the analyses.

The BHPS is an annual panel study of households which were representative of the general British population in the first year of the survey - 1991. Most of the analyses in this project are based on six years of data. In constructing a six-year dataset three issues were addressed.

- First, four sets of health questions were asked in each wave of the survey: general assessments of health; a list of health problems; the General Health Questionnaire (GHQ), a measure of psychosocial wellbeing; and, limiting illness. We explored different ways of analysing these variables and developed a composite health index from them. In the end, however, we decided to investigate each health dimension separately and constructed binary variables to keep the analyses relatively simple and easy to interpret.
- Secondly, we needed to construct an appropriate measure of net family income because one was not included in the public dataset. In the early analyses of the project, we derived a crude measure of equivalent net income based on the methodology devised by Webb (1995). However, in August 1998 a more accurate measure of equivalent net income calculated using tax-benefit simulation models was released (Jarvis and Jenkins, 1998). This was employed for the rest of the project.
- Finally, variables capturing the complex changes in adult circumstances – such as smoking, parental, employment and marital status - across the six years of the survey were developed.

The NCDS is a birth cohort study, based on individuals born in one week in March 1958. Information has been collected when they were aged were aged 7, 11, 16, 23 and 33. Two main issues were addressed in developing a longitudinal dataset for these analyses.

- First, adult respondents were asked a similar set of health questions to those contained in the BHPS: self-assessment of general health; a list of health problems; a malaise inventory of psychosocial problems; and the presence of any limiting illness. In addition, we made use of information on self-reported weight and height to derive a Body Mass Index (BMI) as a potentially more objective measure of physiological health. This enabled us to compare the impact of financial resources in childhood on both subjective and objective measures of adult health.
- Secondly, a fundamental requirement was to develop a 'permanent' family income variable, as a measure of average living standards in childhood. The NCDS dataset only contains income information when the respondents were aged 16. However, there is good reason to believe that persistent poverty, rather than a

single-year measure, is more important in terms of its effect on health outcomes. Moreover, any measure of income reported at a single point in time will be subject to measurement error. As such, the relationship between reported family income during childhood and adult health may be understated. In order to overcome some of these problems, a *within-sample* prediction of permanent total parental income was estimated using information on parental characteristics observed at the same time as income was reported. The predicted measure of permanent income is used in most of the models, and will be deposited at the ESRC Data Archive.

Econometric methods

With both datasets a considerable amount of time was spent exploring the data and the binary and multivariate associations between income and health and the other explanatory factors. In order to keep the analyses reasonable straightforward we mainly employed binary dependent variables and logistic regression or probit for the main analyses. Explanatory variables were considered significant if the change in the scaled deviance associated with their inclusion in the model was significant at the 10 per cent level. Where appropriate, particularly with the measures of income, non-linear functions were explored. Within the conceptual framework, a range of other determinants and confounders were identified and included in the models. Models were developed in stages to assess the effect of these additional explanatory variables on the primary associations of interest between income and health. The specific models developed for each set of research questions are described in more detail in the relevant papers.

For all of the empirical work, we investigated the extent to which the associations varied by health measure, gender and age group.

Two distinct methodological issues were identified in the application as difficulties the project needed to address:

- the existence of unobservable fixed effects;
- the qualitative nature of the dependent variable.

In the application we suggested that the first problem could be overcome either by including lagged histories of income, health and other variables in the models or by including sufficient background information to explicitly control for the potential fixed effects. In the event, both of these methods were employed.

Dynamic analyses of the BHPS were conducted that included a lagged dependent variable on the right hand side and information on the other independent variables accumulated across the six years of the survey. A conceptual framework was also developed, as described above, to locate the project within a lifecourse perspective to contribute to this emerging theme within the Health Variations Programme. Following this framework, the analysis of both the BHPS and the NCDS employed a range of contemporary and background variables, including some proxies for potential fixed effects.

We mainly employed binary dependent variables in order to keep the analyses reasonable simple. However for one NCDS outcome measure with four categories – BMI – a discrete choice logistic model was employed.

RESULTS

Below we briefly highlight the findings in response to each of the research questions identified above. Much more detailed information can be found in the relevant papers. The nominated attached papers cover two of the research areas identified. First, Benzeval and Judge (1999) focuses on analysis of the BHPS to investigate the association between income measured over time and health. Secondly, Taylor (1999) describes the analysis of the NCDS within our lifecourse conceptual framework and the construction of the measure of permanent family income.

Income and health over time

To what extent can the cross-sectional association between income and health be explained by reverse causation or health selection?

In the literature reverse causation has been controlled for in a number of ways, including:

- using measures of income that precede the health outcomes;

- controlling for initial health in models or only including people in good health at the start of the study;
- using measures of income that are unrelated to the employment status of the person whose health is the focus of the study.

We have employed all of these techniques to investigate the possibility of reverse causation. Within both the NCDS and the BHPS we found that there was still a strong association between family income and health when the income measure preceded the health outcome. Including initial health in the models did reduce the coefficient on the income variables suggesting that health selection does play a part in the relationship, however, it did not account for all of the association. For all of the health measures examined, individuals in the lower income quintiles or those who experienced more financial difficulties had poorer health than those respondents who were more affluent.

In addition, we examined the association between parental income and financial circumstances in childhood and health in adulthood. We found that, in general, this was significant, although it was removed when other factors were included in the model.

For both men and women the strongest association between recent family income and health was for the general subjective assessment of health. There was also a strong association for reported limiting illness, particularly for men. In the NCDS there was a strong association between income and malaise, however, this was not true for the measure of psychosocial health in BHPS - the 12 item-GHQ score. The association between income and health was generally stronger for women than men, and the weakest associations were among people over retirement age.

Does the point of time at which income is measured affect the association between income and health? Is persistent poverty more harmful for health than occasional episodes?

In the analysis of the BHPS family income was measured at a number of different points in time. The results showed that a stronger association existed between income and health if long-term income was employed in the models, although current income

appeared to be at least as good for the GHQ or experience of health problems. Across the health measures, population groups and surveys, persistent poverty was more harmful for health than occasional episodes.

Do income fluctuations or volatility have an effect on health over and above income levels?

There was a significant association between income fluctuations and poor health. The larger the fall in income over the six years the more likely people were to report poor health. With a non-linear variable, falls in income appeared to have a harmful effect on health but equivalent increases in income did not have a significant effect. This may be the result of the operation of different time lags and needs further investigation. Income volatility was significantly associated with both subjective assessments of health and the GHQ, with people who experienced more volatile incomes having better health.

Does the association between financial circumstances and health vary depending on whether objective monetary measures of income are considered or more subjective perceptions of financial circumstances?

Across all health measures and population groups there was a stronger and steeper association between subjective assessments of financial difficulties and health than existed for monetary measures of family income. This may simply be the result of negativity i.e. people who report negative experiences in one domain of their lives are more likely to do so in others. Alternatively, however, it may be that it is the gap between resources and needs that is important for health, and perceptions of financial difficulties may be a better proxy for this than actual monetary income.

Lifecourse perspective

What role do financial circumstances in childhood play in shaping educational outcomes and the acquisition of health capital?

Persistent financial difficulties in childhood had a significant effect on both educational attainment and health outcomes at the age of 23. Similarly there was an association between permanent parental income and these outcome measures. However, the strength of these associations was reduced when other childhood factors, in particular parental education, were added to the models. Even so, the

association between income and educational attainment remained significant. Moreover, parental education is a significant determinant of family income, so it is difficult to draw any firm conclusions.

What contribution do education and health capital make to adult health?
Analysis of both the NCDS and the BHPS suggested that education and health capital are key determinants of adult health outcomes. This was true across a range of health measures and population groups. However, while for men and women of working age the contribution of education and health to the change in scaled deviance was similar, for people over retirement age the role of education was minimal.

What role does recent experience of income play in determining adult health after having taken account of accumulated human capital and risk?
Having controlled for education, health capital and fixed factors, there were significant associations between recent family income levels and fluctuations and specific health measures for particular gender and age groups. In the models where income fluctuations were significant, there was a greater probability of reporting ill health among those with the biggest increases in income. This appeared to be the result of two groups. First, women over 75 whom have recently been widowed, perhaps receiving large life insurance payouts but whose health is detrimentally affected by the loss of their partner. The second group was young women under 35 who have degrees, have recently become employed and married. It may be that the strain of combining these roles has a detrimental effect on health despite the associated increases in income.

How does adult income interact with other adult circumstances to affect health?
The literature suggests that many of the factors that affect an individual's income, for example, changes in employment and marital status, will also affect their health. We investigated the extent to which fluctuations in income associated with these life events could account for changes in health status. We found that people who separated during the first six years of the BHPS were poorer and had poorer health status before the separation than those who stayed married. However, controlling for both initial health and income change there was a significant increase in GHQ after a separation for both men and women. Similarly, men who experienced unemployment

during the course of the survey were poorer and had poorer health at the start of the BHPS than those in constant employment. Again, controlling for initial health and income change, people who experienced unemployment had significantly poorer health at the end of the survey than those who were employed.

Policy implications and critique

What policy areas need to be addressed to tackle the causes of health inequalities identified in the study?

The analysis in this project has shown the enduring importance of childhood poverty for health capital and educational attainment, and the additional health-damaging consequences of low income in adulthood. The results suggest that practical policies to reduce poverty, especially for families with children, should be an essential ingredient in any concerted effort to tackle health inequalities. However, as the above summary highlights, the statistical importance of the poverty variables was reduced when other measures, such as education, employment and parent's circumstances, were introduced into the models. This suggests that other policy developments, particularly to promote employment and educational opportunities, are also required.

To what extent does the current Government's social policy agenda addresses these issues?

New Labour's policies to improve living standards suggest that these kinds of analyses have been taken into account and that new initiatives are 'intend[ed] to tackle the *causes* of poverty and social exclusion not just alleviate the *symptoms*' (DH, 1999, p.5). The Government has introduced a range of policies to reduce barriers to employment, for example, the National Childcare Strategy and Employment Action Zones. However, their single biggest investment is on a range of New Deal initiatives to promote employment for a number of different groups. There are three main elements to the Government's efforts to 'make work pay': the introduction of a national minimum wage; increasing benefits for low paid workers with families; and, introducing a new 10p income tax rate and reforming the National Insurance system. In relation to education, the Government has introduced a raft of strategies and reforms to promote literacy and numeracy; reduce school exclusions and truancies; and, give children a better start in life. Finally, successive budgets have redistributed income towards families with children and those at the bottom of the income distribution.

How successful will their strategy be in tackling poverty and reducing health inequalities?

The main thrust of the Government's anti-poverty strategy has two distinct elements. First, it emphasises the central role of formal work as the best route out of poverty. Secondly, it prioritises families with children. Our analysis suggests that both of these are important parts of any strategy to reduce health inequalities. However, although the Government has promoted policies to meet these objectives, to date they have only had marginal effects and are unlikely to make a major impact on the levels of poverty or unemployment in Britain in the foreseeable future (Bell *et al*, 1999; Gregg *et al.* 1999; Piachaud, 1999). Moreover, some key groups are excluded from the Government's anti poverty strategy. In particular, single people and couples without children have, on average, experienced reductions in their real living standards. This is likely to adversely affect their health.

ACTIVITIES

From its inception this project was designed to contribute to both policy and academic debate about health inequalities. We have taken every opportunity to engage with these twin audiences. Fourteen presentations have been given to date, two more are planned and we have contributed to relevant discussions in a range of policy fora and health inequalities networks, as well as within the Health Variations Programme. Our single biggest dissemination activity is an IFS Policy seminar to be held in November 1999. This will bring together an invited audience of policy makers, academics and journalists to discuss the empirical findings and debate their policy implications.

OUTPUTS

To date only short articles have been published from the project. Two chapters have been submitted to book Editors and are awaiting publication, including one for the Health Variations Programme book. In addition, two articles are currently with the referees of peer-review journals and three more are in preparation.

Two secondary datasets have been used for this project. After discussions with the ESRC Data Archive, it was agreed that only the permanent income measure in the NCDS should be submitted to the Archive for public use, since the original datasets are already available from there. Work is in hand to prepare the relevant documentation in order to submit this dataset.

Finally, as a result of our work analysing the health data in the BHPS we were asked to produce a discussion paper on the future shape of the health section of the questionnaire and debate it with other users at the BHPS User Group Meeting in November 1998. This work has contributed to the future design of the questionnaire.

IMPACTS

To date the findings of this project have been presented at fourteen different conferences, ranging from international meetings to conferences of significant users of research such as the *Inter-collegiate forum on poverty and health* and the *Association for Public Health.* At all such events the presentations from this project have been well received and generated correspondence after the events. So, although

much of the main dissemination to end-users has still to be completed (see section 4 of the questionnaire), the findings of this project appear to have generated considerable interest in both the policy and academic communities. Moreover, the growing recognition of the importance of taking a lifecourse or dynamic perspective to examine social problems in order to design effective policy interventions means that the value of this work will continue to grow.

FURTHER RESEARCH PRIORITIES

This project has identified important new evidence about the relationship between income and health over the lifecourse. It identifies a range of issues for further and more detailed study. These fall into two main groups.

First, do the identified relationships hold over longer time spans and for other populations? Both the NCDS and the BHPS are limited in the period of people's lives they cover in different ways. As they expand or other longitudinal datasets become available it will be important to explore the extent to which these relationships are true for other cohorts of the population or over longer time periods. Secondly, a number of research areas were identified during the course of this project, but there was not sufficient time to study them in any great detail. For example, preliminary analysis of the BHPS showed interesting but complex interactions between social transitions, income change and health outcomes. Michaela Benzeval, has submitted an application to the *MRC Health of the Public* competition to explore these relationships further. Her application has been shorted and a full application will be submitted in February 2000.

BIBLIOGRAPHY OF PROJECT OUTPUTS

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ABSTRACT

Study objective

The study has two main aims. The first aim is to identify the mechanisms through which childhood circumstances in general influence adult health, focusing on the mediating effects of educational attainment (or earnings potential) and health capital (or health potential) accumulated in childhood. The second aim is to investigate the specific role of parental income in shaping adult health outcomes.

Design

The study uses data from the British National Child Development Study to relate childhood circumstances and adult health. A conceptual framework is developed to guide the analysis within a lifecourse perspective.

Setting and participants

The survey population includes all children born in Britain during one week in March 1958, followed up at age 7, 11, 16, 23 and 33 years. The final sample on which the study is based includes just over 7,000 individuals.

Measurement and main results

A measure of parental 'permanent' income is derived using information on parental characteristics to obtain a proxy measure of average living standards in childhood. Information on health status in very early adulthood (age 23) and highest qualifications by this age is used to measure accumulated health capital and educational attainment. Adult health is measured using information on self-reported health status age 33.

Childhood circumstances are found to have quite a strong effect on both the accumulation of health capital and educational attainment. In turn, health and qualifications acquired by early adulthood are strong predictors of later health status. Low parental income is associated with poor health outcomes, but the effect appears to be mediated primarily through educational attainment: children from poorer families are less likely to do well in school (conditional on a wide range of other childhood factors) and, in turn, are more likely to have poor health as adults. Other parental influences, particularly those related to time invested in quality parenting, are also found to have an indirect effect on their children's health.

Conclusions

Parental income exerts a strong but indirect influence on a child's later health, operating primarily through educational attainment. Other parental 'inputs' reflecting quality of parenting - which is correlated with income - were also found to be important. The results emphasise the importance of taking a lifecourse approach to the analysis of the determinants of adult health.

Key words: life-course, adult health, parental income.

Words: 5,731 (main text).

Tables: 5 (including appendix); Figures: 1.

KEY POINTS

1. A strong link between childhood circumstances and the accumulation of health capital and educational attainment is found.
2. In turn, qualifications and health capital accumulated in childhood are strong predictors of adult health.
3. Family income in childhood and parental characteristics related to parenting quality are important for later health outcomes. However, the effects of parental influences are not direct; they are mediated through the child's own educational attainment and accumulated health capital.
4. The results emphasise the importance of taking a lifecourse approach to the analysis of the determinants of health inequalities, and provide additional support for the British government's drive to eradicate child poverty and more generally to improve opportunities for children from low income families.

INTRODUCTION

The past two decades have witnessed a proliferation of research into the mechanisms through which socio-economic conditions in childhood influence health outcomes in later life. It is not difficult to understand why childhood material conditions - such as the level of family income and stability of parental employment, together with housing conditions and neighbourhood characteristics - might have an important role to play in a child's health and development.

Increasingly, the availability of longitudinal data, in particular data from birth cohort surveys, is enabling researchers to examine more precisely the links between early life events and later life chances in general and health outcomes in particular. The existing evidence points to a strong relationship between childhood socio-economic conditions and adult health outcomes[1-3], but more recent circumstances are generally found to be more important.[4,5] Further, recent evidence suggests that persistent exposure to relative disadvantage has particularly detrimental effects.[6]

Kuh and colleagues[7], in an excellent summary of the literature on the pathways between childhood and adult health, identify *biological* and *social* chains of risk, both of which are related to socio-economic conditions and also affect adult health. Biological risk relates to adverse early childhood conditions which increase vulnerability to disease, while accumulated social risk is related to adverse childhood conditions which affect life chances in general, thus resulting in unhealthy life careers. These two causal mechanisms might then operate alongside one another to generate a 'double disadvantage'.[8] Two of the most important mediating factors in this process are hypothesised to be the development of

health 'capital' and also educational attainment, both being highly correlated with family background[9,10] *and* strong predictors of adult health.[1,11] As such, an important role for parental income is implied, as higher income enables greater consumption of goods and services that are beneficial both to the development of health capital and to positive educational outcomes.

However, while much of the existing literature points to an important role for childhood socio-economic conditions in shaping adult health outcomes, little attention has been paid explicitly to the role of family *income* per se. There is good reason for this. In most longitudinal surveys that contain sufficient health information, family income in childhood is usually measured imprecisely or inadequately. Consequently, other more broadly defined indicators of childhood socio-economic conditions have often been used, such as parental social class or education[1,2], which might mask important variation in income levels. Indeed, some observers argue that 'the vast majority of variation in individual health is within socio-economic groups, not between them'.[12]

Using data from a British cohort survey, the focus of this paper is twofold. The first aim is to model explicitly the childhood influences on the development of health capital and educational attainment, and to assess the importance of these potential mediating factors in determining adult health outcomes. As such, the current research draws heavily on the existing health inequalities life course literature.

The second aim is to assess the role of family income in childhood in shaping later health outcomes, and to investigate the competing explanations for the importance of childhood socio-economic conditions. For example, does parental income solely reflect financial

circumstances and the corresponding availability of material resources in childhood (such as good quality housing and a healthy diet), or does it simply act as a marker for parental characteristics which are related to parenting skills? An attempt is made to overcome the difficulties associated with the lack of reliable survey data on parental income by estimating a proxy measure of average living standards in childhood, using information on parental characteristics.

The next section describes a conceptual framework to guide our thinking about the links between childhood and adult health, followed by a brief description of the data used and the modelling approach. Then, the results of the empirical analysis are presented. Finally, a short discussion and some conclusions are offered.

METHODS

A CONCEPTUAL FRAMEWORK

Building on the model developed by Kuh and colleagues[7], childhood circumstances are hypothesised to affect the development of earnings potential - measured, for example, by educational attainment - and health capital - measured, for example, by health status in early adulthood. (The authors also identify social capital and healthy behaviours as two further dimensions of accumulated risk, but no attempt is made to model these risk profiles here.) In turn, this accumulated stock of health and earnings potential then interacts with other adult circumstances and experience to influence adult health.

Here, the focus is on the childhood determinants of accumulated health and earnings potential as an individual matures into adulthood. Particular attention is paid to the role of

family income during childhood. The extent to which this early adult stock of health and earnings potential is related to later adult health outcomes is also investigated. This approach provides an opportunity to assess the direct and indirect effects of childhood circumstances on adult health outcomes.

A graphical representation of this process is presented in figure I. Deliberately, no arrows have been drawn between the boxes, as the various inter-relationships become rather complicated as each group of childhood circumstances influence (and are influenced by) each other, but generally we can think of movement from the left to the right of the page along the time continuum. Accumulated health capital and earnings potential as one moves into adulthood is hypothesised to develop as a function of individual characteristics and the environment in which a child is raised, mediated to a large degree through childhood outcomes (such as attitudes and behaviour).

Probably one of the most important influences on a child's development, both in terms of health and earnings potential, is the extent to which parents allocate the necessary resources to this development, both in terms of time and monetary inputs. These inputs will be determined to a large extent by family circumstances (such as total family income, family size and composition) and are related to the nature of the home environment (for example, the amount of time the mother and father spend with the child). The effectiveness of these parental inputs will, in turn, be influenced by the parents' ability and willingness to convert available resources into positive child outcomes (related to parental characteristics).

For example, a child's family might enjoy relatively high levels of income, but if the parents do not spend much time at home with the child because they are working, or they are poorly educated about activities advantageous to the child's development, then the available monetary resources will not necessarily generate positive child outcomes.

Parents' financial resources, time resources and ability or willingness to 'invest' in their child are highly likely to be inter-linked. For example, higher educated parents are more likely to command higher salaries and also have superior parenting skills. The challenge is to untangle the effects of the various parental influences in order to identify the source of the relationship between childhood socio-economic conditions and outcomes in later life.

It is not only parental influences that are likely to be important for a child's health development and educational achievements, however. Figure I identifies 'fixed' factors - such as age, sex and ethnicity - and individual characteristics as possible important determinants of accumulated health and earnings potential. Individual characteristics relate to inherited attributes such as ability, motivation and propensity to be unhealthy, which might all be important in shaping both health and educational outcomes. These inherited attributes are generally unobserved in survey data, but the cohort study utilised in this paper does contain variables which can proxy for these effects to some degree.

External influences outside the experience of the family are also likely to have an impact on the development of health and earnings potential. For example, the influence of peer groups and school experience may have direct effects on health status and qualifications

obtained, and so might the physical characteristics of the neighbourhood in which a child is raised, such as access to public amenities and the level of pollution.

Finally, childhood outcomes are identified as potential mediators between childhood circumstances and accumulated health capital and educational attainment. For example, behaviour and attitudes in adolescence are likely to develop as a function of childhood experience and parental attributes, and to determine the degree to which an individual invests in his or her own health and education. (An individual's decision about his or her own investment in health and, in particular, education may also be influenced by earnings expectations.[13])

DATA

The relative importance of the various childhood influences on the development of health and earnings potential can best be assessed using information from longitudinal surveys. A valuable source of British longitudinal data is the National Child Development Study (NCDS). Previous work using NCDS data points to strong links between childhood circumstances and early adult health[14], but was mainly concerned with explaining class differences in adult health rather than individual differences related specifically to financial circumstances in childhood. (Although more recent work has sought to link individual differences in adult health status to earlier socio-economic conditions [eg. 6].)

The NCDS is a cohort study of individuals born in Great Britain during one week in March 1958, originating in the Perinatal Mortality Survey (for a full description see, for example, Shepherd[15] and Ferri[16]). There have been five follow-up waves of the survey to

date, in 1965 (age 7), 1969 (age 11), 1974 (age 16), 1981 (age 23) and 1991 (age 33). The original sample contained 17,414 births; in the latest wave just over 11,000 respondents were interviewed.

Information was collected during each childhood wave from interviews with parents, questionnaires completed by teachers, and also from the schools health service who carried out a medical examination. Cohort members also completed ability tests and, at age 16, they were interviewed directly. Details of public examinations were also collected in 1978 from schools and colleges. In the two adult waves of the survey, waves 4 and 5, interviews were carried out with subjects and their families directly.

Table I provides a description of the data used in the current analysis. The NCDS provides valuable information on early adult (age 23) health and educational outcomes, that can be used as proxies for earnings and health potential accumulated throughout childhood. Information collected in a later wave of the survey, when respondents were 33 years old, is used to measure adult health. The measures of accumulated health capital and adult health used here are both derived from information on self-reported general health, rated on a four point scale from excellent to poor. Such measures have been shown to be good predictors of both morbidity and mortality[17]. An alternative measure of accumulated health capital was also considered in modelling adult health outcomes, namely self-reported limiting illness age 23; the results obtained were very similar to those using age 23 general health assessments.

The choice of explanatory variables that might be thought to affect selection into different early adult health and education states was guided by the conceptual framework discussed

in the previous section. Seven categories of related variables have been identified and are summarised in table I (sample proportions are shown for dichotomous variables; means are reported for continuous variables).

The full wave 4 sample contains 12,544 individuals, and the final sample on which all the required information is available is 7,124. The final sample was selected on the criteria of having valid data in each relevant wave of the NCDS, i.e. birth survey, waves 1, 2, 3 and 4. In addition, modelling adult health outcomes required valid data in wave 5 of the survey, generating a smaller sample (5,700) on which to base these results. In order to maximise the sample size and minimise the risk of the results being driven by sample selection bias, dummy variables were created for missing information on all other variables of interest.

For reasons discussed below, and common to most longitudinal survey data, the income information available in the childhood waves of the NCDS presents challenges for this study. Consequently, a prediction of average family income in childhood is obtained using information on parental characteristics in wave 3 of the survey (see following sub-section and the appendix for a more detailed discussion of the estimation procedure). As explained in the appendix, family income in childhood is predicted only for individuals living with at least one of their natural parents at age 16 (wave 3).

Table I suggests that the final sample is not substantively different on the basis of most observable characteristics, except that the probability of living with both natural parents at each childhood wave of the survey is much higher. Importantly, the final sample might also differ on some important unobservable attributes which might also be correlated with

the variables of interest. Therefore, the potential for sample selection bias must be borne in mind when interpreting the results.

It is clear that some of the selected variables could be allocated to a number of different categories, and this too will affect interpretation of the results. For example, the number of siblings might be thought to influence later health and educational outcomes through its effect on the availability of both monetary resources and time resources available to each child. Position in the birth order might also be important as a reflection of parental experience of bringing up children. Similarly, parental illness could be included as a constraint on financial resources, as presented in table I, or as an additional indicator of inherited ill-health; and the influence of parental divorce is unlikely to be transmitted entirely through its impact on family income.[18] In addition, low birth weight might represent health inheritance, but it might also simply act as a marker for deprivation in childhood.[19]

Finally, and perhaps most importantly, age 7 characteristics have been included to control for inherited attributes, but could just as easily be interpreted as mediating factors in the same way as age 16 characteristics. There is evidence to suggest that a number of outcomes observed in early childhood are related to parental characteristics in particular and family circumstances in general.[20] The competing interpretations of early childhood characteristics in shaping health and earnings potential are discussed in the results section below.

PREDICTING AVERAGE FAMILY INCOME IN CHILDHOOD

There are a number of reasons why the information on family income in childhood in the NCDS might be deemed inappropriate for the purpose of the current analysis. For example, in the NCDS we only have information on family income at one childhood wave of the survey (wave 3), when the respondent was age 16, which might be a poor reflection of living conditions in earlier childhood. Second, there is good reason to believe that persistent poverty, rather than a single year measure, is more important in terms of its effect on both health and educational outcomes. If parental experience of low income was only temporary, then it is likely to have much less influence on the child than if family income was permanently low in childhood. With only one measure of parental income observed at a single point in time it is impossible to distinguish between transitory and permanent poverty. Finally, any measure of income reported at a single point in time will be subject to measurement error. As such, the relationship between reported family income during childhood and adult health will be understated. Indeed, 'the better the measure of family income and the longer period over which it is measured, the stronger the association between the family's economic well-being and children's outcomes'. [20, pp 14]

In order to overcome some of these problems, average family income during childhood is estimated following an approach very similar to that taken by Dearden and colleagues[21], who used information on individual characteristics to predicted permanent wages for a sample of NCDS respondents and their fathers. Here, a within-sample prediction of permanent total parental income is obtained using information on parental characteristics

observed at the same time as income is reported. Details of the estimation procedure and regression results are presented in the appendix.

Experimentation with non-linear income terms did not prove fruitful. Specifically, including a quadratic term in parental income displayed little explanatory power, particularly when other childhood conditions are included in the models. However, some non-linearity in the relationship between childhood financial circumstances and age 23 and age 33 outcomes is introduced through the inclusion of proxies for experience of *very* low income in childhood. The particular measures relate to reported financial hardship and are describe in table I.

MODELLING APPROACH

Three sets of models are estimated for the three different outcomes of interest: the probability of low earnings potential, the probability of low health potential and the probability of 'bad' health in adulthood. Low earnings potential is defined as having obtained no qualifications by age 23. Both low health potential and 'bad' adult health are defined as self-reported general health (at age 23 and age 33, respectively) being fair or poor, relative to excellent or good.

Because of the binary nature of the dependent variables, a probit equation is estimated for the probability of both low earnings and low health potential, relating each outcome to a set of the same explanatory variables hypothesised to affect the probability of selection into either poor health or low educational attainment by age 23. Health and earnings

potential are modelled sequentially, adding each category of childhood factors summarised in table I in turn, as follows:

Specification 1 Predicted average family income in childhood only.

Specification 2 Plus indicators of severe financial hardship and other influences on family financial circumstances (family composition and parental illness, see table I).

Specification 3 Plus proxies for parental time 'inputs' (time spent reading with child and taking child on outings, and mother's employment).

Specification 4 Plus proxies for parental 'productivity', or ability/willingness of parents to convert monetary and time resources into positive child outcomes (including mother's and father's education, and proxies for parents' attitude to schooling and health).

Specification 5 Plus age 7 characteristics (including early indicators of a child's health, ability and personality/behaviour).

Specification 6 Plus age 16 characteristics / child outcomes, ie. child's own attitude to health and education (proxied by health behaviours such as drinking and smoking, and negative attitudes to school).

Specification 7 Plus external influences (region, local area characteristics and type of school attended age 16).

All models also control for fixed effects, ie. sex and ethnicity (all NCDS subjects are, of course, the same age). In the description of the conceptual framework above it was argued that early indicators of health and behaviour and ability scores (information collected at age 7 in NCDS) might also reflect fixed effects or inherited characteristics to a certain extent. Alternatively, these early childhood attributes might be interpreted as intermediate outcomes, determined by parental characteristics and early life experience [20]. The validity of each of these interpretations is tested by modelling age 7 characteristics as a function of a variety of other childhood factors. A similar approach is taken in testing the role of age 16 characteristics.

Finally, a probit equation is estimated for adult health, linking age 33 self-reported general health to age 23 health and education, with and without controls for childhood circumstances. A note of caution is necessary here. The issue of indirect selection, or joint determination, is likely to be extremely relevant in a model of adult health and accumulated health and earnings potential, with health at age 33 and earlier health and educational attainment strongly related to many of the same early life factors and individual fixed effects (or inherited characteristics). Controlling for a wide range of childhood conditions and early indicators of individual characteristics will mitigate much of the bias that indirect selection might give rise to, but if any potential confounders are omitted from the model the relationship between early adult health and educational attainment and later health outcomes might still be overstated.

A sequential modelling approach like the one employed here enables us to observe how the strength of the association between the variables of interest changes as other factors

are included in the model. Importantly, it enables us to go some way in explaining the competing explanations for the observed relationship between childhood socio-economic conditions and adult health. For example, is parental income important per se or does it exert an influence only through its association with parental characteristics, such as education levels or parenting skills? Or, indeed, are parental influences - including income levels - only important to the extent that they help to shape a child's own educational achievements and the development of health capital? The results presented below help to answer some of these important questions.

RESULTS

Results are presented first for health and earnings potential (measured by age 23 health status and education, respectively), and then for adult (age 33) health. The 'income effect' in each model is presented as the average change in the probability of the modelled outcome associated with a one unit change in income. This is the *marginal effect* of income, and is calculated at the mean of all the other explanatory variables in the model. A marginal effect of less than zero represents a negative relationship between the modelled outcome and the relevant explanatory variable (the opposite is true of a positive marginal effect). The impact on the income effect of including other childhood factors is evaluated via the sequential modelling approach outlined in the previous section. χ^2 statistics are also reported for the likelihood ratio test for joint significance of each broad group of variables described in table I, in order to assess the contribution of various childhood influences to the development of health and earnings potential, and to adult health outcomes.

The results relate to the pooled sample of men and women in the NCDS. Separate models were also estimated and, while some differences in the relative importance of some of the explanatory variables were found, the overall pattern of results did not differ markedly between the sexes.

HEALTH POTENTIAL

Turning first to the results for low health potential in table II. The marginal effect of -0.036 on predicted permanent family income in childhood in the first column suggests quite a large negative and statistically significant correlation with the risk of poor health age 23. A £1 a week increase in childhood family income reduces the probability of low health potential by 3.6 percentage points, if no other childhood factors are included.

However, as soon as we include parental characteristics, particularly parents' education, the influence of family income on early adult health outcomes is much reduced. Some caution should be exercised in interpreting these results, however, because mother's and father's education was used to predict family income in childhood (see appendix). However, diagnostic tests did not suggest that multicollinearity was a large problem and, importantly, just under half of the variation in predicted family income was found to be independent of the other included explanatory variables (the R^2 from a regression of predicted family income on all the other explanatory variables in our health and earnings potential equations is around 0.55).

Table II shows that the influence of parental income on the probability of 'bad' health in early adulthood is gradually reduced as each successive group of other childhood

influences is included. However, experience of *very* low family income in childhood - proxied by family receipt of school meals at age 16 - remains a significant predictor of low health potential whatever other childhood factors are included. In the final model (specification 7), the most important childhood factors in predicting this particular measure of low health potential are shown to be parental time inputs (in particular, the amount of time parents spent reading to the child and taking the child on outings) and the child's own characteristics at age 7 and age 16.

These results suggest a number of potential explanations for the simple correlation between parental income and accumulated risk of poor health (specification 1). First, parental time inputs are correlated with monetary inputs, but the former appear more important in terms of a child's health development for this particular cohort. This implies that financial resources might simply be acting as a marker for parenting skills, with richer parents perhaps being better informed about the benefits of spending quality time with their children.

Second, the child's own characteristics exert a strong independent influence on the risk of low health potential, and their inclusion in the model reduces the income effect further. This implies that at least part of the observed relationship between parental income and early adult health can be explained by the fact that a child's own characteristics are correlated with the income level enjoyed by their family, and it is these individual characteristics that are important for early adult health and not parental income per se.

EARNINGS POTENTIAL

Table III suggests a much stronger relationship between family income in childhood and low earnings potential than was found for low health potential. Even after controlling for a wide range of other childhood conditions and parental characteristics, family income in childhood continues to exert a significant and negative influence on the probability of having no qualifications by age 23. This is reflected in a marginal effect of –0.034 on predicted income in the last column of table III, interpreted as a 3.4 percentage point reduction in the probability of having no qualifications associated with a £1 a week increase in family income in childhood. Childhood 'poverty' experience is also found to exert a strong positive influence on the probability of low earnings potential (receipt of free school meals by the family when the child was 11 years old increases the risk of low earnings potential by 4.1% percentage points).

In the final model (specification 7), the child's own characteristics are again found to have significant effects. Aggressive behaviour and low scores in reading and maths tests at age 7, adolescent self-reported smoking and a strong dislike for school all have large and statistically significant effects on the risk of low earnings potential. While parental time inputs were found to be important predictors of low health potential, other parental influences are more important for low earnings potential. In particular, parents' education and teacher's reporting of parents' interest in their child's education display a strong association with the probability of having no qualifications by early adulthood.

Finally, the last column of table III shows that external influences are important for low earnings potential, in particular the type of school attended at age 16. For example,

children who attended a private school have a much lower risk of having no qualifications than their counterparts who attended comprehensive school. (The influence of private school attendance may in part also reflect parental preferences and income.[22])

As tables II and III illustrate, age 7 and age 16 characteristics were found to be important predictors of the risk of both poor health potential and having no qualifications at age 23. Of course, these characteristics could be reasonably interpreted as intermediate outcomes, so it is not surprising that we observe a high degree of correlation between these variables and later outcomes. Indeed, age 16 attitudes and behaviour are likely to represent early indicators of accumulated risk. However, including age 7 and 16 individual characteristics in the models does not completely remove the effects of other childhood conditions.

In order to investigate these relationships further, a series of models were estimated linking age 7 and age 16 characteristics to parental characteristics, family background and other earlier childhood experience. While quite a strong correlation was found, most of the variation in the modelled outcomes could not be explained by the included childhood variables. Of course, this could be the result of the omission of some important (and possibly unobservable) explanatory variables from the equations, but the results of this analysis suggest that we can have some confidence that age 7 and age 16 characteristics make some independent contribution to the probability of selection into poor health age 23 over and above their role as intermediate outcomes.

ADULT HEALTH

The final stage of the analysis is concerned with modelling adult health outcomes as a function of accumulated health and earnings potential, with and without controls for childhood circumstances. This permits a test of whether childhood factors continue to have an independent impact on adult health outcomes, or whether their influence operates purely as an indirect effect through health and earnings potential accumulated in childhood. The sample size is smaller (5,700 compared to 7,214) due to the additional requirement that respondents have valid data in wave 5 of the survey, and a very slight change to the modelling sequence was made. Results are presented in table IV.

A high degree of correlation is suggested between age 33 health and both educational attainment and health status age 23. There is a danger that the large and statistically significant relationship observed between accumulated health capital and later health outcomes reflects a spurious correlation arising from the use of the same health measure at both age 23 and age 33 (the marginal effects in table IV suggest that reporting fair or poor general health at age 23 increases the probability of reporting fair or poor health at age 33 by around thirty percentage points). However, experimentation with a different measure of low health potential – presence of a limiting illness age 23 – found a similarly strong (albeit slightly smaller) effect and made little difference to the other parameter estimates.

Including parental income in the equation, together with indicators of financial hardship in childhood, does reduce the influence of health and earnings potential slightly, but the effect is very small. Once again, including other childhood conditions, particularly parental characteristics, completely removes the income effect. However, inclusion of

childhood factors does not remove the strong association between adult health and accumulated health and earnings potential, although the effects are, on the whole, gradually reduced as each additional group of childhood variables are added. (As discussed in the methods section above, the potential bias introduced by the omission of unobserved childhood influences related to both age 23 characteristics and age 33 health must be borne in mind when interpreting these results, as such indirect selection effects might cause the coefficients on low earnings and health potential to be overstated.)

In the final model, only age 16 characteristics and parental 'productivity' remain significant as childhood influences on adult health in the final model (specification 7, the last column of table IV). An interesting finding is that mother's education, but not father's, continues to exert a significant influence on self-reported health in adult life even after controlling for all other childhood factors. This confirms the findings of earlier research that suggest that mother's schooling plays an important role in shaping later life chances.[20]

DISCUSSION

Data from the British National Child Development Study was used to evaluate the extent to which educational attainment (earnings potential) and accumulated health risk (health potential) mediate between childhood conditions and adult health. Particular attention was paid to assessing the specific contribution of parental income in determining adult health outcomes.

The results point to a clear link between childhood circumstances and the development of health and earnings potential by early adulthood, with at least some of the effects mediated through individual characteristics such as ability, attitudes and behaviour. In turn, this accumulated stock of health capital and earnings potential has an important role in shaping adult health outcomes.

Low family income in childhood is found to be a strong predictor of poor health potential, but this simple correlation can be accounted for by parental characteristics, family background and the nature of the home environment. In particular, parental time inputs, such as the amount of time spent reading to their child and taking their child on outings, appear to be more important than monetary inputs for the development of a child's health capital. This implies that parental income per se might not be particularly important, instead it simply acts as a marker for parenting skills being as it is strongly correlated with parental characteristics. This is consistent with recent evidence that quality parenting is more influential than income for child outcomes.[23]

There is some evidence to suggest, however, that experience of *very* low income in childhood is strongly associated with an increased accumulated risk of poor health as an individual moves into adulthood. Further, parental income does exert a strong independent influence on educational attainment, even after controlling for a wide range of parental characteristics and other childhood factors.

Of course, evidence from a single birth cohort cannot be generalised to the wider population, particularly when the cohort under analysis was last surveyed during a relatively early stage in their lives when most health problems will not yet have developed.

Nor does this paper consider the important interactions between adult socio-economic circumstances and health status, so that the relative importance of childhood and adult influences in shaping health outcomes cannot be assessed. However, the results presented here do provide important evidence on the relationship between parental income and later health, reaffirming as they do the important mediating role of education.

While family income and parental characteristics appear to have little *direct* effect on adult health outcomes, an *indirect* influence is implied through educational attainment and health capital accumulated in childhood. If individuals enter adult life with few qualifications and poor health then they are also much more likely to eventually find themselves in low paid jobs or out of the labour market altogether. Consequently, the links between poor health and low income will be continually reinforced generating a cycle of deprivation from which it is extremely difficult to escape. This highlights the importance of taking a life course approach to the analysis of the determinants of social inequalities in health, and has particular relevance in light of recent evidence of substantial growth in child poverty in Britain over the past two decades.[24]

From a policy perspective, the results presented here and elsewhere highlight the continued importance of early life experience for later life chances and point to a role for early interventions, both in the form of active policies to eradicate child poverty in general and more targeted initiatives to improve opportunities for children in the poorest families. In this respect, the British government's Sure Start initiative - which aims to improve access to early education, health services and family support and advice - and measures to increase financial support to low income families are positive steps in the right direction.

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APPENDIX

Information on parental income during childhood in NCDS is available at wave 3 of the survey only, when respondents were 16 years of age. In order to obtain an estimate of *average* living standards in childhood, a within-sample prediction of 'permanent' parental income is derived using information on parental characteristics.

Family income in NCDS is reported in banded form separately for father's earnings, mother's earnings and 'other' sources of family income. The banded nature of this income information requires the use of grouped dependent variable techniques. Using OLS will tend to generate inconsistent estimates in this case, because the dependent variable in our family income equation will tend to be left, right or interval censored [25]. The lower and upper band limit of father's and mother's earnings and 'other' family income are summed together and a total (log) family income equation is estimated. Results are presented in the table. The explanatory variables are:

- mother's and father's years of education (calculated by subtracting five from age left full-time education), including dummy variables for missing education
- mother's and father's occupational class dummies (the reference group is skilled manual for men, not working for women)
- dummy variables for whether or not a mother or father figure was ever absent during childhood
- mother's and father's age (and age squared)

- region dummies (the reference group is London and the South East)

Fathers and working mothers with missing occupational class information at NCDS3 are excluded from the analysis. Information on mother's and father's age is only available in the birth survey, thus potentially restricting the sample on which family income is predicted to NCDS respondents with natural parents at wave 3. However, the sample is expanded by imputing the age of non-natural parents - conditional on there being one natural parent in the household - using information on the mean difference in reported mother's and father's age at birth. This procedure assumes implicitly that the characteristics of the non-natural parent are similar to those of the natural parent they have replaced.

The estimated coefficients on the variables deemed to have a *permanent* effect on family income levels – parental education and occupational class, and absence of either parent at any point in childhood – are used to predict average family income in childhood, holding constant parents' age and region (the transitory, time-varying components of family income determination). Predicted log income is then transformed to levels for use in the main analysis.

A crucial assumption is that father's occupational class and mother's employment when the child is 16 years old only affect the development of a child's earnings and health potential through their impact on family income in childhood, *once parents' education and other childhood circumstances are controlled for*. Importantly, the child's accumulated health and earnings potential *is* allowed to vary with mother's employment when the child

was age 7 and age 11, thus assuming that whether or not the mother works is important for the time invested in a child's health but only during early childhood.

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Figure I **Conceptual framework: childhood determinants of adult health**

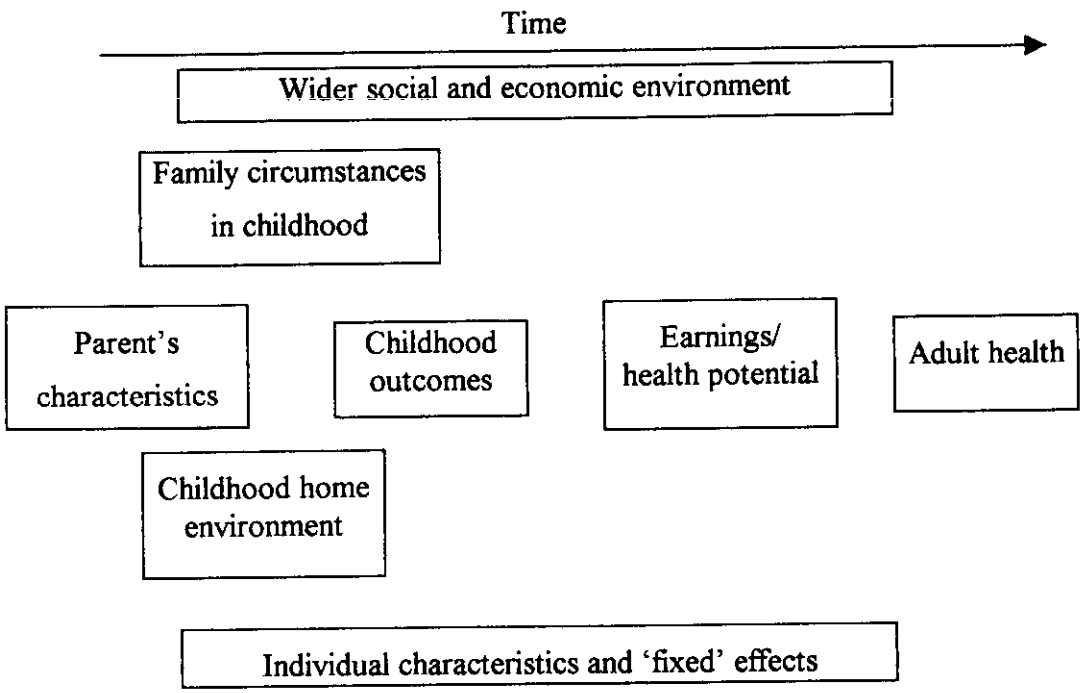

Table I **Data description and sample selection**[a]

	Full NCDS4 sample (N = 12,544)	Final sample (N=7,124)
Adult health potential (self-reported)		
Fair/poor general health age 23	0.10	0.08
Limiting illness age 23	0.05	0.04
Adult earnings potential		
No qualifications age 23	0.16	0.12
'Other' qualifications	0.14	0.14
< 5 'O'-levels/low vocational	0.26	0.26
5+ 'O'-levels/mid vocational	0.17	0.19
'A'-levels	0.09	0.09
Highest vocational	0.08	0.09
Degree	0.10	0.10
Family experience of very low income in childhood		
Family financial difficulties wave 1	0.07	0.07
Receipt of school meals for any child wave 2	0.09	0.08
Receipt of school meals for any child wave 3	0.09	0.08
Other influences on availability of material resources		
Number of siblings wave 3	1.99	2.32
Number of older siblings wave 3	0.97	1.13
Natural parents all three childhood waves	0.58	0.85
Reported parental divorce	0.08	0.07
Reported death of parent(s)	0.06	0.05
Other periods with one parent figure	0.03	0.02
Father chronically ill wave 3	0.08	0.07
Mother chronically ill wave 3	0.06	0.06
Parental time resources		
Mother worked before child started school PT (wave 1)	0.34	0.35
Mother worked before child started school FT (wave 1)	0.10	0.09
Mother worked after child started school PT (wave 1)	0.21	0.21
Mother worked after child started school FT (wave 1)	0.09	0.08
Mother worked since 1965 (wave 2)	0.61	0.62
Mother reads to child every week (wave 1)	0.49	0.50
Father reads to child every week (wave 1)	0.37	0.37
Mother takes child on outings most weeks (wave 1)	0.86	0.87
Father takes child on outings most weeks (wave 1)	0.71	0.72
Child breast fed (wave 1)	0.62	0.70

Notes: see below

Table I continued **Data description and sample selection**[a]

	All NCDS4 (N = 12,544)	Final sample (N=7,124)
Parental willingness/ability to 'produce' healthy/well-educated children		
Mother left school after minimum leaving age (wave 3)	0.27	0.28
Father left school after minimum leaving age (wave 3)	0.28	0.29
Teacher assessment: mother very interested in child's schooling (wave 1)	0.40	0.41
	0.40	0.42
Teacher assessment: father very interested in child's schooling (wave 1)	0.15	0.13
Teacher assessment: mother little interest in child's schooling (wave 1)	0.23	0.21
Teacher assessment: father little interest in child's schooling (wave 1)	0.91	0.82
Parents want child to stay on at school (wave 1)	0.47	0.46
Mother smokes wave 3	0.61	0.61
Father smokes wave 3		
Individual characteristics		
Bottom quintile age 7 reading test score distribution (wave 1)	0.18	0.16
Bottom quintile age 7 maths test score distribution (wave 1)	0.19	0.18
Mother's assessment wave 1: highly aggressive[b]	0.15	0.14
Mother's assessment wave 1: highly anxious[b]	0.21	0.21
Mother's assessment wave 1: highly restless[b]	0.12	0.11
Physically disabling[c] condition age 7 (wave 1)	0.05	0.04
Non-disabling physical condition age 7 (wave 1)	0.45	0.44
Emotional problems age 7 (wave 1)	0.04	0.03
Illness reported in first week of life (birth survey)	0.03	0.03
Low birth weight/estimate	0.06	0.05
Individual behaviour/attitudes (childhood 'outcomes')		
Age 16 (wave 3) self-reported smoking	0.35	0.34
Age 16 (wave 3) self-reported drinking	0.93	0.94
Age 16 self-reported negative attitude to school (above average)[d]	0.68	0.67
External influences[e]		
Comprehensive school age 16 (wave 3)	0.58	0.60
Secondary modern school age 16	0.22	0.22
Grammar school age 16	0.11	0.12
Private school age 16	0.06	0.05
'Other' school age 16[f]	0.03	0.01
Single sex school age 16	0.12	0.10
Area characteristics wave 3: proportion council housing	0.39	0.40
Area characteristics wave 3: proportion unemployed	0.05	0.05
Area characteristics wave 3: persons per room	0.63	0.64
Area characteristics wave 3: proportion shared/no bath	0.08	0.08

[a] Summary statistics shown for all individuals with non-missing observations.
[b] *Behaviour scores age 7 classification based on* Hobcraft (1998).
[c] Defined by the medical examiner as disabling for normal schooling.
[d] Negative attitude to school derived as above average score based on positive response to following: school a waste of time, homework is a bore, difficult to keep mind on work, never take work seriously, do not like school (maximum score = 5). Scores above the mean (0.94) are classified as having a strongly negative attitude to school at age 16.
[e] External influences also include region wave 3.
[f] Individuals who attended special schools age 16 are excluded

Table II **Results - health potential equation**

	Specification						
	1	*2*	*3*	*4*	*5*	*6*	*7*
'Low' health potential (fair/poor general health)							
Marginal effects							
Predicted income	-0.036***	-0.017**	-0.015*	0.008	0.010	0.012	0.012
Financial hardship wave1		0.018	0.011	0.008	0.003	0.003	0.002
School meals wave 2		0.009	0.008	0.005	0.002	0.002	-0.000
School meals wave 3		0.026*	0.026*	0.029**	0.028**	0.028**	0.028**
χ^2 other financial[a]		23.7***	18.5**	18.6**	18.9*	12.3	11.1
χ^2 parental time 'inputs'			49.9***	43.6***	42.0***	42.8***	42.5***
χ^2 parental 'productivity'[b]				42.2***	28.8*	28.1	27.6
χ^2 age 7 characteristics					67.1***	65.6***	62.6***
χ^2 age 16 characteristics						34.1***	33.9***
χ^2 external influences							25.4
Pseudo R^2	0.01	0.02	0.03	0.05	0.06	0.07	0.08
χ^2 model	39.0	88.0	138.2	188.8	256.0	290.7	318.1

Note: All model s control for sex and ethnicity.

[a] Includes variables listed under 'other influences on financial circumstances' in table I.

[b] Parental 'productivity' relates to mother's and father's ability/willingness to convert time and monetary 'inputs' into positive child outcomes (see table I)

*** Statistically significant at the 1% level

** Statistically significant at the 5% level

* Statistically significant at the 10% level

Table III Results - earnings potential equation

	Specification						
	1	*2*	*3*	*4*	*5*	*6*	*7*
'Low' earnings potential (no qualifications)							
Marginal effects							
Predicted income	-0.173***	-0.108***	-0.117***	-0.049***	-0.043***	-0.038***	-0.034***
Financial hardship wave1		0.050***	0.034**	0.015	0.002	0.001	-0.002
School meals wave 2		0.085***	0.083***	0.062***	0.054***	0.049***	0.041***
School meals wave 3		0.030**	0.028**	0.018	0.018	0.013	0.011
χ^2 other financial[a]		110.6***	90.2***	49.1***	41.6***	30.0***	28.4***
χ^2 parental time 'inputs'			87.0***	26.5	27.2	23.5	21.2
χ^2 parental 'productivity'[b]				258.9***	143.0***	119.2***	81.4***
χ^2 age 7 characteristics					220.3***	200.0***	202.4***
χ^2 age 16 characteristics						158.9***	155.8***
χ^2 external influences							100.2***
Pseudo R^2	0.06	0.12	0.13	0.19	0.23	0.26	0.29
χ^2 model	324.9	620.7	708.4	992.2	1224.5	1402.5	1519.8

Notes: See notes to table II.

Table IV **Results – age 33 health**

	Specification						
	1	*2*	*3*	*4*	*5*	*6*	*7*
Fair/poor self-assessed general health							
Marginal effects							
'Low' health potential	0.314***	0.310***	0.302***	0.296***	0.288***	0.282***	0.283***
'Low' earnings potential	0.092***	0.078***	0.067***	0.057***	0.050***	0.042***	0.039***
Predicted family income		-0.037***	-0.034***	-0.010	-0.007	-0.006	-0.004
χ^2 financial hardship[a]		4.4	2.8	2.7	3.5	3.5	3.5
χ^2 other financial[b]			10.7	11.7	11.6	10.6	11.0
χ^2 parental time 'inputs'			30.0*	22.1	20.5	20.9	20.9
χ^2 parental 'productivity'				34.8**	30.2*	29.2*	30.0*
χ^2 age 7 characteristics					30.8	31.1	29.5
χ^2 age 16 characteristics						17.2***	19.5***
χ^2 external influences							22.2
Pseudo R^2	0.08	0.09	0.10	0.11	0.12	0.12	0.13
χ^2 model	354.1	372.1	417.6	453.4	484.0	501.3	528.3

Note: All model s control for sex and ethnicity.

[a] Includes financial difficulties wave 1, school meals receipt waves 2 and 3.

[b] Includes variables listed under 'other influences on financial circumstances' in table I.

*** Statistically significant at the 1% level.

** Statistically significant at the 5% level.

* Statistically significant at the 10% level.

(Appendix) Results: log family income equation

	Coefficient	*p-value*
Father's occupational class		
- professional	0.195	0.000
- intermediate	0.101	0.000
- skilled non-manual	-0.012	0.349
- semi-skilled non-manual	-0.118	0.000
- semi-skilled manual	-0.065	0.000
- unskilled manual	-0.074	0.000
Mother's occupational class		
- professional	0.314	0.000
- intermediate	0.319	0.000
- skilled non-manual	0.276	0.000
- semi-skilled non-manual	0.306	0.000
- skilled manual	0.168	0.000
- semi-skilled manual	0.266	0.000
- unskilled manual	0.151	0.000
Father's years of education	0.026	0.000
Father's education missing	0.210	0.000
Mother's years of education	0.020	0.000
Mother's education missing	0.260	0.000
Father's age	0.039	0.000
Father's age squared	-0.001	0.000
Mother's age	0.006	0.147
Mother's age squared	-0.000	0.041
In childhood, ever no father figure		
In childhood, ever no mother figure	-0.028	0.093
	-0.139	0.003
Number of observations	8,217	
Pseudo R^2	0.160	