From Cradle to Grave? The Lasting Impact of Childhood Health and Circumstance

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ABSTRACT

We quantify the lasting effects of childhood health and economic circumstances on adult health and earnings, using data from a birth cohort that has been followed from birth into middle age. We find, controlling for parents' incomes, educations and social status, that children who experience poor health have significantly lower educational attainment, and significantly poorer health and lower earnings on average as adults. Childhood factors appear to operate largely through their effects on educational attainment and initial adult health. Taken together with earlier findings that poorer children enter adulthood in worse health and with less education than wealthier children, these results indicate that a key determinant of health in adulthood is economic status in *childhood* rather than economic status in adulthood. Overall, our findings suggest more attention be paid to health as a potential mechanism through which intergenerational transmission of poverty takes place: cohort members born into poorer families experienced poorer childhood health, lower investments in human capital and poorer health in early adulthood, all of which are associated with lower earnings in middle age — the years in which they themselves become parents.

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1. Introduction

Recent research has documented that children born into poorer families fall into poorer health as they age. These children arrive at the doorstep of adulthood not only in poorer health but also with lower educational attainment, in part attributable to their poorer health. (Case, Lubotsky and Paxson 2002 provide evidence for the US, and Currie and Stabile 2002 for Canada.) This research suggests that childhood health may be an important contributor to the "gradient," the widely documented positive association between good health and higher economic status observed in adulthood (Adler et al 1994). Researchers studying children's health note that it may be an important 'third factor' that affects both health and earnings in adulthood. However, there is little evidence on the long-run effects of childhood health on adult health and labor market outcomes, or on the contribution of childhood health and circumstances to gradients in adult health.

In this paper, we quantify the lasting effects of childhood health and economic circumstances on adult health and earnings, using data from a birth cohort that has been followed from birth into middle age. We find, controlling for parents' incomes, educations and social status, that children who experience poor health have significantly lower educational attainment, and significantly poorer health on average as adults. Good health in childhood is positively associated with the probability of employment in middle age and, among men, better health and economic circumstances in childhood are positively associated with earnings.

After a brief introduction of our data, we document the ways in which childhood health and family circumstance affect adult health and earnings (Section 3). We then present more speculative results on the pathways leading to correlation between earnings and health in adulthood (Section 4). We find that health status early in adulthood influences men's later earnings, conditional on initial earnings, but that earnings early in adulthood do not affect subsequent health, conditional on initial health. Childhood factors appear to operate largely through their effects on educational attainment and initial adult health. Taken together with the findings that poorer children enter young adulthood in worse health and with less education than

wealthier children, these results indicate that a key determinant of health in adulthood is economic status in *childhood* rather than economic status in adulthood.

Overall, our findings suggest more attention be paid to health as a potential mechanism through which intergenerational transmission of poverty takes place: cohort members born into poorer families experienced poorer childhood health, lower investments in human capital and poorer health in early adulthood, all of which are associated with lower earnings in middle age — the years in which they themselves become parents.

2. The 1958 National Child Development Study

Our analysis is based on data collected in the 1958 National Child Development Study (NCDS), which has followed all children born in Great Britain (Scotland, England and Wales) in the week of March 3, 1958 from birth through to age 42. Parents were interviewed at the time of the birth, and medical, social, demographic and economic data have been collected on these children during follow-up interviews conducted at ages 7, 11, 16, 23, 33 and 42.[1]

Summary statistics for key variables are presented in the first two columns of Table 1. Our primary health outcome measures are individuals' self-reported health status, measured at ages 23, 33 and 42. Each respondent was asked "How would you describe your health generally? Would you say it is ... excellent, good, fair, or poor?" Self-reported health has been shown to predict mortality, even when controlling for physician assessed health status and health-related behaviors. (See Idler and Kasl 1995 for an extensive set of references on studies of self-reported health and mortality.) In the NCDS, self-reported health status at ages 33 and 42 are highly

[1]There has been attrition from the original sample of 17,409 children, and some families who miss a survey round are picked up in later surveys. Attrition does not appear to be systematically associated with socioeconomic status. (A detailed discussion is provided in the appendix.) The survey has also added approximately 700 children born during the week of March 3, 1958 who immigrated to Great Britain prior to the age 16 survey. These children do not appear to be substantially different from the original sample, and we include these children in our analysis (see appendix for details).

correlated with reports that respondents have chronic conditions, and with reports of their disabilities and hospitalizations. (See Appendix Table 2.) Consistent with results from a wide variety of cross-sectional studies, members of the NCDS cohort report worse health at higher ages. The percentage of men reporting themselves to be in excellent health falls from 48% at age 23, to 36% at age 33, and to 31% at age 42. (Transition matrices of health status for men who appear at all three ages are shown in Appendix Table 3.) Patterns are similar for women although, consistent with results from many other countries, women in the NCDS on average report worse health than men in middle age (Case and Deaton 2002).

We examine the effects of childhood health and circumstance on two labor market outcomes in adulthood: employment and earnings. Ninety percent of men are employed part-time or full-time at the time of the surveys administered at ages 33 and 42, and the vast majority of men work full-time (30 or more hours per week.) Employment rates are lower for women, with less than 50% of women working full-time at either of these ages. Our measures of respondents' earnings are log weekly earnings at ages 23, 33 and 42, all measured in 1987 British Pounds. Because substantial fractions of women do not work, we restrict our analysis of earnings to men only.

The NCDS provides a rich set of variables with which to analyze the impact of family background and childhood health on adult health and earnings. Our measures of family circumstance include indicators for the ages at which the cohort member's mother and father left school; indicators for mother's marital status at the time of the cohort member's birth; the number of siblings in the cohort member's household at age 16; log family weekly income at age 16,[2] as well as father's social class at the time of the birth, and grandfathers' social class at the time the

[2]This variable was constructed using information on income categories for both parents together with information from the British Family Expenditure Survey from 1974. See the appendix for details.

cohort member's mother and father left school.[3] Measures of social class are commonly used in British surveys, and are based on occupation (professional, managerial, non-manual skilled, manual skilled, semi-skilled, and unskilled).

Our measures of childhood and prenatal health consist of the number of physician-assessed chronic health conditions at ages 7 and 16, height at age 23, and an indicator that the child was of low weight (less than 2500 grams) at birth. Chronic health conditions at ages 7 and 16 reflect both health problems the child was born with, as well as health problems acquired in childhood. Table 1 indicates that the average number of chronic childhood conditions is small. Of children who received medical exams at these ages, 6.2 percent of children have at least one chronic condition at age 7, and 12.5 percent have a chronic condition at age 16. Height is included as a reflection of childhood (and possibly prenatal) nutrition. Because height also has a genetic component, we control for both mother's and father's heights in all models.

Figure 1 presents preliminary information on the relationship between birth weight and health status in adulthood. The left panel shows locally-weighted regressions of health status at ages 23, 33 and 42 on birth weight, for men in the NCDS who reported health status at all three ages. Men born at birth weights below 2500 grams (88 ounces) report the worst health in middle age. This figure provides a rationale for using the cut-off value of 2500 grams to denote low birth weight. The right panel shows similar regressions on health status in adulthood for women. In both panels, birth weight is observed to be related to health status in adulthood, with the relationship between low birth weight and health becoming more pronounced at older ages.

One way in which childhood health may affect adult outcomes is through educational attainment. In this analysis we will focus on O-level passes at age 16 and an overall measure of

[3]We have experimented with including controls for parents' age at the time the child was born. Although these variables are at times jointly significant, their inclusion does not affect other results.

education completed by age 23. Additional information on the British educational system and the construction of the measure of educational attainment is provided in the appendix.

3. The Effects of Childhood Health and Economic Status on Outcomes in Adulthood

We begin with reduced form estimates of the effects of childhood health and family circumstances on adult outcomes, including educational attainment, adult health, employment and earnings. Our interest is primarily in the long run effects of childhood health — here measured using an indicator of low birth weight, the numbers of chronic conditions in childhood, and height at age 23. In addition, we include indicators of mothers' prenatal smoking behavior, which may affect child health but may also serve as measures of the mothers' socioeconomic status or parenting ability. We are also interested in the long run effects of the family circumstance, for which we include the marital status of the mother at the time of the child's birth, the number of siblings and family income when the child was 16, a set of indicators for the age that the child's mother and father left school, and indicators for the social class of the child's father at the time the child was born, as well as the social classes of the child's paternal and maternal grandfathers.[4] We control for an identical set of family and child characteristics throughout the analysis; a complete list of variables is presented in Appendix Table 4.

Our reduced form results convey information on the associations between childhood and adulthood, without providing information on the underlying mechanisms that link health and economic outcomes over the life-cycle. For example, a finding that poor health in childhood is

[4]Some of these variables are missing for some children. To maintain a large and representative sample, we use observations that contain one or more missing independent variables but include indicators for whether each of the independent variables is missing. For example, the set of indicators for mother's school-leaving age includes an indicator for whether the mother's education is missing. For continuous variables, such as the logarithm of family income at age 16, we include an indicator for whether family income is non-missing, and interact this indicator with family income at age 16. The appendix provides a detailed explanation of the handling of missing values.

associated with reduced earnings in adulthood could be because children in poor health receive less schooling, or because poor health is persistent through time and those in poor health are less productive, even controlling for education. Likewise, a finding that children in poor health are less healthy in middle adulthood could also be due to effects of poor health in childhood on education and earnings early in adulthood, which in turn result in poorer health outcomes. The issue of disentangling these links will be taken up in Section 4.

A. Educational Attainment

Table 2 presents the relationship between childhood health and subsequent human capital investment, using several measures of educational attainment: the total number of O-level exams the child has passed by age 16, whether the English O-level was passed, whether the Math O-level was passed, and finally an index of completed education by age 23, which ranges from 1 (no O-levels passed by age 23) to 5 (a University degree was earned by age 23). The relationship between childhood health and educational attainment is similar for each of our measures, and we will focus here on the passage of the English O-level exam.

The results in Table 2 indicate that health in childhood has pronounced effects on educational attainment. Each childhood condition at age 7 is associated with a 7 percentage point reduction in the probability of passing the English O-level, and each condition at age 16 with an extra 6 percentage point reduction. Children born at low birth weight are 8 percentage points less likely to pass an English O-level.[5] Table 2 also shows that mother's smoking during pregnancy is associated with a significantly lower probability of passing the English O-level, with heavy prenatal smoking associated with a 6 percentage point reduction.

[5]The results on low birth weight presented here are consistent with those presented by Currie and Hyson (1999), who focus on the impact of low birth weight on education and earnings at age 33 for members of the 1958 NCDS.

The results for mother's smoking during pregnancy may represent the causal effect of smoking on fetal development and later cognitive development. Smoking during pregnancy has also been implicated as a source of behavioral and cognitive problems among older children, including lower IQ and Attention Deficit Hyperactivity Disorder (IOM, 2001), all of which could have adverse effects on educational attainment. Animal models also support the hypothesis that prenatal nicotine exposure affects brain development and may have long-lasting effects (see, for example, Slotkin, 1998). However, it may also be that the association between prenatal smoking and lower educational attainment we observe is due to family and environmental characteristics associated with prenatal tobacco use. The dangers of smoking during pregnancy may not have been widely known in 1958, so that the argument that it was the less caring mothers who were more likely to smoke may not be as salient for this cohort. However, mother's smoking may be a marker for her social status that is not measured by family income, her education, or her father's social class, and the association between prenatal smoking and education could work through this channel.

Table 2 provides evidence that childhood socioeconomic circumstances are correlated with educational attainment. Consistent with a large body of literature, we find that children from higher-income families have higher educational attainment: even controlling for mother's and father's schooling and parents' and grandparents' social class, a doubling of family income at age 16 is associated on average with a 10 percentage point increase in the probability that the English O-level is passed. For all four education measures, a set of indicators for mother's school leaving age, and that for father's, are highly significant. (These tests are provided in the last rows of Table 2.) Figure 2 graphs the coefficients for the indicators of mother's and father's school-leaving age from the regression for the English O-level. Greater levels of education among both mothers and fathers are associated with a higher probability of passing the English O-level; similar results are obtained for the other educational outcomes. Father's social status at the time of the cohort

member's birth, and grandfathers' status are all significant predictors of a child's educational attainment.

B. Adult Health

Table 3 presents estimates of the effects of childhood characteristics on health status at ages 23, 33 and 42. Chronic conditions in childhood are significantly associated with poorer health in adulthood, even through age 42. The coefficients on conditions at ages 7 and 16 decline with age but remain jointly significant at all ages. Results from probit regressions (not shown) indicate that these effects are large: acquiring an extra chronic condition at age 16 is associated with a 3.6 percentage point increase in the probability of fair or poor health at age 42, an age at which 18.2 percent of individuals are in fair or poor health. The adverse effects of prenatal smoking increase with age, with heavy maternal smoking associated with a 5.4 percentage point increase in the probability of being in fair or poor health at age 42. However, the association between height and health becomes smaller with age, given family background and childhood chronic health conditions.

Several measures of socioeconomic status in childhood are also related to adult health. Family income at age 16 becomes a larger and more significant predictor of health status with age in adulthood. At age 23, family income at 16 takes a coefficient of –0.07 and is not significantly different from zero. However, the effect increases in absolute value with age, so that by age 33 it is –0.137 and by age 42 it is –0.143, and is significant at the 5 percent level. Mothers' school leaving age is also significantly associated with adult health. As was the case for family income, the association between mothers' education and health becomes more pronounced with age. The coefficients on the indicators for maternal education, graphed in Figure 3, indicate that at age 23, there was little correlation between mothers' school leaving age and the cohort members' health. However, by age 33, maternal education has become strongly associated with better health status.

That association remains strong at age 42. Although fathers' education is not associated with adult health, fathers' social class at the time of the child's birth is strongly related to adult health. The results indicate that children with unskilled fathers are 6.4 percentage points more likely to be in fair or poor health at age 42 than are the children of professionals.

C. Employment and earnings in adulthood

Table 4 presents estimates of the associations between childhood health and circumstances and employment at ages 33 and 42. We show results separately for men and women, because employment rates differ across these groups. The results indicate that chronic health conditions in childhood have significant effects on employment in adulthood. An additional chronic condition at age 16 reduces the probability of employment at age 42 by 2.2 percentage points for women and by 4.8 percentage points for men. For both women and men, the number of chronic health conditions at 7 and 16 are jointly significant predictors of employment at ages 33 and 42.

Family circumstance is a significant predictor of employment for men, but not for women. For men, the social class of the cohort members' father and paternal grandfather are significantly associated with employment at ages 33 and 42. The estimates indicate that men whose fathers were unskilled at the time of their births are 4.6 percentage points less likely than men with "professional" fathers to be employed at age 33 and 4.9 percentage points less likely to be employed at age 42.

Do childhood health and economic circumstances affect earnings in adulthood? We examine this question for men only, because relatively few women are employed. Our results, presented in Table 5, suggest that health in childhood has large and significant effects on earnings even into middle adulthood. Among 42-year-old men, an additional chronic condition at age 7 is associated with a 5.6 percent reduction in earnings, and an additional chronic condition at age 16 is associated with a 4.0 percent reduction in earnings. Height is also associated with higher

earnings, and this effect becomes more pronounced over time as men age. A one-standard deviation increase in male height, of 0.07 meters, is associated with an increase in earnings of 3 percent at age 23, 4.2 percent at age 33, and 6.1 percent at age 42. This evidence is consistent with Persico et al (2001), who find strong effects of height on education and earnings in young adulthood using the same data, although they attribute this relationship to social stigma produced by short stature in adolescence, rather than to poor nutrition. (Both may be contributing factors.) Other variables have mixed effects: low birth weight and heavy maternal prenatal smoking are negatively associated with earnings at ages 33 and 42, although these effects are significant only at age 33.

Consistent with findings in the intergenerational mobility literature (Reville 1995), family income at age 16 becomes a larger and more significant predictor of men's own earnings as they age. Family income is not significantly associated with own earnings at age 23: the coefficient on log family income at age 16 is roughly 0.01, with controls for health in childhood. The coefficient on family income at age 16 jumps to 0.13 for earnings at age 33, and to 0.23 for earnings at age 42. Father's social class at the time of birth is also a significant predictor of earnings in middle age, so that men whose fathers were professionals earn more at ages 33 and 42 than those whose fathers were manual workers.

Our results in Section 3 show large, positive and significant effects of health in childhood on educational attainment, and on health, employment and earnings in adulthood. Moreover, the impact of childhood health on adult outcomes may provide a partial explanation for the correlation observed between economic status and health in adulthood. We turn next to examine what the NCDS data can contribute to what is known about the evolution of the gradient over the life-cycle.

4. The Dynamics of Health and Earnings in Adulthood

Many hypotheses have been put forward to explain the relationship observed between economic status and health status in adulthood. Low incomes may lead to poor health outcomes, possibly because poorer individuals consume fewer of the goods and services thought to maintain or improve health, or because the added stress of being poor results in worse health behaviors (e.g. smoking). In addition, the psychosocial stress induced by lower socioeconomic status may have direct effects on biological processes that affect health (Brunner and Marmot 1999). On the other side, current health status, as a component of human capital, may have direct effects on employment and earnings. Less healthy people may be less productive at work, or may be forced to stop working altogether. Expenses related to poor health may also reduce wealth holdings and asset income (Smith 1999, Wu 2003).

The dynamic links between income and health may begin with childhood circumstance, and research to date has varied greatly in the emphasis placed on childhood health and family resources in determining adult health. A strand of recent work suggests that nutrition *in utero* can affect health status in middle age, through its impact on such important chronic conditions as coronary heart disease and diabetes (Barker 1995, Ravelli et al 1998). In the *fetal origins hypothesis*, a contemporaneous correlation between health and socioeconomic status in adulthood could, in theory, be explained by events prior to birth: poorer children may be more likely to have been deprived of nutrients *in utero* and, having been raised in poorer families, such children are also more likely to earn less when they reach adulthood. At that point, their prenatal nutritional deprivation may manifest in disease, leading to a correlation between earnings and health in adulthood that is due to childhood circumstances.

In a similar vein, some *life course models* emphasize the extent to which illness and deprivation in childhood have lasting effects on adult health—directly, through the illness itself, and indirectly, by restricting educational attainment and life chances (Kuh and Wadsworth 1993).

Life course models may also help to explain the contemporaneous correlation between social status and health: those who have suffered chronic health conditions in childhood may reach adulthood in poorer health, and with less educational attainment and poorer labor market skills. Persistence in the processes generating earnings and health could lead to a contemporaneous correlation in earnings and health in adulthood that was due to conditions in childhood.

In contrast to these approaches, research centered on the role of adult socioeconomic status in determining adult health focuses on childhood health largely to demonstrate that the observed correlation between income and health in adulthood is *not* directly attributable to childhood events. For example, Marmot et al (2001) discuss their finding of a gradient in health among the subset of British civil servants whose parents survived to age 70: "If parents survive beyond the age of 70, they could be thought of as neither genetically nor environmentally predisposed to illness. The fact that the social gradient holds up in this subgroup points to the effect of current social circumstances" (page 305). They conclude that, in their data, "early life circumstances are important because they influence adult social circumstances, which in turn influence disease risk" (page 305). Such *pathways models* posit a causal link from low socioeconomic status earlier in adulthood to poor health later in adulthood, with childhood circumstances important because they affect initial adult socioeconomic position.

Data limitations prior to the publication of the 1958 NCDS data have made it difficult to study the dynamic effects of childhood and early adulthood experiences on income and health in middle age and beyond. Few surveys track individuals from childhood into adulthood, and those that do generally contain little information on health status.[6] Much of what is known for the US comes from a survey of the elderly, which restricts analysis to changes in income, wealth and

[6]The Panel Study of Income Dynamics (PSID) contains information on employment, earnings, and asset holdings, but has asked only one question on health status on a regular basis. This question is asked only of heads of households and their spouses.

health status in later life, and over a relatively short period of time[7]. The Whitehall studies, which collected information on health and mortality of cohorts of British civil servants over time during working adulthood, contain only minimal retrospective information on family background. Results presented below suggest that, in particular, the lack of information in the Whitehall studies on mother's education and own health status in childhood limits the usefulness of the Whitehall data for quantifying the extent to which childhood circumstances can explain the relationship between health and economic status in adulthood[8]. Two other British birth cohort studies, from 1946 and 1970, have been collected. However, data from the 1946 cohort study are not publically available. Moreover, researchers using the 1946 and 1958 cohorts have typically structured their analyses to examine the effects of only a limited number of family and individual background variables, prohibiting the systematic approach necessary to sort through the dynamics.[9]

In the work that follows, we present estimates of the relationship between health and earnings in early and middle adulthood among men in the NCDS birth cohort. Specifically, we examine how earnings and health in middle age are related to lagged values of earnings and health, controlling for childhood characteristics. Interpretation of these results requires care: as we discuss below, strong assumptions are required to draw inferences about causality from these

[7]Adams et al (2003) use three waves of data from the Asset and Health Dynamics of the Oldest Old (AHEAD) data, collected between 1993 and 1998.

[8]Whitehall I contained "no direct data on the social circumstances of these men as children" (Marmot et al 1984, page 1004). Whitehall II collected information on father's occupation (retrospectively reported by the civil servants), on father's school leaving age, and on whether the civil servants' parents died before reaching age 70.

[9]Kuh and Wadsworth break data from the 1946 cohort into life-stages, and analyze each stage separately. Only the significant variables from each stage are then entered into a final model of the determinants of health in adulthood. If variables from one stage have delayed effects on health status, for example, they will be missed by this technique. Power, Matthews and Manor (1998) perform a similar analysis for the 1958 cohort.

models. Provided the assumptions we make are valid, the estimates yield information on the dynamics of health and earnings in adulthood and the role of childhood characteristics.

A. Empirical Framework and Estimation Issues

To illustrate ideas, we express the logarithm of earnings in middle age (e_M) and a measure of health in middle age (h_M) as linear functions of the logarithm of earnings and health in young adulthood (e_Y and h_Y, respectively) and a vector of childhood and prenatal characteristics $\boldsymbol{C}$, which includes the measures of socioeconomic status in childhood, prenatal health, health in childhood and educational attainment at age 16.[10]

$$e_M = \beta_0 + h_Y \beta_h + e_Y \beta_e + C\beta_C + \epsilon_M^e , \quad (1)$$

$$h_M = \alpha_0 + h_Y \alpha_h + e_Y \alpha_e + C\alpha_C + \epsilon_M^h . \quad (2)$$

Health and earnings in young adulthood are assumed to be functions of childhood and prenatal characteristics:

$$e_Y = \gamma_{0e} + C\gamma_e + v_Y^e , \quad (3)$$

$$h_Y = \gamma_{0h} + C\gamma_h + v_Y^h . \quad (4)$$

Substitution of (3) and (4) into (1) and (2) yields "reduced form" equations for health and earnings in middle adulthood, estimates of which were presented in Table 3 (for men and women) and Table 5 (for men only).

Two econometric issues are of special concern. First, the parameter estimates of (1) and (2) will be unbiased only under mean independence between the errors terms and e_Y, h_Y and $\boldsymbol{C}$, i.e. $E[\epsilon_M^e \mid e_Y, h_Y, C] = 0$ and $E[\epsilon_M^h \mid e_Y, h_Y, C] = 0$. There are situations under which conditional mean independence may not hold. There may be individual heterogeneity that is not measured by

[10]We characterize age 23 as "young adulthood," and ages 33 and 42 as "middle adulthood." We estimate (1) and (2) for each of the two middle ages separately, and do not impose stationarity of the coefficients across these ages. Equations for earnings and health at age 42 condition on health and earnings at both ages 23 and 33.

C—for example, individuals may have unobserved personality traits or genetic characteristics that result in both poor health and low earnings throughout the life span. The idea that unobserved heterogeneity can lead to spurious state dependence in models with lags is well understood (Heckman 1981). Unfortunately, solutions to this problem either require a set of valid instruments for earnings and health at younger ages, or the use of fixed effects approaches that require long panels of data. In our case, no plausible instruments are available. Furthermore, the panel is not long enough to estimate equations with individual fixed effects, nor is it obvious that fixed effects models, which rely on the assumption that coefficients are constant over time, make sense when looking at health and earnings over a period of several decades. In what follows, we include a large set of variables in ***C***, and assume that the variables we include are rich enough to capture all individual heterogeneity.

A second issue we must confront is that our estimates may reflect macro shocks — either economic or health shocks that affect large numbers of individuals in specific calendar years. To take an extreme example, an episode of infectious disease that happened to affect predominantly poor individuals in the year 2000, when the cohort was 42 year old, could result in a negative association between earnings at age 33 and health at age 42 when such a relationship does not generally exist. This is a generic problem when using cohort data that are not pooled across years. Although we know of no obvious macroeconomic or health shocks that could be driving our results, it will be useful in future work to estimate similar models using data on cohorts born at different dates.

Bearing these issues in mind, we can relate equations (1) and (2) to the theories of health and earnings mentioned above. Pathways models stress the idea that earnings in young adulthood influence future health (i.e α_e. non-zero), largely through the effects of low economic status on psychosocial stress (Marmot et al 1991). This literature argues that childhood circumstance and health in early adulthood are generally not as qualitatively important as adult socioeconomic

status in determining adult health (i.e. that α_h and α_C are relatively less important than α_e). Brunner et al (1999) state that "whatever the salient features of the adult socioeconomic environment may be, it seems they are equally or more important than circumstances in childhood" in determining cardiovascular risk among British civil servants (page 762). The hypothesis that β_h is non-zero — that health affects future income — is often referred to as the "health selection" or the "social drift hypothesis" (Adler et al 1994). The literature on pathways models argues that although some early health problems — in particular severe forms of mental illness such as schizophrenia or major depression — may affect future socioeconomic status, there is little evidence that current health affects future economic status (Chandola et al 2003). In addition, pathways models hypothesize that an important channel through which childhood factors affect adult health is through their effects on initial social positions (i.e γ_e. is non-zero). Marmot et al (2001) note that their analyses of intergenerational occupational mobility show that "childhood circumstances determine adult circumstances and these, in turn, affect disease risk" (page 305). Much of this research relies on a sample of British civil servants, with economic status measured by salary-based employment grade within the civil service. It is possible that the effects of health on movements through (and possibly out of) the civil service differ from the effects in a general population.

Economic models of earnings provide several reasons why earnings in adulthood may be affected by health. Poor health may have a direct effect on labor market productivity, reducing wage rates at every age. If, in addition, poor health reduces the rate at which workers accumulate skills, then poor health would also slow the rate of wage growth over time. Health may also affect labor supply, and earnings—the product of the wage rate and hours worked—will be reduced if those in poorer health work fewer hours. Those in poorer health may have more spells out of the labor force or may choose to leave the labor force altogether, and time spent out of the labor force may also reduce wage growth by reducing the amount of accumulated labor market

experience. The theory that poor health reduces earnings growth implies that β_h is non-zero. However, human capital models do not rule out the hypothesis that earnings also affect future health.

The fetal origins hypothesis predicts that prenatal development will affect health in middle age, independent of earlier health outcomes. If true, we would expect in equation (2) that, controlling for health in childhood and early adulthood, variables associated with prenatal development would have a significant effect on health in middle age. This is consistent with the relevant coefficients in α_C being non-zero: conditional on health and income in early adulthood, prenatal markers would have a significant effect on health in middle age. The literature on the fetal origins hypothesis stresses the importance of prenatal nutrition, in particular micronutrients, something not directly measured in the NCDS. However, an indicator of low birth weight and information on maternal smoking during pregnancy (included as elements of *C*) provide crude measure of nutrition in *utero*, and in the analyses that follow we examine whether low birth weight and prenatal smoking affect adult health.

Life course models are the least precisely specified of all of the theories discussed here. They emphasize the importance of childhood factors, including childhood health and family circumstances, on both health status and economic status in adulthood. However, they do not rule out any of the possible links between health and earnings in adulthood, nor do they specify whether childhood factors affect adult outcomes only through their effects on health and earnings in young adulthood (i.e γ_h. and γ_e non-zero), or whether childhood factors may also influence later adult outcomes given earlier adult outcomes (i.e α_C. and β_C non-zero).

We use estimates of (1) and (2) to examine which implications of these models find support in our data. Parameter estimates of β_h and α_e provide information on whether health predicts future earnings (as in human capital models), and/or whether earnings predict future health (as in pathways models). The parameters attached to the childhood characteristics provide

information on whether childhood characteristics affect middle-adult outcomes only through their effects on early adult outcomes, or whether they have independent effects as is hypothesized in the fetal origins and life course models.

B. Results

Tables 6 and 7 present estimates of (1) and (2), with controls for educational attainment, for men in the NCDS at ages 33 and 42. For these tables, we restrict our sample to men with complete data on health and earnings at ages 23, 33, and 42.[11]

Table 6 presents estimates of (1), expressing current earnings as a function of past earnings and health. All specifications include controls for family background and childhood and prenatal health variables (i.e. the factors in *C*), and earnings from earlier waves of the survey. The first two columns present results for the log of earnings at age 33. We find the log of earnings at age 23 has a large and significant effect on the log of earnings at age 33: with or without controls for lagged health and education completed by age 16 (column 2), a doubling of earnings at age 23 is associated with a 40 percent increase in earnings at age 33. Family background variables are significantly associated with earnings at 33, even controlling for earnings and health at age 23. Childhood health characteristics are also significant, although less so than in the reduced form models shown in Table 5 that did not control for educational attainment and early adult health and earnings. This is consistent with childhood health affecting adult earnings through these variables.

Central to our focus, health at age 23 is a powerful predictor of earnings at age 33, even when controlling for educational attainment at age 16, earnings at 23, and family background,

[11]We do this to ensure that any differences we find in the predictive power of current health status and current income is not due to changes in the sample between Tables 6 and 7. The last column of Table 1 presents summary statistics for this sub-sample, which show that the family backgrounds of this sub-sample are similar to those for the sample as a whole. However, Table 1 also reveals that this sub-sample is a bit healthier and slightly better educated, on average, than is the sample as a whole. (This is perhaps because those who are less healthy and those less well educated are less likely to be employed at any given age.)

including family income at age 16. Indicators for good, fair and poor health, relative to excellent health, are highly jointly significant (F-test = 11.34, p-value = 0.000). Those who report themselves in "good" health earn on average 7 percent less than those who report "excellent" health; those in "fair health" earn roughly 14 percent less, and those in "poor" health at age 23 earn 50 percent less at age 33. The same general pattern is revealed at age 42, with health at 23 and 33 significant predictors of earnings at 42, although childhood characteristics are no longer significantly correlated with earnings at this age.

Overall, the results in Table 6 present evidence that current health status is a significant predictor of future earnings (β_h is non-zero), and some evidence that childhood health continues to affect earnings in adulthood, conditional on earlier adult earnings and health (β_C are non-zero at age 33).

In Table 7, we test whether earnings predict future health status. The first four columns show results from ordered probits, using health status measured on a 1 to 5 scale as the dependent variable. At ages 33 and 42, with or without controls for the respondent's educational attainment, we find no evidence that earnings predict future health. The coefficient on lagged earnings is small and insignificant in all specifications. The role of childhood factors is also insignificant, once controls for health in early adulthood are included in these models. Neither family income at age 16 nor our set of family background and childhood health measures are jointly significant in any specification. The only childhood factor that is significantly related to adult health is educational attainment at age 16.

We use the ordered probit specification in columns 1 through 4 to be consistent with the reduced form results shown earlier. This specification treats the underlying dependent variable — current health — as a continuous latent variable with four observed categories, whereas the lagged health measures consist of indicators of the possible health states at earlier ages. These indicators are error-ridden measures of lagged latent health, and the parameter estimates will be

inconsistent. As a cross-check on these results, we show estimates of linear probability models in which an indicator of fair or poor health is regressed on indicators of earlier fair or poor health, lagged earnings, and other controls. The results, in columns 5 and 6, are similar to those reported using ordered probits. In particular, we find no evidence that earnings at earlier ages predict health at later ages.

In summary, our analysis of the NCDS suggests that health status in early and middle adulthood predicts future earnings, but that earnings do not predict future health. In terms of equations (1) and (2), we cannot reject the hypotheses that α_y is zero, while the hypothesis that β_h is zero is rejected in our data. With respect to earnings, we find that childhood factors are significantly related to earnings at age 33, even after controlling for health and earnings earlier in adulthood, or in terms of equation (1), that β_C is non-zero. However, the importance of childhood factors for earnings diminishes between ages 33 and 42. We find very different results for adult health: conditional on past values of health and earnings, childhood factors (with the exception of educational attainment at age 16) do not influence health in adulthood at any age (α_C is zero.) This pattern of coefficients provides strong support for human capital models and no support for pathways models or the variant of the fetal origins hypothesis we examine.

5. Conclusions

Consistent with human capital models, health in childhood and young adulthood are large and significant predictors of subsequent earnings. These effects appear to operate primarily through the effect of poor childhood health on educational attainment, and on initial earnings and health at age 23. Because earnings and health are both persistent, and because poor health at ages 23 and 33 depresses earnings growth, the effects of poor health in childhood on initial values of earnings and health in young adulthood are translated forward into lower earnings.

Our evidence is consistent with life-course models of health and earnings, but offers no support for the hypothesis that low birth weight adversely effects health in middle age, conditional on earlier adult outcomes. At age 42, controlling for health at ages 23 and 33, there is little effect of any of the childhood and prenatal health variables on current health. It is possible that our measures of prenatal health (birth weight and maternal smoking) are too crude to identify prenatal effects, or that age 42 is too early for these effects to appear.

Our results are consistent with one hypothesis of pathways models — that childhood factors affect initial adult social position. However, contrary to these models, we find no evidence that initial adult social position as measured by earnings affects later health outcomes. Health at ages 33 and 42 depends on lags of adult health, but not on earlier earnings. This does not imply that economic status is irrelevant for adult health: we do find that higher levels of education, a common marker of socioeconomic status, is positively associated with health outcomes in adulthood, and that children from wealthier families receive more education. In addition, other (broader) measures of socioeconomic status may predict future health where earnings do not. Putting these results together with earlier results that poorer children enter young adulthood in worse health than wealthier children, our results indicate that a key determinant of health in adulthood is economic status in *childhood*, rather than economic status in adulthood.

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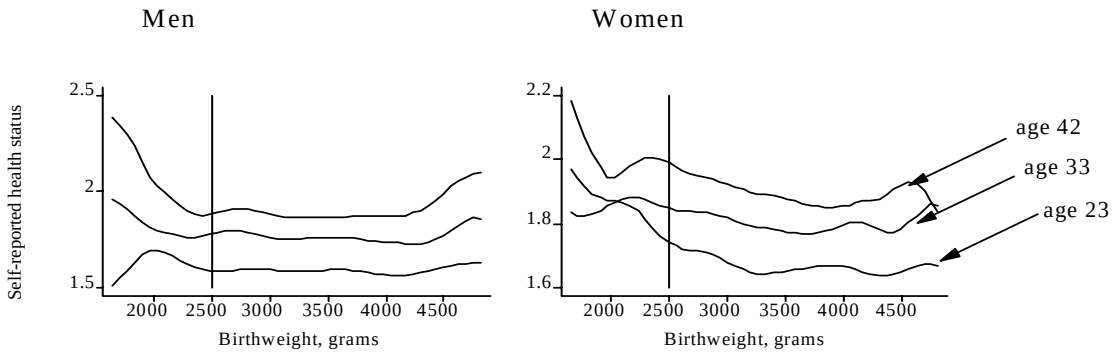

Figure 1: Health Status in Adulthood and Birthweight

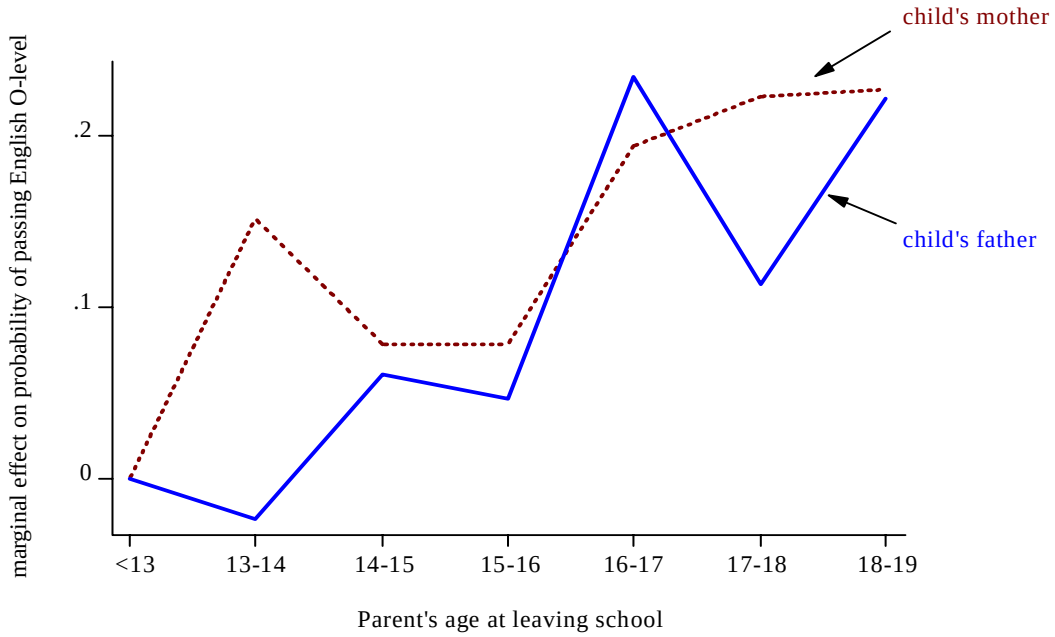

Figure 2: Marginal Effects of Mothers' and Fathers' Education on the Probability of Passing the English O-level Exam

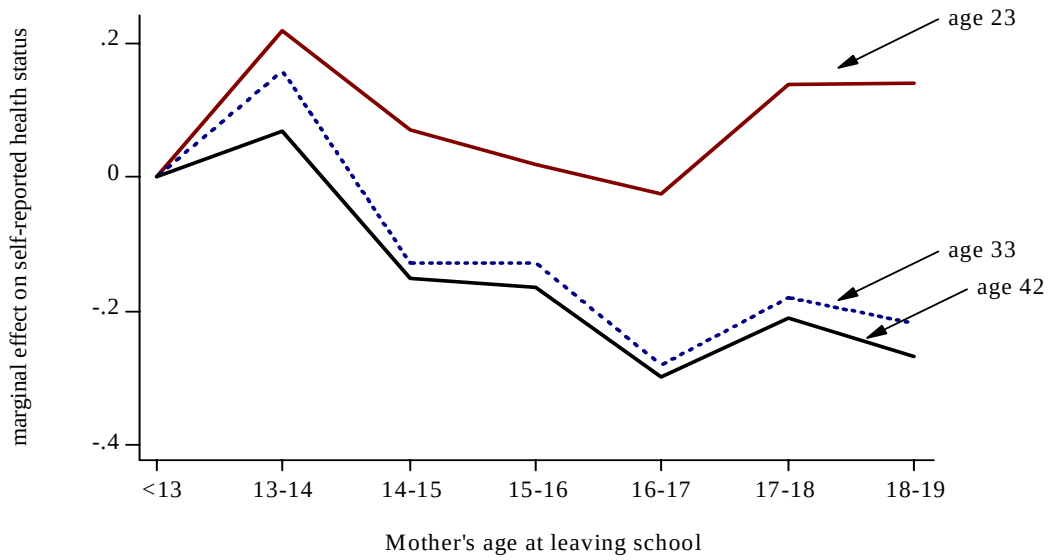

Figure 3: Marginal Effects of Mothers' Education on Self-reported Health Status

Table 1. Summary Statistics, 1958 British Cohort Survey

Household and Individual-level Variables:	Full sample, men and women		Sample of men used in Tables 6 and 7	
	Mean (std.dev.)	# non-missing	Mean (std.dev.)	# non-missing
Self-reported health status at age 23	1.66 (0.67)	12,521	1.55 (0.62)	2,187
Self-reported health status at age 33	1.81 (0.70)	11,269	1.71 (0.65)	2,187
Self-reported health status at age 42 (1=excellent, 2=good, 3=fair, 4=poor)	1.92 (0.76)	11,371	1.81 (0.68)	2,187
ln(weekly earnings) at age 23, men only	4.71 (0.36)	4,839	4.72 (0.31)	2,187
ln(weekly earnings) at age 33, men only	5.12 (0.51)	4,220	5.17 (0.45)	2,187
ln(weekly earnings) at age 42, men only	5.24 (0.69)	3,957	5.28 (0.68)	2,187
Indicator: employed at time of survey, age 33	0.68 (women) 0.90 (men)	5,781 5,582	0.97	2,187
Indicator: employed full-time at time of survey, age 33	0.36 (women) 0.89 (men)	5,781 5,582	0.96	2,187
Indicator: employed at time of survey, age 42	0.79 (women) 0.90 (men)	5,777 5,607	1.00	2,187
Indicator: employed full-time at time of survey, age 42	0.45 (women) 0.88 (men)	5,777 5,607	0.99	2,187
Mother's age at leaving school (median)	15-16	11,475	15-16	1,679
Fathers age at leaving school (median)	14-15	11,274	14-15	1,667
ln(weekly family income) at age 16	5.46 (0.23)	9,415	5.47 (0.208)	1,398
Height at age 23 (meters)	1.70 (0.10)	12,452	1.78 (0.07)	2,176
Indicator: born at low birth weight	0.076	16,776	0.039	2,004
Number chronic conditions, age 7	0.087 (0.422)	14,321	0.074 (0.34)	1,915
Number chronic conditions, age 16	0.181 (0.619)	11,670	0.123 (0.43)	1,664
Number of any O-level passes at age 16	1.96 (2.75)	14,325	2.19 (2.79)	1,906

Notes: All money amounts are in 1987 £. The "full sample" includes all individuals who appeared in the relevant year of the survey. The sample used in Tables 6 and 7 is of men, excluding observations that had missing data on health or earnings in adulthood (ages 23, 33 and 42), or who had earnings of zero at ages 23, 33 or 42. Note that, in the age 42 survey, individuals were only asked about earnings if they were employed at the time of the survey, whereas at age 33 all individuals were asked about earnings regardless of current employment status.

Table 2. Education and Childhood Characteristics, Men and Women

	Dependent Variable:			
	Total O-levels passed by age 16 (OLS)	Indicator: Passed O-level exam by age 16 (probit)		Completed Education Index (ordered probit)
		English	Math	
Ln(family income) at age 16	0.636 (0.129)	0.103 (0.025)	0.084 (0.020)	0.231 (0.063)
Indicator: moderate prenatal smoking	–0.280 (0.060)	–0.036 (0.011)	–0.044 (0.008)	–0.149 (0.029)
Indicator: heavy prenatal smoking	–0.437 (0.067)	–0.058 (0.012)	–0.064 (0.009)	–0.225 (0.033)
Indicator: variable prenatal smoking	–0.452 (0.093)	–0.088 (0.016)	–0.045 (0.013)	–0.237 (0.046)
Indicator: low birth weight	–0.464 (0.091)	–0.076 (0.016)	–0.057 (0.012)	–0.225 (0.046)
# chronic conditions, age 7	–0.310 (0.057)	–0.072 (0.015)	–0.050 (0.013)	–0.291 (0.035)
# chronic conditions, age 16	–0.184 (0.040)	–0.058 (0.010)	–0.029 (0.008)	–0.202 (0.025)
Height at age 23 (meters)	1.840 (0.329)	0.252 (0.063)	0.228 (0.051)	1.395 (0.168)
Tests for joint significance: p-value from $\chi 2$ or F test				
Mother's education indicators	0.000	0.000	0.000	0.000
Father's education indicators	0.000	0.000	0.000	0.000
Father's class at child's birth	0.000	0.000	0.000	0.000
Paternal grandfather's class	0.000	0.000	0.004	0.000
Maternal grandfather's class	0.000	0.000	0.000	0.000
Prenatal smoking indicators	0.000	0.000	0.000	0.000
Chronic conditions	0.000	0.000	0.000	0.000
Observations	14325	14299	14299	12533

Note: For the probits, we report the effects of the independent variables on the probability of passing the indicated O-level exam. Included in all regressions are controls for "family background" and "child health" described in Appendix Table 4. The completed education index takes the value 1 if no O-levels were passed by age 23, 2 if less than 5 O-levels were passed, 3 if 5 or more O-levels were passed, 4 if any A-levels were passed or a teaching, nursing, or technical certificate was earned, and 5 if a degree was earned.

Table 3. Adult Health and Childhood Characteristics, Men and Women

	Dependent Variable: Health status at:		
	age 23	age 33	age 42
Ln(family income) at age 16	–0.069 (0.065)	–0.137 (0.068)	–0.143 (0.066)
Indicator: moderate prenatal smoking	–0.047 (0.030)	0.031 (0.031)	0.052 (0.030)
Indicator: heavy prenatal smoking	0.031 (0.034)	0.138 (0.035)	0.162 (0.034)
Indicator: variable prenatal smoking	0.106 (0.046)	0.080 (0.049)	0.169 (0.047)
Indicator: low birth weight	0.042 (0.046)	0.072 (0.048)	0.085 (0.047)
# chronic conditions, age 7	0.120 (0.027)	0.085 (0.030)	0.054 (0.035)
# chronic conditions, age 16	0.193 (0.020)	0.128 (0.022)	0.124 (0.024)
Height at age 23 (meters)	–0.680 (0.173)	–0.579 (0.172)	–0.202 (0.170)
Tests for joint significance: p-value from $\chi 2$ or F test			
Mother's education indicators	0.045	0.012	0.017
Father's education indicators	0.246	0.301	0.306
Father's class at child's birth	0.011	0.000	0.000
Paternal grandfather's class	0.696	0.320	0.044
Maternal grandfather's class	0.166	0.012	0.021
Prenatal smoking indicators	0.020	0.001	0.000
Chronic conditions	0.000	0.000	0.000
Observations	12521	11269	11371

Note: Ordered probits. Included in all regressions are controls for "family background" and "child health" described in Appendix Table 4.

Table 4. Adult Employment and Childhood Characteristics, Men and Women

	Dependent Variable: Part time or full time employment:			
	women, age 33	women, age 42	men, age 33	men, age 42
Ln(family income) at age 16	0.042	0.068	0.010	0.042
	(0.039)	(0.034)	(0.024)	(0.024)
Indicator: moderate prenatal smoking	–0.009	–0.014	–0.006	–0.020
	(0.018)	(0.016)	(0.011)	(0.012)
Indicator: heavy prenatal smoking	–0.027	0.005	–0.027	–0.018
	(0.021)	(0.017)	(0.013)	(0.013)
Indicator: variable prenatal smoking	0.017	0.003	0.010	–0.050
	(0.029)	(0.025)	(0.016)	(0.020)
Indicator: low birth weight	–0.008	0.007	–0.040	–0.021
	(0.026)	(0.022)	(0.022)	(0.020)
# chronic conditions, age 7	–0.103	–0.043	–0.021	–0.008
	(0.023)	(0.019)	(0.008)	(0.010)
# chronic conditions, age 16	–0.024	–0.022	–0.032	–0.048
	(0.016)	(0.014)	(0.006)	(0.006)
Height at age 23 (meters)	0.186	0.053	0.072	0.128
	(0.114)	(0.101)	(0.064)	(0.067)
Tests for joint significance: p-value from $\chi 2$ or F test				
Mother's education indicators	0.957	0.444	0.949	0.251
Father's education indicators	0.755	0.489	0.034	0.304
Father's class at child's birth	0.145	0.653	0.017	0.023
Paternal grandfather's class	0.048	0.726	0.544	0.036
Maternal grandfather's class	0.550	0.234	0.390	0.230
Prenatal smoking indicators	0.479	0.799	0.133	0.012
Chronic conditions	0.000	0.012	0.000	0.000
Observations	5,780	5,771	5,581	5,607

Note: Probits. Marginal effects on the probability of employment are reported. Included in all regressions are controls for "family background" and "child health" described in Appendix Table 4.

Table 5. Adult Earnings and Childhood Characteristics , Men

	Dependent Variable: ln(earnings) at:		
	age 23	age 33	age 42
Ln(family income) at age 16	0.008 (0.034)	0.128 (0.050)	0.225 (0.071)
Indicator: moderate prenatal smoking	0.024 (0.015)	0.017 (0.023)	–0.039 (0.032)
Indicator: heavy prenatal smoking	0.027 (0.017)	–0.060 (0.024)	–0.029 (0.036)
Indicator: variable prenatal smoking	–0.002 (0.023)	–0.008 (0.034)	–0.012 (0.048)
Indicator: low birth weight	0.013 (0.025)	–0.133 (0.039)	–0.010 (0.055)
# chronic conditions, age 7	–0.053 (0.016)	–0.075 (0.023)	–0.056 (0.035)
# chronic conditions, age 16	–0.126 (0.011)	–0.065 (0.016)	–0.040 (0.028)
Height at age 23 (meters)	0.431 (0.086)	0.604 (0.137)	0.871 (0.196)
Tests for joint significance: p-value from $\chi 2$ or F test			
Mother's education indicators	0.405	0.165	0.902
Father's education indicators	0.534	0.011	0.131
Father's class at child's birth	0.000	0.000	0.000
Paternal grandfather's class	0.210	0.494	0.085
Maternal grandfather's class	0.138	0.006	0.781
Prenatal smoking indicators	0.218	0.061	0.615
Chronic conditions	0.000	0.000	0.056
Observations	4,839	4,220	3,957

Note: Ordinary least squares. Included in all regressions are controls for "family background" and "child health" described in Appendix Table 4.

Table 6. The Impact of Past Health Status on Current Earnings, Men

	Dependent variable:			
	ln(own earnings), age 33		ln(own earnings), age 42	
ln(family income), age 16	0.052	0.044	0.090	0.085
	(0.058)	(0.058)	(0.087)	(0.087)
ln(own earnings), age 23	0.423	0.415	0.202	0.204
	(0.028)	(0.028)	(0.044)	(0.044)
ln(own earnings), age 33			0.547	0.539
			(0.032)	(0.033)
# O-levels passed, age 16	0.038	0.036	0.039	0.038
	(0.004)	(0.004)	(0.006)	(0.006)
Good health indicator, age 23		–0.070		–0.002
		(0.018)		(0.029)
Fair health indicator, age 23		–0.138		–0.100
		(0.039)		(0.061)
Poor health indicator, age 23		–0.500		0.143
		(0.138)		(0.209)
Good health indicator, age 33				–0.025
				(0.029)
Fair health indicator, age 33				–0.038
				(0.052)
Poor health indicator, age 33				–0.441
				(0.162)
Lagged health indicators jointly significant? F (p-val)		11.34		2.14
		(0.000)		(0.047)
Lagged own earnings jointly significant? F (p-val)	228.68	223.02	195.71	187.98
	(0.000)	(0.000)	(0.000)	(0.000)
Family background variables jointly significant? F (p-val)	2.30	2.32	0.61	0.63
	(0.000)	(0.000)	(0.980)	(0.972)
Child health measures jointly significant? F (p-val)	2.65	2.50	1.61	1.64
	(0.032)	(0.041)	(0.170)	(0.161)

Note: Observations=2,187. OLS regressions results are reported. The "family background" variables and "child health measures," included in all regressions, are described in Appendix Table 4.

Table 7. The Impact of Past Earnings on Current Health Status, Men

	Ordered probits. Health status (1=excellent to 4=poor) at:				OLS. Indicators of fair or poor health at:	
	age 33		age 42		age 33	age 42
ln(family income), age 16	–0.026	–0.028	–0.140	–0.133	0.037	–0.106
	(0.170)	(0.170)	(0.168)	(0.168)	(0.041)	(0.046)
ln(own earnings), age 23		0.065		–0.034	0.006	–0.0008
		(0.083)		(0.085)	(0.020)	(0.023)
ln(own earnings), age 33				–0.096		–0.027
				(0.064)		(0.017)
# O-levels passed, age 16	–0.048	–0.048	–0.032	–0.029	–0.007	–0.005
	(0.011)	(0.011)	(0.011)	(0.011)	(0.003)	(0.003)
Good health indicator, age 23	0.832	0.834	0.320	0.313		
	(0.054)	(0.055)	(0.055)	(0.056)		
Fair health indicator, age 23	1.593	1.596	0.565	0.553		
	(0.113)	(0.113)	(0.116)	(0.116)		
Poor health indicator, age 23	1.010	1.011	0.373	0.325		
	(0.398)	(0.397)	(0.397)	(0.397)		
Fair or poor health indicator, age 23					0.304	0.144
					(0.026)	(0.030)
Good health indicator, age 33			0.705	0.702		
			(0.058)	(0.058)		
Fair health indicator, age 33			1.394	1.388		
			(0.101)	(0.102)		
Poor health indicator, age 33			2.184	2.175		
			(0.304)	(0.304)		
Fair or poor health indicator, age 33						0.320
						(0.025)
Lagged health ind jointly significant?	335.97	336.39	421.36	409.68	137.50	118.91
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Lagged own earnings jointly significant?		0.62		3.06	0.11	1.36
		(0.430)		(0.216)	(0.744)	(0.256)
Family background variables jointly significant?	52.85	52.51	38.37	38.12	0.85	0.081
	(0.169)	(0.178)	(0.711)	(0.721)	(0.748)	(0.816)
Child health measures jointly significant?	0.42	0.39	4.89	4.28	1.45	2.71
	(0.981)	(0.983)	(0.299)	(0.370)	(0.216)	(0.029)

Note: Observations=2,187. The "family background" variables and "child health measures," included in all regressions, are described in Appendix Table 4. The tests of joint significance in the bottom panel are χ^2 statistics (p-values in parentheses) for the ordered probit models, and are F statistics (p-values in parentheses) for the models estimated with OLS.

Appendix

A. Sample attrition

Appendix Table 1 shows descriptive statistics for selected variables collected at the baseline survey (i.e. at the time of birth) for the samples of children present at later surveys. These statistics indicate that most of the attrition (from 17,409 children to 11,015 children) occurred between birth and age 16. Children who left between birth and age 6 were more likely than "stayers" to have been born at low birth weight. Only a small portion of the total attrition is due to child death: Power and Li (2000) report that 201 children died between the ages of 1 month and 15 years. However, their finding that deaths in the first year were concentrated among low birth weight children may explain why those who remain in the sample are less likely to have been born at low weight. The other baseline characteristics of the children — measures of mothers' schooling and fathers' occupation — do not change over time as the sample becomes smaller. The survey has also added roughly 700 children born during the week of March 3, 1958 who immigrated to England, Scotland and Wales prior to the age 16 survey. These children do not appear to be substantially different from the original sample. "New" children whose families were present at the age 16 interview had family income that was only 1.5% lower than children from the original sample. We include these children in our analyses.

Appendix Table 1: Sample sizes and means of characteristics at birth, over time.

Age at interview:	birth	6	16	23	33	42
Sample size:	17,409	14,255	11,015	11,886	10,834	10,794
Fraction of children with:						
low birth weight	0.076	0.057	0.057	0.058	0.057	0.056
mothers who left school at minimum school leaving age	0.250	0.248	0.250	0.252	0.259	0.260
professional fathers	0.043	0.039	0.040	0.043	0.045	0.044
managerial fathers	0.123	0.125	0.123	0.128	0.131	0.133
non-manual skilled fathers	0.091	0.094	0.095	0.097	0.097	0.097
manual skilled fathers	0.481	0.483	0.482	0.480	0.485	0.480
semi-skilled father	0.114	0.116	0.119	0.117	0.115	0.115
unskilled father	0.093	0.091	0.093	0.086	0.080	0.083

Note: These statistics include only those who were interviewed at birth, and exclude children added to the sample later. Low birth weight, whether the mother went beyond minimum school-leaving age, and father's social class were all measured at the first interview (i.e. immediately after the child's birth).

B. Self-reported health status and chronic conditions

The following table shows regressions (ordered probits) of reported health status at ages 33 and 42 on a set of indicators for whether the respondent reports having each of the health conditions listed in the table. It also shows the prevalence of each of these conditions. The question wording for several health conditions varied between the age 33 and age 42 interviews; in those cases, the difference is detailed in a footnote.

Appendix Table 2. Health status and health conditions

	Age 33 Means	Dependent Variable: Health Status, age 33	Age 42 Means	Dependent Variable: Health Status, age 42
Longstanding illness/disability	0.155	0.371 (0.085)	0.289	0.437 (0.033)
Illness limits daily activities	0.059	0.704 (0.061)	0.129	0.583 (0.049)
Registered disabled	0.012	0.361 (0.107)	0.022	0.422 (0.084)
Illness limits work [a]	0.135	-0.191 (0.083)	0.113	0.295 (0.050)
Epilepsy	0.012	0.509 (0.102)	0.020	0.294 (0.080)
Diabetes	0.006	0.370 (0.146)	0.017	0.428 (0.086)
Severe headaches, migraines	0.193	0.188 (0.029)	0.203	0.049 (0.028)
BMI>=30	0.110	0.288 (0.036)	0.151	0.282 (0.032)
Asthma	0.089	0.058 (0.044)	0.110	-0.012 (0.041)
Ezcema	0.172	0.096 (0.030)	0.225	0.074 (0.027)
Hay Fever	0.207	-0.074 (0.029)	0.208	-0.063 (0.029)
Bronchitis	0.115	-0.001 (0.038)	0.106	0.030 (0.038)
Hernia	0.030	0.076 (0.066)	0.049	0.149 (0.052)
Kidney/Bladder problems	0.068	0.153 (0.045)	0.080	0.137 (0.041)
High blood pressure	0.082	0.177 (0.041)	0.111	0.338 (0.036)
Cough 1st thing in the morning	0.116	0.206 (0.040)	0.139	0.228 (0.039)
Cough with phlegm	0.101	0.176 (0.042)	0.105	0.196 (0.042)
Short of breath when walk	0.054	0.712 (0.052)	0.086	0.469 (0.043)
Wheezing/whistling in chest	0.280	0.211 (0.030)	0.283	0.126 (0.030)
Persistent Back Pain [b]	0.468	0.159 (0.023)	0.222	0.195 (0.028)
Smokes	0.334	0.312 (0.027)	0.300	0.320 (0.028)
Smoked in the past	0.186	0.102 (0.031)	0.254	0.112 (0.028)
Stomach problems [c]	0.179	0.290 (0.030)	0.146	0.284 (0.032)
Emotional Problems [d]	0.549	0.199 (0.024)	0.481	0.045 (0.008)
Chi-Square (p-value)		2369.40 (0.0000)		3652.64 (0.0000)
Observations		10460		10526

[a] At age 33, an individual is categorized as having an illness that limits work if he answers that his longstanding illness or disability makes it harder to get and keep a paid job compared to other people of his age with the same skills and experience. At age 42, he is not asked to compare his ability to work to those his age or with his skills and experience.
[b] At age 33, the question refers to any back pain that lasted more than one day, where at age 42, the question asks specifically about persistent back pain, lumbago, or sciatica.
[c] At age 33, the question refers to any stomach trouble or indigestion, whereas at age 42, the question asks specifically about peptic, duodenal or gastric ulcer, gallstones, irritable bowel syndrome, ulcerative colitis, or Crohn's disease.
[d] The questions about emotional problems at both interviews refer to a list of feelings the respondent may have had since the last interview; however, the last choice – the "other" category – is worded differently across waves. At age 33, the last category is "other feelings of worry, tension, anxiety, depression or nerves" where at age 42, the last category is "other problems affecting your mood, emotions or behaviour."

Appendix Table 3. Transitions in Health States, Men

Health at age 23 is:	Health at age 33 is: Excellent	Good	Fair	Poor	Row total
Excellent	635 (29.0%)	437 (20.0%)	43 (2.0%)	1 (0.1%)	1,116 (51.03%)
Good	218 (10.0%)	610 (27.9%)	103 (4.7%)	9 (0.4%)	940 (43.0%)
Fair	9 (0.4%)	63 (2.9%)	46 (2.1%)	4 (0.2%)	122 (5.6%)
Poor	3 (0.1%)	5 (0.2%)	0 (0.0%)	1 (0.1%)	9 (0.4%)
Column total	865 (39.6)	1,115 (51.0%)	192 (8.8%)	15 (0.7%)	2,187 (100.0%)

Health at age 33 is:	Health at age 42 is: Excellent	Good	Fair	Poor	Row total
Excellent	482 (22.0%)	340 (15.6%)	39 (1.8%)	4 (0.2%)	865 (39.6%)
Good	235 (10.8%)	728 (33.3%)	145 (6.6%)	7 (0.3%)	1,115 (51.0%)
Fair	15 (0.7%)	92 (4.2%)	78 (3.6%)	7 (0.3%)	192 (8.8%)
Poor	1 (0.1%)	3 (0.1%)	6 (0.3%)	5 (0.2%)	15 (0.7%)
Column total	733 (33.5%)	1,163 (53.2%)	268 (12.3%)	23 (1.1%)	2,187 (100.0%)

Notes: The transition matrices are based on the sample of 2,187 males used in Tables 6 and 7.

C. Variables included in the regressions

1. *Treatment of missing values*

All analyses rely on common sets of "family backgound" and "child health." Some variables are missing in some years, either because the child's parents did not participate in an interview that year, or because the child was not given the medical checkup that was part of the study. Rather than drop observations with missing values, we use the following methods that enable us to retain them:

a. We include full sets of indicators for parental and family characteristics, including mother's and father's education; mother's marital status at the time of the child's birth; the "social class" of the child's father (at the time of the child's birth) and paternal and maternal grandfathers (measured when the child's parents left school); and the mother's smoking behavior during pregnancy. For each of these variables, the category "missing" is included as a separate indicator variable.

b. We include indicator variables for whether the "low birth weight" indicator is missing, an indicator for whether the number of siblings is missing, an indicator for whether height at age 23 is missing, indicators for whether the child's mother's and father's heights are missing, and an indicator for whether the child's family income at age 16 is missing. We also include indicators for whether the parents completed the age 7 and age 11 interviews, and indicators for whether the child was examined for the age 7 and age 16 medical interviews.

c. We interact each of the variables mentioned in b, above, with indicators that the variable is non-missing. For example, the indicator of low birth weight is interacted with with an indicator for whether birth weight is non-missing, so that those with missing birth weight are assigned a value of zero for this variable. The same procedure is followed for variables that measure the number of siblings, height at age 23, mother's height, father's height, ln(family income) at age 16, and the number of medical conditions the child has at ages 7 and 16. The coefficients reported in the Tables for each of these variables in the coefficient on the interaction of the variable (e.g. birth weight) with the indicator that the variable is non-missing. These coefficients therefore represent the effect of the variable conditional on its value being observed.

d. The indicators for missing values are *not* included in the chi-square and F-test reported in the tables for the joint significance of different groups of variables. Thus (for example), tests of joint significance of mother's education tests whether the indicators of the mother's school leaving age, excluding the indicator that school leaving age is missing, are jointly significant. Likewise, tests for the joint significance of child health variables do not include the measures of whether birth weight, height, and measures of chronic conditions are missing. The following table indicates which variables are and are not included in chi-square and/or F-tests.

2. *Definition of variables*

The following table defines the sets of "family background" and "child health" measures:

Appendix Table 4. Family Background and Child Health Measures

Variable:	included in Chi-square and/or F tests for joint significance?
Family background variables	
Mother left school before age 13	omitted category
Mother left school at age 13-14	yes
Mother left school at age 14-15	yes
Mother left school at age 15-16	yes
Mother left school at age 16-17	yes
Mother left school at age 17-18	yes
Mother left school at age 18-19	yes
Mother left school at age 19-21	yes
Mother left school at age 21-23	yes
Mother left school at age 23 or more	yes
Mother's school leaving age is unknown	no
Mother's school leaving age is missing	no
Father left school before age 13	omitted category
Father left school at age 13-14	yes
Father left school at age 14-15	yes
Father left school at age 15-16	yes
Father left school at age 16-17	yes
Father left school at age 17-18	yes
Father left school at age 18-19	yes
Father left school at age 19-21	yes
Father left school at age 21-23	yes
Father left school at age 23 or more	yes
Father's school leaving age is unknown	no
Father's school leaving age is missing	no
Mother divorced at child's birth	omitted category
Mother in "stable union" at child's birth	yes
Mother twice married at child's birth	yes
Mother married at child's birth	yes
Mother unmarried at child's birth	yes
Mother's marital status at child's birth unknown/missing	no
Number of siblings x indicator: siblings nonmissing	yes

Variable:	included in Chi-square and/or F tests for joint significance?
Indicator: siblings missing	no
Mother's height (meters) x indicator: mother's height nonmissing	yes
Indicator: mother's height non-missing	no
Father's height (meters) x indicator: father's height nonmissing	yes
Indicator: father's height non-missing	no
Father's social class at child's birth is "Professional"	omitted category
Father's social class at child's birth is "Managerial"	yes
Father's social class at child's birth is "Non-manual skilled"	yes
Father's social class at child's birth is "Manual skilled"	yes
Father's social class at child's birth is "Semi-skilled"	yes
Father's social class at child's birth is "Unskilled"	yes
Father's social class at child's birth is "Unemployed"	yes
Father's social class at child's birth is missing or unknown	no
Paternal grandfather's social class is "Professional"	omitted category
Paternal grandfather's social class is "Managerial"	yes
Paternal grandfather's social class is "Non-manual skilled"	yes
Paternal grandfather's social class is "Manual skilled"	yes
Paternal grandfather's social class is "Non-manual semi-skilled"	yes
Paternal grandfather's social class is "Manual semi-skilled"	yes
Paternal grandfather's social class is "Unskilled"	yes
Paternal grandfather's social class is missing	no
Maternal grandfather's social class is "Professional"	omitted category
Maternal grandfather's social class is "Managerial"	yes
Maternal grandfather's social class is "Non-manual skilled"	yes
Maternal grandfather's social class is "Manual skilled"	yes
Maternal grandfather's social class is "Semi-skilled"	yes
Maternal grandfather's social class is "Unskilled"	yes
Maternal grandfather's social class is missing	no
Mother did not smoke after 4th month of pregnancy	omitted category
Mother was medium smoker after 4th month of pregnancy	yes
Mother was heavy smoker after 4th month of pregnancy	yes
Mother was variable smoker after 4th month of pregnancy	yes
Mother's smoking after 4th month of pregnancy is missing	yes

Variable:	included in Chi-square and/or F tests for joint significance?
Parent interview at age 0 completed	no
Parent interview at age 7 completed	no
Parent interview at age 11 completed	no
Child health variables	
indicator of low birth weight x indicator: birth weight nonmissing	yes
indicator: birth weight missing	no
height in meters at age 23 x indicator: height at age 23 nonmissing	yes
indicator: height in meters at age 23 missing	no
number of chronic conditions at age 7* x indicator: medical interview at	yes
indicator: medical interview at age 7 completed	no
number of chronic conditions at age 16* x indicator: medical interview	yes
indicator: medical interview at age 16 completed	no

*Chronic conditions are assessed during the course of a medical exam. Our counts of chronic conditions include those determined by the medical examiner to be slight, moderate, or severe. The list of possible conditions at age 7 includes: general motor handicap, disfiguring condition, mental retardation, emotional maladjustment, head and neck abnormality, upper limb abnormality, lower limb abnormality, spine abnormality, respiratory system problem, alimentary system problem, urogenital system problem, heart condition, blood abnormality, skin condition, epilepsy, other CNS condition, diabetes, and any other condition. The list of conditions at age 16 includes: general motor handicap, general physical abnormality, mental retardation, emotional/behavioral problem, head and neck abnormality, upper limb abnormality, lower limb abnormality, spine abnormality, respiratory system problem, alimentary system problem, urogenital system problem, heart condition, haematological abnormality, skin condition, epilepsy, other CNS condition, diabetes, eye condition, hearing defect, speech defect, and any other abnormal condition.

D. Imputation of family income at age 16

The NCDS does not ask the parents of the cohort members their actual earnings in any of the survey years, but does ask in 1975, when the cohort members are 16 years old, which bracket their usual net income falls. We use actual income values reported in the 1974, 1975, and 1976 cross-sectional Family Expenditure Surveys (FES) to impute values which we can assign to our sample of households based on these brackets. We restrict the FES sample to those households with children between the ages of 15 and 17 and drop all observations from Northern Ireland for comparability to the NCDS. The resulting sample size is 2,224 households. We separately categorize the FES fathers and mothers into the NCDS income brackets. We also include two additional categories (self-employed and no mother/father present) and collapse categories with few observations, resulting in a total of 10 mother categories and 10 father categories. We compute the household's mean disposable income given that the mother falls in category i and the father falls in category j and match this value to the corresponding observations in the NCDS sample.

E. The British Education System

The education system relevant for this cohort is based on the student's performance on a series of exams. Upon the completion of primary school (age 11), students take exams which determine whether they go to grammar school, where they prepare to take O-level exams at age 16, or to secondary school, which is a non-university track where the students take exams to receive their Certificate of Secondary Education at age 16 after which they generally enter the labor market. Typically, passing 5 or more O-level exams, including the Math and English exams, qualifies a student to pursue vocational courses or to continue his or her academic studies until age 18, when the A-level subject exams are administered. Students are admitted to universities based on their performance on their A-level exams.

Given this system, the number of O-level exams passed and passing English and Math exams at age 16 are important predictors of completed education. In addition, we have constructed a completed education index which captures the highest educational qualification achieved by age 23. The index takes the value 1 if no O-levels were passed by age 23, 2 if less than 5 O-levels were passed, 3 if 5 or more O-levels were passed, 4 if any A-levels were passed or a teaching, nursing, or technical certificate was earned, and 5 if a degree was earned.