Economic Status and Health in Childhood: The Origins of the Gradient

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The well-known positive association between health and income in adulthood has antecedents in childhood. Not only is children's health positively related to household income, but the relationship between household income and children's health becomes more pronounced as children age. Part of the relationship can be explained by the arrival and impact of chronic conditions. Children from lower-income households with chronic conditions have worse health than do those from higher-income households. The adverse health effects of lower income accumulate over children's lives. Part of the intergenerational transmission of socioeconomic status may work through the impact of parents' income on children's health. (*JEL* I1)

That wealthy people live longer and have lower morbidity, on average, than do poor people has been well documented across countries, within countries at a point in time, and over time with economic growth. The positive correlation between income and health is not limited to the bottom end of the income distribution (Nancy E. Adler et al., 1994). Indeed, the *gradient* in health status—the phenomenon that relatively wealthier people have better health and longevity—is evident throughout the income distribution. In this paper we present evidence that the income gradients observed in adult health have antecedents in childhood, and suggest that part of the intergenerational transmission of socioeconomic status may work through the impact of parents' long-run average income on children's health.

Using several large, nationally representative data sets, we find that children's health is positively related to household income, and that the relationship between household income and children's health status becomes more pronounced as children grow older. A large component of the relationship between income and children's health can be explained by the arrival and impact of chronic health conditions in childhood. Children from lower-income households with chronic health conditions have worse health than do children from higher-income households. Further, we find that children's health is closely associated with long-run average household income, and that the adverse health effects of lower permanent income accumulate over children's lives. These children arrive at the doorstep of adulthood with lower health status and lower educational attainment—the latter, in part, as a consequence of poor health.

Our findings are of interest not only because they provide insight into the determinants of child well-being, but because they suggest sources of an income gradient in adulthood health. Hypotheses on the causes of the relationship between income and health are difficult to untangle in adulthood, and there is little consensus on the relative importance of mechanisms that lead from low income to poor health and of those that lead from poor health to low income (Victor R. Fuchs, 1982; Michael Marmot, 1999; James P. Smith, 1999). By focusing on children, we can eliminate the channel that runs from health to income. Generally in the United States children do not contribute to family income, and so the correlation between poor health in childhood and low family income cannot be ex-

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plained by lower earnings of children (although it should be noted that ill children could reduce parental labor supply, a point we address in what follows). This does not imply that health status has no effect on income in adulthood. In fact, our results indicate that children from poorer households enter adulthood in poorer general health, with more serious chronic conditions, and having missed more days of school—all of which may compromise their future earnings ability.

Wealthier parents may be better able to purchase medical care, nutritious foods, and safer environments for their children and, in these and many other ways, income may have a causal effect on children's health. At the same time, children's health may be influenced by a variety of parental characteristics—including both genetic or behavioral factors—that are correlated with parental income, and we find evidence for some "third factor" explanations in our data.

We begin by establishing several facts about the relationship between children's health and household income, and focus in particular on the role of chronic conditions in children's health. We then explore the extent to which the relationship between income and health can be explained by other characteristics of parents and the child's environment, such as parental health and labor supply. We conclude with a discussion of mechanisms that underlie the relationship between income and health in childhood, and implications of this relationship for children's human capital formation.

I. Data

In our analysis we use data from four sources: the annual National Health Interview Survey (NHIS), the 1988 child health supplement to the NHIS (NHIS-CH), the Panel Study of Income Dynamics with its associated 1997 Child Development Supplement (PSID-CDS), and the Third National Health and Nutrition Examination Survey (NHANES).

The NHIS is a cross-sectional survey that collects annual data on the health status and chronic and acute medical conditions of a large nationally representative sample of American adults and children. We pool NHIS data from 1986 to 1995, which yields roughly 62,000 observations for 1986, and 120,000 observations annually between 1987 and 1995. Our interest is in understanding the relationship between family income and children's health, and for this reason we restrict our "core" sample to all children aged 0 to 17 for whom household income is reported. The NHIS contains information on total household income, presented by income band. We assign incomes to these income categories using data from the 1986–1995 March Current Population Surveys. (Detailed information on the sample and on the income assignment procedure is provided in the Appendix.)

Summary statistics for our core NHIS sample of children are provided in the first column of Table 1. The children are on average 8.3 years old (we have roughly equal numbers at each age), and are on average in very good or excellent health. Only 3 percent of them are reported to be in only fair or poor health. Less than 2 percent of the children are living apart from a mother; 20 percent are living apart from a father. The sample is roughly 78 percent white and 15 percent black.

The sample for the 1988 NHIS-CH consists of one child per family drawn from the 1988 NHIS. The respondents for these children were asked a wide variety of questions regarding the child's health. We use the NHIS-CH to examine issues related to the child's health at birth and the child's health insurance coverage.

Most of our PSID data come from a Child Development Supplement that was conducted in 1997, in which a battery of health-related questions was asked of (a maximum of) two children aged 12 or under in all PSID households. Information was gathered on the children's current health status and their health status at birth. We supplement the 1997 data with information on family income and their parents' work histories and health status from earlier years of the PSID.

Summary statistics for the PSID sample are given in the second column of Table 1. The PSID children are on average younger than the NHIS children (they range in age from 0 to 12, instead of from 0 to 17). Their health is also generally very good or excellent. The PSID sample is less white (52 percent) and more black (42 percent) than the NHIS. Part of our sample comes from the PSID-SEO (Survey of Economic Opportunity), which intentionally oversampled the poor.

TABLE 1—SUMMARY STATISTICS

Variable	NHIS	PSID	NHANES III
Age	8.31	6.29	5.47
Income ($1997)	48,343	47,525	32,192
Health status	1.687	1.701	1.995 [1.401]
Health status very good or excellent	0.807	0.824	0.674 [0.863]
Health status fair or poor	0.026	0.023	0.073 [0.006]
Bed days (past year)	2.88		
Restricted activity days (past 14 days)	0.362		
Hospitalization episodes (past year)	0.042		
Missed school days due to illness (past 14 days), aged 5 and older	0.189		
Male	0.513	0.516	0.492
White	0.779	0.524	0.662
Black	0.149	0.424	0.299
Mother present in family	0.987	0.932	
Father present in family	0.810	0.643	
Household reference person is a woman			0.319
Mother's age (if present)	34.77	33.31	34.43[a]
Father's age (if present)	37.57	36.27	
Mother's education (if present)	12.69	13.14	11.46[b]
Father's education (if present)	13.15	13.33	
Number of observations	229,330	2,950	10,018

Notes: Health status is on a five-point scale: 1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, 5 = Poor. It is reported by a parent in the NHIS and PSID, and by both a parent and a physician in the NHANES; physician-reported health status is given in square brackets. The means presented in the table are unweighted.

[a] Age of reference person.

[b] Education of reference person.

The Third National Health and Nutrition Examination Survey (NHANES) was conducted between 1988 and 1994. As part of the survey, respondents were given an examination by a physician, who was then asked to rate the individual's general health status. We use data on 10,018 children aged 16 and under to compare the relationship between family income and the doctor's assessment of overall health with that observed between family income and the child's parent's assessment measured on the same scale. More details are provided in the Appendix. Sample statistics for the NHANES are shown in the third column of Table 1. These (unweighted) means reflect the fact that the NHANES oversampled young children from lower-income demographic groups: these children are younger and poorer, with lower levels of adult education.

II. The Income-Gradient in Children's Health Status

We first look at the relationship between family income and overall health status, where health status is a categorical variable with values 1 = Excellent, 2 = Very Good, 3 = Good, 4 = Fair, and 5 = Poor. Finding appropriate measures of a child's health status is a challenge. In developing countries, infant mortality rates, anthropometric measures, and indicators for vaccination provide a guide to child health. Using U.S. data, Sanders Korenman and Jane E. Miller (1997) examine how the timing of poverty is related to stunting, wasting, obesity, and several indicators of child development among a sample of 5- to 7-year-olds from the National Longitudinal Survey of Youth (NLSY). However, in the United States, stunting and wasting are quite rare. For adults, a poor self-report of health is a powerful predictor of mortality, even when controlling for physician-assessed health status and health-related behaviors. Poor self-reports of health are also a significant predictor of future changes in functioning among the elderly. (Ellen L. Idler and Stanislav V. Kasl, 1995, presents results on changes in functioning, and an extensive set of references on the studies of self-reported health and mortality.) Much less is known about the predictive power of reported poor health in children. In what follows, we reach similar conclusions using alternative measures of children's health, including bed days and hospitalization episodes, and also find that reported health status correlates strongly with children's chronic conditions.

The upper half of Figure 1 shows the conditional expectation of health status in the NHIS as a function of the log of family income, for children by age group in the left-hand panel, and for younger and older adults by age group in the right-hand panel. The bottom half shows similar graphs for the PSID, although the samples of adults for the PSID consist of parents of the children in the PSID-CDS and so are not

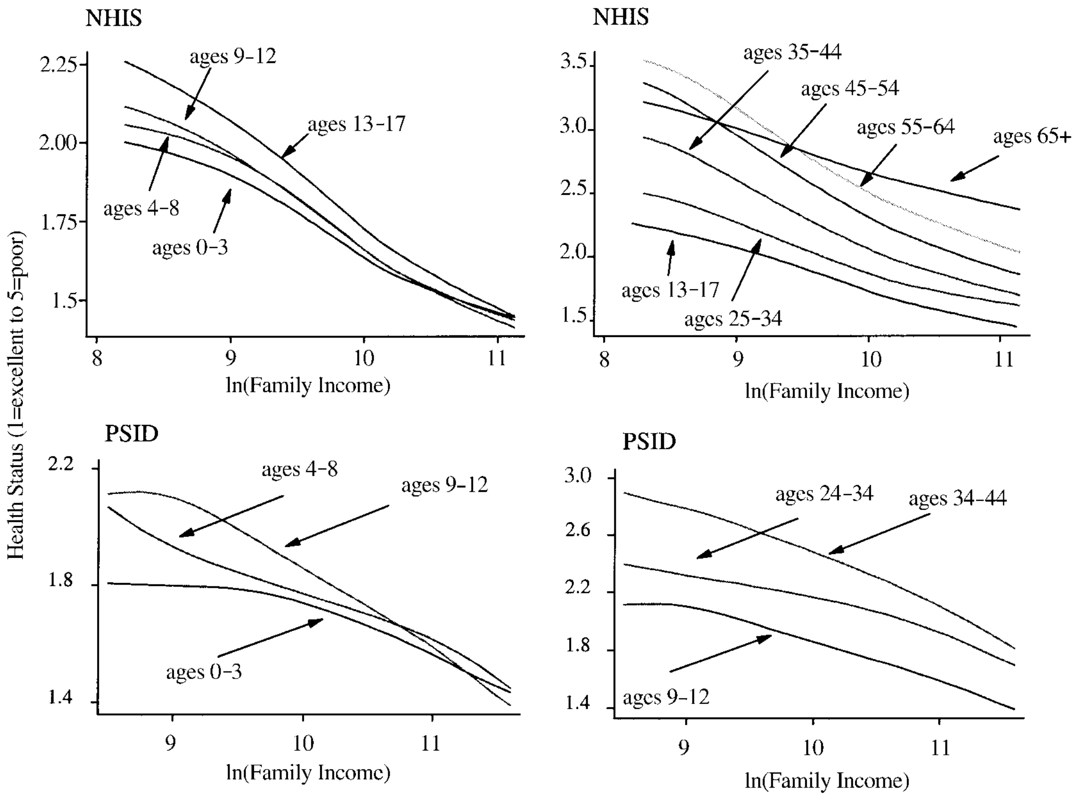

FIGURE 1. HEALTH AND INCOME FOR CHILDREN AND ADULTS: NHIS (1986–1995) AND PSID

representative of all adults in the United States. The conditional expectations are calculated using a Jianqing Fan (1992) locally weighted regression smoother, which allows the data to determine the shape of the function, rather than imposing (for example) a linear or quadratic form. The top left panel of Figure 1 presents results for children ages 0–3, 4–8, 9–12, and 13–17, and the right panel presents those same children 13–17, and compares them with adults of different ages.[1] The PSID uses the same age groupings for children (up to age 12), and two groupings of parents, aged 25–34 and 35–44.

Immediately apparent in the left panel of Figure 1 is the inverse relationship between family income and children's health status for children of all ages. The correlation becomes progressively more negative with age—a phenomenon that holds throughout childhood and adulthood (note the change in scale between the panels). This steepening of the gradient with age is observed until roughly age 65, a result consistent with the findings of other researchers. The results for the PSID are similar to those for the NHIS.

Our findings contrast with those found by Patrick West (1997). Using the 1991 British Census, West concludes that the gradient found among children disappears for youths (ages 11–19), only to reappear in early adulthood (ages 20 and higher). We find that the gradient in reported health status found in childhood becomes more pronounced as youths age, and no evidence that the gradient vanishes in adolescence.

[1] The Fan regressions are weighted using sampling weights provided in the NHIS, and are thus representative of the population as a whole. (Unweighted regression results are very similar.) We do not include adults aged 18–24 in this second panel because we are concerned about the representativeness of this sample of college-aged individuals, and whether these respondents report their current incomes or the incomes of the families in which they were raised.

There are many other parental, household, and child-specific characteristics that may vary between households with 2-year-olds (say) and households with 12-year-olds. In order to control for a range of other characteristics, we run ordered probits of health status (integers from 1 = excellent to 5 = poor) on income and on sets of household controls, and present the results in the first four columns of Table 2 for the NHIS.[2] We present two sets of results for each age group. The first row (labeled "NHIS Controls 1") shows results of ordered probits of health status on the log of family income, with age indicators, year indicators, and with controls for child and household characteristics, excluding parents' educations. (Details are given in the notes to the tables.) The next set of rows ("NHIS Controls 2") presents results in which, in addition to the variables in Controls 1, we include controls for parents' educations and unemployment status. The results in Table 2 show that the negative relationship between income and health status becomes more pronounced and significant for each older age group.[3]

The addition of parents' educational attainment to the set of controls has a large effect on the estimated income coefficients, reducing them by roughly a third for all ages relative to results using Controls 1. However, the gradients remain large and highly significant. Even with controls for parents' educations, a doubling of household income is associated with an increase in the probability that a child is in excellent or very good health of 4.0 percent (for ages 0–3), 4.9 percent (ages 4–8), 5.9 percent (ages 9–12), and 7.2 percent (ages 13–17). (These results are not reported in Table 2, but are available from the authors upon request.)

Although adding controls for education does not eliminate the effects of income, the coefficients on parents' educations are large and significant. Children living with a mother with a high-school degree are reported to be in better health than those whose mothers have not finished high school (the omitted category here). Children whose mothers have more than a high-school degree are reported to be in even better health. A similar pattern is seen with respect to fathers' educations. This may be because education makes parents more adept at protecting their children's health. Alternatively, education itself may not be causal, but may signify that the parent is patient, and may be more nurturing. In either case, if parents' educations are omitted, their effects may load onto the income coefficient, with which they are highly correlated.[4]

Distinct from the pattern we observed for income, we see little change in the impact of parents' educations on children's health status between younger and older ages. Both mothers' and fathers' educations have a slightly stronger impact for children above age 3; the coefficient on the indicator that mother has more than a high-school degree, for example, jumps from −0.244 to −0.322 between age groups 0–3 and 4–8. However, a comparison of the education coefficients for children aged 4–8, 9–12, and 13–17 show that the relationship between parents educations and childrens' health remain

[2] The results presented here are robust to estimating the models using ordinary least squares, and to using an indicator that health is reported to be "excellent" or "very good" as the dependent variable. The results are also robust to income being entered in levels, rather than logarithms. We have also performed some preliminary tests of whether income affects how a family translates different levels of "true" health into "perceived" health by looking at whether the cut points in our ordered probit models are sensitive to income level. One simple test for this is to divide the sample at median income into lower- and upper-income subsamples, and rerun the ordered probits looking for significant differences in cut points between the poorer and richer samples. We find no significant difference in cut points between richer and poorer households. (Results are available upon request from the authors.)

[3] The income coefficients for adjoining age groups are significantly different from one another for all of the NHIS results in Table 2.

[4] Another explanation is that household income is measured with error, and the "true" household income may be correlated with parents' educations, leading to large (or larger) coefficients on parents' educations, as the education coefficients pick up part of the effect of "true" income. We have explored whether measurement error in income is important in our analysis by instrumenting the log of family income with indicators for industry, occupation, and class of worker in the household. For each age group and each specification, the instrumented coefficients show a stronger effect of income on health status, increasing the size of the coefficients in absolute value between 25 and 50 percent. Other than its effect on the sizes of the coefficients, instrumentation does little to the pattern of coefficients observed here: the gradients for older children continue to be steeper than those for younger children. Instrumentation does reduce the estimated effects of mother's and father's educations, but their coefficients remain large and significant.

TABLE 2—HEALTH STATUS AND LN(FAMILY INCOME), NHIS AND NHANES

Panel A. NHIS

	Health status (1 = Excellent to 5 = Poor) (ordered probits)				Bed days	Restricted activity days	Hospital episodes	Missed school days
Ages:	0–3	4–8	9–12	13–17	0–17	0–17	0–17	5–17
Observations:	51,448	54,067	64,746	59,069	229,650	229,650	229,650	164,327
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NHIS Controls 1:								
ln(Family income)	−0.183	−0.244	−0.286	−0.323	−0.096	−0.030	−0.0079	−0.021
	(0.008)	(0.008)	(0.008)	(0.008)	(0.031)	(0.005)	(0.0009)	(0.003)
NHIS Controls 2:								
ln(Family income)	−0.114	−0.156	−0.187	−0.218	−0.198	−0.036	−0.0079	−0.019
	(0.008)	(0.008)	(0.008)	(0.009)	(0.035)	(0.005)	(0.0009)	(0.003)
Mother's education = 12 years	−0.136	−0.169	−0.170	−0.170	0.111	−0.011	−0.0021	−0.008
	(0.018)	(0.018)	(0.017)	(0.017)	(0.075)	(0.011)	(0.0020)	(0.007)
Mother's education > 12 years	−0.244	−0.322	−0.336	−0.319	0.319	0.001	−0.0029	−0.018
	(0.021)	(0.020)	(0.019)	(0.019)	(0.082)	(0.012)	(0.0022)	(0.008)
Father's education = 12 years	−0.148	−0.162	−0.169	−0.166	0.154	0.015	0.0042	0.005
	(0.020)	(0.020)	(0.019)	(0.019)	(0.078)	(0.012)	(0.0021)	(0.007)
Father's education > 12 years	−0.283	−0.298	−0.311	−0.306	0.317	0.038	0.0040	0.012
	(0.022)	(0.021)	(0.020)	(0.020)	(0.083)	(0.013)	(0.0022)	(0.007)

Panel B. NHANES Controls 3

	Parent-assessed health status (ordered probits)				Physician-assessed health status (ordered probits)			
Age:	0–3	4–8	9–12	13–17	0–3	4–8	9–12	13–16
Observations:	4,364	2,913	1,597	1,144	4,364	2,913	1,597	1,144
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Family income)	−0.160	−0.176	−0.202	−0.230	−0.051	−0.071	−0.102	−0.075
	(0.025)	(0.030)	(0.041)	(0.046)	(0.030)	(0.036)	(0.046)	(0.053)

Notes: NHIS results: The numbers in parentheses are robust standard errors, where correlation is allowed between unobservables for observations from the same household. For rows labeled "Controls 1," each regression included complete sets of age and year dummies; the logarithm of family size; indicators variables for whether the child has a mother in the household, has a father in the household, is male, is black, is white; interactions of the indicator for whether a mother (father) is in the household with mother's (father's) age; indicators for whether both the mother and father were respondents to the health survey, whether the father and not the mother was a respondent to the health survey, and whether neither the mother nor father were respondents to the health survey (the excluded category is that the mother but not the father was the respondent). For rows labeled "Controls 2," all variables in "Controls 1" are included plus the measures of the mother's (father's) schooling shown in the table and indicators of whether the mother (father) is unemployed, where each education and unemployment variable is interacted with an indicator of whether the mother (father) is in the household. The sample is restricted to children aged 17 or younger, who come from single-family households, who are members of the "primary family" in the household, who are children of either the reference person or spouse of reference person, who are of the same race as other children in the household, and who have nonmissing values for all of the variables included in the regression. All children in a household are removed if any children in the household are removed. Total sample size is 229,330.

NHANES III results: The numbers in parentheses are standard errors. "Controls 3" includes an indicator for whether the family was in the highest income bracket, whether the child is white or black, male, whether the mother reported for the child, whether the person was sampled in 1988–1991, a complete set of dummies for the child's age, the logarithm of family size, whether the household reference person is a woman, and the reference person's age, education, and marital status. Cases are dropped if the survey respondent was not a parent of the child, or if the respondent was not the household reference person or married to the reference person.

constant above age 3. That there is a steepening gradient of health with respect to income with age, but no steepening with respect to parents' educations, is noteworthy. It appears that income (and what it buys a child) has a different effect on a child's health from the skills that accompany parental education.

One potential objection to the use of parents' reports of their children's health status is that they are not objective, and may be colored by the parent's own health status. Such a finding would be inconsistent with Mark R. Dadds et al. (1995), who present evidence that maternal mental health does not influence mothers' reports of child health. We provide three additional pieces of evidence on this issue. First, we look at 17-year-olds in the NHIS, who were given the option of reporting on their own health. Specifically, we reproduced the results shown in the top panel of Table 2, adding both an indicator for whether the 17-year-olds responded for themselves and an interaction term of the logarithm of income with this indicator. In no case was the effect of either of the added variables significantly different from zero.

In addition, because the NHANES contains both physician-assessed and parent-assessed health status, we can evaluate whether the gradient we observe using parent-assessed health, and the rotation of this gradient with age, are due to a reporting bias that varies systematically with income. The bottom panel of Table 2 presents coefficients of log family income in ordered probits of parent-assessed health [columns (1)–(4)], and physician-assessed health [columns (5)–(8)]. The doctors who conducted the NHANES examinations generally report children to be in better health than do their parents. For example, while 7.6 percent of children in the NHANES are reported by their parents to be in fair or poor health, only 0.6 percent are reported to be in fair or poor health by the NHANES doctors. And, the rank correlation between the parents' and doctors' report (on a five-point scale), although significantly different from 0, is only 0.05. Both the parents' and doctors' reports have potential problems. Parents may be less able than doctors to objectively assess their child's health relative to that of other children. However, the NHANES doctors had very limited information about the children they examined. The doctors who conducted the exams had never seen the children before, were not present at the interview in which the children's health histories were taken, and conducted only basic physical exams.[5] It is therefore not surprising that few children were reported by these doctors to be in poor health, or that there is not more agreement between parents and doctors. Despite these problems, the doctor's assessments provide a useful cross-check on our results that use parent reports. For both, we find a significant correlation between income and children's health status, with larger effects for older children. The coefficients on income for physician-assessed health are smaller in absolute value than those for parent-assessed health, possibly because physicians use a smaller range of the health scale than do parents. That the income gradient in physician-assessed health status also rotates with children's ages (at least through age 12) suggests that the rotation we see in parent-assessed health is not the result of reporting bias.[6]

A third way of evaluating the gradients we find using parent reports of children's health is to compare them with those we find for other health-related outcomes. The last four NHIS columns of Table 2 report the gradients we observe for the number of days the child has spent in bed and the number of hospitalization episodes in the past 12 months, and the number of school days missed and days of restricted activity in the past two weeks. For all four of these measures of children's health status we find large and significant effects of family income.[7] These, then, provide additional evidence

[5] Before giving his or her assessment of a child's general health, the NHANES doctor assessed the child's locomotion, examined the child's eyes for vision problems, took his or her pulse (if age 4 or under) or blood pressure (if age 5 or older), listened to the child's chest and heart, and inspected the child for dermatitis and signs of sexual development. The children were also given a series of laboratory tests. However, these tests were not administered by the examining doctors and results of these tests were not known to doctors when their health assessments were made.

[6] Although the income coefficients are larger at higher ages in the NHANES, the differences between adjoining age groups are not significant.

[7] The relationships between income and the health measures shown in the last four columns of Table 2 do not become uniformly larger with age. This is perhaps not surprising, given that all of these health measures reflect both health problems and responses to health problems. The

that either income is itself protective of children's health, or is correlated with things that are protective of children's health. Perhaps both.

III. Chronic Conditions and the Gradient in Health

The previous section demonstrated that, on average, children's health becomes poorer with age and that the differences in the health of wealthier and poorer children become more pronounced with age. We turn now to examine whether the accumulation of chronic health conditions plays a role in the gradient. Poorer children may be more likely to suffer from chronic conditions—such as asthma, epilepsy, or heart conditions—that lead to poorer health status. In addition, their families may be less able to provide the investments necessary to maintain good health status in the presence of a chronic condition.

To motivate the analysis in this section, suppose that all children are born into excellent health regardless of their income levels, so that there is initially no income gradient in children's health. (That gradients in health become more pronounced with age due to the accumulation of chronic health conditions does not depend on the assumption that all children are born into excellent health. Income-related differences in birth weight and other measures of birth outcomes may account for the income gradients in health observed at the youngest ages. We will return to the role of health at birth in Section V.) Health shocks, in the form of the arrival of chronic conditions, arrive stochastically. We assume that the probability that a child is burdened by a new chronic condition is negatively related to his or her income level. If chronic conditions reduce the child's health stock, then over time poorer children will fall farther behind wealthier children. In addition, parents may be able to undertake investments that offset the effects of chronic conditions on health status. These investments could take many forms, including using appropriate medical care and prescription drugs, carefully following treatment regimens, or modifying the child's living environment to reduce the severity of the symptoms. If these parental investments are correlated with income—either because money is necessary to treat the condition, or because parents who earn high incomes are also better at managing health problems—then chronic conditions will do less damage to the health of wealthier children.

These ideas are formalized in the following empirical framework. Let C be an indicator for whether the child has a specific chronic condition, H be an indicator of poor health (measured in practice as an indicator for whether the child is reported to be in fair or poor health), $\ln y$ be the logarithm of family income, and X be a set of controls, including the logarithm of family size and indicators for the child's age, race, gender, and the survey year. Family income affects the probability that a child contracts a chronic condition. Income also affects health status, and the effect of income on health will depend in part on whether or not the child has a chronic condition.

The probability that a child is in poor health can be expressed as

$$(1)\quad P(H|X) = P(H|C=0, X)P(C=0|X) + P(H|C=1, X)P(C=1|X)$$

where all probabilities depend on the logarithm of income. Suppressing the X's, the change in the probability of poor health with respect to income can be decomposed into three terms:

$$(2)\quad \frac{\partial P(H)}{\partial \ln y} = \frac{\partial P(H|C=0)}{\partial \ln y} + \left[\frac{\partial P(H|C=1)}{\partial \ln y} - \frac{\partial P(H|C=0)}{\partial \ln y}\right]P(C=1) + [P(H|C=1) - P(H|C=0)]\,\frac{\partial P(C=1)}{\partial \ln y}.$$

relationship between income and the first three health measures (bed days, restricted activity days, and hospital episodes) is larger for children aged 0–3 than for those aged 4–8. This could reflect medical treatment for very young children associated with prematurity and low birth weight, something that exhibits a strong income gradient. Income gradients in bed days and restricted activity days increase with age for children over the age of 3. Gradients in hospital episodes and days missed from school show no systematic pattern with age above the age of 3.

The first term is the effect of income on poor health in the absence of the chronic condition. The second term, which we call the "severity effect," is the additional impact of income on poor health given a chronic condition. The third term, which we refer to as the "prevalence effect," is the effect of income on poor health that works through the greater chance that poorer children obtain the chronic condition.[8]

We use the following linear probability models to estimate the terms in (2):

$$C = \alpha_0 + \alpha_1 \ln y + X\delta^C + \varepsilon^C \quad (3)$$

$$H = \beta_0 + \beta_1(\ln y - \overline{\ln y}) + \beta_2 C + \beta_3(\ln y - \overline{\ln y})C + X\delta^H + \varepsilon^H. \quad (4)$$

The probability of poor health is, then, estimated to depend on the logarithm of family income, chronic conditions, and their interactions with family income. In (4), we find it convenient to express incomes as deviations from mean income, in order to more readily interpret the coefficients as the effect of income at mean income. Because the NHIS assigns each family to one of six "condition lists," we do not know the full range of chronic conditions for any child. Equations (3) and (4) are estimated separately for each of 14 different chronic conditions, so that (for example) in one set of estimates C equals 1 if the child has asthma, and 0 otherwise, and in other sets of estimates C is an indicator for one of the 13 other conditions.

The parameters of equations (3) and (4) can be used to test a variety of hypotheses. First, they provide information on whether poorer children are more likely to obtain chronic conditions (in which case α_1 will be negative), and whether chronic conditions have a smaller impact on the health status of wealthier children (in which case β_3 will be negative). Second, the coefficient β_2 provides information on which chronic conditions have the most serious impact on health status. If income is effective at buffering children against the adverse effects of the most serious chronic conditions, then β_3 will be largest (in absolute value) for those conditions for which β_2 is largest. Third, it is plausible that the adverse effects of chronic conditions, and the protective role of income in their presence, become more pronounced with the length of time the child has the condition. We do not observe the date of onset of each of these conditions. However, for conditions that are realized at young ages, older children will on average have had conditions for longer periods. By estimating (4) separately for older and younger groups we can examine whether, in the cross section, β_3 is larger for older children. Finally, the parameters of (3) and (4) can be combined to assess the "severity" and "prevalence" effects of chronic health conditions. The "severity effect" is measured as $\beta_3\bar{C}$, where $\bar{C}$ is the average probability of having the chronic condition, and the "prevalence effect" is measured as $\beta_2\alpha_1$.

Estimates of (3) and (4) may be affected by measurement error in health conditions. Two types of error are possible. First, parents may simply misreport chronic conditions (see Michael Baker et al., 2001). Second, poorer children may be less likely to have their chronic conditions diagnosed, or may not have conditions diagnosed until they reach older ages. Underdiagnosis among poorer children will bias the estimates of the income gradients in conditions (α_1) upwards. In addition, if only more severe cases of illness among poor children are diagnosed, then estimates of the protective effects of income given that a conditions occurs (β_3) will be overstated. These biases are likely to be less of a problem for medical conditions that are difficult to overlook—for example, epilepsy, diabetes, or physical deformities. In what follows, we present results for the full range of conditions, but then focus our attention on conditions for which diagnosis and reporting errors are unlikely.

We begin by examining whether there are gradients in the medical conditions that children contract. We selected a set of 14 potentially serious health conditions on which the NHIS collects information, leaving aside conditions that rarely if ever appear in childhood (e.g., emphysema, arthritis, cirrhosis of the liver). Most of the conditions we consider are "chronic" in

[8] We thank a referee for suggesting this accounting framework.

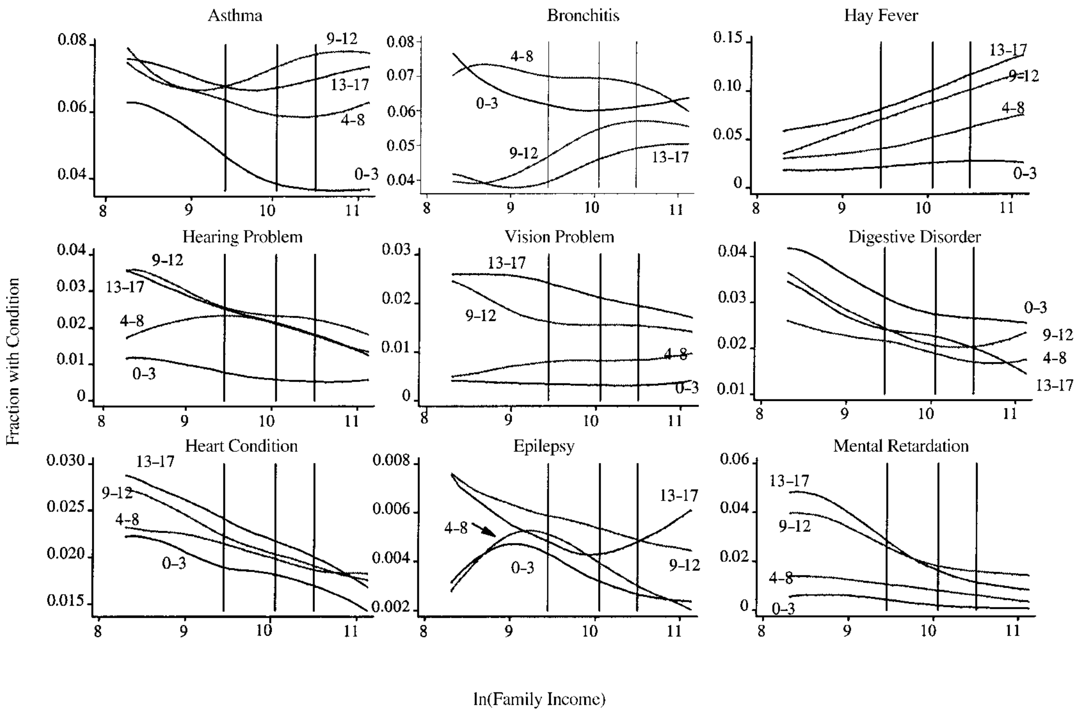

FIGURE 2. GRADIENTS IN CHRONIC CONDITIONS: NHIS (1986–1995)

the sense that the fraction of children who have these conditions increases with age. Exceptions are digestive disorders, which are most common among very young children, and bronchitis. Detailed information on these conditions is provided in the Appendix. Figure 2 parallels Figure 1, and shows nonparametric regressions of an indicator of having a medical condition on the log of family income for children in different age groups. We have graphed 9 of the 14 conditions to illustrate the diversity of relationships between specific medical conditions and income. The vertical lines in the figures are placed at the 25th, 50th, and 75th percentiles of income.

Many of the conditions are more prevalent at lower incomes for all age groups. These include digestive disorders, hearing problems, heart conditions, epilepsy, and mental retardation. Others display a negative relationship between prevalence and income for some but not all ages. For example, there is a negative association between asthma and income for children aged 8 and under, but not for older children. This result is consistent with Neal Halfon and Paul W. Newacheck (1993), who find that the difference in the prevalence of asthma across children above and below the poverty line is largest for young children.

Table 3 presents descriptive statistics for the 14 conditions we examine and estimates of equations (3) and (4). The prevalence rates range from over 5 percent for respiratory ailments, to less than 1 percent for diabetes, epilepsy, and kidney disease. The estimates of α_1 shown in the second column indicate that only two conditions—hay fever and sinusitis—are positively related to income. The steepest (negative) income gradients are for mental retardation, hearing disorders, digestive problems, and asthma. In general, these findings are consistent with Newacheck (1994), who argues that it is the most serious chronic conditions that are more common among poor children.

The estimate of β_2 shows the change in the probability of reporting fair or poor health with each condition, evaluated at mean family income. The results indicate that conditions we

TABLE 3—CHRONIC CONDITIONS, INCOME, AND POOR/FAIR HEALTH, 1986–1995 NHIS

Condition (C)	Fraction with $C = 1$	α_1	β_1	β_2	β_3	β_3 for children ages: 0–8	9–17
Hay fever	0.0648	0.0155	−0.016	0.016	−0.012	−0.013	−0.007
[43,493]		(0.0015)	(0.001)	(0.005)	(0.006)	(0.010)	(0.007)
Bronchitis	0.0561	−0.0007	−0.015	0.056	−0.030	−0.027	−0.038
[43,493]		(0.0014)	(0.001)	(0.006)	(0.008)	(0.010)	(0.012)
Asthma	0.0629	−0.0027	−0.013	0.098	−0.048	−0.042	−0.054
[43,493]		(0.0014)	(0.001)	(0.006)	(0.007)	(0.010)	(0.010)
Sinusitis	0.0652	0.0053	−0.015	0.028	−0.020	−0.016	−0.020
[43,493]		(0.0014)	(0.001)	(0.005)	(0.006)	(0.011)	(0.008)
Heart condition	0.0203	−0.0021	−0.015	0.076	−0.030	−0.026	−0.035
[44,499]		(0.0008)	(0.001)	(0.010)	(0.012)	(0.015)	(0.018)
Diabetes	0.0016	−0.0002	−0.018	0.169	−0.139	0.203	−0.174
[44,197]		(0.0002)	(0.002)	(0.045)	(0.052)	(0.163)	(0.049)
Epilepsy	0.0043	−0.0008	−0.017	0.223	−0.077	−0.025	−0.098
[44,197]		(0.0004)	(0.002)	(0.032)	(0.034)	(0.062)	(0.041)
Frequent headaches	0.0259	−0.0024	−0.017	0.055	−0.037	−0.142	−0.035
[44,197]		(0.0009)	(0.002)	(0.008)	(0.011)	(0.030)	(0.012)
Kidney disease	0.0031	−0.0009	−0.018	0.187	−0.007	−0.055	0.030
[44,197]		(0.0003)	(0.002)	(0.035)	(0.038)	(0.063)	(0.047)
Digestive problem	0.0233	−0.0037	−0.017	0.081	−0.034	−0.015	−0.061
[44,731]		(0.0009)	(0.001)	(0.009)	(0.010)	(0.011)	(0.018)
Vision problem	0.0121	−0.0016	−0.016	0.062	−0.040	−0.062	−0.033
[44,680]		(0.0006)	(0.001)	(0.012)	(0.015)	(0.036)	(0.106)
Hearing disorder	0.0174	−0.0039	−0.016	0.081	−0.038	−0.029	−0.041
[44,680]		(0.0007)	(0.001)	(0.011)	(0.013)	(0.023)	(0.016)
Mental retardation	0.0126	−0.0058	−0.016	0.113	−0.041	−0.008	−0.049
[44,680]		(0.0007)	(0.001)	(0.015)	(0.017)	(0.036)	(0.019)
Deformity	0.0350	−0.0002	−0.015	0.062	−0.045	−0.026	−0.049
[44,680]		(0.0010)	(0.001)	(0.007)	(0.010)	(0.018)	(0.012)

Notes: $H = 1$ if the child is in fair or poor health, and is otherwise 0. $C = 1$ if the child has the health condition listed in the first column, and is otherwise 0. Each row shows means and regression results for each health condition. The number of observations is given in square brackets in the leftmost column. Regression equations are as follows:

$$C = \alpha_0 + \alpha_1 \ln y + X\delta^C + \varepsilon^C$$

$$H = \beta_0 + \beta_1(\ln y - \overline{\ln y}) + \beta_2 C + \beta_3(\ln y - \overline{\ln y})C + X\delta^H + \varepsilon^H.$$

All regressions include a complete set of age dummies, year dummies, the logarithm of family size, and indicator variables for whether the child was male, white, or black. The last two columns show estimates of β_3 for estimates of (4) on separate samples of children aged 0–8 and 9–17. Robust standard errors are in parentheses.

would a priori label as more severe have the largest effect on children's health status: at mean family income, the probability of poor health increases by 9.8 percent with asthma; 16.9 percent with diabetes; 22.3 percent with epilepsy; 18.7 percent with kidney disease; and 11.3 percent with mental retardation. Conditions we would a priori label as less severe have the smallest effect on children's health: at mean household income the probability of poor health increases by 1.6 percent with hay fever and 2.8 percent with sinusitis.

Among children with any given chronic condition, children from wealthier families are in better health. For every condition, the interaction term between income and the chronic condition (β_3) is negative and significant, with the exception of kidney disease. These results support the hypothesis that income (or parental characteristics associated with income) buffers children from the adverse effects of chronic conditions. In addition, the gradient in health is largest for the most severe chronic conditions. That is, the protective effect of income is largest for the conditions that cause the greatest erosion to children's health status. The largest interaction terms are observed for asthma (−0.048), diabetes (−0.139), and epilepsy (−0.077)—three of the chronic conditions that lead to the largest average deterioration of health status. (The only exception here is kidney disease, where the condition has a large and significant effect on health status, but income appears not to be protective.) It was noted above that if poorer children are less likely to be diagnosed unless their conditions are very serious, then estimates of β_3 will be overstated. However, estimates of β_3 are large for conditions such as diabetes, epilepsy, and deformities, for which measurement error and differential diagnosis rates by income are less likely to occur.

In the last two columns of Table 3 we examine whether the protective effect of income in the presence of chronic conditions is larger for older children. Consistent with the hypothesis that the buffering effect of income is cumulative, we find that income is more protective of children's health status at older ages for all but three of the conditions presented. However, the estimates of β_3 are not precise, and the differences between the coefficients for younger and older conditions are not significant.

The top panel of Table 4 presents decompositions of the income gradient in poor health into the three components shown in equation (2), plus a residual, for a selected group of chronic conditions. All terms are expressed as a fraction of the estimated effect of income on poor health, obtained from a regression of H on the logarithm of income and the elements in X.[9] Several of the chronic conditions we observe explain substantial shares of the income gradient in health. Asthma explains the largest share: the sum of the severity and prevalence effects accounts for approximately 20 percent of the gradient. Physical deformities account for 9.3 percent, and heart conditions account for nearly 5 percent. Because there may be co-morbidity across conditions, these shares cannot be summed to arrive at a total share of the income gradient in health explained by the full set of conditions.[10] However, these results provide evidence that chronic conditions play an important role in the income gradient in children's health.

The effect of income that is mediated through chronic conditions works largely through the severity effect rather than the prevalence effect. This is most apparent for asthma and physical deformities. For each of these conditions, poorer children are not much more likely to have the condition, but are more likely to be in poor health given that they have the condition. It was noted above that if poorer children are less likely to be diagnosed when they have milder forms of conditions, the prevalence effect will be biased down and the severity effect will be overstated. However, the fact that the severity effects dominate for conditions that are unlikely to go unnoticed (such as diabetes, epilepsy and deformities) indicates that this cannot be the whole story. In addition, a comparison of the second and third panels in Table 4 indicates that the severity effects are if anything larger for older children, a group for which underdiagnosis is less likely to be a problem.

The last two panels of Table 4 present decompositions for two additional measures of poor health: days in bed due to illness and the number of hospitalization episodes in the last year. Again, asthma accounts for a substantial fraction of the income gradient in these

[9] The estimated effect of income on health, shown in the first column of Table 4, differs across conditions only because different subsamples of the NHIS were asked about different groups of chronic conditions. The results are similar if we instead use the effect of income on health estimated over the full sample.

[10] Evidence from the 1988 NHIS-CH, which collected information about a set of health problems for each sample child, indicates that there is substantial co-morbidity. For this much smaller sample (17,000 children), we find that children with asthma (to take one example) are also significantly more likely to suffer from many other chronic conditions, including repeated tonsilitis, ear infections, deafness, respiratory and food allergies, and frequent headaches. These children are no more likely, however, to suffer from epilepsy, congenital heart disease, diabetes, and hand/arm/leg impairments—none of which have any logical connection with asthma. Regressions of health status on condition indicators and a limited set of interactions between condition indicators demonstrate that the adverse effects of multiple conditions are more severe than the sum of the effects of individual conditions. Returning to our example of children with asthma, we find that in ordered probits of health status, interactions between indicators of asthma and 19 other chronic conditions are highly jointly significant. (Details are available from the authors.)

TABLE 4—A DECOMPOSITION OF THE RELATIONSHIP BETWEEN HEALTH MEASURES AND INCOME FOR SELECTED CHRONIC CONDITIONS

		Fraction of $\partial H/\partial \ln y$ due to:			
Condition (C)	$\partial H/\partial \ln y$ (1)	$\partial H/\partial \ln y$, $C = 0$ (2)	Severity effect of C (3)	Prevalence effect of C (4)	Residual (5)
All Ages, H = Indicator that Health Is Fair or Poor:					
Asthma	−0.0163	0.7742	0.1847	0.0164	0.0247
Heart condition	−0.0160	0.9522	0.0388	0.0098	−0.0008
Diabetes	−0.0180	0.9880	0.0124	0.0017	−0.0021
Epilepsy	−0.0180	0.9717	0.0187	0.0101	−0.0006
Deformity	−0.0169	0.9133	0.0926	0.0009	−0.0067
Ages 0–8, H = Indicator that Health Is Fair or Poor:					
Asthma	−0.0131	0.7562	0.1744	0.0376	0.0318
Heart condition	−0.0145	0.9547	0.0361	0.0093	−0.0000
Diabetes	−0.0136	10.004	−0.0072	0.0006	0.0024
Epilepsy	−0.0136	0.9865	0.0068	0.0090	−0.0023
Deformity	−0.0151	0.9662	0.0319	0.0046	−0.0027
Ages 9–17, H = Indicator that Health Is Fair or Poor:					
Asthma	−0.0204	0.7896	0.1915	−0.0007	0.0196
Heart condition	−0.0177	0.9499	0.0413	0.0105	−0.0017
Diabetes	−0.0232	0.9786	0.0211	0.0023	−0.0020
Epilepsy	−0.0232	0.9631	0.0212	0.0101	0.0056
Deformity	−0.0192	0.8667	0.1382	−0.0014	−0.0035
All Ages, H = Number of Bed Days in Last Year:					
Asthma	−0.2340	0.3944	0.4805	0.0588	0.0663
Heart condition	−0.1041	0.8019	0.1086	0.0917	−0.0022
Diabetes	−0.2386	0.9113	0.0992	0.0064	−0.0169
Epilepsy	−0.2386	0.9184	0.0219	0.0604	−0.0169
Deformity	−0.0869	0.7414	−0.0134	0.2739	−0.0022
All Ages, H = Number of Hospital Episodes in Last Year:					
Asthma	−0.0106	0.5486	0.3767	0.0243	0.0504
Heart condition	−0.0069	0.9412	0.0192	0.0400	−0.0004
Diabetes	−0.0120	0.9967	−0.0005	0.0037	0.0001
Epilepsy	−0.0120	0.9636	0.0080	0.0286	−0.0002
Deformity	−0.0074	0.9792	0.0189	0.0032	−0.0014

Notes: The results in this table are based on the regressions of the form shown in Table 3. Column (1) shows the coefficient on the logarithm of income from a regression of H on the logarithm of income and the set of controls listed in the note to Table 3. Column (2) is equal to β_1 divided by column (1). Column (3) is $\beta_3\bar{C}$ divided by column (1). Column (4) is $\beta_2\alpha_1$ divided by column (1). Column (4) is column (1) minus the sum of columns (2), (3), and (4), divided by column (1).

measures. Over 50 percent of the gradient in bed days and 40 percent of the gradient in hospitalization episodes are explained by asthma alone. Furthermore, the severity effects for asthma are much larger than the prevalence effect. Although children with asthma spend more days in bed and have more hospitalization episodes than children without asthma, this is especially true for poor children with asthma. The other conditions shown, which are more rare than asthma, account for less of the gradient, and also do not consistently show severity effects that are substantially larger than prevalence effects.

TABLE 5—HEALTH STATUS AND FAMILY INCOME AT DIFFERENT AGES, PSID
(Dependent Variable: Health Status [1 = Excellent to 5 = Poor])

	Panel A. Ordered Probits of Health Status on Log of Average Income in Different Periods of Life											
	Ages 0–3			Ages 4–8				Ages 9–12				
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log(mean income 6 years to 1 year before birth)	−0.137 (0.069)		−0.083 (0.077)	−0.160 (0.059)			−0.075 (0.070)	−0.176 (0.068)				−0.066 (0.084)
Log(mean income ages 0–3)		−0.160 (0.068)	−0.125 (0.075)		−0.177 (0.056)		−0.022 (0.079)		−0.199 (0.062)			−0.092 (0.090)
Log(mean income ages 4–8)						−0.223 (0.055)	−0.184 (0.070)			−0.195 (0.066)		0.040 (0.101)
Log(mean income ages 9–12)											−0.236 (0.059)	−0.206 (0.080)
Chi-square test: joint significance of income coefficients			6.68 (0.0354)				18.33 (0.0004)					19.30 (0.0007)
Chi-square test: equality of coefficients			0.10 (0.7463)				1.93 (0.3814)					2.56 (0.4652)
	Panel B. Ordered Probits of Health Status on the Log of Average Income During the Child's Entire Life											
Log(mean income birth year to 1997)			−0.160 (0.068)				−0.253 (0.063)					−0.297 (0.075)
	Panel C. Ordered Probits of Health Status on the Log of Average Income from Six Years Prior to Birth Through 1997											
Log(mean income six years prior to birth to 1997)			−0.182 (0.082)				−0.257 (0.070)					−0.344 (0.075)
	Panel D. Ordered Probits of Health Status on the Log of Average Income from Nine Years Prior to Birth Through 1997											
Log(mean income nine years prior to birth to 1997)			−0.183 (0.081)				−0.261 (0.072)					−0.359 (0.088)
Number of observations:	809	809	809	1,078	1,078	1,078	1,078	883	883	883	883	883

Notes: Standard errors are in parentheses. All regressions include a complete set of age dummies, and indicators that child is male, white, or black; an indicator that mother is present; mother's age interacted with her presence; mother's education interacted with her presence; an indicator that father is present; father's age interacted with his presence; father's education interacted with his presence; and the log of family size. If a parent's education is missing, the mean education for that sex is assigned, and an indicator variable is included that education is missing. Log(mean income ages 0–3) is the log of the mean income for the household when the child was between the ages of 0 and 3. Other income variables analogously defined.

IV. Current Versus Permanent Income

Evidence presented above left open the question of whether the timing of income over a child's life affects a child's health. One possibility is that investment decisions are made based on long-run average income, in which case the timing is not important. Another possibility, which has been discussed in the child development literature, is that the effect of income depends on the age of the child when the income was received (Jeanne Brooks-Gunn et al., 1997). We use data from the PSID to examine whether the timing of income matters, exploiting the fact that we have information on the family's income throughout the child's lifetime (and indeed from the period before the child was born). The first panel of Table 5 presents the results of ordered probits of health status on the log of average income in different periods of life (ages 0–3, 4–8, 9–12), and on the log of average income in the household in the six years before the child was born. We control throughout Table 5 for the child's age, sex, and race; the presence of the child's mother, and her age and education if present; the presence of the child's father, and his age and education if present; and the log of family size. If a parent's education is missing, the mean education for that sex is assigned, and an indicator variable is included that education is missing. Each column of Panel A presents the results of a different ordered probit.

We see in Table 5 that family income in the years before the child is born and those at different ages of life are all equally correlated with a child's current health status. Family income *prior* to the child's birth is significantly correlated with the child's current health, for children of all ages [columns (1), (4), and (8) of Panel A]. Moreover, the coefficient on income prior to birth for children aged 0–3 (−0.137) is not significantly different from that on income during the years when the child is aged 0–3 (−0.160). The same pattern is seen for older children: the coefficient on income prior to birth for children aged 9–12 (−0.176) is not significantly different from that on income during ages 0–3 (−0.199), ages 4–8 (−0.195), or ages 9–12 (−0.236).

These results are consistent with the hypothesis that long-run average income determines health investments and health status at different ages. If this is true, the coefficients on income when the child was aged 0–3, for children now aged 4 or above, cannot be interpreted as the impact of income arriving during ages 0–3. For these older children, the coefficient on income from earlier ages (and indeed that before birth) just provides us with an estimate of the impact of permanent income on children's health at their current age.

We cannot reject that income at different ages have equal effects on a child's health status, and in the last three panels we impose their equality. We estimate ordered probits of health status on the log of average income for all years the child has been alive (birth year to 1997) in Panel B; on the log of average income from the six years prior to birth through 1997, in Panel C; and on the log of average income from the nine years prior to birth through 1997, in Panel D. Using income since birth, we find a significant relationship between income and health status that becomes more pronounced at older ages (the coefficient increases from −0.160 for the youngest children to −0.253 for children aged 4–8, to −0.297 for children aged 9–12). When we use income from six years prior to birth through to current age, these coefficients become larger in absolute value (−0.182, −0.257, −0.344); our measure of permanent income becomes less noisy when we use these additional years of data. The coefficient estimates change very little with additional lags beyond that point (see the results when we add lags of income for seven to nine years before birth in Panel D). We take the evidence in Table 5 to suggest that children's health status is most closely associated with the household's permanent income, and that the impact of permanent income on a child's health status becomes larger, the older is the child.[11]

V. Understanding the Gradient

The results presented above are consistent with a model in which permanent income affects children's health status, and does so in part through its effect on parental management of children's chronic conditions. These results do not rule out many third factor explanations, such as a lasting effect of poor health at birth, or a spurious correlation between children's health and household income that derives from poor parental health. We evaluate these potential explanations in this section.

A. *Health at Birth*

The discussion above proceeded under the assumption that all children were born in excellent health. In fact, health at birth varies across children. Some children are born with health problems, such as prematurity, low birth weight for gestational age, or congenital birth defects.

[11] We do not take this as evidence in support of the permanent income model of consumption and saving. Unlike current consumption, health status is a stock that evolves slowly over time. Even if the permanent income model is not valid, so that current consumption tracks current income (especially for poorer consumers), health status may change little in response to short-term income fluctuations. Although health-related behaviors and stress-induced physical problems may change with current income, their effects on health status may take time to become manifest.

There are several reasons to think that heterogeneity in health at birth could account for at least some of our earlier findings. First, it may be that children born to poorer women are at greater risk of being born with health problems, possibly due to poorer prenatal care, higher rates of maternal smoking that accompany lower income levels, or other maternal or environmental characteristics associated with low income. Poor birth health could therefore produce a gradient in health among very young children. Second, if poorer children are born with the most severe health problems, ones that require a longer recovery period or that result in chronic conditions, then the gap in health between rich and poor children might increase with age, as wealthier children who are born in poor health recover whereas poorer children who are born in poor health do not. Finally, holding constant the severity of health problems at birth, wealthier children may recover faster because their parents spend more on their care.

For policy purposes, it is important to examine whether health at birth accounts for a large part of the gradient between health and income in childhood. If so, it implies that equalizing the quality of prenatal health care and working to improve maternal health behaviors in the prenatal period may go a long way toward eliminating the gradients we observe throughout childhood.

We use data from the NHIS to examine whether health at birth accounts for the relationship between current health and current income. The core NHIS collects no information on health at birth. However, the NHIS-CH supplement collects information for one child per family on the child's birth weight and the number of nights the child spent in the hospital after the birth. In Table 6, we show results of ordered probits of current health status on poor health at birth, including interactions of poor birth health with age and income. We use, as an indicator of poor health at birth, that a child spent one week or longer in the hospital after birth and/or that the child was born at very low birth weight (less than 3.5 pounds). This assigns poor birth health to 10 percent of our sample. (Results are similar using different cutoffs for poor birth health.)

The results indicate that poor birth health has larger adverse effects on children at low income levels, and that improvements with age are slower for poorer children. Column (2) shows that poor health at birth is positively related to poor health later in life, but that the effects of poor health at birth diminish with age. The addition of controls for poor health at birth has very little effect on the health-income gradient, or on our estimate of the rotation of the gradient with age. Results in column (2) also suggest that the adverse effects of poor health at birth on current health dissipate with age.[12] The third column includes an interaction of health at birth and income, and indicates that poor birth health has a larger adverse effect on poorer children. In the fourth column, we examine the hypothesis that higher-income children recover from poor health at birth more quickly than do poorer children, by including an interaction of age, poor health at birth, and income. (The birth health/income interaction is omitted, which imposes the implicit restriction that poor health at birth has identical effects on health status for poor and rich children at age 0.) The parameter estimate for this interaction term is negative and marginally significant, indicating that the adverse effects of health at birth on current health decline more quickly with age for wealthier children. The final column shows results of an ordered probit that include a complete set of interactions of poor health at birth with age, income, and income times age. The parameter estimates are consistent with the hypothesis that wealthier children are less affected by poor health at birth, and recover more quickly. However, although the "health at birth" variables are jointly significant, with this number of interactions the individual parameters are not estimated precisely. Most important for our analysis, adding controls for birth health does not alter the basic finding that lower income is associated with worse health. Health at birth does not account for the income gradient in childhood health.

[12] This is consistent with the findings of Marie C. McCormick et al. (1993) but somewhat at odds with those of Janet Currie and Rosemary Hyson (1999). Currie and Hyson, using data from the British National Child Development Survey (1958 birth cohort) find a significant effect of low birth weight on the probability a woman reports fair or poor health at age 23, but not at age 33, and a significant effect of low birth weight on the probability that men report fair or poor health at age 33, but not at age 23.

TABLE 6—BIRTH HEALTH AND INCOME, NHIS-CH: Ordered Probits
(Dependent Variable: Health Status [1 = Excellent to 5 = Poor])

Variable	(1)	(2)	(3)	(4)	(5)
ln*y*	−0.091	−0.086	−0.082	−0.087	−0.087
	(0.020)	(0.020)	(0.021)	(0.020)	(0.021)
Age	0.067	0.074	0.072	0.065	0.065
	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)
ln*y* × age	−0.006	−0.007	−0.007	−0.006	−0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Indicator: poor birth health		0.400	0.847	0.397	0.354
		(0.062)	(0.315)	(0.062)	(0.595)
(Poor birth health) × age		−0.026	−0.025	0.029	0.033
		(0.006)	(0.006)	(0.032)	(0.060)
(Poor birth health) × ln*y*			−0.047		0.004
			(0.032)		(0.061)
(Poor birth health) × ln*y* × age				−0.006	−0.006
				(0.003)	(0.006)
Chi-square test: joint significance of birth health and all birth health interactions		48.41	50.46	51.43	51.44
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
Chi-square test: joint significance of birth health interactions			20.06	20.96	20.97
			(0.0000)	(0.0000)	(0.0000)

Notes: Standard errors are in parentheses. "Poor birth health" is an indicator variable equal to 1 if birth weight is less than 3.5 pounds or the child is in the hospital for one week or longer after the birth. Sample size = 13,841. Other controls include a complete set of age dummies, the logarithm of family size, indicators variables for whether the child has a mother in the household, a father in the household, whether the child is male, black, or white; interactions of the indicator for whether a mother is in the household with mother's age and mother's education, and interactions of the indicator for whether a father is in the household with father's age and father's education. Other controls include dummy variables for whether both the mother and father were respondents to the health survey, whether the father and not the mother was a respondent to the health survey, and whether neither the mother nor father were respondents to the health survey (the excluded category is that the mother but not the father was the respondent).

B. *Parental Health as a Determinant of Children's Health*

Children's health may also be affected by the health status of their parents, possibly through an inherited susceptibility to different diseases, a less healthy uterine environment, or lower quality care by sick parents. In addition, the health of parents and children might be affected by common but unmeasured environmental factors, resulting in a correlation between their health levels. It is also possible that parental health is a "third factor" that accounts for the income gradient in children's health: an income gradient in children's health might be observed if parents in poor health have lower earnings, and poor health is transmitted from parents to children—producing a spurious correlation between income and children's health.

This line of reasoning might suggest equations of the form shown in Table 2 should include controls for parental health. However, doing so has several potential pitfalls. If the health of parents is affected by their income levels (as is argued in much of the literature on socioeconomic status and health), and income is measured with error, then the "effects" of parental health may simply reflect the effects of income. In addition, if the health of both parents and children are affected by current and lagged values of income, the parental health may serve

TABLE 7—HEALTH STATUS, INCOME, AND PARENTAL HEALTH, NHIS AND PSID

Panel A. NHIS 1986–1995

	Health status (1 = Excellent to 5 = Poor) (ordered probits)			
Ages:	0–3	4–8	9–12	13–17
Observations:	51,448	54,067	64,746	59,069
Variable	(1)	(2)	(3)	(4)
ln(Family income)	−0.048	−0.077	−0.098	−0.125
	(0.009)	(0.008)	(0.008)	(0.009)
Mother's health is excellent or very good	−0.746	−0.782	−0.771	−0.744
	(0.017)	(0.014)	(0.013)	(0.013)
Father's health is excellent or very good	−0.458	−0.489	−0.531	−0.498
	(0.017)	(0.016)	(0.015)	(0.015)

Panel B. PSID

	Health status (1 = Excellent to 5 = Poor) (ordered probits)					
Ages:	0–3		4–8		9–12	
Observations:	801	801	1,073	1,073	878	878
Variable	(1)	(2)	(3)	(4)	(5)	(6)
ln(Current family income)	−0.011	—	−0.177	—	−0.109	—
	(0.052)		(0.040)		(0.049)	
ln(Mean income six years prior to birth to current year)	—	−0.163	—	−0.249	—	−0.250
		(0.084)		(0.070)		(0.086)
Mother's health is excellent or very good	−0.379	−0.374	−0.461	−0.480	−0.496	−0.488
	(0.101)	(0.101)	(0.084)	(0.084)	(0.091)	(0.091)
Father's health is excellent or very good	−0.202	−0.200	−0.155	−0.136	−0.358	−0.345
	(0.127)	(0.127)	(0.108)	(0.108)	(0.116)	(0.116)

Notes: Robust standard errors are in parentheses. For the NHIS, the sample and set of controls is identical to that used in the lower panel of Table 2, the only difference being the addition of the parental health measures. For the PSID, the sample and set of controls is identical to that in Table 5 except for the addition of the parental health measures and the loss of a small number of observations due to missing information on parental health. In all cases, parental health is interacted with an indicator for whether the parent is present in the household. An indicator of whether the parent is present is also included.

as a proxy for the income levels experienced by children at earlier ages. For both of these reasons, we cannot cleanly separate the effects of parent's health and family income on children's health.

Mindful of these problems, we estimate models identical to those in the lower panel of Table 2 but with additional controls for mothers' and fathers' health status, to see whether this eliminates the income gradient in health or the steepening of the gradient with age. The results are shown in Table 7. The top panel presents results for the NHIS in which indicator variables are included for whether the child's mother and father are in excellent or very good health. The bottom panel presents analogous results for the PSID. Because the PSID is a panel, we can also test whether results are more robust when using long-run average income, in place of current income. There are several key findings. First, there are large "effects" of parent's health on children's health. For example, if a child aged 0–3 has a mother in very good or excellent health, his or her chance of also being in very good or excellent health rises by 27 percent (estimate not reported in Table 7). The corresponding increase associated with having a father in very good or excellent health is 16 percent. Second, mother's health is more strongly associated with children's health than is father's health, which is consistent with the idea that women in worse health bear less healthy children, or that poor health in women makes them less able caregivers.[13]

Third, the inclusion of controls for parents' health reduces the coefficients on family income. For children in the oldest age group, the coefficient on family income in an ordered probit of health status declines from −0.218 when no health variables are included (lower panel of Table 2), to −0.125 when indicators of whether parent's health is excellent or very good are included. However, these estimates are still large and highly significant. In addition, the gradients in income still increase substantially with the age of the child, whereas the gradients in parental health do not. Controlling for parental health status does not eliminate the rotation of the gradient with age.

The results in the lower panel, using the PSID, provide evidence that some of the decline in the coefficients for family income may be because parental health is a proxy for permanent or long-run income. As was true for the NHIS, when controls for parental health are added, the coefficients on current family income decline [columns (1), (3), and (5)]. However, when long-run income is substituted for current income, the coefficients on family income return to values that are similar to those in Table 5. Although parental health (and especially maternal health) is associated with child health, it does not account for the relationship between long-run income and child health.[14]

C. *Genetic Ties*

The powerful connection between parents' health status and children's health status leads us to ask whether permanent income is simply proxying for a genetic tie between parents and children. A simple genetic story is that parents who are healthier have healthier children, and also earn more money because of their better health endowments. We use information on adoptive versus biological parents (available in the NHIS-CH) to test this hypothesis. Provided that wealthier adoptive parents are not in a position to select healthier infants, we should find a significant income gradient in the health of birth children, but little gradient in the health of adopted children, if a simple genetic story is driving our results. Panel A of Table 8 shows estimates of ordered probits identical to those in Table 2 (using Controls 2), but on the smaller NHIS-CH sample. As before, we find an income gradient in health that increases with age. The ordered probits in Panel B add a complete set of indicators for family type: birth mother and father, birth mother and other father, birth mother only, other mother only, other mother and birth father, birth father only, other father only, or two nonbirth parents, and each of these controls interacted with the log of family income. We present in the table the coefficients for two polar cases: the income effect for a child living with both birth parents, and the income effect for a child living with two nonbirth parents. For no age group is there a significant difference in the impact of income based on parental type and, for three of the four age groups, the impact of income is larger for children living with nonbirth parents. We cannot reject equality of the eight income × parental type coefficients for any age group. These results cast doubt on the simple genetic story.

[13] We also estimated regressions with a complete set of indicators for parental health (along a five-point scale). There is a nonmonotonic relationship between mother's health status and that of children aged 0–3: as one moves from "fair" to "poor" health of the mother, the child's health status improves. Perhaps when mother's health is especially poor fathers play a bigger role in children's health provision. We also find evidence that a parent's health has a bigger "effect" on a child's health if that parent is the respondent, and a smaller (although still large and significant) effect if the other parent is the respondent. This is true for both mothers and fathers. This is evidence of a possible reporting bias, so that sick parents think of their children as more sickly. An alternative explanation is that when the other parent reports, the health of the parent who does not report is measured with more error, and this shows up as an attenuated coefficient. In either case, the income effect is unchanged when these interactions are included.

[14] Interestingly, the coefficients on parental health do not change when long-run income is substituted for current income. This is not because parental health is uncorrelated with long-run income: an ordered probit of mother's health status on all of the controls appearing in Table 7 show mother's health to be significantly correlated with long-run average family income (z-score = 3.3). However, when the logarithm of long-run family income is omitted from ordered probits of children's health, its effect is absorbed primarily by an indicator that the child is black (which increases by 28 percent), and by mother's education (which more than doubles in absolute value), and by father's education (which increases by 50 percent in absolute value).

TABLE 8—BIRTH PARENTS, OTHER TYPES OF PARENTS, AND FAMILY INCOME, NHIS-CH

	Health status (1 = Excellent to 5 = Poor) (ordered probits)			
Ages:	0–3	4–8	9–12	13–17
Observations:	3,686	3,910	2,842	4,263
Variable	(1)	(2)	(3)	(4)
Panel A:				
ln(Family income)	−0.104	−0.130	−0.120	−0.202
	(0.025)	(0.025)	(0.032)	(0.025)
Panel B:				
(Birth mother and birth father) × ln(family income)	−0.094	−0.124	−0.104	−0.147
	(0.034)	(0.036)	(0.049)	(0.041)
(Nonbirth mother and nonbirth father) × ln(family income)	−0.109	−0.155	−0.027	−0.242
	(0.527)	(0.104)	(0.111)	(0.089)
Chi-square test: birth mother, birth father = nonbirth mother, nonbirth father	0.10	0.08	0.44	0.99
	(0.752)	(0.773)	(0.507)	(0.320)

Notes: Standard errors are in parentheses, except for chi-square test, which presents *p*-values. All probits include a complete set of age indicators, and indicators that the child is male, white, or black, the log of family size, indicators for whether the mother or father or another adult was the child's health respondent, an indicator that a mother figure is present, and her age and education if present, an indicator that a father figure is present, and his age and education if present. Panel B also includes a complete set of indicators for family type: birth mother and father, birth mother and other father, birth mother only, other mother only, other mother and birth father, birth father only, other father only, or two nonbirth parents, and each of these controls interacted with the log of family income. The chi-square test is for equality of the coefficients for log of family income when child is living with a birth mother and birth father and the log of family income when the child is living with two nonbirth parents.

TABLE 9—HEALTH INSURANCE AND THE EFFECTS OF CHRONIC CONDITIONS ON HEALTH, 1988 NHIS: Ordered Probits (Dependent Variable: Health Status [1 = Excellent to 5 = Poor])

Variable	(1)	(2)	(3)	(4)
ln*y*	−0.233	−0.223	−0.219	−0.208
	(0.019)	(0.019)	(0.019)	(0.022)
Has condition	0.634	0.649	0.642	0.371
	(0.231)	(0.231)	(0.231)	(0.274)
ln*y* × has condition	−0.024	−0.026	−0.033	−0.005
	(0.023)	(0.023)	(0.024)	(0.028)
Insured		−0.099	−0.146	−0.167
		(0.032)	(0.045)	(0.048)
Insured × has condition			0.090	0.060
			(0.063)	(0.066)
Medicaid				0.093
				(0.062)
Medicaid × has condition				0.139
				(0.083)
Chi-square test: insurance variables jointly insignificant			11.78	17.81
			(0.0028)	(0.0001)
Chi-square test: Medicaid variables jointly insignificant				17.72
				(0.0001)

Notes: Robust standard errors are in parentheses. Sample size = 12,708. "Insured" equals 1 if the child had private insurance or had Medicaid coverage. 85.8 percent of the children are insured; 12.4 percent are on Medicaid. "Has condition" equals 1 if the child has had at least one of the following types of conditions: vision problem, hearing problem, speech problem, deformity, digestive problem, epilepsy, frequent headaches, heart condition, respiratory problem, tonsilitis, anemia (including sickle cell anemia), a set of infectious diseases (e.g., mononucleosis, hepatitis, pneumonia), a skin or bone condition, frequent ear infections, diabetes, or asthma. All variables in "Controls 1" (listed in Table 2) are included in each regression.

D. *Health and Health Insurance*

The results presented above are consistent with a model in which parental investments, interacting with accumulated chronic conditions, are key determinants of childhood health status. If investment is comprised mainly of medical expenditure, then access to health insurance might be an important determinant of health status.[15] Our finding that poorer children have worse health given specific chronic conditions could be due to poorer children having no insurance coverage, or insurance coverage that pays for lower quality care.

The NHIS-CH contains information on whether the child was covered by Medicaid or other health insurance, and we use these data to examine whether the relationships between income, chronic conditions, and health status are altered when we include controls for insurance. Table 9 shows ordered probit estimates of health status on income, controlling for whether the child has had one of a number of medical conditions included in the 1988 NHIS child health supplement (listed in the footnote to the table), interactions of income and the condition measure, and controls for insurance.[16]

[15] Although not all children with insurance receive identical medical care. For example, Currie and Duncan Thomas (1995) find significant differences in doctors visits for illness between white and black children covered by Medicaid.

[16] We estimated similar equations that used information from the 1992–1995 insurance supplements to the NHIS. The results are similar to those based in the 1988 NHIS-CH.

The second column indicates that children with insurance—either private insurance or Medicaid—are in significantly better health. The point estimate indicates that in the absence of any medical conditions, being insured has the same effect on health status as a 54-percent increase in income. However, adding the insurance measure does not alter the estimated effects of income on health. The third column adds an interaction of the indicators for whether the child is insured and whether he or she has an adverse medical condition. This coefficient should be negative if families with insurance are better equipped to deal with medical problems. Instead, it is positive and imprecisely estimated.

This anomalous result could be due to the fact that the insurance measure includes Medicaid, and a child on Medicaid may have worse health for a variety of other reasons. (The parents of poor children may learn that their children are eligible for Medicaid only when the children are sick and presented for treatment.) In the fourth column we add an indicator for whether the child receives Medicaid, and an interaction of Medicaid with the condition indicator. We find that adding these controls for Medicaid does not alter the previous finding that insurance does nothing to improve the health of children with adverse medical conditions. In addition, the results indicate that children who are insured and receive Medicaid have worse health status than those who have private insurance, and the hypothesis that the net effect of Medicaid on health is zero (given no adverse medical conditions) cannot be rejected.[17] Children who receive Medicaid and have a medical condition have significantly worse health status than those with no insurance and a medical condition (F-statistic $= 4.41$, p-value $= 0.04$). It seems implausible that Medicaid actually damages children's health (see Currie and Jonathan Gruber, 1996, on the beneficial impact of Medicaid expansions on infant mortality rates) and we think the more likely explanation for this result is that Medicaid is correlated with unmeasured family characteristics that are related to poor health outcomes. For our purposes, the important finding is that controlling for insurance does not substantially alter the estimated effects of income on health.

E. *Children's Health and Maternal Labor Supply*

Another possible explanation for the income gradient in children's health is that the parents of less-healthy children reduce their labor supply, producing a positive correlation between low income and poor health. Our earlier results suggest that this is unlikely to provide a complete explanation of our findings: incomes from before the child was born were seen to have as strong an effect on children's health status in the PSID as income in any period of a child's life. We provide additional evidence here, using data from the PSID to examine the impact of a child's poor health at birth on subsequent maternal labor supply. We focus on birth health in Table 10, in order to compare mother's labor-supply decisions before and after the birth of the child in poor health. (It is not possible to assess how health problems contracted later in childhood affect maternal labor supply, because the PSID does not provide information on the date of onset of health problems.) We look at maternal labor supply during the first three years of a child's life, since our earlier results indicate that poor health at birth carries over into poor health in this time period. The PSID has information on whether the child was born at low weight (5.5 pounds or less) or spent time in a neonatal intensive care unit, which we use to construct an indicator of poor health at birth.

Table 10 shows regressions of an indicator of mothers' employment status on an indicator of the child's health at birth. These results provide evidence that poor health at birth does not affect maternal labor supply. Mothers of infants with health problems are not significantly less likely to work in the first three years of the child's

The advantage of using the NHIS-CH for this analysis is that information on a wide range of medical conditions was collected from all sample children, so that it is possible to construct a measure of whether the child had any of a number of health conditions.

[17] The net effect of having Medicaid when there are no adverse health conditions is $-0.1171 + 0.0754 = -0.0417$. The F-statistic for the test that this effect equals zero is 0.79 (p-value $= 0.38$).

TABLE 10—MOTHERS' LABOR-FORCE PARTICIPATION FOLLOWING THE BIRTH OF A CHILD, PSID

	Indicator: mother works in birth year			Indicator: mother works in 1st year after birth			Indicator: mother works in 2nd year after birth		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Indicator: low birth weight or ICU stay	0.015 (0.032)	0.009 (0.031)	0.014 (0.048)	0.023 (0.031)	−0.012 (0.031)	−0.009 (0.052)	0.021 (0.034)	0.008 (0.035)	0.001 (0.058)
Indicator: mother worked year before		0.461 (0.022)			0.422 (0.023)			0.384 (0.025)	
ICU/LBW × mother worked year before birth			0.455 (0.060)			0.416 (0.061)			0.394 (0.065)
Not ICU/LBW × mother worked year before birth			0.462 (0.024)			0.423 (0.024)			0.382 (0.027)
F-test: ICU = not ICU (*p*-value)			0.01 (0.9101)			0.01 (0.9237)			0.03 (0.8696)
Number of observations:	1,996	1,799	1,799	2,083	1,782	1,782	1,722	1,508	1,508

Notes: Robust standard errors are in parentheses, estimated allowing correlation between unobservables for children in the same household. Also included in all regressions are mother's age and education (if she is present in the household); father's education (if he is present in the household); indicators that mother and father are present in the birth year [columns (1), (4), and (7)]; in the 1st year after birth [columns (2), (5), and (8)]; and in the 2nd year after birth [columns (3), (6), and (9)]; and indicators that the mother is white and that the mother is black. The variable ICU/LBW is an indicator that the child had a low birth weight (less than 2,500 grams, 5.5 pounds) or that the child was moved to a neonatal intensive care unit (ICU) after birth.

life; neither do they work significantly fewer hours.[18] In the first regression, the coefficient on the indicator of poor health at birth is typically *positive*, although not significantly different from zero. The second column indicates that whether a woman worked in the year prior to the birth is an important determinant of whether and how much a mother works in the first three years after the birth. However, as indicated in the third column, of mothers who worked prior to the child's birth, there is no significant difference in work status of those who did and did not have a child with poor health at birth. Our conclusion is that the positive relationship between income and health in childhood is not due to the poor health of children reducing family income.

F. *Parent and Child Health-Related Behaviors*

The robust relationship between children's health status and family income may be due to differences in parent and child health-related behaviors at different levels of income. Choices made concerning how often a child sees a doctor or dentist, how closely a child is supervised at home, and whether the child wears a seat belt, together with family routines and eating habits, may have both short-term and long-term health implications. Many of these behaviors are correlated with socioeconomic status, and so may potentially explain at least part of the association between children's health and household income. Case and Paxson (2002) found that children in higher-income households are significantly more likely to wear seat belts and to have a regular bedtime, and are significantly less likely to live with a cigarette smoker. Although these behaviors are correlated with income, it is not possible to tell whether the effect of income is causal: buckling seat belts does not cost money; neither does refraining from smoking at home. However, it is possible that the lack of adequate resources strips parents of the energy necessary to wrestle children into seat belts. Poorer parents may also smoke to buffer themselves from poverty-related stress and depression.

That these parent and child health-related behaviors are correlated with children's health

[18] Evidence on mothers' work hours, and on fathers' labor-force participation, are consistent with results presented in Table 10. These are available from the authors upon request.

TABLE 11—CHILDREN'S HEALTH STATUS AND HEALTH-RELATED BEHAVIORS: NHIS-CH (Ordered Probits)

	Health status (1 = Excellent to 5 = Poor)			
	Ages 0–8		Ages 9–17	
Variable	(1)	(2)	(3)	(4)
ln(Family income)	−0.119	−0.109	−0.171	−0.159
	(0.018)	(0.018)	(0.020)	(0.020)
Indicator: =1 if child has a regular bedtime		−0.068		−0.104
		(0.038)		(0.036)
Indicator: =1 if child wears a seat belt		−0.151		−0.134
		(0.035)		(0.029)
Indicator: =1 if child has a place for regular medical care		−0.049		0.093
		(0.061)		(0.051)
Indicator: =1 if child has a place for sick care		0.086		−0.077
		(0.067)		(0.058)
Indicator: =1 if routine doctor's visit in past year		0.058		0.095
		(0.036)		(0.029)
Indicator: someone in household smokes		0.092		0.064
		(0.028)		(0.029)
Mother's body mass index (BMI)		0.008		0.011
		(0.003)		(0.003)
Father's body mass index (BMI)		0.001		0.003
		(0.004)		(0.004)
Mother: no doctor visit in last 12 months		−0.029		−0.097
		(0.038)		(0.034)
Chi-square test: joint significance (five child health behavior variables)[a]		26.30		45.79
		(0.0001)		(0.0000)
Chi-square test: joint significance (four parental health-behavior variables)		18.81		30.43
		(0.0009)		(0.0000)
Number of observations:	7,461	7,461	6,945	6,945

Notes: Standard errors are in parentheses. See notes to Table 9 for the list of controls included in each ordered probit. Body mass index (BMI) is weight in kilograms divided by height in meters, squared. People with BMIs above some cut-off are said to be "obese," which puts them at much greater risk for diabetes, hypertension, and cardiovascular disease.

[a] Child health behavior variables are those in rows 2–6.

outcomes is apparent in Table 11, which presents results of ordered probits in which a child's health status is modeled as a function of the log of family income and a number of health behaviors related to the children, including whether the child has a regular bedtime, wears a seat belt all or most of the time, has a place for routine medical care and a place for sick care, and whether the child has had a routine doctor's visit in the past year. Some of these behaviors—particularly regular bedtimes and wearing seat belts—are highly correlated with children's health status. It seems unlikely that seat belt use directly affects the child's health (short of having an accident), but both seat belt use and regular bedtimes may be correlated with stability in household life. Jointly, these child health behaviors are highly significant (chi-square test = 26.3 for the younger children, 45.8 for the older children).

In addition, we condition on variables we have in our data set that may provide information on parents' own health-related behaviors. These are mother and father's body mass indices (BMI); whether mother has been to the doctor at least once in the past year; and whether someone smokes at home. High adult BMI is a signal of obesity, which puts a person at risk for cardiovascular disease, hypertension, and diabetes. We use it to proxy, in part, for the care parents take with their own health. We use the lack of any doctor's visit by mother as a signal that she has not gone for the annual checkup generally recommended for women. These variables, most notably mother's BMI and cigarette smoking at home, are highly correlated with children's health status.

Inclusion of these health-related behaviors reduces the observed income gradient, but only slightly. If we had a complete set of family routines and behaviors, we might see the income gradient diminish substantially in importance. Future work will focus on factors that we cannot examine in the data sets here, but which may be related—including such parental behaviors as staying home with children when the children are sick, getting them to a doctor in a timely fashion when they fall ill, and overseeing the children's meals on a daily basis. The link between income, nutrition, and children's health outcomes may prove important in explaining the gradient in children's health.

VI. Conclusions: Mechanisms and Implications

We have shown that the relationship between income and health status observed for adults has antecedents in childhood. A family's long-run average income is a powerful determinant of children's health status, one that works in part to protect children's health upon the arrival of chronic conditions. The health of children from families with lower incomes erodes faster with age, and these children enter adulthood with both lower socioeconomic status and poorer health.

An important priority for future research is to identify the mechanisms that underlie the relationship between income and children's health. We have been able to rule out several possible mechanisms: insurance does not play a crucial role in protecting health upon the arrival of a chronic condition, health in childhood does not appear to be a persistent reflection of health at birth, and a simple genetic model cannot explain the association between health and income.

The results in this paper highlight the role of chronic conditions in the relationship between income and health. It may be that higher-income parents are better able to manage chronic health problems. For example, socioeconomic status has been implicated as a determinant of adherence to and compliance with treatments for childhood epilepsy (S. R. Snodgrass et al., 2001) and diabetes (Catherine L. Davis et al., 2001; S. J. Thompson et al., 2001).

What are the implications of poor health in childhood? In addition to the direct welfare and financial costs of illness, poor childhood health results in lower levels of human capital accumulation. Less-healthy children spend more days in bed and miss more school. We have explored the implications of this for years of completed schooling using data on school-aged children (ages 5–17) from the NHIS-CH. In regressions of years of completed education on a complete set of age indicators, income, whether the child has one of the medical conditions defined in the footnote to Table 9, and interactions of income and the condition indicator, we find that having a condition reduces years of education, but that it does so less for children with higher incomes. In addition, the greater adverse effect of having a medical condition for a poorer child grows larger as the child becomes older: the positive effect of income on education when a condition is present is more than four times larger for the older age group. Poorer children arrive at the doorstep of adulthood with lower health status and with less education. It is an open question whether these factors result in lower earnings as adults—contributing to the gradients observed in adulthood and providing a partial explanation for observed intergenerational transmission of poverty.

Appendix

National Health Interview Survey 1986–1995

The NHIS asks a knowledgeable household member to report on the health status and health conditions of children aged 0–17. Each household was randomly assigned to answer questions from one of six "conditions lists," and information was collected on whether each household member had experienced each of the medical conditions on the assigned condition list. (The NHIS was substantially redesigned after 1995, which limits us to the period 1986–1995.)

We start with 314,455 children aged 0–17, and drop 43,707 cases (14 percent) for whom household income is not reported. After removing these observations, we also exclude children who fall into the following categories: (1) We deliberately exclude children when there is doubt about whether reported household income adequately reflects the income over which the child may have a claim. Thus we remove from our analysis children who, at the time of the interview, were not living with at least one of their parents (5,483 cases). (2) We remove children who were not the sons or daughters of the reference person or spouse (18,608 children). Our concern with including children residing with a grandparent head of household (the largest alternative to residing with a parental head—13,741 cases) is that we do not know how long the child has lived with the grandparent, and we may be falsely assigning to the child income that does not reflect the income in which the child has a share, or has had a share for an unknown period of time. (3) We remove children in households containing more than one family (899 children), and children who are not members of the "primary family" within the household (2,382 children). (4) We remove 5,095 children from households where children in the households are reported to be of different races. (Difference in race within a sibship may reflect children having fathers of different races, and we would not choose to remove such children just for this reason. However, difference in reported race may also be due to measurement error, or to children being fostered.) (5) We are also interested in whether our results are robust to the inclusion (exclusion) of controls for

TABLE A1—NHIS CONDITION CODES AND DEFINITIONS

Chronic condition	Code	Definition
Vision problem	201	blind—both eyes
	202	other visual impairments
	240	tinnitus
	241	cataracts
	242	glaucoma
	243	diseases of the retina
Hearing problem	203	deaf—both ears
	204	other hearing impairments
Retardation	208	mental retardation
Deformity	209	absence—both arms/hands
	210	absence—one arm/hand
	211	absence—fingers, one or both hands
	212	absence—one or both legs
	213	absence—feet/toes, one or both limbs
	214	absence—lung
	215	absence—kidney
	216	absence—breast
	217	absence—bone, joint, muscle of extremity
	218	absence—tips of fingers, toes
	219	paralysis of entire body
	220	paralysis of one side of body—hemiplegia
	221	paralysis of both legs—paraplegia
	222	other total paralysis
	223	partial paralysis—cerebral palsy
	224	partial paralysis—one side of body only—hemiparesis
	225	partial paralysis—legs—both or paraparesis
	226	other partial paralysis
	227	paralysis—complete or partial—other site
	228	curvature/deformity of back or spine
	229	orthopedic impairment of back
	230	spina bifida
	231	orthopedic impairment of hands, fingers only
	232	orthopedic impairment of shoulders
	233	other orthopedic impairment of upper extremities
	234	flat feet
	235	club feet
	236	other orthopedic impairment of lower extremities
	237	other deformities/orthopedic impairments
	238	cleft palate
Digestive problem	301	gallbladder stones
	302	liver diseases including cirrhosis
	303	gastric ulcer
	304	duodenal ulcer
	305	peptic ulcer
	306	hernia of abdominal cavity
	307	disease of the esophagus
	308	gastritis and duodenitis
	309	indigestion
	310	other functional disorders of stomach and digestive system
	311	enteritis and colitis
	312	spastic colon
	313	diverticula of intestines
	314	constipation
	315	other stomach and intestinal disorders
Diabetes	403	diabetes
Epilepsy	405	epilepsy
Frequent headaches	406	migraine headache
	407	other headache
Kidney disease	409	kidney stone
	410	kidney infections
	411	other kidney trouble
Heart disease	501	rheumatic fever with or without heart disease
	502	ischemic heart disease
	503	tachycardia or rapid heart
	504	heart murmurs
	505	other unspecified heart rhythm disorders
	506	congenital heart disease
	507	other selected types of heart disease
Bronchitis	601	bronchitis
Asthma	602	asthma
Hay fever	603	hay fever
Sinusitis	605	sinusitis

parental and household characteristics that might have independent effects on children's health (family size; race; mothers' age, education, and an unemployment indicator if she is present; fathers' age, education, and an unemployment indicator if he is present); and we restrict our core sample to children for whom this information is available. Our core sample of children from the NHIS is 229,330 observations. When we turn to the analysis of (sometimes rare) medical conditions, we use the full sample of all children with nonmissing information on income, family size, race, age, and gender.

Assignment of household income: The NHIS contains information on total household income for 27 income categories, in \$1,000 intervals between an income of \$0 and \$20,000, and in \$5,000 intervals between \$20,000 and \$50,000. All household incomes above \$50,000 are top coded. We assign incomes to these income categories using data from the 1986–1995 March Current Population Surveys. Specifically, we calculate, for each income category in each year, the mean total household income in the CPS for households whose head's education matches that of the reference person in the household and whose income falls into that income category. For households containing both a reference person and spouse, we used the education of the male (whether he was the reference person or not) to match income information across the data sets. The resulting income distribution tracks closely that found in the Current Population Survey.

Definitions of medical conditions:
The conditions we use are drawn from five of the six "condition lists" in the National Health Interview Survey. Table A1 maps the NHIS condition codes and definitions into the definitions we use.

National Health and Nutrition Examination Survey

We restrict our sample to children whose survey information was given by a parent, and whose household reference person was either that parent or a spouse. Family income is measured within twenty $1,000 brackets between $0 and $19,999 per year, $5,000 brackets between $20,000 and $49,999, and one bracket for $50,000 and above. The survey was conducted in the period 1988–1994. Families are only identified as being surveyed in the first or second wave (each of roughly three years). The average annual inflation rate of 3.8 percent that prevailed during this period is likely to introduce a moderate degree of measurement error in measures of real income. We assign families to the midpoint of their income interval and adjust for the difference in the average price level between the first and second half of the survey.

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