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The Dynamic Effects of Family Income on Child Health in the United States*

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Abstract

Recent studies on the relationship between family income and child health show that children from poorer families have worse health than those from wealthier families, and that the negative effects of low income on health accumulate during childhood. In this paper, we aim to disaggregate the accumulated effects of income on child health found in the past studies into the "marginal" (i.e., contemporaneous) effects and investigate how the contemporaneous effects evolve as children become older. Using data from the two waves of the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), we found weak evidence that the contemporaneous effects of family income on child health seem to accumulate with a decreasing rate throughout childhood.

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1. Introduction

A better understanding of the relationship between parental socioeconomic status (SES) and child health is of great importance in designing effective public policies that aim to eliminate health disparities among children. Moreover, recent research in epidemiology and economics has demonstrated that SES and health in adulthood are strongly influenced by parental SES and by illness experienced earlier in life (Currie and Hyson, 1999; Forrest and Riley, 2004; Case et al., 2005). Thus, investigating the relationship between family SES and health during childhood is crucial, not only for improving current child welfare, but also for preventing the emergence of an income gradient later in life.

A benchmark study on this issue is the one by Case et al. (2002). They examine the relationship between family income, which is one of the most important measures of SES, and children's health status in the U.S. Using cross-sectional data, the authors show that children living in lower-income families suffer from worse health than those living in higher-income families, and that the relationship between income and health becomes more pronounced as children get older. According to their arguments, the increasing gradient implies that the adverse effects of low income on child health accumulate over time.

While Case et al. (2002) introduce the notion that the effects of family income on health accumulate during childhood, they do not make a further attempt to disaggregate the effects accumulated over time into the "marginal" (i.e., contemporaneous) effects at each age of childhood. However, disaggregating the accumulated effects and exploring how the contemporaneous effects change as children grow up would have important implications for the optimal timing of policy interventions related to child health. They would also provide us with useful information for a discussion of

whether and to what extent health policies targeted at specific age groups of children are effective in mitigating the adverse effects of low income on child health and in reducing health inequalities among children.

The objective of this study is to distinguish the contemporaneous effects of income on child health from the accumulated effects and investigate how the effects evolve during childhood. Our hypothesis is that, although the accumulated effects of family income on child health increase as time passes, the contemporaneous effects are largest for the youngest children and then diminish as children get older. This conjecture is based on the fact that children's development during the period from conception to age three is most intensive, rapid, and sensitive to environments (UNICEF, 1998; reviewed in Wadsworth and Butterworth, 2006). Using two-period longitudinal data from the Child Development Supplement (CDS) of the Panel Study of Income and Dynamics (PSID), we have found weak evidence that the contemporaneous effects seem to accumulate at a decreasing rate during childhood.

The rest of this paper is organized as follows. Section 2 surveys related literature. Section 3 presents a conceptual model that describes how family income is related to child health. Section 4 contains a description of the data, a descriptive analysis, model specifications, and estimation results. Section 5 concludes.

2. Literature review

Based on various measures of SES and health, a vast literature has documented that adults with lower SES have poorer health than those with higher SES (reviewed in Feinstein, 1993; Adler et al., 1994; Mullahy, Robert, and Wolfe, 2004; Marmot and Wilkinson, 2006). Recent work on this issue has focused on identifying the causal effects of SES on health, for example, by searching for appropriate instrumental

variables (IV) (e.g., Ettner, 1996; Meer et al., 2003) or by exploiting a natural experiment (e.g., Frijters et al., 2005).

While past studies on the relationship between SES and health have traditionally dealt with adults, recent research in epidemiology and economics has provided some evidence that low SES and disorders in adulthood have their roots in childhood poverty and illness. For example, using data from Great Britain, Currie and Hyson (1999) show that the incidence of low birth weight, which is more prevalent among poorer families, has long-lasting negative effects on educational attainment, employment status, and health status in young adulthood. Case et al. (2005) also find that a poor prenatal environment, illness in childhood, and low parental SES lead to disadvantaged economic status and health status in middle age. These findings seem to suggest that a special emphasis should be placed on exploring the relationship between parental SES and health early in life.

Case et al. (2002) conduct a benchmark study on this issue. With cross-sectional data from various sources, including the 1986-1995 National Health Interview Survey (NHIS) and the first wave of the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), the authors investigate the relationship between family income and child health in the U.S. Using a subjective measure of children's health status reported by parents, they find that children in lower-income families have poorer health than those in higher-income families across all age groups (i.e., those aged 0-3, 4-8, and 9-12 years). They also show that the relationship between family income and child health is more pronounced for older age groups. Based on these findings, the authors argue that family income has cumulative effects on child health.

After the study by Case et al. (2002), the relationship between family income and health has been successively examined for children in other countries. For example,

Currie and Stabile (2003) conduct an analysis similar to that of Case et al. using panel data on Canadian children. They find that in Canada, like in the U.S., the income gradient exists and becomes steeper with children's age. Furthermore, they provide evidence that the increasing gradient can be explained by childhood accumulation of the effects of a higher incidence of adverse health shocks for children in poorer families. Currie et al. (2007) also apply a methodology similar to that of Case et al. using cross-sectional data on children in England. Their findings show that the income gradient in England is small and that, unlike the case of the U.S. and Canada, the slope of the gradient is independent of children's age.

Although these previous studies make valuable contributions to an understanding of how family income may affect child health, their focus is only on the effects of income accumulated during childhood; no attempt is made to disaggregate the accumulated effects into the contemporaneous effects at each age of childhood. This motivates us to differentiate the contemporaneous effects from the accumulated effects and to examine the manner in which the effects evolve throughout childhood. In the next section, we propose a simple conceptual model that describes how family income may determine child health, and we clarify the association between the contemporaneous effects and the accumulated effects.

3. Conceptual Model

The conceptual framework of this study comes from a human capital model applied in the context of child health by Currie (2000).[1] In this model, it is assumed that child health formation is a cumulative process where the stock of child health today depends

[1] A similar model is introduced by Blau (1999) in the context of child development. I also refer to Todd and Wolpin (2001, 2006).

on current and past health inputs combined with a child's endowment through a health production function and on the depreciation rate of health capital. Health inputs include purchased goods and services, as well as family members' time. Parents have a utility function that contains the stock of child health as an argument, and they choose the optimal level of child health inputs by maximizing their utility subject to the budget and time constraints and to the technology of the child health production function. The demand functions for the inputs derived from the parents' optimization problem can be substituted into the health production function to yield a child health demand function that depends on input prices, the current and past resources of the family, observed and unobserved factors that influence the productivity of child health and the preferences of parents, and a child's endowment.[2]

A reduced-form child health production function that reflects the above framework is assumed to take the following form:

$$H_{ia}^{*} = X_{ia}\psi_{1}^{a} + X_{ia-1}\psi_{2}^{a} + ... + X_{i1}\psi_{a}^{a} + \phi^{a}\mu_{i} + \varepsilon_{ia} \qquad (1)$$

where H_{ia}^{*} is the health outcome of child i at age a; X_{ia} is a set of time-invariant and variant factors that represent the family's resources available for the production of child health, the productivity of child health, and the preferences of the parents when child i is at age a (e.g., socioeconomic status); μ_{i} is a child's health endowment; and ε_{ia} represents a random error.

In this analysis, permanent family income is one of the elements in the vector X_{ia},

[2] In this model, reverse causality running from child health to family income is not considered. This may not be realistic given the evidence that mothers' employment is adversely affected by child disability (Powers, 2003). More elaborate models are needed to deal with the simultaneous determination of family income and child health, though Case et al. (2002) argue that the health of children may be assumed to have a relatively small impact on family SES when compared with the health of adults. In addition, this model does not take account of interactions among household members, which are considered by Jacobson (2000) and Bolin et al. (2001).

and its coefficient is our parameter of interest.[3] Let $X_{ia} = (1, Y_i, Z_i, Z_{ia})$, where Y_i is the log of permanent family income, Z_i is a vector of other time-invariant variables, and Z_{ia} is a vector of time-variant variables. Then, Equation (1) becomes:

$$
\begin{aligned}
H_{ia}^{*} &= \alpha_1^a + \alpha_2^a + ... + \alpha_a^a + Y_i\beta_1^a + Y_i\beta_2^a + ... + Y_i\beta_a^a + Z_i\gamma_1^a + ... + Z_i\gamma_a^a \\
&+ Z_{ia}\delta_1^a + ... + Z_{i1}\delta_a^a + \phi^a\mu_i + \varepsilon_{ia} \\
&= (\alpha_1^a + \alpha_2^a + ... + \alpha_a^a) + Y_i(\beta_1^a + \beta_2^a + ... + \beta_a^a) + Z_i(\gamma_1^a + ... + \gamma_a^a) \\
&+ Z_{ia}\delta_1^a + ... + Z_{i1}\delta_a^a + \phi^a\mu_i + \varepsilon_{ia} \\
&= A^a + Y_iB^a + Z_iC^a + Z_{ia}\gamma_1^a + ... + Z_{i1}\gamma_a^a + \phi^a\mu_i + \varepsilon_{ia} \qquad (2)
\end{aligned}
$$

The distinction between the contemporaneous and accumulated effects of income on child health is made clear in Equation (2). The coefficient β_1^a represents the former effects and the coefficient B^a represents the latter.[4]

In the following analysis, we estimate Equation (2) and test our hypothesis that the contemporaneous effects are largest for the youngest children and then diminish over time; that is, $\beta_1^1 > \beta_1^2 > ... > \beta_1^a > ....\beta_1^T$, where T is the last age of childhood.

4. Empirical Analysis

4.1 Data

We use data from the 1997 and 2002 waves of the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), as well as data from the main PSID. The CDS supplements the PSID, a nationally representative longitudinal survey of individuals and their families in the U.S., with detailed information on children's health, social and emotional well-being, and cognitive and behavioral development. In

[3] Case et al. (2002) discuss whether it is appropriate to use permanent family income or current income to investigate the effects of income on child health. For this analysis, we focus on permanent family income. As noted by Blau (1999) in the context of child development, child outcomes seem to have stronger relationships with permanent income than with transitory income. In addition, taking the average of current income over several years may reduce random measurement error in income. We are planning to alternate the definition of income as a robustness check. In what follows, we use the phrases "permanent family income" and "family income" interchangeably.

[4] Throughout this paper, parameters in capital letters indicate the accumulated effects.

this analysis, the information from the CDS is matched with the demographic and economic data on children's families that are provided in the main PSID. The initial survey was conducted in 1997, when data were collected from 3,563 children aged 0-12 years in 2,394 families. In 2002, the CDS re-contacted the families from the 1997 CDS who remained in the PSID data as of 2001, and gathered data on 2,907 children in 2,019 families.

The variables included in this analysis and their summary statistics are provided in Tables 1a and 1b for the data of 1997 and 2002, respectively.[5] As in the past studies, the health outcome of a child is represented by a subjective measure of general health status, which is a categorical variable on a five-point scale (1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor).[6] This health measure is reported by the person called the primary caregiver (PCG), who lives with the child and takes the primary responsibility of caring him or her. In a majority of cases, the PCG is the child's biological mother.[7] The average value of the subjective health measure was 1.65 in 1997 and 1.59 in 2002. In 1997, 83% of the children were in very good or excellent health, and 0.02% of them were in fair or poor health. The figures from 2002 are similar to those from 1997.

As a proxy for permanent family income, we use the average of total family income over four years (1995, 1997, 1999, and 2001), where total family income is defined as

[5] Summary Statistics in Table 1 are weighted using children's sampling weights provided in the CDS. The unweighted values of summary statistics, which are comparable with those in Case et al. (2002), are provided in Appendix A in Tables A1a and A1b.

[6] It has been argued that, if respondents with certain characteristics differ systematically from others in reporting their health status, a subjective measure may be prone to a measurement error (Contoyannis et al., 2004; Dowd, 2007). Taking this potential problem into account, Case et al. (2002) use physician-assessed health status of children as an objective measure, and show that the relationship between income and child health becomes stronger with children's age for this measure as well. We plan to conduct a similar robustness check using a height-for-age z-score as an objective measure.

[7] In the 1997 CDS, 92.4% of the PCGs are biological mothers: in the 2002 CDS this figure is 89%. If the biological mother is not present in the family, the child's stepmother, adoptive mother, foster mother, biological father, stepfather, adoptive father, foster father, legal guardian, or a person who knows most about the child's activities is regarded as the PCG.

the sum of the taxable income, the transfer income, and the social security income of all family members.[8] Income amounts are adjusted with the Consumer Price Index (CPI) to reflect 1997 dollars. They are also adjusted with an equivalence scale for family size.[9]

The other control variables used in this analysis are indicators for whether the child is female, is nonwhite, has a biological mother in the family, has a biological father in the family, the biological mother's age and educational level if she is living with the child, the biological father's age and educational level if he is living with the child, and the log of family size. These variables are intended to represent the productivity of child health and the preferences of parents.

4.2 Descriptive Analysis

Figures 1a and 1b present the distribution of the PCG-reported general health status of children in the CDS sample by income quintile group in 1997 and 2002, respectively.[10] These graphs show that children from lower-income families suffer from worse health than those from higher-income families. In addition, this relationship is observed not only between the poor and non-poor groups, but also among higher income groups, which is consistent with the findings of the previous studies (reviewed in Chen et al., 2002). For instance, the percentages of children

[8] To reduce the number of missing values as much as possible, the average is taken even when the information on income is not available for all four years. For example, when data on family income is available only for the years 1997 and 1999 for a certain child, the average over two years is calculated and is used as a proxy for permanent income.

[9] The equivalence scale is calculated as $(a + 0.6 \times c)^{0.65}$, where a is the number of adult members in the family and c is the number of children under age 18 in the family. To adjust income more precisely, c must also include the number of children of the household head under age 18 living outside the family as in Wenzlow et al. (2004).

[10] The measure of income used to divide the sample into the quintile groups is the proxy for permanent income adjusted with an equivalence scale, as explained in the previous subsection. This measure of income is used throughout the following descriptive analysis and regression analysis.

reported to be in very good or excellent health in 1997 were approximately 72.9%, 77.4%, 84.6%, and 90.9% for the lowest, second-lowest, third-lowest, and highest income groups, respectively. In contrast, the percentages of children reported to be in fair or poor health in 1997 were about 5.1%, 2.8%, 1.7%, and 0.9% for the lowest, second-lowest, third-lowest, and highest income groups, respectively. The data in 2002 reveal a similar relationship between income quintiles and children's health status.[11] Thus, disparities in children's health status appear to exist across the entire range of income groups.

The variation in the relationship between income and child health among children of different ages is given in Figures 2a and 2b.[12] These graphs describe the percentage of children reported to be in fair or poor health by their age and by whether their family income is above or below the median income of the sample in 1997 and 2002. The graphs clearly demonstrate that children from lower-income families are more likely to be in fair or poor health at any given age. Moreover, the differences in health status between the lower- and higher-income groups appear to increase with children's age (Figures 2c and 2d).[13]

A similar relationship is illustrated in a different way in Figures 3a and 3b. These figures are drawn by a nonparametric locally-weighted regression (Lowess) of health status on the log of family income.[14] Figure 3a is for children aged 0-3, 4-8, and 9-12 years in 1997, and Figure 3b is for children aged 4-8, 9-12, and 13-17 years in 2002.

[11] The percentages of children reported to be in very good or excellent health status were 74.3%, 81.2%, 88.8%, and 93.7% for the lowest, second-lowest, third-lowest, and highest income groups. Corresponding values for those reported to be in fair or poor health status were 5.4%, 3.8%, 1.1%, and 0.7%. It is, however, somewhat misleading to directly compare values in 1997 with those in 2002, because data in 1997 and data in 2002 cover different age groups.

[12] In 2002, the CDS collected information from children aged 0-12 years in the 1997 CDS. Children aged 0-3 years in 1997 were 4-8 years old in 2002, so there are no children aged 0-3 years old in the 2002 sample.

[13] Currie and Stabile (2003) also show the widening gap using similar graphs.

[14] These graphs are produced by the STATA command "lowess".

In both years, a negative relationship exists between income and the PCG-reported general health status of children for all age groups. In addition, the gradient seems to be steeper for older age groups. These findings indicate that, on average, children from lower-income families have worse health than those from higher-income families, and that the association between income and health strengthens with children's age. However, this comparison involves different children, and therefore this pattern might simply reflect different characteristics of each age cohort. Thus, in the subsequent figures, we draw similar curves by following the same children.

Figures 4a, 4b, and 4c describe nonparametric Lowess plots of health status against the log of income by year for children aged 0-3, 4-8, 9-12 years in 1997, respectively. A negative correlation between income and the PCG-reported general health status is observed in both years for all age groups. For the youngest age group, the gradient appears to become steeper between 1997 and 2002 (Figure 3a). On the other hand, for older age groups, this phenomenon is not observed (Figures 3b and 3c). This nonparametric analysis therefore suggests that the contemporaneous effects might be large for younger children and negligible for older children. In the following section, we present empirical models to test this hypothesis by controlling for other observable characteristics of parents, families, and children.

4.3 Model Specifications[15]

We consider three different specifications for estimating the reduced-form child health production function in Equation (2). For each specification, we briefly discuss which effects (i.e., the accumulated effects or the contemporaneous effects) of family

[15] Most of the discussion in this section is based on Todd and Wolpin (2001, 2006) who conduct similar analyses in the context of child cognitive achievement.

income on child health could be estimated. In order to develop intuitions regarding the assumptions necessary to identify the effects, we use a latent variable model to express each specification.

4.3.1 Specification 1

Specification 1 takes the following form:

$$H_{it}^{*} = A^{a} + Y_i B^{a} + Z_i C^{a} + Z_{it}\delta^{a} + v_{it} \qquad (3)$$

where H_{it}^{*} is the latent variable of the health outcome of child i at age a in period t; Y_i is the log of permanent family income; Z_i is a set of other time-invariant factors such as the child's gender and race; Z_{it} is a set of time-variant factors such as the presence of a mother and a father in the family, the age and education of a mother and a father if they are living with the child, and the family size; and v_{it} is a residual term.[16] A comparison of Equations (2) and (3) indicates that the coefficient B^{a} in the latter represents the accumulated effects of family income on child health. Thus, Specification 1 is useful for estimating the accumulated effects. The model can be estimated with cross-sectional data. This specification is the one implemented in many of the previous studies including Case et al. (2002).

4.3.2 Specification 2

Specification 2 is for identifying the contemporaneous effects when we have data for two or more periods. The model is represented as follows:

$$H_{it-1}^{*} = A^{a-1} + Y_i B^{a-1} + Z_i C^{a-1} + Z_{it-1}\delta^{a-1} + v_{it-1}$$

$$H_{it}^{*} = (A^{a-1} + \alpha^{a}) + Y_i (B^{a-1} + \beta^{a}) + Z_i (C^{a-1} + \gamma^{a}) + Z_{it}\delta^{a} + v_{it} \qquad (4)$$

[16] The content of the residual term v_{it} is discussed in Appendix B.

where the variables are the same as those defined in the preceding specification. The first equation is a reduced-form health production function for children at age $(a-1)$ in period $(t-1)$, while the second equation is a reduced-form health production function for the same children at age a in period t. The contemporaneous effects can be captured by the coefficient β^a in Equation (4) under the assumption that the effects of family income on child health at earlier ages accumulate over time without depreciation. Detailed discussions on this condition are provided in Appendix B.

4.3.3 Specification 3

Specification 3 is another model that can be used to identify the contemporaneous effects of family income on child health when panel data are available. It assumes the following form:

$$H_{it}^{*} = \alpha^a + H_{it-1}^{*}\rho^a + Y_i\beta^a + Z_i\gamma^a + Z_{it}\delta^a + \eta_{it} \qquad (5)$$

where η_{it} represents a residual term. This specification differs from Specifications 1 and 2 in that it contains a lagged health outcome, which is expected to capture every past factor and an unobserved child health endowment. Todd and Wolpin (2001, 2006) call this the value-added specification. In Equation (5), the coefficient β^a represents the contemporaneous effects if the effects of family income from earlier ages depreciate at rate $(1-\rho^a)$. The proof of this condition is presented in Appendix B.

In the following analysis, we implement all three specifications and compare the estimation results.

4.4 Estimation and Results

4.4.1 Specification 1

We begin by presenting the estimation results for Specification 1. The two waves of data (1997 and 2002) are used separately for this specification in order to make our analysis comparable with that of Case et al. (2002). Following the convention of the literature in this field, we first divide the sample in each wave into three age groups: children aged 0-3, 4-8, and 9-12 years for the sample in 1997, and those aged 4-8, 9-12, and 13-17 years for the sample in 2002. Since the dependent variable (PCG-reported health status of children) is a categorical variable, we use an ordered probit model and estimate Equation (3) separately for each wave and each age group of the sample.[17][18]

Table 2a presents the results of the estimations using the data from 1997. The estimated coefficient on family income is negative and significant for all age groups; in addition, this coefficient becomes progressively more negative as children grow older. The magnitudes of the coefficient are -0.099, -0.222, and -0.284 for children aged 0-3, 4-8, and 9-12 years, respectively.[19] These results indicate that, on average, children in poorer families suffer from worse health than their counterparts in wealthier families, and that this association between income and health becomes more pronounced with children's age. The results are consistent with the findings of Case et al. (2002).

Table 2b provides the results of the estimations for the data from 2002. The estimated coefficient on income is negative and significant for all age groups. The magnitudes of the coefficient are -0.299, -0.194, and -0.329 for children aged 4-8, 9-12,

[17] The results of estimating Equation (3) with a linear probability model are presented in Appendix C in Table C1a for 1997 and C1b for 2002.

[18] Using semi-nonparametric estimation to relax the distributional assumption of ordered probit model is left as our future work.

[19] In terms of marginal effects, a 1% increase in family income is associated with 0.004, 0.013, and 0.011 percentage point decrease in the probability of being reported as in fair health status for children aged 0-3, 4-8, and 9-12 years, respectively. Similarly, a 1% increase in family income is associated with 0.03, 0.09, and 0.11 percentage point increase in the probability of being reported as in excellent health status for children aged 0-3, 4-8, and 9-12 years, respectively.

and 13-17 years, respectively.[20] The absolute value of the coefficient on income is smallest for those aged 9-12 years.

In order to further examine how the gradient changes with children's age, we divide the sample into groups of each age rather than into three age groups, and then we estimate the coefficient on income for each of the groups.[21] The estimation result using the 1997 data appears to confirm that the coefficient on income tends to become more negative with children's age (Figure 5a). In contrast, the estimation result for the 2002 data does not reveal a similar pattern across children's ages (Figure 5b). This difference by year may partly be due to the fact that the children in the 2002 sample are five years older than those in the 1997 sample. If we focus on the coefficient on income for children older than five years, the estimation results for the 1997 and 2002 data may not appear contradictory.

The above estimations using Specification 1 reveal how the accumulated effects of income on child health change across age groups. These changes in the accumulated effects across age groups could be interpreted as contemporaneous effects. However, as we discussed in the descriptive analysis in Section 4.2, each age group consists of different children. We next identify the contemporaneous effects by following the same group of children across two periods.

4.4.2 Specification 2

[20] Calculations of marginal effects show that a 1% increase in family income is associated with 0.011, 0.009, and 0.011 percentage point decrease in the probability of being reported as in fair health status for children aged 4-8, 9-12, and 13-17 years, respectively. Similarly, a 1% increase in family income is associated with 0.09, 0.06, and 0.13 percentage point increase in the probability of being reported as in excellent health status for children aged 4-8, 9-12, and 13-17 years, respectively.
[21] When estimating the coefficient on income for each age of childhood, we impose the restriction on Equation (3) that only the constant term and the coefficient on income can change with age. The same restriction is imposed when we conduct a similar analysis for Specifications 2 and 3. We are planning to test whether this restriction is appropriate, which must be examined by using an F-test.

For this specification, the sample is restricted to children who were surveyed in both waves of the CDS, and to those for whom we have information on family income and health status in both years. This yields a balanced panel with 2,856 children per year. Tables 3a and 3b provide summary statistics of the variables included in our analysis for this restricted sample for 1997 and 2002, respectively.[22] As can be seen by comparison with Table 1, no significant difference is observed in the summary statistics of the variables between the unrestricted and restricted samples.

Table 4 presents the results of estimating Equation (4) using an ordered probit model separately for the three age groups: children aged 0-3, 4-8, and 9-12 years in 1997.[23] The estimated coefficient on income in the baseline year (1997) is negative for all age groups and becomes progressively more negative as children get older.[24] On the other hand, the change in the coefficient on income between 1997 and 2002 is negative and significant only for the youngest group. A similar pattern is observed when Equation (4) is estimated for each age of childhood. The result of this estimation shows that the change in the coefficient on income between 1997 and 2002 is negative for younger children and fluctuates around zero for older children (Figure 6). These findings may suggest that the negative contemporaneous effects (over five years) of low income on health could be most crucial for younger children and could diminish as children get older.[25]

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[22] Summary Statistics in Table 3 are weighted using children's sampling weights provided in the CDS. The unweighted values of the summary statistics are provided in Appendix A in Tables A2a and A2b.

[23] The results of estimating Equation (4) with a linear probability model are presented in Table C2 in Appendix C.

[24] In terms of marginal effects, a 1% increase in family income is associated with 0.008 percentage point more decrease in the probability of being reported as in fair health status in 2002 than in 1997 for children aged 0-3 in 1997. Similarly, a 1% increase in family income is associated with 0.07 percentage point more increase in the probability of being reported as in excellent health status in 2002 than in 1997 for those aged 0-3 in 1997.

[25] Here, we are comparing the contemporaneous effects among different children. Thus, we cannot

As we mentioned in Section 4.3.2, the coefficient on the interaction term of income and the year dummy for 2002 in Specification 2 represents the contemporaneous effects under the assumption that the effects of family income on child health at earlier ages accumulate during childhood without depreciation. This assumption, however, seems to be very restrictive.[26] Therefore, in the following subsection, we implement another specification that enables us to compare estimation results under an alternative assumption on a depreciation rate.

4.4.3 Specification 3

Table 5 reports the results of estimating Equation (5) separately for each of the three age groups defined above.[27,28] The estimated coefficient on family income is negative and significant for all age groups, as expected. The absolute value of the coefficient is largest for the youngest group, but there is no specific pattern across age groups.[29] The coefficient on the lagged dependent variable, i.e., on health status in 1997, is positive and significant for all age groups, which implies a persistency of child health. We also estimate Equation (5) for each age of childhood. The result of this estimation shows that the coefficient on family income is negative for younger children and tends toward zero for older children, though this pattern across ages is not so significant (Figure 7). An implication of the findings here is that the negative contemporaneous effects of low

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deny the possibility that the difference in magnitude of the effects across age groups simply reflects the unique characteristics of each age cohort. Addressing this issue would require longer panel data of more than two periods. This is the same for Specification 3.

[26] If, in practice, the effects of income on child health at younger ages depreciate over time, the estimated coefficient on income in Specification 2 would be biased upward.

[27] Again, the balanced panel data is used for this specification.

[28] The results of estimating Equation (5) with a linear probability model are presented in Table C3 in Appendix C.

[29] Marginal effects of a 1% increase in family income on the probability of being reported as in fair health status is – 0.007, -0.003, and -0.005 for children aged 0-3, 4-8, and 9-12 years in 1997, respectively. Marginal effects of a 1% increase in family income on the probability of being reported as in excellent health status is 0.1, 0.04, and 0.09 for children aged 0-3, 4-8, and 9-12 years in 1997, respectively.

family income on health might be largest for younger children and might accumulate over time at a decreasing rate.

As we discussed in Section 4.3.3, Specification 3 imposes a weaker theoretical assumption on the coefficient of persistency than does Specification 2. However, a dynamic discrete-choice model like Specification 3 has two potential problems (Hsiao 2003).[30] First, initial conditions may not be exogenous. Second, true persistency must be identified separately from spurious persistency, which could be caused by unobserved heterogeneity or by serial correlation in a residual term. Therefore, we need to be cautious when interpreting the coefficients estimated with this specification. Further considerations are required to predict the directions of bias that could occur when the problems are not dealt with appropriately.

5. Summary and Future Work

This study has attempted to separate the contemporaneous effects of family income on child health from the accumulated effects. Also, we have sought to investigate how the contemporaneous effects evolve throughout childhood by estimating two different models (Specifications 2 and 3). What we have found from the estimations is weak evidence that the contemporaneous effects of income on health are most significant for younger children and that they accumulate at a diminishing rate as children get older. This finding could suggest that policy interventions at earlier ages are more effective in mitigating health inequalities among children, though it is necessary for us to use more elaborate estimation methodologies in order to obtain more convincing results.

While the main focus of this analysis is on family income as a determinant of child health, we have also found that race and a mother's educational level have a significant

[30] The potential problems of omitted variable bias pertaining to all of the specifications are discussed in Appendix B.

relationship with child health. In addition to these factors, Bramlett and Blumberg (2007) have shown that family structures influence child health. The fact that health is a multidimensional outcome makes it extremely important to take account of these factors comprehensively when designing public policies pertaining to child health. Thus, it is worth investigating the relationship between various family characteristics other than income and child health as an extension of this study.

Another direction for future research is to conduct analysis on how and why the contemporaneous effects of income on child health are realized. For example, Currie and Stabile (2003) show that the poorer health of children in lower-income families is explained by their higher incidence of health shocks rather than by their lower rate of recovery from illness. This result may reflect the fact that parents with high income are able to purchase enough health care products to save children from health shocks. Instead, as discussed by Case and Paxson (2002) and by Currie et al. (2007), wealthier parents may have more preferences for healthy behaviors that could prevent children's illnesses. Exploring the mechanisms of the occurrence of the contemporaneous effects is left as our future work.

Appendix A

A1a. Un-weighted Summary Statistics (Year 1997)

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 1997 (N=3510)[a]				
Age	6.07	3.64	1	12
Health status[b]	1.72	0.83	1	5
Health status very good or excellent[b]	0.81	0.39	0	1
Health status fair or poor[b]	0.03	0.16	0	1
Permanent Income[c]	23121	22072	1050	316754
Female	0.49	0.50	0	1
Nonwhite	0.53	0.50	0	1
Mother present in family[d]	0.94	0.25	0	1
Mother's age (if present)	32.72	6.92	16	58
Mother's education (if present)	12.77	2.34	2	17
Father present in family[d]	0.63	0.48	0	1
Father's age (if present)	36.19	7.38	18	77
Father's education (if present)	13.08	2.60	2	17
Family size	4.21	1.28	2	12

Notes:

(a) We exclude children from the sample if the information on their permanent family income, health status, or parent's age is not available. This leaves us with 3,510 observations in 1997.

(b) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(c) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(d) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

A1b. Un-weighted Summary Statistics (Year 2002)

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 2002 (N=2877)[(a)]				
Age	10.05	3.71	4	17
Health status[(b)]	1.65	0.81	1	5
Health status very good or excellent[(b)]	0.84	0.36	0	1
Health status fair or poor[(b)]	0.03	0.16	0	1
Permanent Income[(c)]	23358	22640	1050	316754
Female	0.49	0.50	0	1
Nonwhite	0.53	0.50	0	1
Mother present in family[(d)]	0.91	0.28	0	1
Mother's age (if present)	37.12	6.85	18	57
Mother's education (if present)	12.95	2.36	3	17
Father present in family[(d)]	0.54	0.50	0	1
Father's age (if present)	40.67	7.18	22	81
Father's education (if present)	13.19	2.65	2	17
Family size	4.25	1.28	2	13

Notes:

(a) We exclude children from the sample if the information on their permanent family income, health status, or parent's age is not available. This leaves us with 2,877 observations in 2002.

(b) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(c) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(d) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

A2a. Un-weighted Summary Statistics of Balanced Panel (Year 1997)

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 1997 (N=2856)[(a)]				
Age	5.97	3.59	1	12
Health status[(b)]	1.72	0.83	1	5
Health status very good or excellent[(b)]	0.82	0.39	0	1
Health status fair or poor[(b)]	0.03	0.16	0	1
Permanent Income[(c)]	23415	22701	1050	316754
Female	0.49	0.50	0	1
Nonwhite	0.53	0.50	0	1
Mother present in family[(d)]	0.94	0.23	0	1
Mother's age (if present)	32.87	6.91	16	52
Mother's education (if present)	12.83	2.36	2	17
Father present in family[(d)]	0.65	0.48	0	1
Father's age (if present)	36.22	7.44	18	77
Father's education (if present)	13.13	2.60	2	17
Family size	4.20	1.27	2	12

Notes:

(a) Only children who have the information on their permanent family income, health status, and a parent's age in both waves of the CDS are included in this sample.

(b) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(c) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(d) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

A2b. Un-weighted Summary Statistics of Balanced Panel (Year 2002)

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 2002 (N=2856)[(a)]				
Age	10.06	3.71	4	17
Health status[(b)]	1.65	0.81	1	5
Health status very good or excellent[(b)]	0.84	0.36	0	1
Health status fair or poor[(b)]	0.03	0.16	0	1
Permanent Income[(c)]	23415	22701	1050	316754
Female	0.49	0.50	0	1
Nonwhite	0.53	0.50	0	1
Mother present in family[(d)]	0.91	0.29	0	1
Mother's age (if present)	37.14	6.85	18	57
Mother's education (if present)	12.95	2.35	3	17
Father present in family[(d)]	0.54	0.50	0	1
Father's age (if present)	40.67	7.19	22	81
Father's education (if present)	13.21	2.62	2	17
Family size	4.25	1.28	2	13

Notes:

(a) Only children who have the information on their permanent family income, health status, and a parent's age in both waves of the CDS are included in this sample.

(b) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(c) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(d) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

Appendix B.

B.1 Proof of the Conditions for the Coefficient on Income to Represent the Contemporaneous Effects

B.1.1 Specification 2

In this subsection, we prove the condition for the coefficient β^a in Equation (4) to represent the contemporaneous effects of family income on child health. Equation (4) indicates that the coefficient β^a corresponds to the difference between B^a and B^{a-1}. Therefore, using the expressions in Equation (2), we can write the coefficient β^a as follows:

$$\beta^a = B^a - B^{a-1} = (\beta_1^a + \beta_2^a + ... + \beta_a^a) - (\beta_1^{a-1} + \beta_2^{a-1} + ... + \beta_{a-1}^{a-1})$$
$$= \beta_1^a + (\beta_2^a - \beta_1^{a-1}) + ... + (\beta_a^a - \beta_{a-1}^{a-1}) \qquad (B1)$$

where the contemporaneous effects of family income on child health are represented by β_1^a. Equation (B1) shows that the coefficient β^a reduces to β_1^a if $\beta_{j+1}^a = \beta_j^{a-1}$ for all $j = 1,....., a-1$; that is, if the effects of permanent income from earlier ages are independent of the distance from an age the health outcome is measured. This does not hold if the effects of permanent family income experienced at earlier ages depreciate over time.

B.1.2 Specification 3

To prove the condition for the coefficient β^a in Equation (5) to represent the contemporaneous effects of family income on child health, let's consider the following two equations:

$$H_{it-1}^* = A^{a-1} + Y_i B^{a-1} + Z_i C^{a-1} + Z_{it-1}\delta_1^{a-1} + ... + Z_{it-a+1}\delta_{a-1}^{a-1} + \phi^{a-1}\mu_i + \varepsilon_{it-1} \qquad (B2)$$

$$H_{it}^* = A^a + Y_i B^a + Z_i C^a + Z_{it}\delta_1^a + ... + Z_{it-a+1}\delta_a^a + \phi^a\mu_i + \varepsilon_{it} \qquad (B3)$$

Equation (B1) is a reduced-form health production function of children at age $(a-1)$ in period $(t-1)$, and the Equation (B2) is a reduced-form health production function of the same children when they become age a in period t written in the form of Equation (2). Multiplying Equation (B2) by ρ^a and subtracting the result from Equation (B3) yields the following equation:

$$H_{it}^{*} - H_{it-1}^{*}\rho^a = (A^a - A^{a-1}\rho^a) + Y_i(B^a - B^{a-1}\rho^a) + Z_i(C^a - C^{a-1}\rho^a)$$
$$+ Z_{it}\delta_1^a + Z_{it-1}(\delta_2^a - \delta_1^{a-1}\rho^a) + ... + Z_{it-a+1}(\delta_a^a - \delta_{a-1}^{a-1}\rho^a)$$
$$+ (\phi^a - \phi^{a-1}\rho^a)\mu_i + \varepsilon_{it} - \varepsilon_{it-1}\rho^a \qquad (B4)$$

Comparing Equation (5) with (B4) reveals that the coefficient β^a is equivalent to the difference between B^a and $B^{a-1}\rho^a$, and thus, can be expressed as follows:

$$\beta^a = B^a - B^{a-1}\rho^a = \beta_1^a + (\beta_2^a - \beta_1^{a-1}\rho^a) + ... + (\beta_a^a - \beta_{a-1}^{a-1}\rho^a) \qquad (B5)$$

where, again, β_1^a represents the contemporaneous effects of family income on child health. According to Equation (B5), the coefficient β^a is equivalent to β_1^a if $\beta_{j+1}^a = \beta_j^{a-1}\rho^a$ for all $j = 1,.....,a-1$; that is, the effects of permanent family income from earlier ages decline with the distance from an age the health outcome is measured at rate $(1-\rho^a)$.

B.2 Some Considerations of Error Terms

B.2.1 Specifications 1 & 2

In this subsection, we provide conditions for the coefficients B^a in Equation (3) and β^a in Equation (4) to be consistently estimated. We consider a linear probability model for discussions in this appendix, although an ordered probit model is used in our analysis. As can be seen in comparison with Equation (2), the residual term v_{it} in Equations (3) and (4) contains all the omitted current and past factors, a child health

endowment, and a random error. The coefficients in Equations (3) and (4) could be consistently estimated if Y_i, the vectors Z_i and Z_{it} are not correlated with any of the elements in the residual term v_{it}. This condition may not be plausible, because it is violated if, for example, permanent family income and a child health endowment are correlated with each other through the effects of unobserved parental endowments. The condition also does not hold if permanent family income is correlated with the omitted variables in the residual term that would represent parental preferences. Thus, when we interpret the estimation results, directions of potential bias must be taken into account.

B.2.2 Specification 3

Before discussing the condition required to consistently estimate the coefficient β^a in Equation (5), we need to consider what elements are included in the residual term η_{it}. For this specification, contents of the residual term depend on assumptions we place on parameters. If we assume that $\delta_{j+1}^a = \delta_j^{a-1}\rho^a$, $\gamma_{j+1}^a = \gamma_j^{a-1}\rho^a$ for all $j = 1,.....,a-1$ and $\phi^a = \phi^{a-1}\rho^a$, namely, the effects of factors other than permanent income and of a child health endowment depreciate at the same rate ρ^a, then Equations (2) and (B4) indicates that the residual term η_{it} contains all the omitted factors and a composite error term $\varepsilon_{it} - \rho^a \varepsilon_{it-1}$. If, instead, we assume that $\phi^a \neq \phi^{a-1}\rho^a$, the residual term will include the effects of a child health endowment as well.

The condition required to obtain consistent estimators of the coefficients in Equation (5) is that Y_i, H_{it-1}^*, and the other covariates are not correlated with the residual term η_{it}. This requirement, however, may be unrealistic. Even if $\phi^a = \phi^{a-1}\rho^a$ and the

residual term does not contain the effects of a child health endowment, H^{*}_{it-1} will be endogenous: H^{*}_{it-1} is necessarily correlated with ε_{it-1}, and therefore with $\varepsilon_{it} - \rho^{a}\varepsilon_{it-1}$ in the residual term, unless the composite error term is independently identically distributed.[31] In the case where $\phi^{a} \neq \phi^{a-1}\rho^{a}$ and the residual term does include the effects of a child health endowment, H^{*}_{it-1} will be correlated with the residual term not only through the composite error term but also through a child health endowment. Y_i may also be endogenous for the reasons we have discussed for Specifications 1 and 2. In any case, if there is a problem of endogeneity, the coefficient on income will be biased.

[31] The composite error term is iid if ε_{it} is serially correlated and the degree of correlation is ρ^{a} (Todd and Wolpin; 2001, 2006).

Appendix C. Linear Probability Model

Table C1a. Linear Probability Estimation of Specification 1 (Year 1997)

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=1069	N=1358	N=1083
	(1)	(2)	(3)
ln(Income)	-0.068	-0.160	-0.198
	(0.042)	(0.040)**	(0.042)**
Female	-0.014	-0.024	-0.088
	(0.048)	(0.045)	(0.049)+
Nonwhite	0.126	0.180	0.198
	(0.056)*	(0.052)**	(0.057)**
Mother present in family	-0.103	-0.019	0.118
	(0.143)	(0.096)	(0.096)
Mother's age * Mother present in family	0.024	-0.048	0.135
	(0.038)	(0.038)	(0.054)*
Mother's age squared * Mother present in family	-0.001	0.001	-0.002
	(0.0010)	(0.0010)	(0.001)*
Mother's education=12 * Mother present in family	-0.073	-0.074	0.008
	(0.075)	(0.077)	(0.082)
Mother's education>12 * Mother present in family	-0.172	-0.141	-0.105
	(0.085)*	(0.085)+	(0.090)
ln(Family size)	0.046	0.021	-0.115
	(0.089)	(0.081)	(0.088)

Notes:

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table C1b. Linear Probability Estimation of Specification 1 (Year 2002)

	Age 4-8 in 2002	Age 9-12 in 2002	Age 13-17 in 2002
	N=893	N=1124	N=860
	(1)	(2)	(3)
ln(Income)	-0.196	-0.144	-0.231
	(0.046)**	(0.042)**	(0.047)**
Female	-0.090	-0.063	0.108
	(0.051)+	(0.048)	(0.054)*
Nonwhite	0.143	0.139	0.093
	(0.059)*	(0.056)*	(0.064)
Mother present in family	-0.227	-0.153	-0.040
	(0.116)+	(0.093)	(0.103)
Mother's age * Mother present in family	-0.003	0.049	0.138
	(0.045)	(0.048)	(0.069)*
Mother's age squared * Mother present in family	0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)+
Mother's education=12 * Mother present in family	-0.039	-0.168	-0.099
	(0.090)	(0.093)+	(0.102)
Mother's education>12 * Mother present in family	-0.137	-0.277	-0.268
	(0.099)	(0.099)**	(0.109)*
ln(Family size)	0.013	-0.043	-0.026
	(0.095)	(0.086)	(0.093)

Notes:

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table C2. Linear Probability Estimation of Specification 2

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=1772	N=2232	N=1708
	(1)	(2)	(3)
Ln(Income)	-0.057	-0.144	-0.248
	(0.042)	(0.037)**	(0.042)**
Ln(Income)*year02	-0.120	0.013	0.042
	(0.049)*	(0.043)	(0.050)
Female	-0.064	-0.042	-0.003
	(0.037)+	(0.034)	(0.038)
Nonwhite	0.149	0.203	0.139
	(0.042)**	(0.040)**	(0.045)**
Mother present in family	-0.209	-0.102	0.089
	(0.092)*	(0.071)	(0.076)
Mother's age * Mother present in family	-0.033	-0.018	0.127
	(0.027)	(0.029)	(0.040)**
Mother's age squared * Mother present in family	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)**
Mother's education=12 * Mother present in family	-0.017	-0.084	-0.077
	(0.060)	(0.063)	(0.070)
Mother's education>12 * Mother present in family	-0.119	-0.163	-0.241
	(0.067)+	(0.068)*	(0.076)**
Ln(Family size)	0.058	-0.009	-0.027
	(0.068)	(0.061)	(0.069)
Year02	0.966	-0.238	-0.434
	(0.485)*	(0.428)	(0.497)

Notes: Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%
(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor. (2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale. (3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father). (4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table C3. Linear Probability Estimation of Specification 3

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=886	N=1116	N=854
	(1)	(2)	(3)
Health96	0.311	0.381	0.368
	(0.032)**	(0.027)**	(0.033)**
Ln(Income)	-0.189	-0.094	-0.154
	(0.044)**	(0.039)*	(0.045)**
Female	-0.074	-0.049	0.156
	(0.049)	(0.044)	(0.051)**
Nonwhite	0.096	0.034	0.024
	(0.057)+	(0.053)	(0.060)
Mother present in family	-0.173	-0.153	-0.107
	(0.111)	(0.086)+	(0.096)
Mother's age * Mother present in family	-0.008	0.049	0.069
	(0.043)	(0.045)	(0.066)
Mother's age squared * Mother present in family	0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Mother's education=12 * Mother present in family	-0.049	-0.128	-0.057
	(0.086)	(0.086)	(0.096)
Mother's education>12 * Mother present in family	-0.115	-0.195	-0.160
	(0.095)	(0.092)*	(0.103)
Ln(Family size)	-0.003	-0.018	-0.018
	(0.091)	(0.080)	(0.087)

Notes: Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

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Table 1a. Summary Statistics (Year 1997)[a]

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 1997 (N=3510)[b]				
Age	6.09	3.62	1	12
Health status[c]	1.65	0.80	1	5
Health status very good or excellent[c]	0.83	0.37	0	1
Health status fair or poor[c]	0.02	0.15	0	1
Permanent Income[d]	25977	24524	1050	316754
Female	0.49	0.50	0	1
Nonwhite	0.36	0.48	0	1
Mother present in family[e]	0.94	0.22	0	1
Mother's age (if present)	33.44	6.52	16	58
Mother's education (if present)	12.78	2.58	2	17
Father present in family[e]	0.70	0.45	0	1
Father's age (if present)	36.42	6.99	18	77
Father's education (if present)	13.19	2.80	2	17
Family size	4.31	1.27	2	12

Notes:

(a) Summary statistics are weighted using children's sampling weights provided in the CDS.

(b) We exclude children from the sample if the information on their permanent family income, health status, or parent's age is not available. This leaves us with 3,510 observations in 1997.

(c) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(d) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(e) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

Table 1b. Summary Statistics (Year 2002)[a]

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 2002 (N=2877)[b]				
Age	10.10	3.68	4	17
Health status[c]	1.59	0.80	1	5
Health status very good or excellent[c]	0.85	0.35	0	1
Health status fair or poor[c]	0.03	0.16	0	1
Permanent Income[d]	26094	24456	1050	316754
Female	0.50	0.50	0	1
Nonwhite	0.36	0.48	0	1
Mother present in family[e]	0.92	0.27	0	1
Mother's age (if present)	37.92	6.47	18	57
Mother's education (if present)	12.99	2.65	3	17
Father present in family[e]	0.64	0.48	0	1
Father's age (if present)	40.91	6.93	22	81
Father's education (if present)	13.27	2.83	2	17
Family size	4.38	1.33	2	13

Notes:

(a) Summary statistics are weighted using children's sampling weights provided in the CDS.

(b) We exclude children from the sample if the information on their permanent family income, health status, or parent's age is not available. This leaves us with 2,877 observations in 2002.

(c) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(d) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(e) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

Table 2a. Ordered Probit Estimation of Specification 1 (Year 1997)

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=1069	N=1358	N=1083
	(1)	(2)	(3)
Ln(Income)	-0.099	-0.222	-0.284
	(0.060)+	(0.055)**	(0.062)**
Female	-0.015	-0.041	-0.142
	(0.070)	(0.062)	(0.070)*
Nonwhite	0.179	0.250	0.282
	(0.082)*	(0.072)**	(0.082)**
Mother present in family	-0.138	-0.013	0.166
	(0.205)	(0.131)	(0.138)
Mother's age * Mother present in family	0.039	-0.061	0.188
	(0.055)	(0.052)	(0.078)*
Mother's age squared * Mother present in family	-0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)*
Mother's education=12 * Mother present in family	-0.101	-0.080	0.038
	(0.107)	(0.102)	(0.115)
Mother's education>12 * Mother present in family	-0.248	-0.177	-0.140
	(0.122)*	(0.115)	(0.127)
Ln(Family size)	0.061	0.015	-0.163
	(0.128)	(0.110)	(0.125)

Notes:

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes the value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table 2b Ordered Probit Estimation of Specification 1 (Year 2002)

	Age 4-8 in 2002	Age 9-12 in 2002	Age 13-17 in 2002
	N=893	N=1124	N=860
	(1)	(2)	(3)
Ln(Income)	-0.299	-0.194	-0.329
	(0.071)**	(0.061)**	(0.070)**
Female	-0.142	-0.102	0.156
	(0.079)+	(0.070)	(0.080)*
Nonwhite	0.234	0.229	0.166
	(0.091)*	(0.082)**	(0.093)+
Mother present in family	-0.312	-0.151	-0.053
	(0.171)+	(0.133)	(0.147)
Mother's age * Mother present in family	-0.003	0.065	0.201
	(0.070)	(0.070)	(0.102)*
Mother's age squared * Mother present in family	0.001	-0.001	-0.002
	(0.001)	(0.001)	(0.001)+
Mother's education=12 * Mother present in family	-0.019	-0.198	-0.076
	(0.133)	(0.131)	(0.145)
Mother's education>12 * Mother present in family	-0.201	-0.398	-0.345
	(0.149)	(0.141)**	(0.157)*
Ln(Family size)	-0.027	-0.076	-0.026
	(0.145)	(0.124)	(0.133)

Notes:

Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes the value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table 3a. Summary Statistics of Balanced Panel (Year 1997)[a]

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 1997 (N=2856)[b]				
Age	6.03	3.58	1	12
Health status[c]	1.64	0.79	1	5
Health status very good or excellent[c]	0.85	0.36	0	1
Health status fair or poor[c]	0.02	0.15	0	1
Permanent Income[d]	26529	24771	1050	316754
Female	0.51	0.50	0	1
Nonwhite	0.35	0.48	0	1
Mother present in family[e]	0.95	0.21	0	1
Mother's age (if present)	33.73	6.55	16	52
Mother's education (if present)	12.91	2.65	2	17
Father present in family[e]	0.75	0.44	0	1
Father's age (if present)	36.58	6.99	18	77
Father's education (if present)	13.32	2.78	2	17
Family size	4.31	1.26	2	12

Notes:

(a) Summary statistics are weighted using children's sampling weights provided in the CDS.

(b) Only children who have the information on their permanent family income, health status, and a parent's age in both waves of the CDS are included in this sample.

(c) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(d) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(e) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

Table 3b. Summary Statistics of Balanced Panel (Year 2002)[a]

	Mean (A)	S.d. (B)	Min (C)	Max (D)
Year 2002 (N=2856)[b]				
Age	10.10	3.68	4	17
Health status[c]	1.59	0.80	1	5
Health status very good or excellent[c]	0.85	0.35	0	1
Health status fair or poor[c]	0.03	0.16	0	1
Permanent Income[d]	26147	24518	1050	316754
Female	0.50	0.50	0	1
Nonwhite	0.36	0.48	0	1
Mother present in family[e]	0.92	0.27	0	1
Mother's age (if present)	37.93	6.47	18	57
Mother's education (if present)	13.00	2.63	3	17
Father present in family[e]	0.64	0.48	0	1
Father's age (if present)	40.91	6.93	22	81
Father's education (if present)	13.29	2.80	2	17
Family size	4.38	1.33	2	13

Notes:

(a) Summary statistics are weighted using children's sampling weights provided in the CDS.

(b) Only children who have the information on their permanent family income, health status, and a parent's age in both waves of the CDS are included in this sample.

(c) We use a subjective measure of children's health status reported by primary care givers. It is a categorical variable which takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, and 5 = Poor.

(d) Permanent income is defined as the average of total family income over years 1995, 1997, 1999, and 2001 adjusted with an equivalence scale.

(e) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

Table 4. Ordered Probit Estimation of Specification 2

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=1772	N=2232	N=1708
	(1)	(2)	(3)
Ln(Income)	-0.080	-0.189	-0.348
	(0.062)	(0.054)**	(0.063)**
Ln(Income)*year02	-0.207	0.006	0.044
	(0.075)**	(0.063)	(0.074)
Female	-0.091	-0.069	-0.009
	(0.055)	(0.049)	(0.056)
Nonwhite	0.227	0.305	0.212
	(0.064)**	(0.058)**	(0.065)**
Mother present in family	-0.294	-0.102	0.125
	(0.135)*	(0.100)	(0.109)
Mother's age * Mother present in family	-0.046	-0.029	0.181
	(0.039)	(0.040)	(0.059)**
Mother's age squared * Mother present in family	0.001	0.001	-0.002
	(0.001)	(0.001)	(0.001)**
Mother's education=12 * Mother present in family	-0.005	-0.092	-0.057
	(0.088)	(0.087)	(0.098)
Mother's education>12 * Mother present in family	-0.178	-0.227	-0.304
	(0.099)+	(0.095)*	(0.107)**
Ln(Family size)	0.054	-0.024	-0.030
	(0.101)	(0.087)	(0.098)
Year02	1.685	-0.220	-0.461
	(0.736)*	(0.614)	(0.729)

Notes: Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%
(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor. (2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale. (3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father). (4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Table 5. Ordered Probit Estimation of Specification 3

	Age 0-3 in 1997	Age 4-8 in 1997	Age 9-12 in 1997
	N=886	N=1116	N=854
	(1)	(2)	(3)
Health96	0.475	0.566	0.536
	(0.052)**	(0.044)**	(0.052)**
Ln(Income)	-0.313	-0.138	-0.231
	(0.072)**	(0.062)*	(0.072)**
Female	-0.119	-0.092	0.248
	(0.081)	(0.072)	(0.082)**
Nonwhite	0.167	0.095	0.080
	(0.093)+	(0.085)	(0.096)
Mother present in family	-0.253	-0.171	-0.152
	(0.173)	(0.136)	(0.150)
Mother's age * Mother present in family	-0.011	0.069	0.116
	(0.071)	(0.072)	(0.106)
Mother's age squared * Mother present in family	0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Mother's education=12 * Mother present in family	-0.035	-0.156	-0.024
	(0.135)	(0.133)	(0.148)
Mother's education>12 * Mother present in family	-0.179	-0.313	-0.210
	(0.151)	(0.144)*	(0.161)
Ln(Family size)	-0.054	-0.034	-0.015
	(0.147)	(0.128)	(0.136)

Notes: Standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

(1) The dependent variable is children's health status. This is a categorical variable which is reported by primary care givers and takes 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(3) The indicator of mother's (father's) presence in the family takes value of one if the child is living with his or her biological mother (father).

(4) Child age dummies and father's characteristics (presence in the family, age, and education) are also included.

Figure 1a. Distribution of Health Status by Income Quintile (Year 1997)

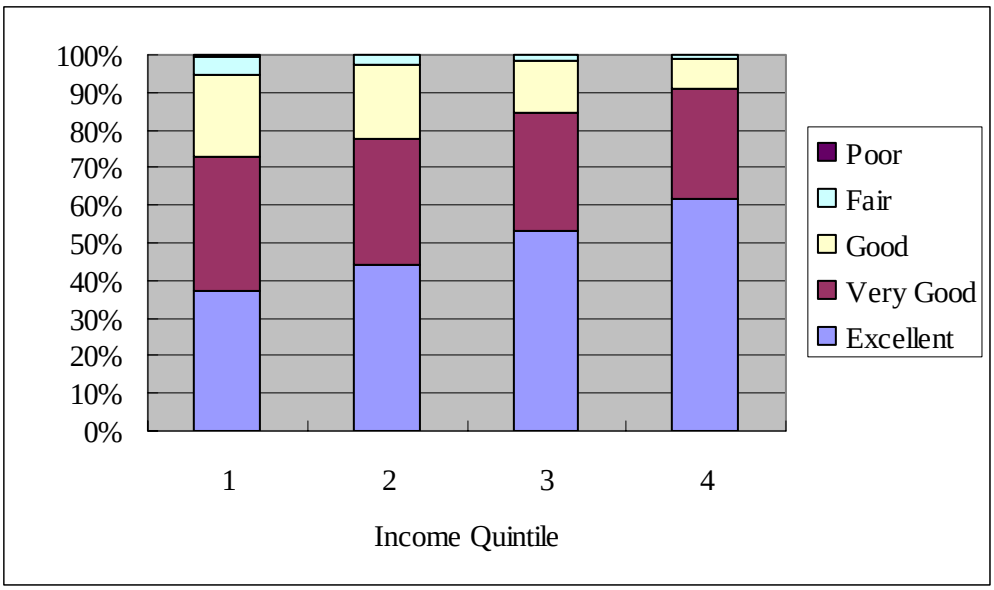
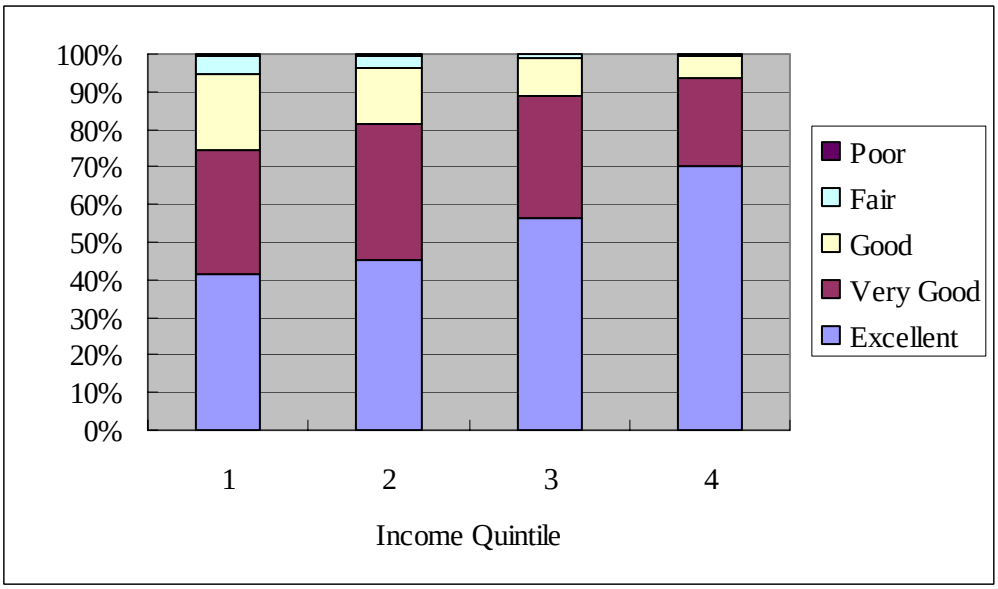


Figure 1b. Distribution of Health Status by Income Quintile (Year 2002)



Note:

(1) Children's health status is represented by a categorical variable which is reported by primary care givers and takes a value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

Figure 2a. Percentage of Fair or Poor Health Status by Age and Income (Year 1997)

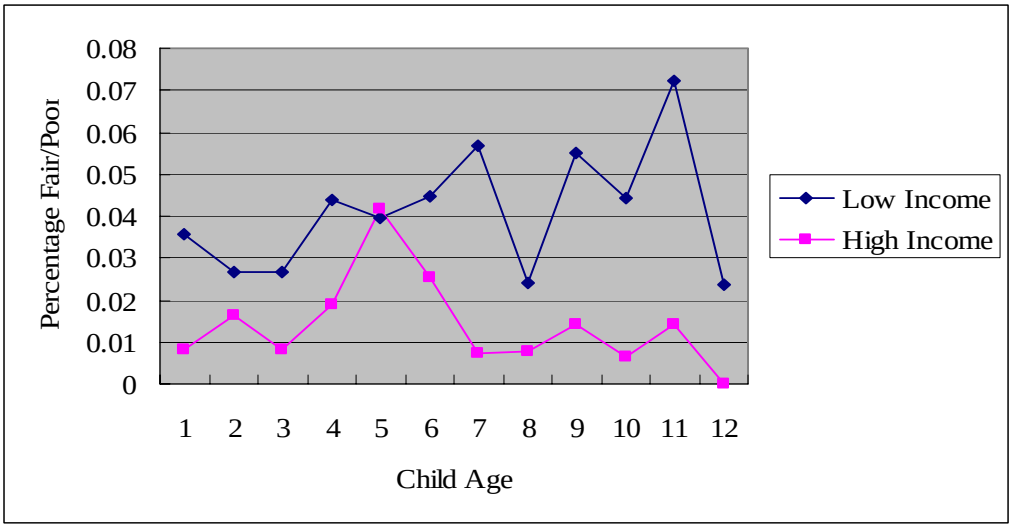
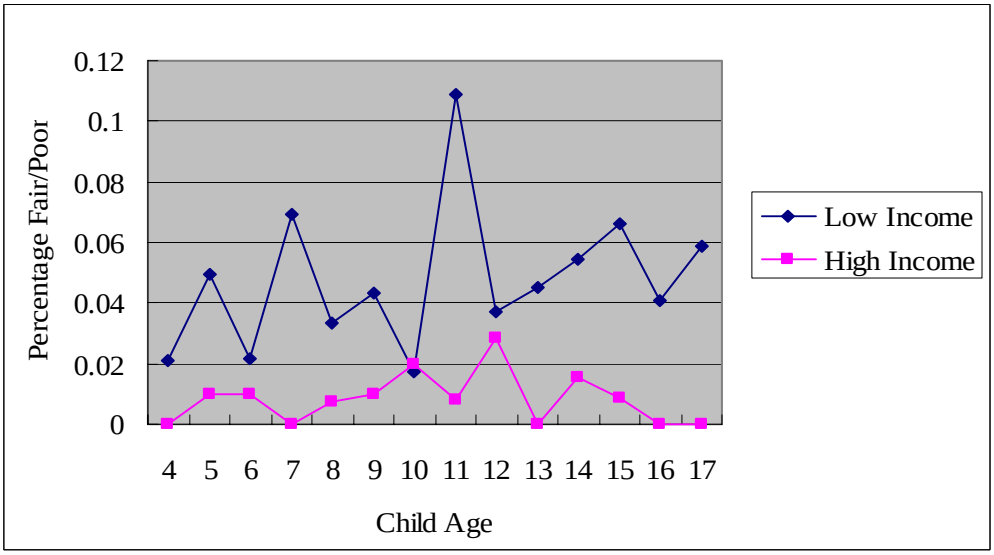


Figure 2b. Percentage of Fair or Poor Health Status by Age and Income (Year 2002)



Notes:

(1) Children's health status is measured with a categorical variable which is reported by primary care givers and takes a value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Children with fair or poor health status are those whose general health status is reported to be a value of four or five.

(3) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(4) Income is defined as low (high) if it is below (above) the median income of the sample

Figure 2c. Difference in Percentage of Fair or Poor Health Status between Low and High Income (Year 1997)

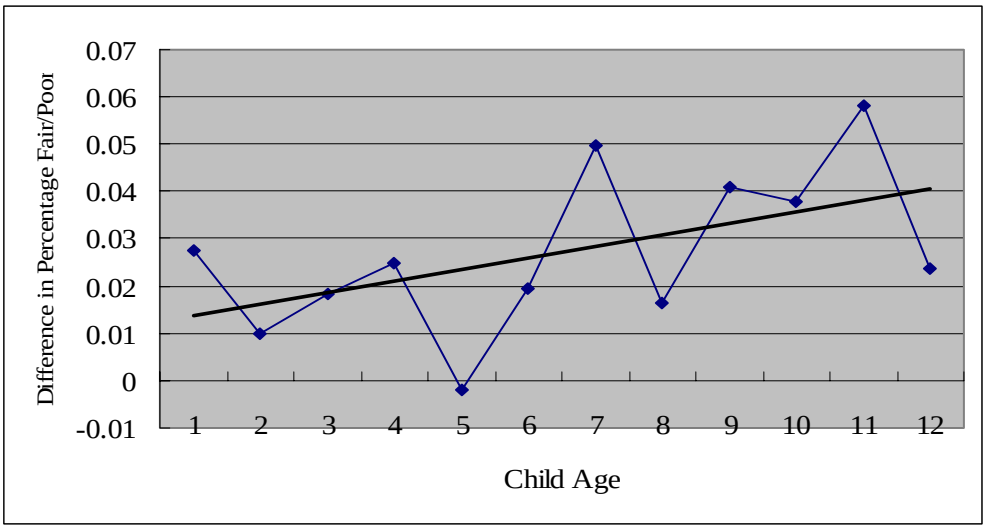
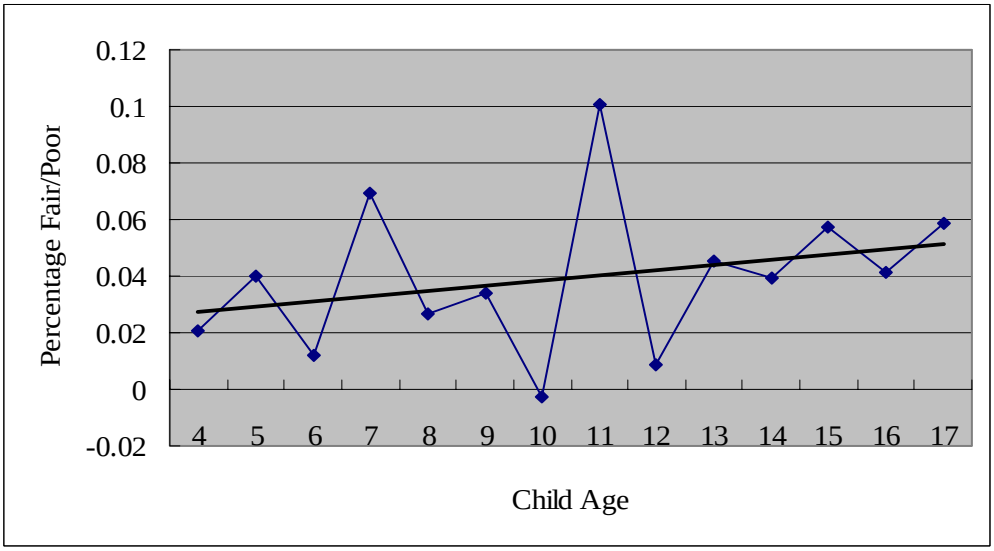


Figure 2d. Difference in Percentage of Fair or Poor Health Status between Low and High Income (Year 2002)



Notes:

(1) Children's health status is measured with a categorical variable which is reported by primary care givers and takes a value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Children with fair or poor health status are those whose general health status is reported to be a value of four or five.

(3) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

(4) Income is defined as low (high) if it is below (above) the median income of the sample

Figure 3a. Locally Weighted Regression of Child Health on Income by Age Gr oup (Year 1997)

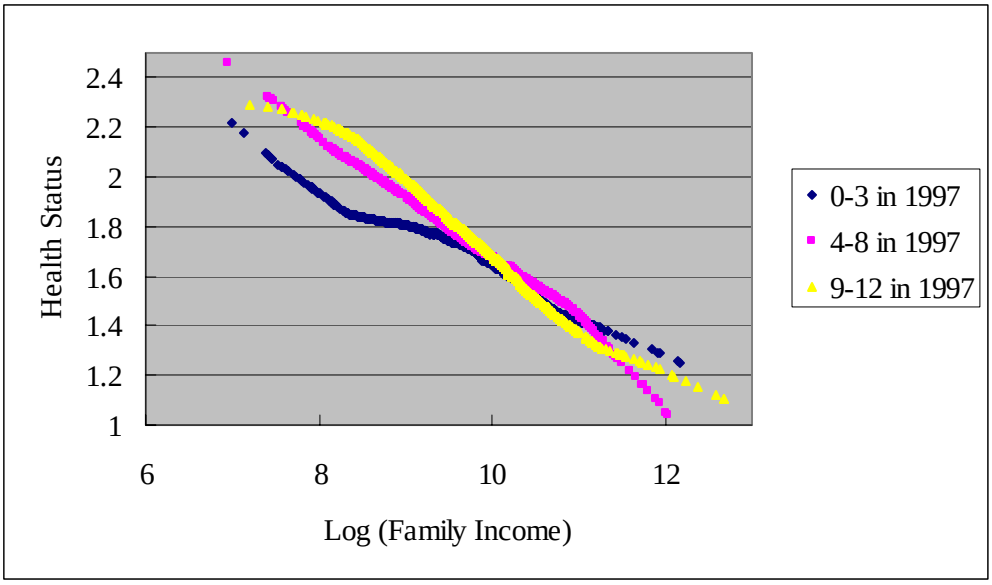
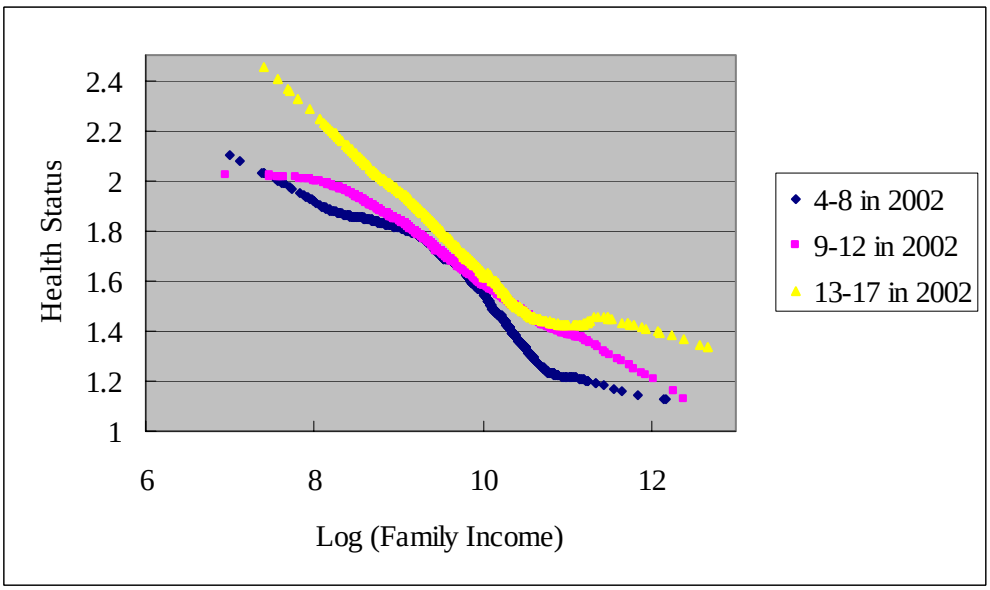


Figure 3b. Locally Weighted Regression of Child Health on Income by Age Group (Year 2002)



Notes:

(1) Children's health status is represented by a categorical variable which is reported by primary care givers and takes a value of 1 = Excellent, 2 = Very Good, 3 = Good, 4=Fair, or 5 = Poor.

(2) Income is the average of total family income in years 1995, 1997, 1999 and 2002 adjusted with an equivalence scale.

Figure 4a. Locally Weighted Regression of Child Health on Income by Year (Age 0-3 in 1997)

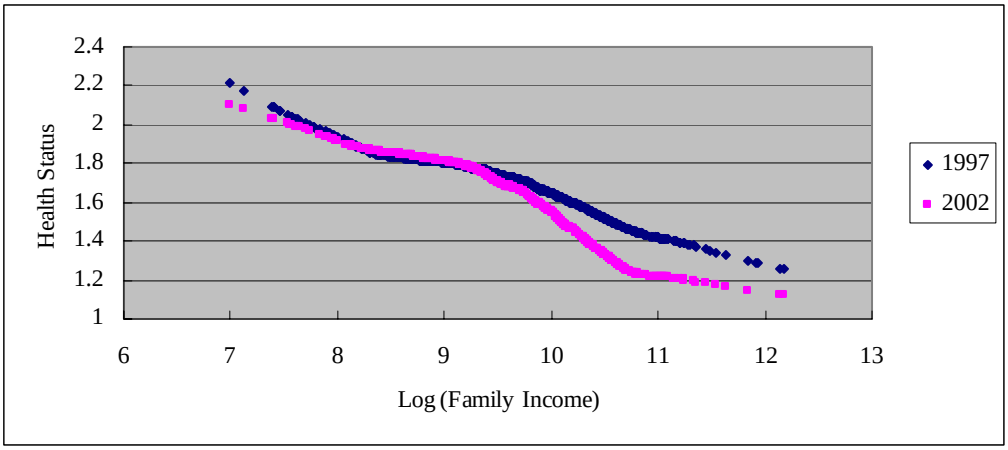
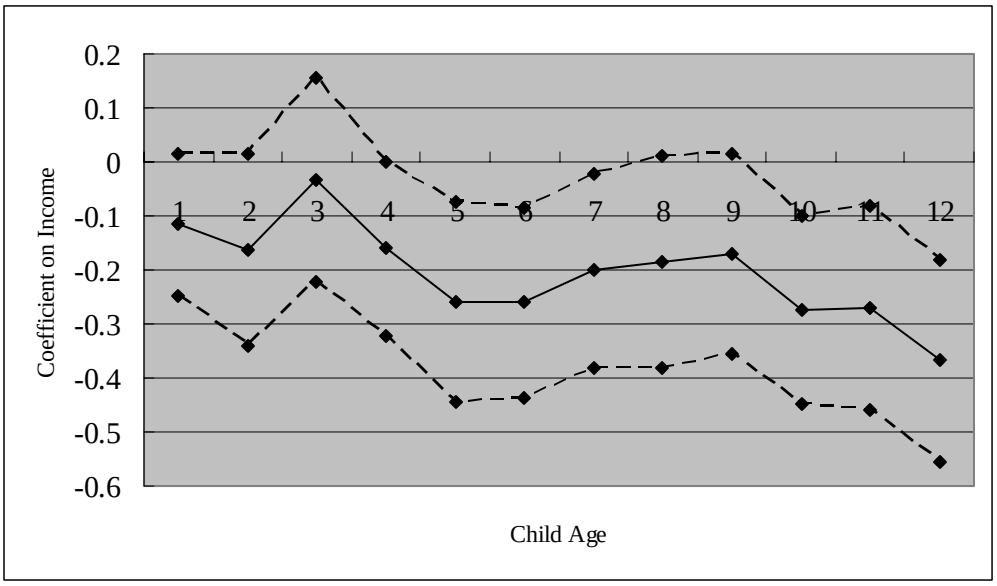


Figure 4b. Locally Weighted Regression of Child Health on Income by Year (Age 4-8 in 1997)

Figure 4c. Locally Weighted Regression of Child Health on Income by Year (Age 9-12 in 1997)

Please refer to notes on Figure 3.

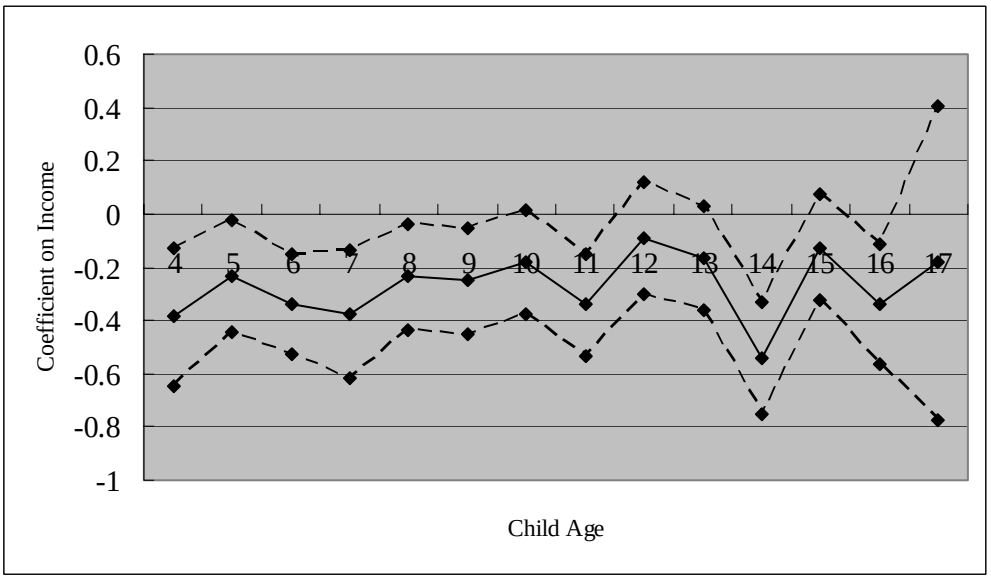
Figure 5a. Coefficient on Income (Specification 1, Year 1997)



Note:

The dotted lines represent 95% confidence interval

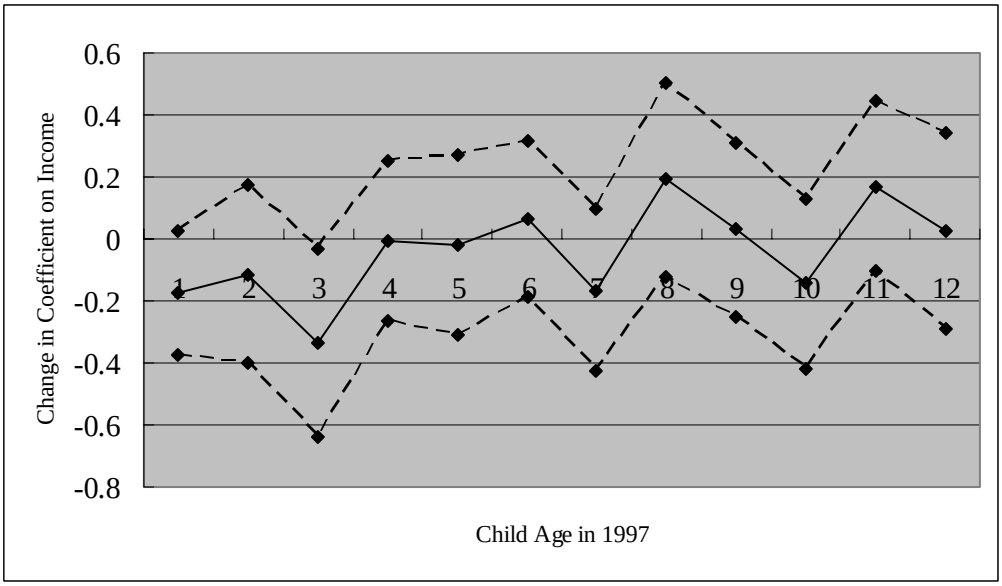
Figure 5b. Coefficient on Income (Specification 1, Year 2002)



Note:

The dotted lines represent 95% confidence interval

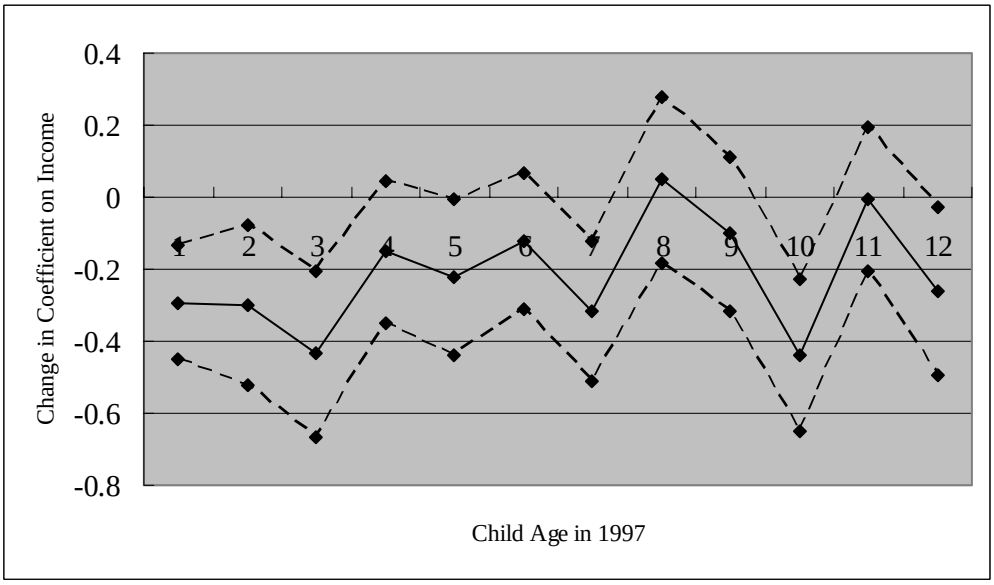
Figure 6. Change in Coefficient of Income between 1997 and 2002 (Specification 2)



Note:

The dotted lines represent 95% confidence interval

Figure 7. Coefficient on Income (Specification 3)



Note:

The dotted lines represent 95% confidence interval