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ABSTRACT

Is the Child Health / Family Income Gradient Universal? Evidence from England*

In an influential study Case et al. (2002) documented a positive relationship between family income and child health in the US, with the slope of the gradient being larger for older than younger children. In this paper we explore the child health income gradient in England, which has a comprehensive publicly-funded National Health Service (NHS) founded on the twin principles of health care being free at the point of delivery and equality of access for the whole population. Our analysis is based on a sample of over 13,000 children (and their parents) drawn from the Health Survey for England. In accordance with Case et al. (2002), we find consistent and robust evidence of a significant family income gradient in child health using the subjective general health status measure. However, in England the size of the gradient is considerably smaller than that found for the US and we find no evidence that its slope increases with child age. We also provide new evidence that nutrition and family lifestyle choices have an important role in determining child health and that child health outcomes are highly correlated within the family. In addition, we find no evidence of an income gradient for objective indicators of child health, derived from nurse measurements and blood test results. Together our evidence is consistent with the hypothesis that the NHS has a protective effect on the health of children in England.

JEL Classification: I1

Keywords: child health, income gradient, chronic illness, nutrition, lifestyle

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I. Introduction

The relationship between income and health is an important policy-related issue that has generated a large empirical literature in economics and other social sciences (see Adler et al., 1994; Deaton and Paxson, 1998; Smith, 1999; van Doorslaer et al., 1997; Wilkinson and Marmot, 2003). However, the mechanisms by which income is related to health remain controversial (Chase, 2002) and, as noted by Deaton and Paxson (1998), "there is a well-documented but poorly understood gradient linking socio-economic status to a wide range of health outcomes". Recent studies that have used panel data, observing how health changes in response to income movements, have found little evidence that increased income leads to improved health (see, for example, Adams et al., 2003; Contoyannis et al., 2004; Frijters et al., 2003; Meer et al., 2003).

Another strand of this literature, in which economists have recently started to make a strong contribution, focuses on the relationship between family income and child health. This relationship is important as it has been shown that poor health in childhood is associated with lower educational attainment, worse health and inferior labor market outcomes in adulthood (see Case et al., 2004a; Currie, 2004; Currie and Hyson, 1999; Graham and Power, 2004).

In an influential contribution to the child health literature, Case et al. (2002) undertook a detailed analysis of the relationship between family income and child health using data from the US National Health Interview Survey. The authors presented robust evidence of a significant positive income gradient, with children in poorer families having significantly worse health than children from richer families. They also showed that the income gradient in child health increased with child age in the US, with the protective effect of income accumulating over the childhood years. Currie and Stabile (2003) also found evidence of an increasing income gradient with child age, which they attributed to low income children experiencing more health shocks than high income children.

In this paper we contribute to this recent literature by asking whether or not these important policy-related findings are universal. We do this firstly by replicating the analysis of Case et al. (2002) using a large sample of English children and their parents, with data that has virtually the same structure as that used for the US. This is of considerable interest due to the contrasting institutional structure of the two countries' health care systems. Unlike the US, where private health insurance is the norm, the UK has had, since 1948, a National Health Service (NHS) based on health care being free at the point of delivery and equal access given equal need (see Culyer and Wagstaff, 1993). Moreover, there are widely recognized medical and social norms in the UK, that children are able to get priority appointments with their general practitioner (GP), that GPs are more willing to make house-calls for children than adults, and that children have priority (given equal need) in hospital accident and emergency departments.[1] If this is the case, and the NHS has achieved its objectives, then there should be no evidence of an increasing income gradient in child health in England. Our findings are consistent with this hypothesis.[2]

In addition, our data enable us to explore this issue further than Case et al. (2002) in three ways. First, we are able to document the extent of the correlation in general health status between children in the same family, since up to two children are surveyed in the same family. We find that around 60% of the total variation in general child health can be accounted for by unobserved family effects. Second, we explore whether the nutritional intake of children and family lifestyle indicators offer any protective benefit to child health. Our evidence indicates that there is a clear mandate for policies to promote increased vegetable consumption and physical activity amongst children, but that the inclusion of these variables leaves the income gradient largely unaffected. Third, we examine whether the positive association between family income and child health remains for more objective measures of child health, derived from measurements and blood samples obtained by qualified nurses. Interestingly, we are unable to find any significant effect of family income on a wide range of objective child health indicators.

In Section II we describe our data and highlight the raw relationship between child health and family income. The results of our statistical models of child health are discussed in Section III and conclusions are drawn in Section IV.

II. Data and Sample Characteristics

Data

In this study we utilize pooled data from the 1997-2002 Health Surveys of England (HSEs) in order to explore the association between child health indicators and family income. The HSE was commissioned by the UK's Department of Health and has been conducted by the Joint Health Surveys Unit of the National Centre for Social Research and the Department of Epidemiology and Public Health, Royal Free and University College London. Beginning in 1992, each HSE is a nationally representative survey of private households in England, providing an annual cross-section of the population with which to monitor trends in the nation's health. It uses the Postcode Address File as a sampling frame. The average response rate of households at selected addresses is 75%, within which successful interviews are conducted with 90% of individuals. A sample of around 16,000 individuals is typically obtained. The data are collected by a combination of face-to-

[1] Of course, due to rationing by waiting-lists in the NHS, there are still considerable delays for pediatric elective surgery in the UK.

[2] It is also relevant that the take-up of private health insurance is not widespread in the UK (see Propper, 2000).

face interviews, self-completion questionnaires and medical examinations undertaken by a qualified nurse. If consent is given by the respondent (and by the parent in the case of children), blood and saliva samples are taken and tests on these samples are conducted. Hence the HSE contains detailed information on a range of self-reported and objectively assessed health indicators, including blood pressure measurements, ferritin and hemoglobin counts. Many individual and household demographic characteristics, which are likely to be important factors in determining health outcomes, are also recorded. Information on family income was only collected from the 1997 survey onwards.

Since 1995 the HSE has not only interviewed adults but also surveyed a maximum of two (randomly selected) children, aged 2–15, from the sampled households (see Sprosten and Primatesta, 2003, for further details). Information is obtained directly from children between the ages of 13 and 15, with parental consent, whilst questions about younger children are asked to the parents with the child present. From 2001 the survey was extended in order to obtain information about infants and toddlers (under 2 years old). Each annual survey has a particular theme that might require certain groups to be over-sampled. In the years when there is an over-sampling a smaller nationally representative sample of around 8,000 individuals is obtained with a further 8,000 interviews conducted for the focused sample. During the period we are concerned with, the themes that required such samples were the health of children (1997), the health of ethnic minorities (1999), the health of older people (2000) and the health of children and young people, maternal and infant health (2002). Therefore our sample comprises a disproportionate number of observations from 1998 and 2001, where the nationally representative sample is roughly double that obtained in the other years.

The six years of pooled data that we use provide a sample of 15,528 children less than 16 years of age. It is important for our purposes that we are able to match parental characteristics. Hence for each household with up to two sampled children we matched information on up to two parents, based on the adult responses to the survey. Crucially, we are able to exactly identify fathers and mothers, amongst all the adults in the households, for 99.4% of children and determine whether an absence of information on one parent from the data represents a permanent absence from the household (resulting in a single parent family or non-genetic parent being present), a temporary absence at the time of the interview (e.g. working away from the household) or an incomplete interview response. Amongst non-genetic parents we can also distinguish between adopted, foster and step parents and other blood relatives with parental responsibility (e.g. grandparents or older siblings). Unfortunately, we are unable to make substantial use of the over-sampling of children and young people in the 1997 and 2002 HSEs as the parents of these children are not sampled.

Of the 15,528 children, we drop 193 cases either because we could not match at least one parent or the parental responsibility lay solely with grandparents or older siblings. In addition, we omit from our analyses the 10.3% of cases where information on annual family income was not provided by the parents. Our resulting sample size is therefore 13,745 children in 8811 families.[3]

Measuring Child Health

As with Case et al. (2002) and Currie and Stabile (2003) our main child health variable of interest is subjective, resulting from the question asked to parents about the general health of their child (or to the children themselves in the case of 13-15 year olds). The possible responses are on the following ordinal scale (with the percentage of children in each response category in parentheses):

1. Very Good (56.1%)
2. Good (36.8%)
3. Fair (6.3%)
4. Bad (0.7%)
5. Very Bad (0.2%)

In the statistical analyses that follow,[4] due to the small percentage of children in England classed as being in "Very Bad" health, we collapse the responses "Bad" and "Very Bad" into one category (4 = Bad or Very Bad), providing us with a four-point ordinal indicator of self-assessed general health status.

Information is also collected on whether or not children have a long-term chronic health condition, the type of condition and whether or not the condition limits normal day-to-day activities. Up to a maximum of six different health conditions are recorded for each child and subsequently these are grouped into 42 categories in the HSE data files. For our analyses we have further grouped the conditions into 12 broad categories. These are (with the percentage of children with each condition shown in parentheses):

[3] As with Currie and Stabile (2003) we have also re-estimated all of our statistical models retaining the children for whom we do not observe household income, and including a dummy variable for these missing values. Importantly, our results are unchanged with or without these cases. In the paper we follow Case et al. (2002) by excluding the children for whom income is missing (14% of their sample). In our data, for those cases where income data was missing, the following reasons are given (percentages of the total sample given in parentheses): a) for 655 child cases (4.3%) the person answering the household questions did not know what the total annual household income was; b) for 564 child cases (3.7%) there was a refusal to answer the income question, and c) 368 child cases (2.4%) the total household income variable is coded as 'missing' in the data.

[4] However, in Figure 1, the full scale is used to describe the raw child health / income gradient.

1. Arthritis/rheumatism/fibrositis (5.4%)
2. Back problems/spine/neck/other problems of bones/joints/muscles (6.6%)
3. Asthma (7.5%)
4. Bronchitis/emphysema/other respiratory complaints (3.1%)
5. Blindness/deafness/tinnitus/other eye and ear complaints (3.6%)
6. Mental illness/mental handicap/epilepsy/other problems of nervous system (5.3%)
7. Diabetes (including hyperglycemia)/other endocrine/metabolic conditions (3.3%)
8. Hypertension/high blood pressure/blood pressure related problems (2.9%)
9. Cerebral hemorrhage or thrombosis/heart problems (3.6%)
10. Digestive system complaints/stomach conditions/abdominal hernia (3.3%)
11. Skin complaints (2.7%)
12. Other conditions including cancer/kidney complaints (4.3%)

The respondent is then asked whether any of the above conditions limits the day-to-day activities of the child. In our sample, 77.9% of children have no chronic health condition, 14.1% have a condition that was not considered as limiting by the respondent, and 8.0% of children are reported as suffering from a limiting chronic health condition.

Measuring Income

Following Case et al. (2002), the main measure of income that we use is current total pre-tax annual family (living in the same household) income, which is provided in 31 bands in the data, ranging from less than £520 to more than £150,000. To get a measure of income that is consistent with Case et al. (2002), and since the data were collected over a period of six years, we took midpoints of these bands and deflated them (to 2000 prices) using the UK average earnings index according to the month in which the interview was conducted.[5] Hence we have a pseudo-continuous measure with over 2000 potential values for total family income, which we then convert into natural logarithms for use in the statistical analyses. The average annual family real income is £27,899 (US$51,000), with a standard deviation of £2,502.[6] We have conducted a number of robustness checks of our estimated income gradient by fitting separate models for each of the years and by fitting a model using dummy variables for the bands. The results of these exercises show

[5] Our results are robust to alternative deflators, such as the Consumer Price Index for the UK.

[6] One limitation of the income data used by Case et al. (2002) was that the 27 bands in the National Health Interview Survey (the main data set used for the analysis) had a highest band of above US$50,000 per year. Since the average income was reported at just over US$48,000, this means that nearly half their sample was top-coded in the highest income band.

that there is consistency in the estimated income gradient, across the sample years. The income gradient is also present in estimates which use just the raw income bands and when the McClements family equivalence measure of income is used, providing us with confidence that the main findings presented in this paper are not a consequence of the method we have used to create our income variable.[7]

The Raw Child Health / Income Gradient

Figure 1 illustrates the average level of general health (on the full scale, 1 = Very Good to 5 = Very Bad) by family income and child age. It clearly shows that an income gradient is present for both younger and older children in England. However, there is no suggestion in the raw data that the income gradient increases with child age, as was found by Case et al. (2002) for the US. This is also evident from the raw correlation coefficient, between family income and child health, which does not increase systematically with child age.

Figure 2 compares the percentage of children in low income (i.e. <£10,000 per annum) and high income (£50,000+) families who have at least one chronic health condition. While it is clear that the likelihood of a child having a chronic health condition is higher amongst children from low income families, the health differential between the high and low income children actually declines with age. This is evident from the fact that low income children, aged less than 4 years old, are twice as likely to have a chronic health condition, compared to high income children, whereas, amongst children aged 13 to 15, children in low income households are only 25% more likely to have a chronic health condition than those in high income households. This is further evidence to indicate that the child health gradient is not increasing in child age in England.

III. Empirical Analyses

In this section we use a number of econometric models to shed light on the size of the income gradient in child health in England, by providing a replication of the analyses presented by Case et al. (2002) for US children. We begin by presenting the results from ordered probit models of child general health status, for all children and then separately by age group, using the same two sets of control variables used by Case et al. (2002). We also provide additional results that show the robustness of the gradient in selected samples of children. We then investigate if children from poorer families experience more chronic health conditions than their richer counterparts, and

[7] These additional results are available from the authors on request.

examine whether higher income to some extent 'protects' children from the negative health consequences of having a chronic health condition.

Given the richness of the data in terms of child and parental characteristics available, we then undertake a similar exercise to Case et al. (2002) by extending the models to include a number of parental and demographic variables thought to be important in determining a child's health outcome. We also expand the modeling framework to shed light on the degree of clustering of health outcomes of children in the same family and we provide new evidence on the influence of nutrition and family lifestyle on child health, using information contained in the 1997 HSE. This is an area that Case et al. (2002) highlighted as important for future research. Finally, we explore whether the income gradient exists for some objective child health measures, derived from measurements and blood samples obtained by a qualified nurse.

The Income Gradient

Our primary estimates of the child health income gradient are shown in Table 1. We use the exact sets of explanatory variables (Controls 1 and Controls 2 – see the Notes to Table 1 for details) used in Case et al. (2002). We begin by focusing our discussion on the coefficient on the log of annual family income. Importantly, the size of the income coefficient from the ordered probit model, estimated using the full sample of English children, is roughly the same magnitude as that found for the youngest age group (0-3) in the US. The point estimate indicates that a one-log point increase in family income is associated with a 0.187 improvement in latent health, with an absolute t-statistic of 10.6. In terms of probability, we have calculated that a one-log point increase in family income is associated with only a 3% decline in the probability of a child having poor health (i.e. having fair, bad or very bad general health, relative to either very good or good general health). Although the size of the income gradient increases by around 45% for the 4-8 age group, compared to the 0-3 age group, in line with the US analysis, the gradient does not increase further for children aged 9-12 or 13-15.[8]

One potential concern with these estimates is the direction of causality between family income and child health, since it is possible that parental labor supply, particularly on the part of the mother, might itself be affected if a child has a chronic health condition that limits their day-to-day

[8] Case et al. (2002) found that a doubling of family income was associated with an increase in the probability that a child was in excellent or very good health of 4.0% (for ages 0-3), 4.9% (ages 4-8), 5.9% (ages 9-12) and 7.2% (ages 13-17). With our data there is the possibility of a structural break in our data between children aged 12 and 13 years old. This may arise because it is the parents who answer the health questions for younger children whereas children aged 13-15 are the actual respondents to the survey questionnaire. To explore this possibility we have also estimated 16 separate models for each age and found no evidence on an increasing income gradient amongst children aged 0-12 years old.

activities. To examine this possibility we re-estimated the models excluding those 1,103 children who had a limiting health condition. This is based on the reasonable assumption that parental labor supply will be largely unaffected by a child who has a non-limiting health condition in comparison with a child with no chronic health condition. As shown in Table 1 (Controls 1 – Additional Experiments), the income gradient is virtually unchanged when these children are excluded.

A further concern with our primary estimates is that it is possible that part of the income gradient may be due to unobservable family characteristics that are related to family income. For example, it might be the case that families with higher incomes have more knowledge about what constitutes good or bad health. To explore this we have re-estimated the models for only those children whose responding parent (i.e. who answered the child health question) is a registered nurse or medical doctor. Here we are assuming that these parents have a fuller and more equal knowledge of what constitutes good or bad health than amongst the full sample of parents. Importantly, we find that the income gradient (although now somewhat larger) is still evident across all the age groups, but it still does not increase with child age. In fact, the smallest coefficient on log family income is found for the oldest age group. This result is similar to that found by Case et al. (2002) who also estimated the income gradient on physician-assessed child general health status, rather than parent-assessed, using data from the US Third National Health and Nutrition Examination Survey. In their results the size of the income gradient did not significantly increase with child age and was smaller amongst the oldest age group (-0.075, 13 - 16 year olds) than amongst the youngest children (-0.102, 9 – 12 year olds).[9]

The inclusion of additional explanatory variables for parental education and employment status (Controls 2) explains about one-third of the income gradient with the interesting exception of children aged 0-3, where the magnitude of the gradient is unaffected. However, including these additional variables does not lead us to find any evidence of an increasing income gradient for older groups of children.

Permanent Family Income

The HSE only contains information on current family income. However, one might think that long-term family income might be the important factor in determining child health. To examine this issue we have used data from the British Household Panel Survey (BHPS), which has been collected annually since 1991. Between 1994 and 1998 limited health information was collected for

[9] Case et al. (2002, footnote 4) also instrumented family income using indicators of industry, occupation and class of worker in the household, and found that the size of the income gradient increased for each age group. Although we have concerns about the validity of such instruments we have also undertaken this exercise and found the same general effect. However, we still do not find any evidence of an increasing income gradient with age for English children.

children aged 11-15, as well as adults in the same household. Using this information we estimated an ordered probit model of general health status for the 948 children observed in the 1998 wave using Controls 1, but replacing current family income with family income averaged over the five-year period 1993-1998. As with the analysis of Case et al. (2002), we found the coefficient on the log of average family income to be significant and of the same general magnitude as when we used current income.[10] Due to having health information only for children aged 11-15, and a limited sample, we were unable to use the BHPS to examine whether the income gradient increases with age.

The Importance of Chronic Health Conditions

Table 2 shows the coefficient on log family income, from the separate binary probit models estimated for each of the 12 broad groups of chronic health conditions, firstly for all children and then separately for younger (0-8) and older (9-15) children in the HSE. Importantly, a negative income gradient is only evident for three out of twelve groups of chronic health conditions, namely asthma, mental illness/mental handicap/epilepsy/other nervous system problems and skin complaints. This is in line with Case et al. (2002) who found that the income gradient was largest for asthma and mental retardation. However, there are some differences between young and old children. The asthma effect is mainly evident for children aged 0-8, while the mental illness/mental handicap/epilepsy/other nervous system problems and skins complaints effects are stronger for older children. An important policy finding then is that for most health conditions, English children from poor families are no more likely to experience ill health than children from rich families. Of course, as with all studies in this area we cannot fully rule out the possibility that richer children are more likely to have their condition diagnosed or to adhere to their treatment programs (Case et al., 2004b), although this is less of a concern in the UK context with its universal NHS, than in the US.

We have also followed Case et al. (2002) by investigating the possibility that children from richer families will be less affected by, or more 'protected' from, chronic illnesses than poorer children. Table 3 shows the results from an ordered probit model of general health status that includes a dummy variable for each of the 12 conditions (coefficients β_0) and an interaction for each condition with log family income (coefficients β_1). As can be seen, even with these controls, the coefficient on log family income remains highly significant (-0.178, |t|-stat = 9.40) and of a similar magnitude. All chronic health conditions have a positive effect on the probability of having

[10] As with Case et al. (2002) we do not take this as evidence in support of the permanent income model of consumption and savings.

poor health. Of these conditions, three are significant in determining general health status, namely, mental illness/mental handicap/epilepsy/other nervous system problems, diabetes/other endocrine/metabolic problems and hypertension/high blood pressure/ other blood pressure problems. The important roles that diabetes and epilepsy have in affecting general health are also found by Case et al. (2002). Interestingly, we find that higher income cushions children from the adverse health effects of these three groups of chronic health conditions and this effect is larger for the chronic conditions that have the greatest influence on general health status. The particular importance of diabetes and mental health, found in the US, is hence confirmed for English data.

Extended Models of Child Health

We now discuss the estimates from four models (presented in Table 4) where we gradually expand on the set of control variables previously employed (Controls 2). It is evident from all the different model estimates that both mother's and father's education is positively related to better child health, with the role of mothers' education having a much larger effect. However, we find no evidence that parental unemployment affects child health. Another interesting policy-related finding is that Black and Asian ethnic minority children in England have significantly worse health than their white counterparts. The differential between these ethnic groups is also large relative to the income effect. Interestingly, children in larger households are less healthy, which might indicate that less parental time or resources are available to each child in larger families.

In the first model (Controls 3), we additionally include the birth weight of the child in order to examine the fetal-origins hypothesis. This maintains that the in-utero environment, especially in relation to nutrition and maternal smoking behavior, is critical to lifelong health outcomes (see, for example, Ravelli, et al., 1998). If it is the case that poor mothers have an inferior nutritional intake and are more likely to smoke whilst pregnant then, to the extent that birth weight captures variations in the health of children when they are born, we would expect that the size of the remaining income gradient will decline when birth weight is included in the child health model. However, whilst birth weight is significant at the 1% level, with children who were heavier at birth having better general health in later childhood years, the family income gradient remains virtually unchanged (at -0.125).

In the next model we add in a number of measures of parental health (Controls 4) to explore whether healthy parents are more likely to have healthy children. There are three main aspects potentially driving such an association. First, there are likely to be genetic links in health between parents and children. Second, poor parental health might directly affect child health. Third, there might be unobservable family characteristics jointly affecting the health of parents and children.

Although we cannot unravel these three effects completely, we can use information on both genetic and non-genetic parents to shed some light in this area. The main parental health control we include is whether or not the mother or father has a limiting chronic health condition. For this measure we also include a variable indicating whether or not the mother or father is a non-genetic parent and has a limiting chronic health condition (which is the case for 190 parents). We also include a variable for each parent indicating whether or not they are obese and whether or not they have high blood pressure using information collected by a qualified nurse (see the notes to Table 4 for detailed definitions).

We find that children whose genetic parents have a limiting chronic health condition are more likely to be in poor health, with the effect being larger for the mother than the father. The coefficient on the term interacting the limiting chronic health condition with a non-genetic mother is positive and only about 20% smaller than the equivalent for the genetic mother. Although this coefficient is not statistically significant (due to the small number of affected cases), the result indicates that the 'nurture' aspect of mothering may be important alongside the genetic health legacy. In contrast, the coefficient on the interaction for non-genetic father is much smaller than in the genetic case suggesting that the 'nature' effect dominates in the paternal line.

Next we also include a dummy variable for each broad region of residence in England, and the UK government Index of Multiple Deprivation (IMD), derived for each of the 100 District Health Authorities in England (Controls 5)[11], in order to capture geographical differences in average incomes and deprivation that could potentially lie behind our estimated income gradient. However we find little evidence of regional variation in child health (for brevity these results are not reported in Table 4) or any significant effect of area deprivation on child health, for a number of different functional forms of the IMD. We interacted the deprivation measure with family income and found no evidence that children of poor families, residing in non-deprived areas, are any healthier than similarly poor children in deprived areas. Moreover, the income gradient is unchanged when these regional and area controls are included in the model.

As a further investigation we utilize the fact that for many families we have health information on two children in order to investigate the extent of health clustering in the same family. We estimate an ordered probit model with family random effects, including the same explanatory variables as in Controls 4. We find evidence of considerable clustering in the family, which

[11] The IMD is produced by the UK government and is constructed as a weighted average of the six domains of deprivation (Department for the Environment, Transport and the Regions, 2000). These domains are (with their weights in brackets) low income (25%), employment (25%), education and training (15%), poor health and disability (15%), poor housing (10%) and poor geographical access to services (10%). The mean (standard deviation) of the IMD is 25.56 (10.49).

explains about 60% of the total variation in child health. However, since these random effects are by definition unobserved, we are unable to distinguish between ‘nature’ and ‘nurture’ effects. Since the coefficients on log family income and the other explanatory variables remain statistically significant and qualitatively unchanged from those reported above, these additional results are not presented.

The Importance of Nutrition and Family Lifestyle in Explaining Child Health

Here we provide new evidence on the importance of nutrition and family lifestyle in determining child health, using information on child fruit and vegetable consumption and parental exercise and activity, which is available in the 1997 HSE. Table 5 shows the main results from an ordered probit model of general health status (using Controls 2) when we additionally include variables for the number of days the child consumes fruit and vegetables each week and the number of days the mother and father participate in physical activity (lasting 15 minutes plus) per month. Just less than 5% (4.8%) of children are reported to consume fruit every day, while 17.4% are reported to rarely or never eat fruit. Even fewer English children consume vegetables on a daily basis (1.8%) and 14.1% rarely or never eat vegetables. Due to causality concerns we do not include a measure of child physical activity directly in the model, but rather assume that parental lifestyle traits are likely to influence childrens’ physical activity levels.

An important policy-related result is that children who eat vegetables on a regular basis are significantly healthier, even after controlling for family income. Those children who eat vegetables on three or more days in a week enjoy roughly the same health benefit as a one-log point increase in family income. No such health benefit is found for fruit consumption even though the correlation between the fruit and vegetable measures is only 0.26. The amount of physical exercise undertaken by parents per month is also an important determinant of child health, with the positive effect on child health of having active parents being nearly twice as large in the case of the mother as the father. These results are robust to the exclusion of those children with a limiting chronic health condition. Importantly, even with the inclusion of these nutritional and lifestyle indicators, the child health family income gradient is still highly significant and remains of a similar magnitude.

Other Measures of Child Health

So far this study has focused on the income gradient when child health is measured subjectively by a parent (for 0 – 12 year old children) or by the children themselves (for 13 – 15 year olds). Here we explore whether or not the income gradient remains when we consider nurse-assessed measures of physical health together with the results of blood sample tests undertaken as part of the HSE.

Our findings are presented in Table 6, with each model including Controls 2. The first measure we consider is birth weight for children aged less than one year old. As with previous research, we find that low family income is significantly associated with lower birth weight. We next consider child height and find that children from rich families are significantly taller than those from poor families. However, this income gradient completely disappears once we control for father's and mother's height. We also investigate obesity, which is now classified as an epidemic in the US and many other Western countries, and whilst we find that the children of obese parents are themselves more likely to be obese, there is no evidence that family income is a significant determinant of childhood obesity in England. Similarly, parents with high blood pressure are more likely to have children with high blood pressure, but no significant income gradient is found.

We now turn to the results of tests performed on blood samples, namely, the hemoglobin and ferritin counts. Hemoglobin is the part of red blood cells that takes oxygen from the lungs to the rest of the body, and then collects carbon dioxide and takes it back to the lungs where it is exhaled. A low level of haemoglobin is indicative of anaemia. Ferritin is an iron-protein complex and is one of the forms in which iron is stored in the tissues of the intestine, spleen, and liver. Whilst these two measures are not direct indicators of child health they are routinely collected by physicians because they are useful markers for a number of underlying health conditions. Here we find no evidence that family income is important in determining these measures.[12] There is also no significant relationship between these objective parental measures and those of the child, although all the coefficients are positive.

IV. Conclusions

In this study we have undertaken a detailed investigation into the relationship between family income and child health using matched child-parent data from the Health Survey of England. Our analysis is motivated by the influential study by Case et al. (2002), who found that a significant income gradient exists in the US, and that the size of the gradient was larger for older than younger children, implying a protective effect from family income. This is an important policy-related finding as health in childhood has been shown to be important in determining education attainment, health in adulthood, and future labor market outcomes. However, in contrast to the US where income influences the access to health care for a large proportion of the population, the UK has a

[12] We have also examined a number of alternative forms of these health measures. For example, we included birth weight and height in logs. We treated BMI, hemoglobin and ferritin as continuous measures. We explored low blood pressure, low hemoglobin and low ferritin counts. We have also estimated the models using deviations from the median values of each of the measures calculated separately by age and gender. None of these additional tests suggest any evidence of a significant income gradient.

publicly-funded National Health Service, which is free at the point of delivery and is guided by the principle of equal access given equal need. If the NHS has been effective in its health care provision we would expect to find evidence that family income plays less of a role in protecting child health in England. Furthermore, Case et al. (2002) highlighted the need for research into whether nutritional intake and lifestyle factors are important determinants of child health that might contribute to our understanding of the observed gradient.

Our analyses have highlighted a number of interesting factors associated with child health in England. First, we have found robust evidence of an income gradient using subjectively assessed general health status. However, the size of this gradient is considerably smaller than that found for the US. Second, we have found no evidence that the income gradient in child health is increasing with child age in England, in contrast to the findings of Case et al. (2002) for the US. Third, we do not find a significant family income differential in the probability of having a chronic health condition, with the exceptions of asthma, mental illness/mental handicap/epilepsy/other nervous system problems and skin complaints, which have a higher incidence in poorer families. However, there is some evidence to suggest that higher family income does 'protect' children from the adverse general health consequences of mental illness/mental handicap/epilepsy/other nervous system problems, diabetes/endocrine/metabolic problems and hypertension/high blood pressure/other blood pressure problems.

Confirming the results of previous studies, and verifying the quality of our data, we have found that parental education, especially the mother's education, plays an important role in protecting the health of children. However, we find no evidence that parental unemployment, conditioning on income, is associated with worse child health in England. We find that children whose genetic parents have limiting chronic health conditions are themselves more likely to be in poorer health, and evidence suggestive of a 'nurture' benefit from non-genetic mothers. Additionally, we found that the health of children in the same family is very highly correlated.

We have also been able to shed new light on the roles of nutrition and lifestyle indicators explaining child health. We have shown that a low percentage of English children are reported to frequently eat fruit and vegetables. However, the regular consumption of vegetables by the child, and regular physical activity by parents (especially the mother), are associated with significantly better child health, even though a significant income gradient remains. The size of these effects suggest that the promotion of healthy eating and active lifestyles may be a more effective policy instrument for improving child health than even sizeable re-distributions of income. One such example would be to improve the nutritional intake of children in England, and hence their subsequent health outcomes, through the provision of free or heavily subsidized school meals.

Importantly, using a number of objective child health measures, from nurse measurements and blood test results, we find no evidence of a family income gradient. Taken together with our findings of a small family income gradient for the general child health measure, whose slope does not increase with child age, our results are consistent with the view that the free and equal access to health care provided by the National Health Service in England has a protective effect on child health.

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FIGURE 1:

The Child Health Income Gradient in England by Age Group

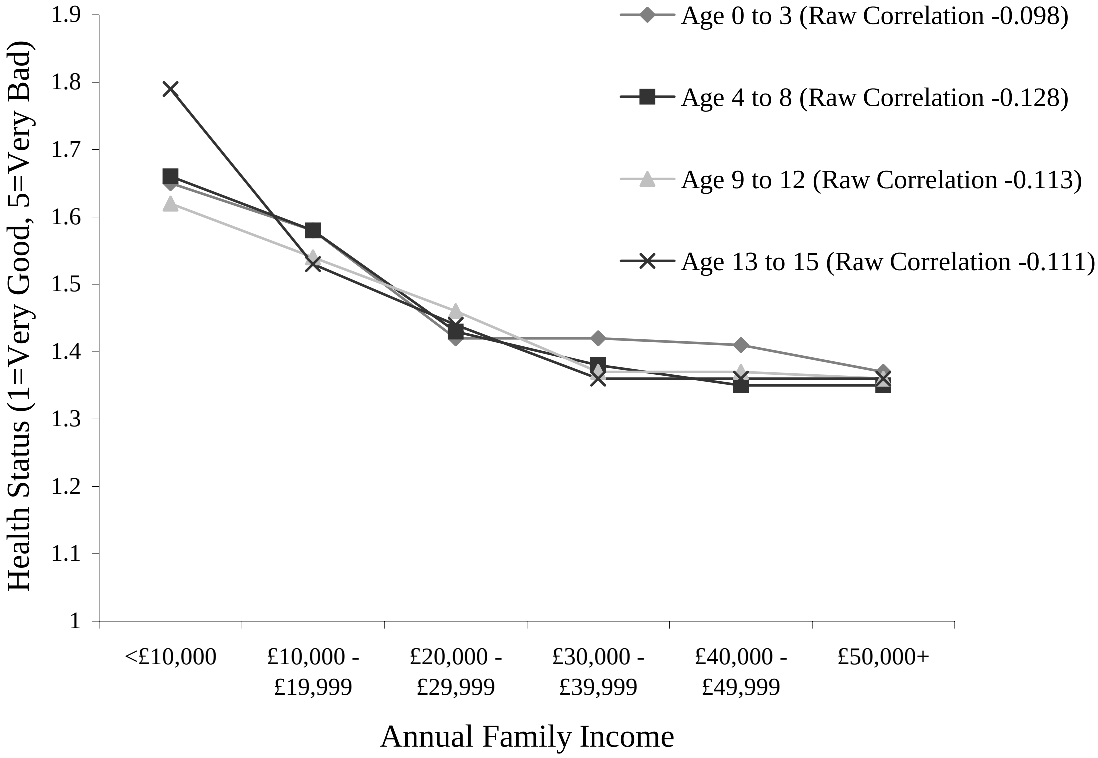

FIGURE 2:

The Incidence of Chronic Health Conditions Amongst Children in England by Income

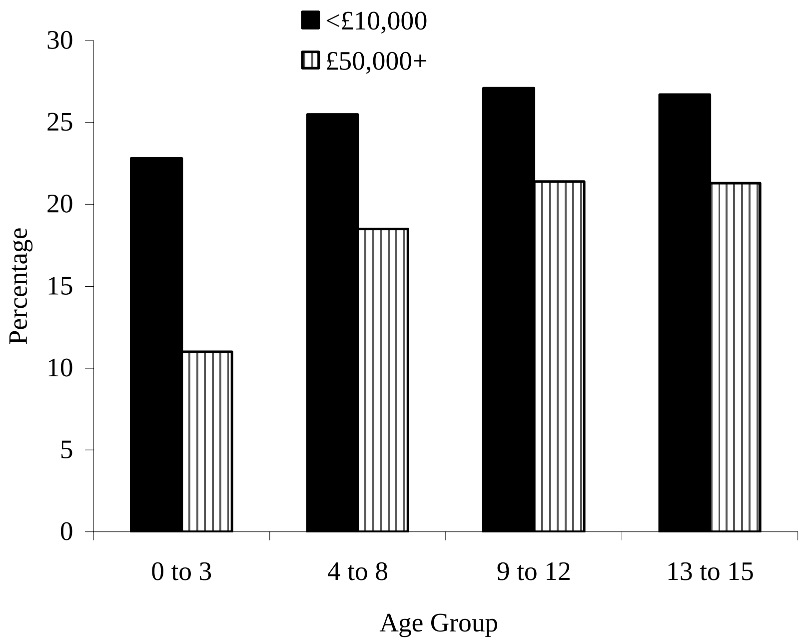

TABLE 1:

The Income Gradient in Child General Health Status (Ordered Probit Models)

	General Health Status				
Age Group	**All**	**0-3**	**4-8**	**9-12**	**13-15**
	Controls 1				
Log Family Income	-0.187	-0.146	-0.212	-0.196	-0.174
	(10.57)	(3.69)	(7.44)	(6.34)	(5.18)
	[-0.028]	[-0.026]	[-0.031]	[-0.029]	[-0.021]
Sample	13745	2505	4936	3734	2570
	Controls 1				
	Additional Experiments				
Log Family Income	-0.177	-0.126	-0.200	-0.207	-0.154
(Excluding children with chronic limiting condition)	(9.44)	(3.08)	(6.77)	(6.28)	(4.23)
Sample	12642	2376	4585	3393	2288
Log Family Income	-0.277	-0.369	-0.310	-0.385	-0.265
(Parent either Registered Nurse or Medical Doctor)	(3.27)	(1.19)	(2.63)	(2.45)	(1.64)
Sample	591	112	206	159	114
	Controls 2				
Log Family Income	-0.126	-0.142	-0.136	-0.108	-0.133
	(6.15)	(3.14)	(4.23)	(3.02)	(3.30)
	[-0.018]	[-0.027]	[-0.019]	[-0.017]	[-0.012]
Sample	13745	2505	4936	3734	2570

Notes:

1. Coefficients on log family income from ordered probit models of general health status (1= Very Good, 2= Good, 3= Fair, 4 = Bad or Very Bad) are reported. Absolute t-statistics, shown in parentheses, are calculated using robust standard errors. Thresholds are also estimated.
2. The change in the probability of reporting fair or bad/very bad health (relative to very good or good health) associated with a one-log point increase in household income is shown in square brackets.
3. Controls 1 include the full set of age and year dummies, male, ethnicity, log of household size, age of mother, age of father, indicators for the absence of a father from the household, the absence of survey information on a father present in the household (with the base being a father is present in the household and a respondent to the survey) and similar controls for the absence or presence of a mother in the household. Fathers and mothers age controls are conditional on them being present in the household and a respondent to the survey.
4. Controls 2 include all variables in “Controls 1” plus measures of mother’s and father’s education, mother’s and father’s employment status, where each education and employment status variable is interacted with an indicator of whether the mother or father is in the household.

TABLE 2:

The Effect of Family Income on the Incidence of Child Chronic Health Conditions

(Binary Probit Models)

Chronic Health Conditions	**All**	**Age 0-8**	**Age 9-15**
Arthritis/rheumatism/fibrositis	-0.005	-0.010	0.001
	(0.17)	(0.26)	(0.02)
Back problems/spine/neck/other	0.017	-0.020	0.070
	(0.70)	(0.59)	(1.98)
Asthma	-0.050	-0.069	-0.034
	(2.10)	(2.14)	(0.97)
Bronchitis/emphysema/hayfever/other	0.006	-0.041	0.060
	(0.19)	(0.86)	(1.31)
Blindness/deafness/tinnitus/other	0.021	0.051	-0.001
	(0.71)	(1.19)	(0.03)
Mental illness/mental handicap/epilepsy/other	-0.047	-0.029	-0.065
	(1.83)	(0.76)	(1.64)
Diabetes/other endocrine/metabolic	0.039	0.040	0.044
	(1.25)	(1.07)	(0.85)
Hypertension/high blood pressure/other	-0.036	-0.030	-0.052
	(1.15)	(0.77)	(1.06)
Cerebral haemorrhage or thrombosis/heart	0.047	0.045	0.055
	(1.54)	(1.11)	(1.18)
Digestive system/stomach /abdominal hernia	0.026	0.037	0.017
	(0.82)	(0.87)	(0.35)
Skin complaints	-0.066	-0.058	-0.098
	(2.12)	(1.50)	(1.96)
Other includingcancer/kidney/infectious diseases	0.014	0.012	0.026
	(0.49)	(0.30)	(0.61)
Sample	13745	7442	6306

Notes:

1. Coefficients on log family income from binary probit models (1= has chronic heath condition, 0 = otherwise) are reported. Absolute t-statistics, shown in parentheses, are calculated using robust standard errors.
2. The other explanatory variables are the same as “Controls 1” (see notes to Table 1).

TABLE 3:

The Effect of Chronic Health Conditions and Family Income on Child General Health Status

(Ordered Probit Model)

	General Health Status	
Log Family Income	-0.178	
	(9.40)	
	β_0	β_1
Arthritis/rheumatism/fibrositis	0.423	-0.047
	(0.69)	(0.76)
Back problems/spine/neck/other	-0.106	0.012
	(0.20)	(0.23)
Asthma	-0.100	0.042
	(0.22)	(0.90)
Bronchitis/emphysema/hayfever/other	0.659	-0.053
	(1.04)	(0.84)
Blindness/deafness/tinnitus/other	0.576	-0.043
	(0.86)	(0.64)
Mental illness/mental handicap/epilepsy/other	0.976	-0.091
	(1.92)	(1.76)
Diabetes/other endocrine/metabolic	1.413	-0.143
	(2.01)	(2.07)
Hypertension/high blood pressure/other	2.163	-0.225
	(2.67)	(2.76)
Cerebral haemorrhage or thrombosis/heart	0.854	0.093
	(1.28)	(1.40)
Digestive system/stomach /abdominal hernia	0.521	0.062
	(0.74)	(0.88)
Skin complaints	-0.172	0.054
	(0.23)	(0.87)
Other includingcancer/kidney/infectious diseases	-0.413	0.054
	(0.67)	(0.87)
Sample	13745	

Notes:

1. Coefficients from an ordered probit model of general health status (1= Very Good, 2= Good, 3= Fair, 4 = Bad or Very Bad) are reported. Absolute t-statistics, shown in parentheses, are calculated using robust standard errors. Thresholds are also estimated.

2. β_0 is the coefficient for a dummy variable included for each chronic health condition and β_1 is the coefficient on the interaction of log family income with each chronic health condition dummy variable. The coefficient on Log Family Income is reported in the first row3. The other explanatory variables are the same as "Controls 1" (see notes to Table 1).

TABLE 4:

Extended Models of Child Health (Ordered Probit Models)

	General Health Status		
	Controls 3	**Controls 4**	**Controls 5**
Log Family Income	-0.125***	-0.122***	-0.122***
Age	Included	Included	Included
Male	0.021	0.022	0.021
Black	0.191***	0.193***	0.171**
Asian	0.254***	0.251***	0.239***
Other ethnic minority	0.104	0.099	0.084
Log (household size)	0.127***	0.139***	0.138***
Father's age	-0.002	-0.002	-0.002
Mother's age	-0.003	-0.004	-0.004
Father has degree level highest qualification	-0.076*	-0.052	-0.051
Mother has degree level highest qualification	-0.178***	-0.176***	-0.175***
Father has A-level highest qualification	-0.101**	-0.089**	-0.092**
Mother has A-level highest qualification	-0.152***	-0.151***	-0.148***
Father has O-level highest qualification	-0.070*	-0.069*	-0.069*
Mother has O-level highest qualification	-0.116***	-0.111***	-0.110***
Father unemployed	0.030	-0.001	-0.001
Mother unemployed	0.068	0.063	0.060
Birth weight (kg)	-0.057***	-0.053***	-0.053***
Genetic father has a limiting chronic health condition	-	0.200***	0.198***
Genetic mother has limiting chronic health condition	-	0.276***	0.278***
Non-genetic father has a limiting chronic health condition	-	0.050	0.041
Non-genetic mother has a limiting chronic health condition	-	0.218	0.216
Log of Index of Multiple Deprivation (DHA level)	-	-	0.006
Sample		13745	

Notes:
1. Coefficients from ordered probit models of general health status (1= Very Good, 2= Good, 3= Fair, 4 = Bad or Very Bad) are reported. *** indicates statistical significance at 1% level, ** indicates significance at 5% level and * indicates significance at 10% level. Robust standard errors calculated. Thresholds are also estimated.
2. "Controls 3" has the same explanatory variables as Controls 2 (see the notes to Table 1), plus birth weight (available for 85% of children) and a dummy variable for whether birth weight is missing (15% of children).
3. "Controls 4" has the same explanatory variables as Control 3, plus controls for genetic (and non-genetic) father having a limiting chronic health condition, genetic mother (and non-genetic) having a chronic health condition, whether the father is obese, whether the mother is obese, whether the father has high blood pressure, whether the mother has high blood pressure and controls for if these variables are missing. Obesity is defined as a binary variable taking the value 1 when the Body Mass Index (BMI), which is calculated as weight in kilograms divided by the square of height in meters (both height and weight having been measured by a qualified nurse), exceeds 29.9 and zero otherwise. High blood pressures (also measured by the nurse) is also a binary indicator taking the value 1 for a Diastolic pressure greater than 89.9 and zero otherwise.
4. "Controls 5" has the same explanatory variables as Controls 4, plus dummy variables for broad region of England and the log of the Index of Multiple Deprivation, derived at the level of the 100 District Health Authorities in England.

TABLE 5:

The Importance of Diet and Sporting Activity in Explaining Child Health Status

(Ordered Probit Model, 1997 data only)

	General Health Status
Log Family Income	-0.148
	(2.90)
Number of days the child eats fruit each week	-0.016
	(1.03)
Number of days the child eats vegetables each week	-0.053
	(2.39)
Number of days the mother is physically active (15+ minutes) each month	-0.005
	(1.96)
Number of days the father is physically active (15+ minutes) each month	-0.003
	(1.06)
Sample	1914

Notes:

1. Coefficients from an ordered probit model of general health status (1= Very Good, 2= Good, 3= Fair, 4 = Bad or Very Bad) are reported. Absolute t-statistics, shown in parentheses, are calculated using robust standard errors. Thresholds are also estimated.
2. Model estimated using only 1997 HSE data (for all children aged 0-15).
3. The other explanatory variables are the same as Controls 2 (see notes to Table 1).

TABLE 6:

The Income Gradient using Objective Measures of Child Health

	Birth Weight	Height	Obese	High Blood Pressure	Low Haemoglobin Count	Low Ferritin Count
	OLS	OLS	Probit	Probit	Probit	Probit
Log Household Income	0.128	0.410	0.016	0.061	0.042	0.044
	(2.05)	(3.00)	(0.55)	(1.27)	(0.63)	(0.66)
Log Household Income	-	0.025	0.015	0.063	0.039	0.039
		(0.20)	(0.50)	(1.33)	(0.58)	(0.59)
Father's health measure	-	0.245	0.133	0.182	0.072	0.054
		(18.21)	(2.74)	(2.44)	(0.44)	(0.33)
Mother's health measure	-	0.343	0.111	0.156	0.122	0.065
		(30.02)	(2.69)	(1.96)	(0.69)	(0.42)
Sample Size	275	9014	9793	5923	2920	2955

Notes:

1. The dependent variables are (i) Birth Weight (in kg), (ii) Height (in cm), (iii) Obese (BMI > 29.9), (iv) High Blood Pressure (Diastolic pressure > 89.9), (v) Low Hemoglobin Count (lowest decile i.e. < 12 grams of hemoglobin per deciliter of blood and (vi) Low Ferritin Count (lowest decile i.e. < 17 nanograms of ferritin per milliliter of blood).
2. These models are estimated only for children for whom a valid measure was obtained. The samples are as follows: (i) Birth Weight - only children under 1 years of age (4.0% missing; mean = 3.34kg), (ii) Height – all children over 3 years old (4.9% missing; mean = 137.38cm), (iii) Obese – all children over 3 years old (12.9% missing; mean BMI = 23.31, (iv) High Blood Pressure - all children over 3 years old (37.3% missing; mean diastolic pressure = 66.67); (v) Low Hemoglobin Count (not collected for 78.5% of children; mean hemoglobin count = 13.9) and (vi) Low Ferritin Count (not collected for 78.8% of children; mean ferritin count = 74.4).
3. Absolute t-statistics, given in parentheses, are calculated using robust standard errors.
4. The other explanatory variables are the same as Controls 2 (see notes to Table 1), plus in the equivalent health measure for the father and mother, dummy variables indicating if the measure is missing for the father or mother, and a dummy variable for if the father or mother is non-genetic.