

Inequality of opportunity in health: evidence from a UK cohort study

Article (Unspecified)

Rosa Dias, Pedro (2009) Inequality of opportunity in health: evidence from a UK cohort study. *Health Economics*, 18 (9). pp. 1057-1074. ISSN 1057-9230

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/41386/>

This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

Copyright and reuse:

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

INEQUALITY OF OPPORTUNITY IN HEALTH: EVIDENCE FROM A UK COHORT STUDY

PEDRO ROSA DIAS*

Centre for Health Economics, University of York, UK

SUMMARY

This paper proposes an empirical implementation of the concept of inequality of opportunity in health and applies this to data from the UK National Child Development Study. Drawing on the distinction between *circumstance* and *effort* variables in John Roemer's work on equality of opportunity, *circumstances* are proxied by parental socio-economic status and childhood health; *effort* is proxied by health-related lifestyles and educational attainment. Stochastic dominance tests are used to detect inequality of opportunity in the conditional distributions of self-assessed health in adulthood. Two alternative approaches are used to measure inequality of opportunity. Econometric models are estimated to illuminate and quantify the triangular relationship between circumstances, effort and health. The results indicate the existence of a considerable and persistent inequality of opportunity in health. Circumstances affect health in adulthood both directly and through effort factors such as educational attainment. This indicates that, while the influence of some unjust circumstances can only be tackled during childhood, the implementation of complementary educational policies may be of paramount importance. Copyright © 2009 John Wiley & Sons, Ltd.

Received 2 October 2008; Revised 3 June 2009; Accepted 13 June 2009

KEY WORDS: inequality of opportunity; childhood conditions; lifestyles

1. INTRODUCTION

Much of the attention traditionally given to equality of outcomes has shifted towards equality of opportunities. This change of emphasis is the consequence of the latest developments in political philosophy, inspired by the work of Rawls and Sen, systematised by Dworkin (1981), and subsequently modified by Arneson (1989) and Cohen (1989). In recent years, equality of opportunity prompted a series of applications in different fields of economic research¹ and attracted growing interest of policymakers, as becomes clear in the World Bank Development Report 2006. Within health economics, Rosa Dias and Jones (2007) argued that equality of opportunity is the implicit underlying concept of a broad range of inequality studies published over the last decade. Despite this, the number of empirical applications that explicitly apply this concept to health is still scarce;² this paper aims primarily at narrowing this gap.

All conceptions of equal opportunity draw on some distinction between fair and unfair sources of inequality. Environmental factors such as genetic endowment and parental income are largely seen as illegitimate sources of health inequalities. On the contrary, the differences in health status that are due

*Correspondence to: Centre for Health Economics, University of York, Alcuin Block A, Heslington, York YO10 5DD, UK. E-mail: sprcd500@york.ac.uk

¹For example Betts and Roemer (1998), Le Grand and Burchardt (2002), Lefranc *et al.* (2004) and Bourguignon *et al.* (2005).

²Zheng (2006) and Devaux *et al.* (2008) are two of the very few papers focused on inequality of opportunity in health.

to lifestyles are often seen as ethically justified by individual choice. These contrasting sorts of factors have been studied independently by two well-developed strands of research: the literature on the impact of childhood conditions on adult health and that concerned with health and lifestyles. The interaction between the two is much less explored. Furthermore, both strands were developed in relative isolation from the literature on health inequalities. Establishing a bridge between all these branches of research is the second purpose of this paper.

This paper is grounded on the framework proposed by Roemer (1998, 2002). This is then augmented with a set of testable conditions defined in Lefranc *et al.* (2004, 2008a) and embedded in the framework of Fleurbaey and Schokkaert (2009). The data used are from the UK National Child Development Study (NCDS).

2. BACKGROUND

2.1. Equality of opportunity: the Roemer model

The empirical analysis developed in this paper is explicitly grounded on the theoretical framework of the Roemer model (1998, 2002). It starts by sorting all factors influencing individual attainment between a category of *effort factors*, for which individuals should be held responsible and a category of *circumstance factors*, which, being beyond individual control, are the only source of illegitimate differences in outcomes. The outcome of interest is health as an adult (H). A health production function $H(C, E(C))$ is defined, where C denotes individual circumstances and E denotes effort.

The Roemer model does not specify which causal factors constitute circumstances and effort.³ In the case of inequality of opportunity in health, this dilemma is facilitated by the existence of medical and economic evidence on the main determinants of health in adulthood. There is a branch of economic literature devoted to the impact of childhood circumstances on health outcomes: Currie and Stabile (2004), Case *et al.* (2005) and Lindeboom *et al.* (2006) are recent examples. Using different data sets, these studies appraise conflicting theories about the channels by which childhood conditions influence long-term health. The most prominent among these theories are: the *fetal-origins hypothesis* (Barker, 1995; Ravelli *et al.*, 1998) according to which parental socioeconomic characteristics influence the *in utero* conditions for fetal growth which, in turn, condition long-term health; the *life course models* (Kuh and Wadsworth, 1993), which emphasise the impact of deprivation in childhood on adult health and longevity; the *pathways models* (Marmot *et al.*, 2001) which suggest that health in early life is important mainly because it will condition the socioeconomic position in early adulthood, which explains disease risk later in life.

This paper follows this strand of research: it considers as circumstances the parental socioeconomic characteristics, spells of financial hardship during the cohort members' childhood and adolescence, proxies of congenital endowment such as the prevalence of chronic conditions in the family and birth weight, as well as incidence of acute conditions, chronic illnesses and obesity in childhood and early adolescence. All these factors affect the cohort members before the age of 16, reflecting conditions and choices that are largely beyond individual control.

There is also considerable work done on the relationship between health and lifestyles; examples include Mullahy and Portney (1990), Kenkel (1995), Contoyannis *et al.* (2004) and Balia and Jones (2008).

³The normative distinction between circumstances and effort is the pivotal argument of an entire philosophical debate. Authors such as Arneson, Cohen and Roemer postulate that individuals should be held responsible for what is within their control. Others, such as Dworkin and Van Parijs, consider that people should instead be deemed responsible for their preferences and for the choices that follow from them. Furthermore, this *responsibility cut* is hardly dealt with by the standard economic rational choice models: since these represent individual behaviour as a mechanical optimisation process determined by pre-defined preferences and constraints there is little space for true individual responsibility. A meticulous discussion of this issue can be found in Fleurbaey (2008, pp. 245–276).

Lifestyles, such as cigarette smoking, alcohol consumption, and diet are at least partially within individual control, hence they constitute the primary effort factors. While the literature has established that educational outcomes are impacted very strongly by childhood circumstances, it remains plausible to postulate that a degree of educational attainment lies within individual control. Because of this, and given that it is a potential explanatory factor of health in adulthood, it is also taken here for an effort factor.

The Roemer model defines social types consisting of the individuals who share exposure to the same circumstances. The set of observed individual circumstances allows the specification of these social types in the data. It is assumed that the society has a finite number of T types and that, within each type, there is a continuum of individuals. A fundamental aspect in this setting is the fact that the distribution of effort within each type (F^t) is itself a characteristic of that type; since this is beyond individual control, it constitutes a circumstance.

In order to make the degree of effort expended by individuals of different types comparable, Roemer proposes the definition of quantiles of the effort distribution (in this case, the number of cigarettes per day or number of units of alcohol consumed per week) within each type: two individuals are deemed to have exerted the same degree of effort if they sit at the same quantile (π) of their type's distribution of effort. When effort is observed, this definition is directly applicable. However, if effort is unobservable, an additional assumption is required: by assuming that the average outcome, health in this case, is monotonically increasing in effort, i.e. that healthy lifestyles are a positive contribution to the health stock, effort becomes the residual determinant of health once types are fixed; therefore, those who sit at the π th quantile of the outcome distribution also sit, on average, at the π th quantile of the distribution of effort within this type.

The definition of equality of opportunity used in this paper also follows from the Roemer model: equality of opportunity in health attains when average health outcomes are identical across types at fixed levels of effort. This means that, on average, all those who adopt identical lifestyles should be entitled to experience a similar health status, irrespective of their circumstances. Such a situation corresponds to a full nullification of the effect of circumstances, keeping untouched the differences in outcome that are caused solely by effort.

When aggregating over different effort levels Roemer (2002) employs the *Mean of Mins* social ordering criterion, as defined by Fleurbaey (2008, pp. 201). This criterion consists of maximizing the average (health) outcome of the whole population that would result if each individual outcome were put at the minimum observed in its own responsibility class. The model is nevertheless compatible with many alternative criteria, as clarified in Roemer (2002, pp. 459), so the adoption of the *Mean of Mins* is not essential for any of the results in the following sections.⁴

2.2. Definitions and testable conditions

The definition of equality of opportunity given by Roemer (2002) is more appropriate for the situation in which a public policy is being evaluated rather than for inequality measurement from survey data. A set of alternative definitions was recently proposed by Lefranc *et al.* (2008a) and Devaux *et al.* (2008): these appeal to the concept of stochastic dominance and are coherent with the rationale of the previous section.

A lottery stochastically dominates another if it yields a higher *expected utility*. Several orders of stochastic dominance may therefore be defined according to the restrictions one is willing to make on the individual utility function. First-order stochastic dominance (FSD) holds for the whole class of increasing utility functions ($u' > 0$); this corresponds to simply comparing cdfs of the earnings paid by

⁴Roemer (2002) obtains an indirect outcome function $v^t(\pi, \varphi)$, defined for each type, and solves for the equal-opportunity policy φ that equalises $v^t(\pi, \varphi)$ across types, at fixed levels of effort π , by using the *Mean of Mins* criterion: $\varphi = \arg \max_{\varphi} \int_0^1 \min_t v^t(\pi, \varphi) d\pi$. For an account of the numerous alternative criteria, see Van de Gaer (1993) and Vallyntyne (2008).

alternative lotteries. Second-order stochastic dominance (SSD) applies to utility functions that are increasing and concave in income, reflecting the notion of risk aversion ($u' > 0$ and $u'' < 0$); SSD evaluates integrals of the cdfs. While FSD implies SSD, the converse is clearly not true.

These assumptions define broad classes of utility functions and are therefore applicable to the case of health. The exposure to different circumstances defines alternative lotteries; stochastic dominance allows the comparison of their health-related outcomes under standard assumptions on preferences.

Roemer's notion of inequality of opportunity applies to individuals who, having expended the same effort, achieve different outcomes due to different circumstances; inequalities due to effort are deemed acceptable. Denoting by $F(\cdot)$ the *cdf* of health, a literal translation of this would mean saying that there is inequality of opportunity whenever: $\forall c \neq c', F(\cdot|c) \neq F(\cdot|c')$.

This condition is, however, too stringent to be useful in empirical work. Lefranc *et al.* (2008a) consider that the data are consistent with the hypothesis of inequality of opportunity if the social advantage provided by different circumstances can be unequivocally ranked by SSD,⁵ i.e. if the distributions of health conditional on different circumstances can be ordered according to *expected utility*:

$$\forall c \neq c', F(\cdot|c) \succ_{\text{SSD}} F(\cdot|c')$$

In this paper the main outcome of interest is self-assessed health (SAH), which is inherently ordinal. This fact dictates the need of redefining this condition in terms of FSD:

$$\forall c \neq c', F(\cdot|c) \succ_{\text{FSD}} F(\cdot|c')$$

Since FSD implies SSD, this is a stronger condition, which necessarily satisfies the requirements set by Lefranc *et al.* (2008a). This condition is statistically testable and therefore it is used to assess the existence of inequality of opportunity.⁶

2.3. Measures of inequality of opportunity

The stochastic dominance conditions are testable, but do not provide a measure of inequality of opportunity in health. For this purpose, this paper uses two alternative measures. The first is the Gini-opportunity index, first put forward by Lefranc *et al.* (2008b). It quantifies the health inequality between different social types, defined by the researcher according to the exposure to particular circumstances. The second is a measure that avoids the subjective definition of a discrete number of types, inspired in the *conditional equality* approach proposed by Fleurbaey and Schokkaert (2009).

2.3.1. The Gini-opportunity index. The area underneath the generalised Lorenz curve (A) relates to the Gini coefficient according to $A = \int \text{GL}(p) dp = \frac{1}{2}\mu(1 - G)$, where GL stands for the generalised Lorenz curve, μ for the mean outcome and G for the Gini coefficient. The double of A , i.e. the expression $\mu(1 - G)$, is known as the *Sen evaluation function*,⁷ and constitutes the primary measure of social welfare when only the mean level of outcome and the Gini coefficient are known.

In this context, Bensaid and Fleurbaey (2003) interpret the area underneath the generalised Lorenz curve as a cardinal measure of opportunity: for example, the area underneath the generalised Lorenz curve of one given type is a measure of that type's opportunity set. Following this line of thought, Lefranc *et al.* (2008b) propose using a modified Gini coefficient to quantify the inequality between the different types' opportunity sets: ranking types (not individuals) according to their respective values

⁵SSD with equal means is equivalent to the Lorenz curve dominance criterion, which is widely used in health economics.

⁶The *cdf* approach and FSD procedure do not hinge on the *Mean of Mins* criterion or any other aggregation method, as discussed by Fleurbaey (2008, pp. 218) and illustrated in Lefranc *et al.* (2004).

⁷There are several ways of interpreting the Sen evaluation function in terms of social welfare. These range from the original Sen's pairwise maximin criterion, to the grounds of relative deprivation and its relationship with a particular class of altruistic welfare functions. These connections are meticulously discussed in Lambert (2001, pp. 122–126).

of $A_j = \mu_j(1 - G_j)$ and starting from the smallest one, the *Gini-opportunity index* is defined as: $G - Opp = (1/\mu) \sum_i^k \sum_{i < j} p_i p_j [\mu_j(1 - G_j) - \mu_i(1 - G_i)]$.

This index gives the weighted average of the differences between the types' opportunity sets in which the weights are the sample weights of the different types ($p_{i,j}$). It increases in the number of types, therefore depending on the subjective definition of these by the researcher.⁸

In the specific case of health, a potential limitation of this index concerns the fact that the Gini coefficient, hence also the Gini-opportunity index, is not invariant to the scale on which the health variable is measured. This is a well-known fact, but the use of mean-based indices, such as Gini coefficients and concentration indices, as well as of regression models that assume a particular scale of the health variable is widespread: this is for example the approach used by Wagstaff *et al.* (1991), Contoyannis *et al.* (2004) and Van Doorslaer and Koolman (2004) in the field of health inequalities, and also the methodology implemented in many other papers concerned with different aspects of health economics such as Case *et al.* (2005). Resolving this limitation is therefore beyond the scope of this paper.⁹ However, to mitigate its impact and to ensure the robustness of the results, sensitivity analysis was undertaken regarding the latent scale of the SAH variable.¹⁰

2.3.2. An alternative approach. In some situations, the definition of social types has a clear intuitive appeal; in others, however, it may be hard to justify. In order to avoid this downside, one may treat each individual as a type: by assuming that the number of social types equals the number of individuals, the Gini-opportunity index equals, by construction, the conventional Gini coefficient.

Fleurbaey and Schokkaert (2009) propose a range of different approaches to the measurement of health inequalities that do not require the definition of a discrete number of types. The measure used in this paper is inspired in one of them, the *conditional equality*, and is computed as follows. The health outcome is indirectly standardised for circumstances by running $h_i = \alpha + \beta C_i + \varepsilon_i$ and computing $\hat{h}_i = \hat{\beta} C_i = h_i - \varepsilon_i$. The pseudo-Gini coefficient¹¹ is then applied directly to \hat{h}_i , in order to measure the overall health inequality that is due to circumstances, hence the extent of inequality of opportunity.

This approach diverges from Fleurbaey and Schokkaert (2009) with respect to the indirect standardisation procedure: the first stage regression implemented in this paper omits all the effort variables; as pointed-out by Gravelle (2003), this might lead to biased estimates, for the partial correlations between circumstances and effort are not taken into account. However, in the context of the Roemer model, these partial correlations should also be treated as circumstances for they embody the indirect effect of the unjust circumstances on health that is channelled through effort. This omission is therefore deliberate.

The value of this measure is directly comparable with that of the (unstandardised) health pseudo-Gini¹² coefficient $G(h_i)$. The health pseudo-Gini coefficient has been used in the literature to measure inequality of outcomes. It implicitly treats as circumstances all the sources of variation in health and, therefore, the value of $G(h_i)$ constitutes an upper bound for inequality of opportunity. In turn, $G(\hat{h}_i)$

⁸The Gini-opportunity index also satisfies all the fundamental properties required by the indices of relative inequality: within type anonymity; between-type Pigou–Dalton principle of transfers; normalisation (if *cdfs* are equal, the index is equal to zero); homogeneity of degree zero; invariance to a replication of the population. For details, see Lefranc *et al.* (2008b) and references therein.

⁹A series of different possibilities to deal with this problem was recently proposed by Erreygers (2009).

¹⁰Following the approach of Van Doorslaer and Jones (2003), values from the *McMaster Health Utility Index Mark III*, which is a truly cardinal health measure, were used to rescale the self-assessed health variable and to conduct a sensitivity analysis of the inequality measures computed in the paper. The conclusions inferred on the basis of these proved to be robust to the use of this different health scale.

¹¹The outcome of interest in this paper is SAH, measured in a discrete ordinal scale. Because of this, individuals cannot be simply ranked by health: grouped data are therefore used and *pseudo-Lorenz curves* and *pseudo-Gini coefficients* defined.

¹²In this paper, $G(h_i)$ denotes the unstandardised pseudo-Gini coefficient. It must be mentioned that standardisation of the pseudo-Gini indices for variables for which individuals cannot be made accountable, such as gender and age, is however a well-established methodology in the literature. This is carefully discussed in Fleurbaey and Schokkaert (2009).

treats as circumstances only the sources of unfair inequality that are labelled as such by the researcher; it is therefore a lower bound for the extent of inequality of opportunity in health.

It is important to stress that these measures of inequality of opportunity are inherently different and therefore do not necessarily bring about the same ranking of social states. The Gini-opportunity index measures the inequality between a discrete number of social types subjectively defined by the researcher. $G(\hat{h}_i)$ also requires a normative cut between circumstances and effort, but it respects the continuous nature of these variables; it quantifies the overall contribution of circumstances to the observed (health) outcome inequality. Finally, the pseudo-Gini index is the standard tool for the measurement of pure health inequalities; it implicitly assumes that all causes of inequality of opportunity are circumstances.

3. DATA

3.1. The NCDS

The NCDS follows the cohort of nearly 17 000 individuals born in Great Britain in the week of 3rd March 1958. Individuals are followed from birth to the age of 46. Parents were interviewed for the first time in 1958; extensive medical data on children were collected together with comprehensive information about the socioeconomic characteristics and educational achievements of their parents. Posterior interviews were conducted in 1965, 1969, 1974, 1981, 1991, 1999/2000 and 2004. Information in the first three waves of the survey was obtained from parents and school teachers. At the age 7 and 11, ability tests were administered in mathematics and reading. During this period of childhood and adolescence, data on some aspects of parental health were systematically collected, such as incidence of hereditary conditions in the family. Parental occupation and education, exposure to financial difficulties and other socioeconomic characteristics of the household were also recorded in these first three waves of the survey.

Questionnaires from waves 4 to 7 were addressed to cohort members (rather than their parents) and cover a broad range of subjects grouped in the following categories: employment, income, health and health-related behaviour, citizenship and values, relationships, parenting and housing, education and training.

The issue of attrition has been considered both in research papers and in reports produced by the NCDS advisory panel. Attrition does not seem to be associated with socioeconomic status, as shown in Case *et al.* (2005), and has modest positive correlation with cohort members' spells of unemployment, as reported by Lindeboom *et al.* (2006). In this paper, a variable addition test was carried out to investigate whether health-related attrition is a problem: ordered probit regressions were used to determine whether being in subsequent waves of the panel is correlated with health status. No evidence of health-related attrition was found.

3.2. Variables: health, circumstances and effort

The main health outcome considered in this paper is self-assessed health (SAH) measured in a four-point scale: excellent, good, fair and poor health.¹³ SAH is measured when the cohort members are 23, 33, 42 and 46 years old. SAH is widely used in health economics and was shown to predict mortality and deterioration of health even after controlling for the medical assessment of health conditions: Idler and Kasl (1995) provide an extensive literature review on this issue. In the specific case of the NCDS, the focus on SAH is also corroborated by its high correlation with reported disability and number of hospitalisations.¹⁴

¹³In the latest wave of the survey, SAH is however measured in a five-point scale, which also includes the category of 'very poor health'.

¹⁴See Case *et al.* (2005, pp. 370).

Two sorts of circumstance variables are considered: the parental socioeconomic background of the cohort members and their congenital and childhood health conditions.

The socioeconomic background of the cohort members is characterised by a comprehensive set of variables. The NCDS allows us to trace the social class of the parents and of both grandfathers of the cohort members. This is derived from the respective Registrar General's Social Class in the first three waves of the survey (for parents) and at the time in which parents left school (for the grandfathers). Following the literature on the NCDS, data on wages were not taken directly into account given substantial non-response. Along the lines of Case *et al.* (2005) and Lindeboom *et al.* (2006) this was replaced by the incidence of financial difficulties during the childhood of the cohort members. The number of years of schooling of the mother and of the father is also included in the set of circumstances.

The proxies for health endowment used in this paper have all been cited in the literature as systematic determinants of adult health. Birthweight is taken as the main indicator of health at birth; dummy variables for whether the mother smoked after the fourth month of pregnancy and for whether the child was breastfed are included as controls. The NCDS provides information about a comprehensive set of morbidities experienced by the child up until the age of 16. Measures of morbidity, which aggregate 12 categories of health conditions, are constructed according to Power and Peckham (1987) and treated as circumstances. Dummy variables for the occurrence of chronic diseases in the parents and for the incidence of hereditary conditions such as diabetes and epilepsy in parents, brothers and sisters of the cohort members complement the information on health endowments. Dummy variables for whether the child was obese at age 16 and for whether both parents were smokers in 1974 are also treated as circumstances.

The effort factors considered in the paper are health-related lifestyles such as cigarette smoking, alcohol consumption, consumption of fried food and educational attainment: these are strongly constrained by circumstances, but also reflect individual choices.

All the variables used to proxy lifestyles are based on self-reported information. The variable for cigarette smoking is the self-reported number of cigarettes smoked per day. Alcohol consumption is measured by the number of units of alcohol consumed on average per week: NCDS respondents are asked about their weekly consumption of a wide range of alcoholic drinks (glasses of wine, pints of beer and so forth). These were then converted to units of alcohol using the UK National Health Service official guidelines.¹⁵ Educational attainment is measured by the highest academic qualification awarded to cohort members.¹⁶ The summary statistics of the main variables used in the paper is shown in Table I.

4. TESTING AND MEASURING INEQUALITY OF OPPORTUNITY IN HEALTH

The existence of inequality of opportunity in health can be tested using the set of conditions defined in Section 2.2. As explained above, the data are consistent with inequality of opportunity if $\forall c \neq c', F(.|c) \succ_{\text{FSD}} F(.|c')$. In order to illustrate the application of this condition to the NCDS data, three social types are defined on the sole basis of the social class of the cohort members' father in 1974: a top class including professional and managerial workers, a middle class including partially skilled non-manual and skilled manual workers, and a bottom class including unskilled manual and unemployed workers.

The outcome of interest is SAH at age 46, measured in a five-point scale. Given the existence of a common discrete support, Kolmogorov–Smirnov test procedures were carried out to test for first-degree

¹⁵These are publicly available at: <http://www.nhsdirect.nhs.uk/magazine/interactive/drinking/index.aspx>.

¹⁶O-level (Ordinary levels) were a secondary education qualification corresponding, typically, to 11 years of education; A-levels (advanced levels) are a qualification that corresponds to 13 years of education. Completion of A-levels is a prerequisite for university admission.

Table I. Summary statistics

Variable	Full sample			
	Mean	Std. Dev.	Min	Max
Self-assessed health, age 46	3.987719	0.9302554	1	5
Male	0.5171652	0.4997187	0	1
Parental socioeconomic status at birth: high	0.2727015	0.4453612	0	1
Parental socioeconomic status at birth: middle	0.49983	0.5000141	0	1
Paternal grandfather's socioeconomic status	1.975576	0.7470104	1	3
Maternal grandfather's socioeconomic status	2.04248	0.7366398	1	3
Years of education: father	9.904075	1.621967	7	16
Years of education: mother	9.916638	1.376012	7	16
Indicator: mother smoker, age 16	0.7865378	1.010508	0	4
Indicator: father smoker, age 16	1.119048	1.136957	0	4
Indicator: maternal smoking after 4th month of pregnancy	0.3364165	0.472497	0	1
Indicator: breastfed	0.6421394	0.4793864	0	1
Birthweight	128.3177	72.43585	11	509
Physical/mental impairments, age 16	2.236591	1.541278	0	10
Indicator: financial hardship, age 11	0.0714425	0.2575708	0	1
Indicator: financial hardship, age 16	0.0789546	0.269677	0	1
Indicator: diabetes in parents, brothers or sisters	0.0212642	0.1442684	0	1
Indicator: epilepsy in parents, brothers or sisters	0.073906	0.2616263	0	1
Indicator: other hereditary chronic condition	0.025154	0.1565977	0	1
Indicator: chronic conditions in cohort member's mother, age 16	0.0477003	0.2131386	0	1
Indicator: obesity, age 16	0.0324388	0.1771673	0	1
Indicator: university degree or equivalent	0.2313824	0.4217384	0	1
Indicator: A-levels or higher qualification	0.3206419	0.4667478	0	1
Indicator: O-levels, or higher qualification	0.8212712	0.3831451	0	1
Mathematics test score, age 11 (scores range from 0 to 40)	15.23885	11.01308	0	40
Indicator : smoker, age 33	0.3197992	0.4664195	0	1
Number of cigarettes per day	5.543246	9.519264	0	70
Arguments with parents about risks of smoking	0.0913892	0.2881695	0	1
Avoidance of fried food in diet: weekly frequency (1–6), age 33	4.538137	0.9861445	1	6
Weekly consumption of vegetables, age 33	0.6580174	0.638489	0	2
Weekly alcohol consumption, age 33	2.453389	1.619937	0	4
Sweets consumption: weekly frequency, age 33	4.152178	1.667634	1	9
Socioeconomic status: high (age 33)	0.5977131	0.4903824	0	1
Socioeconomic status: middle (age 33)	0.2081837	0.4060281	0	1

Table II. Tests for stochastic dominance between types

Null hypothesis	Corrected <i>p</i> -value
Null: Type 1 FSD type 2	0.999
Null: Type 1 FSD type 3	0.999
Null: Type 2 FSD type 3	0.959

stochastic dominance between types; this approach was previously used in the literature by Lefranc *et al.* (2004) and Devaux *et al.* (2008). Table II shows the results of these tests: the distribution of health in the top social class dominates at first degree that of the middle class which, in turn, dominates, also at first degree, the outcome distribution of the bottom social type at the 5% significance level. These results establish the existence of inequality of opportunity between types.

Two approaches to the measurement of inequality of opportunity are presented in Section 2. The first of them, the Gini-opportunity index, is implemented using the social types defined for testing for stochastic dominance, and its values tabulated for the four latest waves of the NCDS in the first column of Table III. This index measures the extent of inequality of opportunity between the three social types when the cohort members were 23, 33, 42 and 46 years old. To allow for sampling error, the standard

Table III. Measures of inequality of opportunity

NCDS wave	Gini-opportunity index	$G(\hat{h}_i)$	Health pseudo-Gini: $G(h_i)$	Ratio: $\frac{G(\hat{h}_i)}{G(h_i)}$
Wave 4: 1981 (age 23)	0.0088496 (0.0017707)	0.02205	0.10257	0.21497
Wave 5: 1991 (age 33)	0.0165535 (0.0015658)	0.02976	0.11304	0.26326
Wave 6: 1999/2000 (age 42)	0.018381 (0.0018364)	0.03257	0.12765	0.25515
Wave 7: 2004 (age 46)	0.0178522 (0.0026443)	0.0338	0.15405	0.2194

Note: Bootstrapped standard errors in parentheses, with independent re-sampling within each of the three types.

errors of the Gini-opportunity indices are bootstrapped in each wave, with independent re-sampling within each of the three types.

The second column of Table III presents the values of the indirectly standardised pseudo-Gini coefficient $G(\hat{h}_i)$, which measures the overall inequality that is attributable to circumstances, avoiding the subjective definition of social types. It is computed as described in Section 2.3.2. The circumstances used in the standardising regression are the following:¹⁷ gender, regional dummies, socioeconomic status of the father and of both grandfathers, number of years of education of the father and of the mother, indicators for whether the father and the mother were smokers in 1974, birthweight, incidence of physical and mental impairments during childhood and adolescence, exposure to financial hardship at age 11 and at age 16, indicators for the prevalence of diabetes, epilepsy and other (unspecified) chronic conditions in the family and a dummy variable for whether the cohort member was obese at age 16. This standardising equation is the same for all the waves, making the values of $G(\hat{h}_i)$ directly comparable.

The third column of Table III displays the values of the (unstandardised) health pseudo-Gini coefficient $G(h_i)$. As seen in Section 2, this measure treats all the sources of variation in health as circumstances, equating inequality of opportunity and inequality of outcomes; $G(h_i)$ is therefore an upper bound to the extent of inequality of opportunity.

The Gini-opportunity index exhibits a remarkable persistence over the time: it does not change significantly over the last three waves of the survey. This suggests that the long-term association between parental socioeconomic status and the cohort members' health is far from being restricted to childhood and adolescence. The values of $G(\hat{h}_i)$ and $G(h_i)$ show an increasing trend, as the 1958 cohort ages and the prevalence of illness mounts.¹⁸ The increasing trend of $G(\hat{h}_i)$ indicates that the set of childhood circumstances used in its computation constitutes an increasingly prominent cause of inequality of opportunity in health. $G(\hat{h}_i)$ is, as seen above, a lower bound for the inequality of opportunity in health.

The fourth column of Table III displays the ratio $G(\hat{h}_i)/G(h_i)$; this corresponds to the proportion of total health inequality that is due to inequality of opportunity (i.e. due to the direct and indirect effect of the observed circumstances). The weight of inequality of opportunity in the total health inequality is relatively steady across the four waves, assuming values between 21 and 26%. Since these circumstances affect the cohort members before age 16, at least 21% of the health inequalities observed in adulthood are due to factors that are only amenable to policy interventions early in life.

¹⁷As explained above, this standardisation procedure is in line with van Doorslaer and Koolman (2004), in the sense that only circumstance variables are used as standardising variables in the first stage regression.

¹⁸It must be stressed that there is no theoretical reason ensuring that the three indices depict the same trend. For example, Lefranc *et al.* (2008b, pp. 539–540) use a data set of nine countries to compare the extent of income inequality (measured by the Gini coefficient) with that of the inequality of opportunity for the acquisition of income (measured by the Gini-opportunity index). Their results show that the correlation between the values of these two measures can be negative in practice.

5. ESTIMATION RESULTS

So far the analysis has been focused on identifying and measuring inequality of opportunity in health. The attention is now turned to explaining it. On a first stage, a model of association between SAH at age 46 and a comprehensive set of circumstances is estimated; this allows an assessment of the global impact of circumstances on health. These estimates are then contrasted with those of an alternative model, which controls for effort variables; this compares the relative importance of the pathway of circumstance through effort, with its direct effect. The estimates of the effort factors must however be seen as associations that do not necessarily reflect causality. Finally, in order to illuminate further the triangular relationship between circumstances, effort and health, a set of univariate equations is estimated for each of the effort variables.

5.1. Adult health and early life circumstances: direct and indirect effects

Table IV shows the results of the ordered probit regression of SAH at age 46 on circumstances. A general-to-simple *kitchen sink* approach was followed, starting with a large number of regressors, all of them potential circumstances. These circumstance variables are also the ones used to compute $G(\hat{h}_i)$ in Table III. The reported marginal effects are computed by averaging across all the individual marginal effects in the sample, and by taking *excellent health* as the reference category.

The estimated coefficients for the social class of the cohort member's father are positive and statistically significant. Compared with the bottom social class, individuals whose father or male head of household is in the top occupational category are 5.7 percentage points more likely to report excellent health. This partial effect is of 4.1 percentage points for the middle social class. These facts are striking given the large number of controls used and mirror the results of the stochastic dominance analysis, confirming the existence of inequality of opportunity in health.

The number of years of education of the mother is significantly associated with good health in adulthood; paternal education is however statistically insignificant after controlling for paternal social class. This is in line with Case *et al.* (2005, pp. 377); it is also a statistically significant result for women, but not for men.

Financial difficulties at age 16 are a statistically significant determinant of health deterioration in adulthood, especially for men: spells of bad household finances at age 16 are associated with a 13.4 percentage points lower probability of reporting excellent health at age 46. Propper *et al.* (2004) show that spells of low income in early years affect health in childhood and adolescence; the results in Table IV make clear that this association persists in adulthood.

Health endowments are also crucial: the incidence of illness in adolescence is significantly correlated with a worsening of self-reported health at age 46. Marginal effects are identical for men and women, corresponding to a nearly 2 percentage points lower probability of reporting excellent health. The prevalence of obesity at age 16 is also highly correlated with a deterioration of adult health. This effect is statistically significant for women (but not for men) and accounts for a reduction of around 8.4% in the probability of reporting excellent health in adulthood.

Table IV accounts for the global impact of circumstances on SAH at age 46, but it omits important determinants of health, namely effort factors. These are added to the model in Table V.

After controlling for many of the factors that individuals partially control, and including among them educational attainment and even own social class at age 33, most of the circumstances preserve their statistical significance. However, the size of the marginal effects¹⁹ of circumstances such as parental social class and bad finances at age 16 are strongly reduced. This indicates that only a fraction of the effect of circumstances is a direct one: effort factors now capture part of their impact on health.

¹⁹The marginal effects in Table V are also for the probability of reporting excellent health.

Table IV. Adult health and circumstances.^a Ordered probit estimates

Dependent variable	Full sample		Women		Men	
	Coefficient	Marginal eff. ^b	Coefficient	Marginal eff. ^b	Coefficient	Marginal eff. ^b
Self-assessed health (age 46)						
Parental SES at birth: high	0.202*** (0.0615)	0.0574	0.239*** (0.0855)	0.0401	0.163* (0.0897)	0.0616
Parental SES at birth: middle	0.142*** (0.0459)	0.0414	0.185*** (0.0633)	0.0330	0.104 (0.0676)	0.0394
Paternal grandfather SES	-0.0287 (0.0293)	-0.00836	-0.0374 (0.0409)	-0.00665	-0.0137 (0.0424)	-0.00520
Maternal grandfather SES	-0.0171 (0.0247)	-0.00498	0.00123 (0.0345)	0.000220	-0.0392 (0.0356)	-0.0149
Years of education: father	-0.0116 (0.0130)	-0.00338	-0.00838 (0.0184)	-0.00149	-0.0185 (0.0186)	-0.00704
Years of education: mother	0.0282* (0.0148)	0.00823	0.0378* (0.0203)	0.00672	0.0183 (0.0218)	0.00697
Mother smoker (age 16)	-0.0491** (0.0221)	-0.0143	-0.0489 (0.0307)	-0.00871	-0.0439 (0.0321)	-0.0167
Father smoker (age 16)	-0.0158 (0.0158)	-0.00462	-0.0228 (0.0218)	-0.00405	-0.0144 (0.0230)	-0.00548
Maternal smoking during pregnancy	0.0132 (0.0450)	0.00384	0.0229 (0.0622)	0.00406	-0.00707 (0.0656)	-0.00269
Breastfed	0.0541 (0.0371)	0.0159	0.0845 (0.0523)	0.0154	0.0181 (0.0529)	0.00688
Birthweight	0.000377 (0.000258)	0.000110	0.000987** (0.000400)	0.000176	-0.000115 (0.000342)	-4.37e-05
Mathematics test score: age 11	0.00455*** (0.00164)	0.00133	0.00475*** (0.00237)	0.000846	0.00468** (0.00231)	0.00178
Physical/mental impairments (age 16)	-0.0760*** (0.0109)	-0.0222	-0.0846*** (0.0150)	-0.0151	-0.0647*** (0.0162)	-0.0246
Financial hardship (age 11)	-0.0653 (0.0802)	-0.0195	-0.216** (0.110)	-0.0431	0.134 (0.119)	0.0502
Financial hardship (age 16)	-0.201** (0.0791)	-0.0627	-0.0825 (0.113)	-0.0153	-0.346*** (0.112)	-0.134
Diabetes in parents or siblings	-0.0680 (0.110)	-0.0203	0.160 (0.149)	0.0260	-0.353** (0.164)	-0.137
Epilepsy in parents or siblings	-0.0856 (0.0640)	-0.0256	0.00330	0.000587	-0.178* (0.0910)	-0.0685
Other hereditary chronic condition	-0.0685 (0.107)	-0.0205	-0.0483 (0.152)	-0.00884	-0.0566 (0.152)	-0.0216
Chronic condition: mother (age 16)	-0.0880 (0.0801)	-0.0264	-0.114 (0.113)	-0.0215	-0.0619 (0.115)	-0.0237
Obesity (age 16)	-0.268*** (0.0788)	-0.0848	-0.341*** (0.108)	-0.0724	-0.173 (0.116)	-0.0668
Number of observations	4408		2220		2188	

Notes: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Coefficients and marginal effects for regional variables are suppressed here (due to statistical insignificance) but available upon request.

^aThe same circumstances used to compute in Table III.

^bMarginal effects for the probability of reporting excellent health.

The health endowment circumstances that were statistically significant in Table IV remain significant in Table V; their marginal effects are also reduced. Particularly striking is the fact that obesity at age 16 remains statistically significant after controlling for a series of lifestyles and dietary choices, carrying a negative partial effect of nearly 4 percentage points. Although this is statistically significant only for

Table V. Adult health, circumstances and effort ordered probit estimates

Dep. variable	Full sample		Women		Men	
	Coefficient	Marginal eff. ^a	Coefficient	Marginal eff. ^a	Coefficient	Marginal eff. ^a
<i>Circumstance variables</i>						
SAH (age 46)						
Parental SES at birth: high	0.222*** (0.0696)	0.0274	0.315*** (0.0957)	0.00922	0.126 (0.103)	0.0336
Parental SES at birth: middle	0.104** (0.0523)	0.0137	0.150** (0.0711)	0.00518	0.0571 (0.0780)	0.0154
Paternal grandfather SES	0.0178 (0.0333)	0.00233	0.0282 (0.0458)	0.000958	0.0220 (0.0491)	0.00595
Maternal grandfather SES	-0.0123 (0.0278)	-0.00161	0.0106 (0.0383)	0.000359	-0.0463 (0.0411)	-0.0125
Years of education: father	-0.00986 (0.0144)	-0.00129	-0.0214 (0.0203)	-0.000727	0.000520 (0.0207)	0.000140
Years of education: mother	0.0254 (0.0166)	0.00332	0.0438* (0.0229)	0.00149	0.00861 (0.0245)	0.00233
Mother smoker (age 16)	-0.0432* (0.0253)	-0.00567	-0.0605* (0.0346)	-0.00206	-0.0183 (0.0379)	-0.00493
Father smoker (age 16)	-0.00738 (0.0179)	-0.000967	-0.0250 (0.0246)	-0.000847	0.00699 (0.0265)	0.00189
Maternal smoking during pregnancy	0.0355 (0.0512)	0.00461	0.0808 (0.0700)	0.00268	-0.0379 (0.0765)	-0.0103
Breastfed	0.0630 (0.0420)	0.00841	0.0833 (0.0585)	0.00291	0.0542 (0.0611)	0.0148
Birthweight	0.000645** (0.000308)	8.45e-05	0.000773* (0.000450)	2.62e-05	0.000430 (0.000428)	0.000116
Physical/mental impairments (age 16)	-0.0733*** (0.0123)	-0.00962	-0.0660*** (0.0169)	-0.00224	-0.0827*** (0.0185)	-0.0223
Financial hardship (age 11)	-0.0350 (0.0923)	-0.00469	-0.185 (0.124)	-0.00742	0.185 (0.140)	0.0465
Financial hardship (age 16)	-0.156* (0.0911)	-0.0225	-0.0624 (0.129)	-0.00224	-0.292** (0.131)	-0.0870
Diabetes in parents or siblings	-0.0832 (0.123)	-0.0115	0.108 (0.166)	0.00330	-0.341* (0.187)	-0.103
Epilepsy in parents or siblings	-0.0651 (0.0741)	-0.00886	-0.0436 (0.103)	-0.00154	-0.105 (0.109)	-0.0293
Other hereditary chronic condition	-0.103 (0.122)	-0.0144	-0.0377 (0.170)	-0.00133	-0.142 (0.179)	-0.0402
Chronic condition: mother (age 16)	-0.130 (0.0942)	-0.0185	-0.135 (0.129)	-0.00516	-0.142 (0.141)	-0.0402
Mathematics test score: age 11	0.000855 (0.00203)	0.000112	0.000727 (0.00283)	2.46e-05	0.00133 (0.00295)	0.000359
Obesity (age 16)	-0.268*** (0.0877)	-0.0414	-0.393*** (0.119)	-0.0190	-0.119 (0.132)	-0.0336
<i>Effort variables</i>						
University degree or equivalent	-0.0619 (0.0700)	-0.00832	-0.0361 (0.0948)	-0.00126	-0.126 (0.105)	-0.0347
A-levels or higher qualification	0.104* (0.1102)	0.0132	0.0421 (0.0892)	0.00140	0.192* (0.103)	0.0508
O-levels or higher qualification	0.0452 (0.0631)	0.00606	0.141 (0.0924)	0.00530	-0.0249 (0.0876)	-0.00667
Indicator (smoker)*Log (cigarettes/day) [†]	-0.124*** (0.0159)	-0.0163	-0.104*** (0.0224)	-0.00352	-0.145*** (0.0231)	-0.0392
Fried food avoidance: frequency ^b	0.0549*** (0.0206)	0.00720	0.0782** (0.0311)	0.00266	0.0425 (0.0291)	0.0115
Weekly vegetables consumption ^b	-0.0224 (0.0302)	-0.00293	-0.0476 (0.0411)	-0.00162	0.0340 (0.0463)	0.00917
Weekly alcohol consumption ^b	0.00296 (0.0145)	0.000388	0.00127 (0.0239)	4.30e-05	-0.00881 (0.0200)	-0.00238

Table V. *Continued.*

Dep. variable	Full sample		Women		Men	
	Coefficient	Marginal eff. ^a	Coefficient	Marginal eff. ^a	Coefficient	Marginal eff. ^a
SAH (age 46)						
Sweets consumption: frequency ^b	0.00347 (0.0117)	0.000455	0.00118 (0.0161)	4.00e-05	0.00480 (0.0172)	0.00130
Own socioeconomic status: high ^b	0.111** (0.0550)	0.0149	0.110 (0.0685)	0.00385	0.0964 (0.0945)	0.0262
Own socioeconomic status: middle ^b	0.128** (0.0633)	0.0159	0.0984 (0.112)	0.00307	0.115 (0.0919)	0.0305
Number of observations	3535		1833		1702	

Notes: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Coefficients and marginal effects for regional variables are suppressed here (due to statistical insignificance) but available upon request.

^aMarginal effects for the probability of reporting excellent health.

^bDenotes 'at age 33'.

women, it suggests that childhood obesity has an important direct effect on adult health, therefore amenable only to early policy interventions.

Among effort factors, the detrimental effect of cigarette smoking on SAH is prominent. This is in line with most of the literature: Power and Peckham (1987), Marmot *et al.* (2001), Contoyannis *et al.* (2004) and Balia and Jones (2008) report similar results. The avoidance of fried food is the only dietary choice that shows a statistically significant positive impact on SAH at age 46.

After controlling for own social class in adulthood and for a commonly used proxy of intellectual ability (maths test scores at age 11), the attainment of A-levels or higher academic qualifications shows to be statistically significant: compared with those with no secondary education, individuals attaining at least A-levels have an approximately 1.3 percentage points higher probability of reporting excellent health. This result is much more pronounced for men than for women, and suggests that inequalities in education may be key determinants of health inequalities. Finally, the effect of (own) social class is also statistically significant: compared with the bottom social category, individuals in the top and middle classes have a nearly 1.5 percentage points higher probability of reporting excellent health at age 46.

5.2. Circumstances and effort: primary pathways

In order to illuminate further the effect of circumstances on effort, single equations for each of the most important effort variables are estimated in Table VI.

The first and second equations of the table concern cigarette smoking. The number of cigarettes smoked per day shows a spike at zero, which is typical of cigarette smoking data. In order to take this into account, two equations are estimated: the first is a probit model, estimated for the whole sample, for whether an individual is a smoker or a non-smoker; the second, features the logarithm of the number of cigarettes smoked as the dependent variable and is estimated only for smokers.

Parental smoking, bad household finances at age 16 and the prevalence of hereditary conditions in the family are chief determinants of cigarette smoking at age 33. Parental smoking accounts for a statistically significant increase in the probability of smoking of 3.6 percentage points, in the case of the father, and of around 2.4 percentage points in the case of the mother. The partial effect of financial difficulties in adolescence is even larger: 9.2 percentage points. Conversely, the prevalence of chronic diseases in the family, other than diabetes and epilepsy, has a statistically significant negative partial effect of 9.8 percentage points. This corroborates the thesis that perceived physical frailty leads to the adoption of healthy lifestyles to offset health risks.

Table VI. The impact of circumstances on effort

	Dep. variable		Dep. variable		Dep. variable		Dep. variable		Dep. variable	
	Indicator: smoker	Cigarettes/day	Fried food	University degree ^a	A-levels or higher	O-levels or higher				
	(OLS estimates)		(Ordered probit estimates)		(Probit estimates)		(Probit estimates)		(Probit estimates)	
	Coefficient	Marg. eff.	Coefficient	Marg. eff.	Coefficient	Marg. eff.	Coefficient	Marg. eff.	Coefficient	Marg. eff.
Male	-0.0326 (0.0492)	0.0655 (0.0475)	-0.573*** (0.0381)	0.0859* (0.0517)	0.0214 (0.0505)	0.0107 (0.0660)	-0.179*** (0.0660)	-0.0283 (0.0660)		
Parental SES at birth: high	-0.0878 (0.0852)	-0.0324 (0.0792)	-0.0459 (0.0665)	0.0507 (0.0976)	0.0127 (0.0931)	0.0262 (0.111)	-0.0366 (0.111)	-0.00581 (0.111)		
Parental SES at birth: middle	-0.0384 (0.0637)	-0.0521 (0.0581)	-0.0320 (0.0504)	0.0152 (0.0780)	0.00377 (0.0735)	0.0169 (0.0772)	0.0473 (0.0772)	0.00747 (0.0772)		
Paternal grand-father SES	-0.0278 (0.0411)	0.0696* (0.0395)	-0.0523* (0.0317)	-0.0887* (0.0457)	-0.0220 (0.0435)	-0.0317 (0.0435)	-0.0936* (0.0536)	-0.0148 (0.0536)		
Maternal grand-father SES	0.0276 (0.0344)	0.0131 (0.0331)	-0.0217 (0.0263)	0.000487 (0.0374)	0.000121 (0.0361)	-0.00323 (0.0451)	0.0136 (0.0451)	0.00214 (0.0451)		
Years of education: father	0.00999 (0.0180)	-0.0107 (0.0167)	-0.00219 (0.0137)	0.0435*** (0.0176)	0.0108 (0.0176)	0.0130 (0.0181)	0.0195 (0.0294)	0.00308 (0.0294)		
Years of education: mother	0.0184 (0.0206)	-0.0164 (0.0195)	-0.0375** (0.0157)	0.131*** (0.0201)	0.0326 (0.0201)	0.0438 (0.0209)	0.101*** (0.0343)	0.0159 (0.0343)		
Mother smoker (age 16)	0.0244 (0.0303)	0.0372 (0.0268)	-0.0222 (0.0241)	0.00256 (0.0350)	0.000636 (0.0350)	-0.0111 (0.0339)	-0.0782** (0.0382)	-0.0123 (0.0382)		
Father smoker (age 16)	0.0369 (0.0216)	0.0571*** (0.0198)	-0.00447 (0.0170)	-0.0493** (0.0247)	-0.0122 (0.0247)	-0.0169 (0.0236)	-0.0920*** (0.0276)	-0.0145 (0.0276)		
Maternal smoking during pregnancy	-0.0179 (0.0622)	0.0810 (0.0569)	0.0491 (0.0486)	0.00978 (0.0705)	0.00244 (0.0705)	-0.00677 (0.0683)	-0.00255 (0.0793)	-0.000402 (0.0793)		
Breastfed	0.00416 (0.0517)	-0.00747 (0.0488)	-0.000747 (0.0398)	0.0391 (0.0576)	0.00969 (0.0553)	-0.00712 (0.0553)	0.0260 (0.0664)	0.00412 (0.0664)		
Birthweight	-0.000152 (0.000367)	0.000313 (0.000362)	0.000367 (0.000280)	-0.000178 (0.000405)	-4.43e-05 (0.000405)	6.70e-05 (0.000389)	0.00117* (0.000545)	0.000184 (0.000545)		
Physical/mental impairments (age 16)	0.00579 (0.0152)	0.00740 (0.0143)	0.000202 (0.0117)	-0.0114 (0.0167)	-0.00283 (0.0167)	-0.00238 (0.0162)	0.00696 (0.0200)	0.00110 (0.0200)		

Financial hardship (age 11)	0.280*** (0.106)	0.0925	0.0913	0.0913	-0.171** (0.0868)	-0.0637	-0.0267 (0.150)	-0.00660	-0.0734 (0.141)	-0.0195	-0.262** (0.120)	-0.0461
Financial hardship (age 16)	0.100 (0.110)	0.0318	-0.141 (0.0905)	-0.141 (0.0905)	0.0286 (0.0888)	0.0107	-0.173 (0.162)	-0.0411	-0.112 (0.148)	-0.0295	-0.350*** (0.119)	-0.0638
Diabetes in parents or siblings	0.0747 (0.0600)	0.0235	0.0929 (0.143)	0.0929 (0.143)	-0.00731 (0.121)	-0.00273	0.116 (0.170)	0.0297	0.0756 (0.168)	0.0204	-0.0461 (0.201)	-0.00741
Epilepsy in parents or siblings	0.00600 (0.0905)	0.00186	-0.0762 (0.0838)	-0.0762 (0.0838)	-0.0103 (0.0703)	-0.00386	-0.0412 (0.105)	-0.0102	0.20 (0.0980)	0.0327	0.243 (0.122)	0.0345
Other hereditary chronic condition	-0.358** (0.163)	-0.0989	0.0540 (0.169)	0.0540 (0.169)	-0.0429 (0.117)	-0.0160	-0.224 (0.188)	-0.0524	-0.264 (0.179)	-0.0680	-0.0146 (0.189)	-0.00231
Chronic condition: mother (age 16)	-0.0866 (0.119)	-0.0261	-0.0388 (0.113)	-0.0388 (0.113)	-0.0584 (0.0903)	-0.0218	0.105 (0.129)	0.0267	0.126 (0.126)	0.0341	-0.0403 (0.146)	-0.00646
Obesity (age 16)	-0.120 (0.110)	-0.0360	0.0525 (0.108)	0.0525 (0.108)	0.188** (0.0851)	0.0697	-0.157 (0.130)	-0.0374	-0.0570 (0.121)	-0.0151	0.00271 (0.135)	0.000427
Mathematics test score: age 11	-0.00341 (0.00251)	-0.00105	-0.000888 (0.00247)	-0.000888 (0.00247)	-0.00108 (0.00191)	-0.000403	0.0317*** (0.00255)	0.00789	0.0409*** (0.00248)	0.0109	0.0358*** (0.00339)	0.00564
University degree or equivalent	-0.189** (0.0910)	-0.0570	-0.151 (0.0980)	-0.151 (0.0980)	0.0853 (0.0659)	0.0319	—	—	—	—	—	—
A-levels or higher qualification	-0.192** (0.0848)	-0.0586	-0.101 (0.0882)	-0.101 (0.0882)	0.0868 (0.0633)	0.0325	—	—	—	—	—	—
O-levels or higher qualification	-0.377*** (0.0728)	-0.127	0.0167 (0.0611)	0.0167 (0.0611)	0.186*** (0.0598)	0.0698	—	—	—	—	—	—
Own socioeconomic status: high ^a	-0.234*** (0.0656)	-0.0746	-0.108* (0.0596)	-0.108 (0.0596)	0.107** (0.0527)	0.0403	0.634*** (0.0854)	0.150	0.737*** (0.0781)	0.201	0.648*** (0.0766)	0.110
Own socioeconomic status: middle ^a	-0.0302 (0.0767)	-0.00927	-0.0214 (0.0673)	-0.0214 (0.0673)	-0.129** (0.0617)	-0.0486	-0.223* (0.114)	-0.0534	-0.213** (0.103)	-0.0566	0.270*** (0.0873)	0.0398
Constant	-1.025*** (0.296)	—	2.674*** (0.290)	2.674*** (0.290)	—	—	-3.520*** (0.312)	—	-3.629*** (0.315)	—	-0.462 (0.441)	—
Number of observations	3660	994	994	3727	3727	3738	3738	3738	3738	3738	3738	3738

Notes: Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Coefficients and marginal effects for regional variables are suppressed here (due to statistical insignificance) but available upon request.

^aOr equivalent.

^bAt age 33.

Finally, the results suggest the existence of a socioeconomic and educational gradient in the probability of smoking: those with higher qualifications are less likely to smoke, even after controlling for own and parental socioeconomic status. Although the estimates of academic qualifications should not be seen as causal effects, this backs the idea that complementary educational policies may be crucial to reduce inequality of opportunity in health.

The evidence concerning the number of cigarettes smoked per day is mixed: there is neither a clear socioeconomic gradient nor an educational gradient. This is in accord with papers such as Jones (1989): education and social status reduce the probability of an individual becoming a smoker; however, for those who are already smokers, tobacco is a normal good.

The third equation in Table VI is an ordered probit with degrees of avoidance of fried food as the dependent variable. The results suggest that males are less likely to avoid fried food than females. Those hit by financial hardship at age 16 are approximately 6.3 percentage points less likely to be in the highest category of fried food avoidance. Education matters once more: individuals reporting at least O-levels bear a positive and statistically significant association with the avoidance of fried food. Of special interest, however, is the positive and statistically significant effect of obesity at age 16; this corresponds to an estimated partial effect of approximately 7 percentage points. This is once again in line with the rationale of risk offsetting in face of perceived frailty, and confirms that the harmful impact of child obesity on adult health is largely a direct one that needs to be tackled early in life.

Given the substantial influence of education on other effort variables and on health, a final note concerns the estimates of the impact of circumstances on the probability of attaining each educational level. The last three columns of Table VI give probit estimates for three levels of education: academic degree or equivalent, A-levels or higher and O-levels or higher.

Women are more likely to report having at least O-levels; however, men are more likely to attain a university degree. Ill health in childhood and obesity at age 16, bear a negative but statistically insignificant association with the educational outcomes. These are largely sensitive to the social position of the parents: parental education has a positive and statistically significant impact on all levels of educational attainment and bad finances at age 16 accounts for a statistically significant reduction of roughly 4.6 percentage points of the probability of reporting O-levels or a higher qualification. This suggests that equality of opportunity in education may be a key factor to reduce inequality of opportunity in health, highlighting the potential for complementary policies between the educational and health care sectors.

6. CONCLUSIONS

This paper proposes two approaches to measuring inequality of opportunity in health and finds evidence of such inequality among NCDS cohort members. It puts forward two approaches to measuring it: the results suggest that at least 21% of the health inequalities observed in adulthood are due to inequality of opportunity.

Econometric models are used to identify the most influential circumstances beyond individual control and to quantify their impact. Accounting for a comprehensive set of controls, parental socioeconomic status is a crucial explanatory factor of SAH in adulthood. The education of the mother (but not of the father) is also crucial, but mostly for women. Spells of financial difficulties during childhood and adolescence are particularly detrimental to men: alone, these are associated with a 13.4 percentage points reduction in the probability of reporting excellent health at age 46. In terms of health endowments, ill health during childhood is negatively associated with SAH at age 46, affecting both men and women. Obesity in childhood and adolescence is negatively associated with health at age 46, and is mainly detrimental to women.

Once effort factors, such as lifestyles and educational attainment, are added to the model, most of the circumstances remain statistically significant, although their marginal effects are reduced. This suggests that, although part of their effect is channelled through effort, an important part of it is a direct one.

Separate equations are estimated for each of the effort factors, to illuminate the indirect pathways of the effect of circumstances through effort. The results show that the influence of circumstances on effort factors can be paramount, as for example in the cases of cigarette smoking and educational attainment. They also suggest that inequality of opportunity in the educational sector may exacerbate health inequalities via the influence that education exerts on lifestyles.

Policy implications are inferred. Some unjust circumstances are only amenable to policy during childhood. Moreover, given that parental characteristics are among the most influential circumstances, policy interventions aimed at young adults, and namely at young parents, may be crucial to prevent inequality of opportunity from carrying over from one generation to the next. Finally, since the influence of circumstances on health is often channelled through effort, key complementary policies to reduce health inequalities may need to be implemented outside the health care system and, in particular, in the educational sector.

ACKNOWLEDGEMENTS

I thank Andrew Jones, Nigel Rice and Peter Smith for their invaluable suggestions and Maarten Lindeboom, Eddy van Doorslaer, Marc Fleurbaey, seminar participants at the University of York, Erasmus University, the Seventeenth Workshop on Health Econometrics, the Editor and two anonymous referees for their constructive comments. I gratefully acknowledge funding by Fundação para a Ciência e a Tecnologia. This research was supported by the ESRC under grant RES-060-25-0045.

REFERENCES

- Arneson R. 1989. Equality and equal opportunity for welfare. *Philosophical Studies* **56**: 77–93.
- Balia S, Jones AM. 2008. Mortality, lifestyle and socio-economic status. *Journal of Health Economics* **27**(1): 1–26.
- Barker DJP. 1995. Foetal origins of coronary disease. *British Medical Journal* **311**: 171–174.
- Bensaid J, Fleurbaey M. 2003. La fiscalité des ensembles de budgets: Quelques Propositions. *Economie et Prévision* **22**: 110–111.
- Betts J, Roemer J. 1998. Equalizing opportunities through educational finance reform. *U.C. Davis Working Paper No. 99-08*.
- Bourguignon F, Ferreira F, Menéndez M. 2005. Inequality of opportunity in Brazil. *World Bank Policy Research Working Paper Series No. 3174*.
- Case A, Ferting A, Paxon C. 2005. The lasting impact of childhood health and circumstance. *Journal of Health Economics* **24**: 365–389.
- Cohen GA. 1989. On the currency of egalitarian justice. *Ethics* **99**: 906–944.
- Contoyannis P, Jones AM. 2004. Socio-economic status, health and lifestyle. *Journal of Health Economics* **23**(5): 965–995.
- Contoyannis P, Jones AM, Rice N. 2004. The dynamics of health in the British Household Panel Survey. *Journal of Applied Econometrics* **19**: 473–503.
- Currie J, Stabile M. 2004. Socioeconomic status and health: why is the relationship stronger for older children? *American Economic Review* **93**(5): 1813–1823.
- Devaux M, Jusot F, Trannoy A, Tubeuf S. 2008. La santé des séniors selon leur origine sociale et la longévité de leurs parents. *Economie et Statistique* **411**: 25–46.
- Dworkin R. 1981. What is equality? Part 2: Equality of resources. *Philosophy and Public Affairs* **10**: 283–345.
- Erreygers G. 2009. Correcting the concentration index. *Journal of Health Economics* **28**(2): 504–515.
- Fleurbaey M. 2008. *Fairness, Responsibility and Welfare*. Oxford University Press: Oxford.
- Fleurbaey M, Schokkaert E. 2009. Unfair inequalities in health and health care. *Journal of Health Economics* **28**(1): 73–90.
- Gravelle H. 2003. Measuring income related inequality in health: standardisation and the partial concentration index. *Health Economics* **12**: 803–819.

- Idler EL, Kasl SV. 1995. Self-ratings of health: do they also predict change in functional ability? *Journal of Gerontology* **50**(6): 344–353.
- Jones AM. 1989. A double hurdle model of cigarette consumption. *Journal of Applied Econometrics* **4**: 23–39.
- Kenkel DS. 1995. Should you eat breakfast? Estimates from health production functions. *Health Economics* **5**: 15–25.
- Kuh DJ, Wadsworth ME. 1993. Physical health status at 36 years in a British national cohort. *Social Science and Medicine* **37**(7): 905–916.
- Lambert PJ. 2001. *The Distribution and Redistribution of Income*. Manchester University Press: Manchester.
- Lefranc A, Pistoiesi N, Trannoy A. 2004. Le revenu selon l'origine sociale. *Économie et Statistique* **31**: 49–88.
- Lefranc A, Trannoy A, Pistoiesi N. 2008a. Equality of opportunity: definitions and testable conditions with an application to income in France. *THEMA Working Paper Series No. 2006-13*, University of Cergy-Pontoise.
- Lefranc A, Trannoy A, Pistoiesi N. 2008b. Inequality of opportunities vs inequality of outcomes: are western societies all alike? *Review of Income and Wealth* **54**: 513–546.
- Le Grand J, Burchardt T. 2002. Constraint and opportunity: identifying voluntary unemployment. *CASE Discussion Paper Series No. 55*, LSE.
- Lindeboom M, Llena-Nozal A, van der Klaauw B. 2006. Disability and work: the role of childhood circumstances. *Timbergen Institute Discussion Paper 06-039/3*, Tinbergen Institute.
- Marmot MG, Brunner S, Hemingway S. 2001. Relative contributions of early life and adult socioeconomic factors to adult morbidity in the Whitehall II study. *Journal of Epidemiology and Community Health* **55**: 301–307.
- Mullahy J, Portney P. 1990. Air pollution, cigarette smoking and the production of respiratory health. *Journal of Health Economics* **9**: 193–205.
- Power C, Peckham C. 1987. Childhood morbidity and adult ill-health. *National Child Development Study User Support Working Paper No. 37*.
- Propper C, Burgess S, Rigg JA. 2004. The impact of low income on child health: evidence from a Birth Cohort Study. *CASE Discussion Paper Series No. 085*.
- Ravelli ACJ, van der Meulen JHP, Michels RPJ, Osmond C, Barker DJP, Hales CN, Bleker OP. 1998. Glucose tolerance in adults after prenatal exposure to famine. *The Lancet* **351**: 173–177.
- Roemer JE. 1998. *Equality of Opportunity*. Harvard University Press: Harvard.
- Roemer JE. 2002. Equality of opportunity: a progress report. *Social Choice and Welfare* **19**: 455–471.
- Rosa Dias P, Jones AM. 2007. Giving equality of opportunity a fair innings. *Health Economics* **16**: 109–112.
- Vallentyne P. 2008. Brute luck and responsibility. *Politics, Philosophy and Economics* **7**: 57–80.
- Van de Gaer D. 1993. Equality of opportunity and investment in human capital. *Ph.D. Thesis*, KU Leuven.
- Van Doorslaer E, Jones AM. 2003. Inequalities in self-reported health: validation of a new approach to measurement. *Journal of Health Economics* **22**: 61–87.
- Van Doorslaer E, Koolman X. 2004. Explaining the differences in income-related health inequalities across European countries. *Health Economics* **13**: 609–628.
- Wagstaff A, Paci P, Van Doorslaer E. 1991. On the measurement of inequalities in health. *Social Science and Medicine* **33**(5): 545–557.
- Zheng B. 2006. Measuring health opportunity. *Working Paper 06-06*, Department of Economics, University of Colorado at Denver and Health Sciences Centre.