Supplement

Inequality of opportunities in health and death:
an investigation from birth to middle age in
Great Britain

Damien Bricard,1 Florence Jusot,2 Alain Trannoy3 and
Sandy Tubeuf 4*  

1IRDES, Paris, France, 2PSL, Université Paris-Dauphine, LEDA-LEGOS, Paris, France, 3CNRS, EHESS, 
Centrale Marseille, AMSE, Aix-Marseille University, Marseille, France, and 4Institute of Health and 
Society (IRSS) and Institute of Economic and Social Research (IRES), Université catholique de 
Louvain, Brussels, Belgium  

*Corresponding author. Institute of Health and Society (IRSS), Université catholique de Louvain, Clos Chapelle-Aux-
Champs, 30, BTE B1.30.15, B-1200 Brussels, Belgium. E-mail: sandy.tubeuf@uclouvain.be  

Editorial decision 23 January 2020; Accepted 7 July 2020

Abstract

Objective: We assess the existence of unfair inequalities in health and death using the 
normative framework of inequality of opportunities, from birth to middle age in Great 
Britain.  
Methods: We use data from the 1958 National Child Development Study, which provides 
a unique opportunity to observe individual health from birth to the age of 54, including 
the occurrence of mortality. We measure health status combining self-assessed health 
and mortality. We compare and statistically test the differences between the cumulative 
distribution functions of health status at each age according to one childhood circum-
stance beyond people’s control: the father’s occupation.  
Results: At all ages, individuals born to a ‘professional’, ‘senior manager or technician’ father report a better health status and have a lower mortality rate than individuals born to ‘skilled’, ‘partly skilled’ or ‘unskilled’ manual workers and individuals without a father at birth. The gap in the probability to report good health between individuals born into high social backgrounds compared with low, increases from 12 percentage points at age 23 to 26 at age 54. Health gaps are even more marked in health states at the bottom of the health distribution when mortality is combined with self-assessed health.  
Conclusions: There is increasing inequality of opportunities in health over the lifespan in 
Great Britain. The tag of social background intensifies as individuals get older. Finally, 
there is added analytical value to combining mortality with self-assessed health when 
measuring health inequalities.  

Key words: Childhood, equality of opportunity, health inequality, longitudinal, self-assessed health, mortality
Introduction

In the past 20 years, numerous empirical studies have evaluated the magnitude of health inequalities between socioeconomic groups. Most of this literature usually focuses on health status at only one age or on life expectancy. Life course epidemiology has proposed to explain health inequalities in adulthood by the long-term biological, behavioural and psychosocial processes acting during gestation, childhood, adolescence, early adult life and across generations. In this paper, we focus on the health trajectory from birth to adulthood alone. Since health status is an evolving outcome, it is important to stretch the snapshots of health inequalities over a lifetime. Few studies have considered health inequalities over a lifetime at different ages or for different age cohorts. They have mainly shown that socio-economic health inequalities increase with age until a certain age from which they decrease because of a population selection effect. Here, we document the worsening effect of inequality of opportunities in Great Britain, one of the most egalitarian countries in terms of nationalized health care.

Measuring health inequalities over a lifetime requires following individuals from birth to death and so, we need to account for the problem of sample selection due to mortality. In general, empirical studies on inequalities separately consider health indicators and do not combine general health measures with mortality indicators. Some studies have used synthetic health indicators over the life-cycle, such as healthy life expectancy, combining health status and mortality from birth. Others have considered general health measures with mortality indicators. These indicators can be compared at different ages using a non-parametric method based on stochastic dominance to show the impact of social background on health overall from birth. Third, we evaluate over the longest lifespan possible using the 1958 National Child Development Study (NCDS), which is the longest birth cohort data available worldwide, providing the health status of a sample of individuals at several ages. Lastly, we consider the complete health trajectory of individuals combining, in a consistent manner, self-assessed health and mortality information to measure health status.

Conceptual framework

The question of inequality of opportunities has become key to the study of inequalities in health, as well as in other outcomes. The equality of opportunity theory calls for a normative understanding of health determinants. More generally, childhood characteristics are considered as socially or morally unacceptable sources of inequality. Any difference in the distribution of health in adulthood according to social background is considered an inequality of opportunities in health. The concept of inequality of opportunities in health, which are the most unjust inequalities. The contribution of the paper is 4-fold. First, the use of a normative approach brings a new perspective on health inequalities considering fairness within the life-course and provides relevant long-term elements to motivate public health policies. Second, we use cumulative distribution functions (CDFs) to trace the evolution of inequality of opportunities in health over the lifecycle. CDFs have the advantage of being a validated tool for the measurement of inequality of opportunities in many outcomes. CDFs allow a synthetic and complete description of inequality accounting for the discrete nature of health indicators. They can be compared at different ages using a non-parametric method based on stochastic dominance to show the impact of social background on health overall from birth. Third, we evaluate over the longest lifespan possible using the 1958 National Child Development Study (NCDS), which is the longest birth cohort data available worldwide, providing the health status of a sample of individuals at several ages. Lastly, we consider the complete health trajectory of individuals combining, in a consistent manner, self-assessed health and mortality information to measure health status.

Key Messages

- Inequality of opportunities in health prevail at all ages in Great Britain and this is true even when using a single indicator of social background—father’s occupation.
- As individuals age, the health gap widens between the health distributions of the most and least advantaged social backgrounds.
- The gap in the probability to report a good health status reaches more than 25 percentage points after age 50 years and differences are more marked when mortality is combined with self-assessed health to measure health status.
- The worst social background tag, in terms of health disadvantages, is that of being born to a family without a father or a father in ‘unskilled’ or ‘partly skilled’ work.
opportunity distinguishes between legitimate and illegitimate sources of inequality. Legitimate inequalities are due to factors for which the individual can be held responsible, whereas the latter stem from factors beyond the individual’s control. In the terminology of Roemer, these are efforts and circumstances, respectively. While circumstances are usually proxied by social background, health-related lifestyles have been used to measure efforts in health. The typical ethical prescription is that inequalities due to circumstances should be compensated for, whereas those due to efforts, and hence ‘legitimate’, should be respected. We do not elaborate further here about how these principles should be adapted to the health sphere and refer to relevant literature for additional discussions on that issue. It is however important to underline that most studies in epidemiology that examine the relationships between early childhood circumstances and/or parental characteristics and health could be interpreted through the lens of equality of opportunity theory. According to Bartley (p. 186) ‘new and important advances in this kind of thinking has linked life-course ideas to ideas from philosophy about individual responsibility versus the force of circumstances’.

Such a conceptual framework influences empirical analyses and often relies upon non-parametric methods. Here, we adopt an ex ante perspective for measuring inequalities of opportunities; we consider father’s occupation at birth as a proxy of the social background and do not use information on health-related lifestyles. This implies that the part of effort that is correlated to father’s occupation is also considered as a circumstance.

Exposure to disadvantaged early life conditions and social background has been associated with poorer health in later life. Four main mechanisms have been discovered in the fields of life course epidemiology as well as social sciences, such as psychology, sociology, demography and economics. The latency model shows the direct influence of social and family living conditions in childhood on health in adulthood following a latency period. The pathway model relies on social background having an indirect influence on health status in adulthood and subsequent life trajectories, particularly through the transmission of socio-economic status over different generations. According to the risk accumulation hypothesis, poor social and family background combined with social reproduction processes may increase the duration of exposure to disadvantaged conditions. This is associated with long-term health problems and poor social conditions as individuals age. Finally, there is evidence of an intergenerational transmission of health-related outcomes such as health disorders, general health and health-related behaviours.

### Methods

#### Data sources

We used data from the NCDS, which follows a cohort of 17,500 people born in the same week in March 1958 in Great Britain. We used two alternative samples of data in the empirical analysis: a balanced sample of living individuals, whose data were collected at birth and then collected again at ages 23, 33, 42, 46, 50 and 54 ($n=5472$), and a sample where individuals have died since 1958 ($n=6608$) (see Table 1).

#### Measures

We considered an ordered and qualitative measure of health status, referred to as self-assessed health, which corresponds in NCDS to individuals’ answers to the question ‘how would you describe your health generally?’ Self-assessed health (SAH) is widely used in the literature on health inequalities and data are available for ages 23, 33, 42, 46, 50 and 54 years. A drawback of NCDS is that while the question remained the same across survey waves, the suggested SAH response items changed in the last two waves of the survey. From age 23–46 years, the four health states were (i) poor, (ii) fair, (iii) good, and (iv) excellent, and from age 50 years, a ‘very good’ category was added between ‘good’ and ‘excellent’. Since it is valuable for us to consider individuals over the longest possible lifespan, we considered the SAH variable to have seven potential health states, where individuals reported their health over four

| National Child Development Study (NCDS) 1958 | Birth | Wave 4 | Wave 5 | Wave 6 | Wave 7 | Wave 8 | Wave 9 |
|---------------------------------------------|-------|--------|--------|--------|--------|--------|--------|
| Collection year                             | 1958  | 1991   | 2000   | 2004   | 2008   | 2013   |
| Age, years                                  | 23    | 33     | 42     | 46     | 50     | 55     |
| Collected sample                            | 17415 | 11899  | 10899  | 10830  | 9057   | 9279   | 8670   |
| Dead                                        | 883   | 953    | 1000   | 1045   | 1084   | 1136   |
| Balanced sample without mortality           |       |        |        |        | 5472   |        |
| Balanced sample with mortality              |       |        |        |        | 6608   |        |
Social background was measured by the father’s occupation at the time of birth. The choice of father’s occupation as a single circumstance was motivated by previous research using NCDS and showing that father’s occupation is a leading determinant of health.\cite{58,59} Similarly, a recent paper by Jivraj et al.\cite{60} using NCDS included father’s occupation as a single confounding variable to measure childhood social class in order to account for neighbourhood selection across the life course. Father’s occupation is available following the registrar general’s class scheme, which indicates employment in six possible fields: professional (I), managerial and technical (II), skilled non-manual (III n. m), skilled manual (III m), partly skilled (IV), and unskilled (V) professions. A seventh category was added if the mother reported no male figure in the household at the time of birth. The distribution of the sample according to social groups is available in Table 3.

### Assessing inequality

We tested the presence of inequality of opportunities in health between individuals using a non-parametric approach. The ordered discrete nature of the combined SAH and mortality indicator has the advantage of allowing simple comparisons of health status at each age. The use of a non-parametric approach, based on CDFs and dominance tools, permitted us to account for all the ordered health states and maximize the use of all health and mortality information that is available.

The use of non-parametric methods to assess inequality of opportunities originates from Lefranc et al.\cite{17} and was firstly applied in a health context in Trannoy et al.\cite{25} Evidence of inequality of opportunities relies on the comparison of cumulative distribution functions of the health outcome according to social background — here the father’s occupation, which represents ‘circumstances’, according to Roemer.\cite{21} It is assumed that being born in a particular family is equivalent to getting a lottery ticket whose winnings will only be known later on. The CDF of health status of individuals born to a specific social

### Table 2 Distribution of health status and mortality at each wave [source: National Child Development Study—NCDS (1958)]

| Self-assessed health | 23 years old % | 33 years old % | 42 years old % | 46 years old % | 50 years old % | 54 years old % |
|----------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Dead                 | 4.99           | 6.10           | 6.88           | 7.60           | 8.37           | 9.24           |
| Poor                 | 0.61           | 1.24           | 2.49           | 5.79           | 3.88           | 4.45           |
| Fair                 | 6.29           | 9.55           | 11.63          | 13.82          | 10.63          | 11.93          |
| New good             |                |                | 44.27          | 48.42          | 49.21          | 42.81          |
| Old good             |                |                |                |                | 31.88          | 32.69          |
| Very good            |                |                |                |                |                |                |
| Old excellent        |                |                | 43.84          | 34.68          | 29.79          | 29.99          |
| New excellent        |                |                |                |                |                | 18.74          |

### Table 3 Distribution of father’s professional status [source: National Child Development Study—NCDS (1958)]

| Father’s professional status | Freq. | All (%) |
|------------------------------|-------|---------|
| I—Professional               | 324   | 4.90    |
| II—Managerial/technical      | 932   | 14.10   |
| III n. m—Skilled non-manual  | 665   | 10.06   |
| III m—Skilled manual         | 3179  | 48.11   |
| IV—Partly skilled            | 721   | 10.91   |
| V—Unskilled                  | 487   | 7.37    |
| No father at birth           | 300   | 4.54    |
background (the conditional CDF) gives the probability of not reaching a given health status (for example, death or poor SAH, etc.). In this context, the CDF can be described as the ‘misfortune curve’; the lower, the better. Hence, the conditional CDFs for all backgrounds summarize all the information about the distribution of opportunities in health for people who grew up in different social backgrounds.

We say that there is inequality of opportunities if there are at least two backgrounds for which one CDF is statistically significantly higher than the other. It is much more demanding for a CDF to be higher than it is for the conditional expectation. The price to pay for a robust analysis based on the full probability distribution is that we may not be able to conclude in all cases. For example, if the CDFs cross or the gaps are tiny, it does not allow a judgment. We then need a statistical test to rank the conditional CDFs, a typical situation of first-order stochastic dominance.

Empirically, the inference procedure relies on pairwise tests of equality of distribution for stochastic dominance of CDF based on one-sided Kolmogorov–Smirnov (KS) tests, which are appropriate with discrete variables. The null hypothesis is that one distribution is always above or equal to the other distribution, and if the KS statistic is small or the P-value is high then we cannot reject the null hypothesis.

We present the CDFs of SAH with and without mortality according to fathers’ occupation at each age as a graphical demonstration of the dominance. We then complete this graphical intuition with the significance level of the KS tests of the pairwise differences between distributions.

**Results**

**Cumulative distribution functions**

Figures 1 and 2 graphically compare the CDFs of health status, respectively, when measured by SAH with and without mortality. Figure 1 shows inequality of opportunities in health according to the father’s occupation at each of the six ages. At age 23 years, the distributions are grouped, whereas they slowly separate over the lifetime, drawing a social gradient in health related to the father’s occupation. At all ages, we observe a gap between the health distribution of individuals who had no father at birth and the distributions of individuals born to a father in the top two occupations, and to a lesser extent, to those born to a non-manual skilled worker. The gap increases between ages 23 and 50 years. For example, the gap in the probability to be in good health between individuals born to a ‘professional’ and those whose father was absent at birth is 26 percentage points (hereafter p.p.) at age 54 years, whereas it was only 12 p.p. at age 23.

When we include death as the worst health state, the CDFs are flatter to the left until age 42 years (Figure 2). This comes from the inclusion of child and adolescence mortality rates and shows that premature mortality is more frequent than reporting a poor health status at younger ages, and this is true across social classes. The gap in reporting good health between individuals born to a ‘professional’ and those without a father at birth is 15 p.p. at age 23 years (12 p.p. when compared with individuals born to an ‘unskilled’ father), which increases to 25 p.p. at age 50 years and 28 p.p. at age 54 years (respectively 25 p.p. at age 50 years, and 26.5 p.p. at age 54 years when compared with individuals born to an ‘unskilled’ father). However, the health distribution of individuals born to a ‘skilled manual’ or ‘partly skilled’ father does not clearly separate from both groups and often crosses other distributions from one age to the other. There is an apparent social gradient in health according to the father’s occupation across all ages. The father’s occupation clearly divides the population into two groups, especially from age 33 to 50 years: individuals born to a father in the top three occupations, who are in better health, and individuals born to an ‘unskilled’ father or without a father, who are in poorer health; this is apparent at all ages.

**Inference tests**

The one-sided KS tests in Tables 4 and 5 confirm the existence of inequalities of opportunity in health according to the father’s occupation. The results show that the distributions of health in adulthood of people born to a ‘professional’ or ‘managerial/technical’ father dominates that of those born to a ‘partly skilled’ or ‘unskilled’ worker or who did not have a father at birth (KS tests: $P < 0.05$ at age 23 years and $P < 0.01$ at ages 33–54 years). When mortality is included as the worst possible health state, the KS tests level of significance increases to $P < 0.01$, regardless of age.

The results also show that the distributions of health of individuals born to a father in ‘skilled non-manual’ and ‘skilled manual’ work significantly dominate those of individuals born to a ‘partly skilled’ or ‘unskilled’ worker or those who did not have a father at birth only in older age (age 50 and 54 years). When mortality is included, the distributions of health of individuals born to a ‘skilled non-manual’ father are always in better health than individuals of ‘partly skilled’ or ‘unskilled’ worker or who did not have a father at birth (KS tests: $P < 0.05$). Furthermore, the number of dominance relationships between the
distributions, as well as the level of significance in the differences between those distributions, increase.

**Discussion**

This analysis provides evidence of inequality of opportunities in health at all ages, favouring individuals born to a father in ‘professional’, ‘managerial/technical’ and ‘skilled non-manual’ positions in Great Britain. There is a health disadvantage of having no father at birth or a father who is ‘unskilled’ or ‘partly skilled’ over the lifetime. Inequality of opportunities in health is found to increase with age and the diagnosis worsens when premature death is taken into account. This outcome prevails despite vigorous action taken in Britain to fight health inequalities.\(^{61-63}\)

Our study results align with the literature in life-course epidemiology, showing that individuals from a less well-off social background report poorer health at all ages and are more likely to die prematurely in Great Britain.\(^{5,6}\) The principal novelty of the paper is to provide a simple quantification of the increasing unfair health inequalities over a lifetime, combining self-

---

Figure 1 Cumulative distribution functions of self-assessed health according to fathers’ professional status (without mortality) at each age [source: National Child Development Study—NCDS (1958)]. The six graphs represent the cumulated distribution functions of the health status items of the seven possible father’s professional status at each age. At age 33 years, the proportion of individuals who report a ‘fair’ health is 14% among sons of ‘partly skilled’ (IV) or ‘unskilled’ (V) manual workers whereas it is only 5% among sons of ‘professionals’ (I). In other words, cumulative distribution functions represent the distribution of the misfortune of health according to father’s professional status.
assessed health and mortality consistently. This finding is consistent with the work of van Kippersluis et al.\textsuperscript{64} which suggests an increase in income-related health inequalities until retirement age in the UK, however it does not confirm the predictions of the theoretical modelling proposed by Galama and van Kippersluis.\textsuperscript{65} Another novelty is the use of a robust non-parametric method allowing us to mobilize all the response items of the SAH instead of summarising them in a binary indicator. We do not throw any piece of information away thanks to the chosen statistical methodology. In that sense, our statistical approach can be described as comprehensive. Additionally, we offer an original and simple way to combine an ordered discrete health indicator with mortality. The additional advantage of including mortality as a health indicator is that it allows us to work with...
a larger sample and accounts for the selection bias of premature mortality related to social status.

Our results are particularly striking since we identify substantial differences in health status until late in adulthood, using only one indicator of childhood circumstances. This is a minimalistic identification of inequalities of opportunities in health but it is robust. Although one might like to see further circumstances being considered, a difficulty of the dominance analysis is that it assumes the availability of large samples to perform inference tests. If we intersect several circumstances, then sample size substantially reduces, and the dominance statistical inference tests cannot be useful any longer. Since equality of conditional CDFs is a necessary condition for equality of opportunity, even if circumstances are not fully described we can say that equality of opportunity in health is violated when the KS test shows significant differences between CDFs.\(^{17}\) This will remain true if we had the possibility to measure circumstances perfectly.

Another limitation comes from the 1958 NCDS having a singular structure with the different waves not being

### Table 4

| Column dominates row\(^{b}\) | I   | II  | III n. m | III m | IV  | V   | No father |
|-----------------------------|-----|-----|-----------|-------|-----|-----|-----------|
|                             | 23, 33, 42, 46, 50, 54 years old |
| I                           |     |     |           |       |     |     |           |
| II                          |     |     |           |       |     |     |           |
| III n. m                    |     |     |           |       |     |     |           |
| III m                       |     |     |           |       |     |     |           |
| IV                          |     |     |           |       |     |     |           |
| V                           |     |     |           |       |     |     |           |
| No father                   |     |     |           |       |     |     |           |

\(^{a}\)F* represents first order stochastic dominance (FOSD) at 1% (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(<0.01\)); \(F\) represents FOSD at 5% (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(<0.05\)); ? indicates that we cannot conclude on dominance (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(>0.05\)).

\(^{b}\)The one-sided KS test is read horizontally, the distribution of self-reported health of people born to a father who was in professional work (I) dominates at first order the distribution of self-reported health of people born to a father who had skilled non-manual work (III n. m) at the level of significance \(P < 0.05\) at age 46 years at and at the level of significance \(P < 0.01\) at age 54 years, however we cannot conclude on dominance at ages 23, 33, 42 and 50 years.

Note: For the sake of clarity we only report the dominance relationships comparing column against row, however we also tested the dominance relationships comparing row against column to infer the direction of the dominance relationship.

### Table 5

| Column dominates row\(^{b}\) | I   | II  | III n. m | III m | IV  | V   | No father |
|-----------------------------|-----|-----|-----------|-------|-----|-----|-----------|
|                             | 23, 33, 42, 46, 50, 54 years old |
| I                           |     |     |           |       |     |     |           |
| II                          |     |     |           |       |     |     |           |
| III n. m                    |     |     |           |       |     |     |           |
| III m                       |     |     |           |       |     |     |           |
| IV                          |     |     |           |       |     |     |           |
| V                           |     |     |           |       |     |     |           |
| No father                   |     |     |           |       |     |     |           |

\(^{a}\)F* represents first order stochastic dominance (FOSD) at 1% (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(<0.01\)); \(F\) represents FOSD at 5% (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(<0.05\)); ? indicates that we cannot conclude on dominance (the \(P\)-value of the one-sided KS test of the difference between the two distributions is \(>0.05\)).

\(^{b}\)The one-sided KS test is read horizontally, the distribution of health (self-assessed health combined with mortality) of people born to a father who was in professional work (I) dominates at first order the distribution of health (self-assessed health combined with mortality) of people born to a father who had skilled non-manual work (III n. m) at the level of significance \(P < 0.01\) at age 33, 42, 46, 50 and 54 years, however we cannot conclude on dominance at age 23 years.

Note: For the sake of clarity we only report the dominance relationships comparing column against row, however we also tested the dominance relationships comparing row against column to infer the direction of the dominance relationship.
equidistant in time. While there is a 4-year interval between the two last sweeps, there were about 10 years between the previous waves. It was not possible in our non-parametric approach to account for this effect.

Inequality of opportunities in health and death deepens with age, at least up to mid-life. Our study does not provide new information about the mechanisms behind this phenomenon, but clearly it is an issue that should be further investigated to develop health policy recommendations for reducing health inequalities.

Funding

We gratefully acknowledge the financial support of the Health Chair, a joint initiative by PSL, Université Paris-Dauphine, ENSAE and MGEn under the aegis of the Fondation du Risque (FDR) to present the work in various conferences. This paper was presented and discussed in a number of workshops and seminars; we would like to thank Jérôme Wittwer, Brigitte Dormont, Erik Schokkaert, Aki Tsuchiya, Rhiannon Tudor-Edwards and John Mullahy for their comments and suggestions. We thank four anonymous reviewers for their valuable comments and suggestions.

Conflict of interest

None declared.

References

1. Mackenbach JP, Bos V, Andersen O et al. Widening socioeconomic inequalities in mortality in six western European countries. Int J Epidemiol 2003;32:830–37.
2. Mackenbach JP, Kulhánová I, Artnik B et al. Changes in mortality inequalities over two decades: register based study of European countries. BMJ 2016;353.
3. Mackenbach JP, Stirbu I, Roskam AJ et al. Socioeconomic inequalities in health in 22 European countries. N Engl J Med 2008;358:2468–491.
4. Masseria C, Mossialos E, Allin S. Measurement of socioeconomic inequality of health in 10 European countries: an exploratory analysis of SHARE using three approaches. LSE Research Note; 2006. https://ec.europa.eu/employment_social/social_situ ation/docs/tr_exploratory_analysis_%20of_share.pdf.
5. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. Int J Epidemiol 2002;31:285–93.
6. Ben-Shlomo Y, Cooper R, Kuh D. The last two decades of life course epidemiology, and its relevance for research on ageing. Int J Epidemiol 2016;45:973–88.
7. Kuh D. From paediatrics to geriatrics: a life course perspective on the MRC National Survey of Health and Development. Eur J Epidemiol 2016;31:1069–079.
8. Galama TJ, van Kippersluis H. Health inequalities through the lens of health capital theory: issues, solutions, and future directions. Res Econ Inequal 2013;21:263–84.
9. Grossman M. On the concept of health capital and the demand for health. J Polit Econ 1972;80:223–55.
10. van Kippersluis H, Van Oort T, O’Donnell O, van Doorslaer E. Health and income across the life cycle and generations in Europe. J Health Econ 2009;28:818–30.
11. van Kippersluis H, O’Donnell O, van Doorslaer E, Van Oort T. Socioeconomic differences in health over the life cycle in an Egalitarian country. Soc Sci Med (1982) 2010;70:428–38.
12. Deaton AS, Paxson CH. Aging and inequality in income and health. Am Econ Rev 1999;88:248–53.
13. Gerdfhalm UG, Johannesson M. Income-related inequality in life-years and quality-adjusted life years. J Health Econ 2000;19:1007–026.
14. Burstrom K, Johannesson M, Diderichsen F. Increasing socioeconomic inequalities in life expectancy and QALYs in Sweden 1980–1997. Health Econ 2005;14:831–50.
15. Petrie D, Allanson P, Gerdfhalm UG. Accounting for the dead in the longitudinal analysis of income-related health inequalities. J Health Econ 2011;30:1113–123.
16. Fleurbaey M, Schokkaert E, Equity in health and health care. In: Pauly M, McGuire T, Barros P (eds). Handbook of Health Economics. London: Elsevier, 2011, pp. 1003–092.
17. Lefranc A, Pistolesi N, Trannoy A. Equality of opportunity and luck: Definitions and testable conditions, with an application to income in France. J Public Econ 2009;93:1189–208.
18. Roemer J Trannoy A. Equality of opportunity. In: Atkinson A, Bourguignon F (eds). Handbook of Income Distribution. London: Elsevier, 2014, pp. 217–300.
19. Jusot F, Tubeuf S. Equality of opportunity in health and health-care. In: Jones AJ (ed). Oxford Encyclopedia of Health Economics. Oxford: Oxford University Press; 2019.
20. Arneson R. Equality and equal opportunity of welfare. Philos Stud 1989;56:77–93.
21. Roemer JE. Equal opportunity for health: paying the costs of smoking-induced lung cancer. In: Laslier J-F (ed). Freedom in Economics: New Perspectives in Normative Analysis: Studies in Social and Political Thought, vol. 6. London and New York: Routledge, 1998, pp. 241–51.
22. Dworkin R. What is equality? Part II: Equality of resources. Philos Public Aff 1981;10:283–345.
23. Fleurbaey M. Fairness, Responsibility, and Welfare. Oxford: Oxford University Press; 2008.
24. Fleurbaey M, Schokkaert E. Unfair inequalities in health and health care. J Health Econ 2003;22:73–90.
25. Trannoy A, Tubeuf S, Jusot F, Devaux M. Inequality of opportunities in health in France: a first pass. Health Econ 2009;19:921–38.
26. Bartley M. Health inequality: an introduction to concepts, 2nd edn. Theories and Methods. Cambridge: Polity Press, 2016, p. 264.
27. Li Donni P, Peragine V, Pignaataro G. Ex-ante and ex-post measurement of equality of opportunity in health: a normative decomposition. Health Econ 2014;23:182–98.
28. Alwin DF. Commentary: It takes more than one to tango: life course epidemiology and related approaches. Int J Epidemiol 2016;45:988–93.
29. Kjellson G, Gerdfhalm UG, Petrie D. Lies, damned lies, and health inequality measurements: understanding the value judgments. Epidemiology (Cambridge, Mass) 2015;26:673–80.
30. Agahi N, Shaw BA, Fors S. Social and economic conditions in childhood and the progression of functional health problems.
from midlife into old age. *J Epidemiol Community Health* 2014; 68:734–40.
31. Blane D, Netuveli G, Stone J. The development of life course epidemiology. *Rev Epidemiol Sante Publique* 2007;55:31–8.
32. Shippee TP, Rowan K, Sivagnanam K, Oakes JM. Examining the impact of maternal health, race, and socioeconomic status on daughter’s self-rated health over three decades. *Int J Aging Hum Dev* 2015;81:155–75.
33. Wadsworth M. Early life hypothesis. In: Marmot M, Wilkinson R (eds). *Social Determinants of Health*. Oxford: Oxford University Press, 1999.
34. Barker D. Fetal origins of coronary heart disease. *BMJ* 1989;295:115–18.
35. Lindeboom M, Llena-Nozal A, van der Klauw B. Parental education and child health: evidence from a schooling reform. *J Health Econ* 2009;28:109–31.
36. Bricard D, Justo F, Trannoy A, Tubeuf S. Inequality of opportunities in health and the principle of natural reward: evidence from European Countries. In: Rosa Dias P, O’Donnell O (eds). *Health and Inequality. Resource Economics Inequality Series*, 2013, vol. 21, pp. 335–70. Bingley: Emerald; distributed by Turpin Distribution, Biggleswade.
37. Burkhauser R, Hahn M, Lillard D, Wilkins R. Does Income Inequality in Early Childhood Predict Self-Reported Health in Adulthood? A Cross-National Comparison of the United States and Great Britain. *Inequality: Causes and Consequences. Research in Labor Economics*, 2016, vol. 43, pp. 407–76. Bingley: Emerald Group Publishing Limited.
38. Currie J, Hynson R. Is the impact of health shocks cushioned by socioeconomic status? The case of birth weight. *Am Econ Rev* 1999;89:243–500.
39. Elstad JI. Childhood adversities and health variations among middle-aged men: a retrospective lifecourse study. *Eur J. Public Health* 2003;15:51–8.
40. Hertzman C, Power C, Matthews S, Manor O. Using an interactive framework of society and lifecourse to explain self-rated health in early adulthood. *Soc Sci Med. (1982)* 2001;53:1575–585.
41. Hyde M, Jakub H, Melchior M, Van Oort F, Weyers S. Comparison of the effects of low childhood socioeconomic position and low adulthood socioeconomic position on self-rated health in four European studies. *J Epidemiol Community Health* 2006;60:882–86.
42. Melchior M, Berkman LF, Kawachi I et al. Lifelong socioeconomic trajectory and premature mortality (35–65 years) in France: findings from the GAZEL Cohort Study. *J Epidemiol Community Health* 2006;60:937–44.
43. Melchior M, Lert F, Martin M, Ville I. Socioeconomic position in childhood and in adulthood and functional limitations in mid-life: Data from a nationally representative survey of French men and women. *Soc Sci Med. (1982)* 2002;65:2813–824.
44. Power C, Hertzman C. Social and biological pathways linking early life and adult disease. *Br Med Bull* 1997;53:220–21.
45. Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. Life course epidemiology. *J Epidemiol Community Health* 2003;57:778–83.
46. Kuh D, the HALCyon teamA life course approach to physical capability: findings from the HALCyon research programme. *BMC Proc* 2013;7:54.
47. Kuh D. A life course perspective on telomere length and social inequalities in aging. *Aging Cell* 2006;5:579–80.
48. Thompson O. Genetic mechanisms in the intergenerational transmission of health. *J Health Econ* 2014;35:132–46.
49. Thompson O. Gene-environment interaction in the intergenerational transmission of asthma. *Health Econ* 2017;26:1337–352.
50. Laaksonen E, Martikainen P, Lahelma E et al. Socioeconomic circumstances and common mental disorders among Finnish and British public sector employees: evidence from the Helsinki Health Study and the Whitehall II Study. *Int J Epidemiol* 2007;36:776–86.
51. Ahlborg G. Intergenerational transmission of health. *Am Econ Rev* 1998;88:265–70.
52. Cournil A, Kirkwood TB. If you would live long, choose your parents well. *Trends Genet* 2001;17:233–35.
53. Ball K, Mishra GD. Whose socioeconomic status influences a woman’s obesity risk: her mother’s, her father’s, or her own? *Int J Epidemiol* 2006;35:131–38.
54. Classen TJ, Thompson O. Genes and the intergenerational transmission of BMI and obesity. *Econ Hum Biol* 2016;23:121–33.
55. Dolton P, Xiao M. The intergenerational transmission of body mass index across countries. *Econ Hum Biol* 2017;24:140–52.
56. Kantomaa MT, Tamme-Tamme LH, Nayha S, Taanila AM. Adolescents’ physical activity in relation to family income and parents’ education. *Prev Med* 2007;44:410–15.
57. van de Mheen H, Stronks K, Looman CW, Mackenbach JP. Does childhood socioeconomic status influence adult health through behavioural factors? *Int J Epidemiol* 1998;27:431–37.
58. Rosa Dias P. Inequality of opportunity in health: evidence from a UK cohort study. *Health Econ* 2009;18:1057–074.
59. Tubeuf S, Justo F, Bricard D. Mediating role of education and lifestyles in the relationship between early-life conditions and health: Evidence from the 1958 British cohort. *Health Econ* 2012;21:129–50.
60. Jivraj S, Norman P, Nicholas O, Murray ET. Are there sensitive neighbourhood effect periods during the life course on midlife health and wellbeing? *Health Place* 2019;57:147–56.
61. Bambra C, Smith KE, Garthwaite K, Joyce KE, Hunter DJ. A labour of Sisyphus? Public policy and health inequalities research from the Black and Acheson Reports to the Marmot Review. *J Epidemiol Community Health* 2011;65:399–406.
62. Marmot M. From Black to Acheson: two decades of concern with inequalities in health. A celebration of the 90th birthday of Professor Jerry Morris. *Int J Epidemiol* 2001;30:1165–171.
63. Marmot MG. Tackling health inequalities since the Acheson inquiry. *J Epidemiol Community Health* 2004;58:262–63.
64. van Kippersluis H, O’Donnell O, van Doorslaer E. Long run returns to education: does schooling lead to an extended old age? *J Hum Resour* 2009;4:1–33.
65. Galama TJ, van Kippersluis H. A theory of socio-economic disparities in health over the life cycle. *Econ J* 2019;129:338–74.