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Childhood Intelligence and Adult Mortality, and the Role of Socio-Economic Status

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Abstract

The initial purpose of this study was to establish the effect of childhood conditions on longevity from the Brabant data set. This data set combines information at ages 12, 43, 53 and mortality between 53 and 71 for a sample of some 3000 individuals born around 1940 in the Dutch province of North Brabant. Proportional hazard analysis confirms the known association of early intelligence or cognitive ability with longevity, with a standardized hazard ratio of .80; this is the only significant childhood influence. Among men, the effect of some elements of adult socio-economic status can also be ascertained: education, income and wealth are each found to contribute about as much to a longer life as intelligence. The joint effect of all four variables is dominated by childhood intelligence and adult wealth at the expense of education and income.

1 Introduction. The data set

My initial purpose was to identify childhood conditions that affect longevity. I soon found that intelligence or cognitive ability is the dominant factor, and somewhat later that it works only in part through elements of socio-economic status like education and income. There is a substantial epidemiological literature about both issues and my conclusions are largely in line with its findings, although I make use of a particular test of cognitive ability (Raven's *progressive matrices test*) that is rarely used by others and find a somewhat smaller effect of socio-economic status than most. But by and large I can only report that results already obtained for other countries also apply to the Dutch, and draw attention to a data set that will repay a repeat visit in five or ten years' time.

This Brabant data set originates from a survey of educational performance among 5800 schoolchildren in the sixth form of primary schools in the Dutch province of North Brabant in 1952. The records of this survey, including the identity of the participants, were preserved, and they were used in 1983 by Hartog as the basis of a postal survey of education and labour market careers (Hartog, Pfann and Ridder, 1989; Van Ophem, Hartog and Vijverberg, 1993). This exercise was repeated in 1993 by van Praag, with additional questions about entrepreneurship (Van Praag and Cramer, 2001). Since not all individuals could be traced in the later years, and only part of the traced individuals responded to the postal surveys, the final sample was reduced to 3000 individuals who had participated in the 1952 survey and in at least one of the two later surveys. For these individuals deaths between October 1994 and February 2009 (i.e. between 53 and 71 years of age) were retrieved from national archives. This permits an analysis of the effect of childhood conditions on adult mortality while taking into account certain aspects of adult life.

The data set has three weaknesses. First, the number of deaths is small - barely 14% among men and 8% among women. There remain large proportions of incomplete lives or censored observations that give little information about mortality, so that the estimation of hazards is tenuous: only strong effects will show up. The subsample of women is particularly vulnerable to further reductions of the effective sample size by nonresponse. The only remedy is to repeat the analysis five or ten years onwards, when more people will have died. Second, the sample mortality is about 20% below the level of a comparable nationwide cohort and I have no viable explanation for this discrepancy; the same misfortune befell Deary et al, 2008 (p.879). Since we find that intelligence reduces mortality, one might think of selective attrition in favour of the more intelligent in the remaining sample. But Table 1 shows that there is no systematic effect apart from a shift towards the lowest intelligence class, who resist attrition much better than the rest; overall, the 2010 selection is therefore slightly duller than the 1952 sample. - The third weakness of the data set is a substantial item nonresponse for income variables, particularly among women.

Table 1. Attrition from 1952 to 2010 by intelligence class (IQa)

IQa index	number 1952	number 2010	% ratio
72 – 81	284	208	73.2
82 – 91	857	396	46.2
92 – 101	1428	780	54.2
102 –111	1104	586	53.1
112 – 121	882	375	42.5
122 – 131	419	158	37.7
132 – 141	171	73	42.7
142 – 151	25	12	48.0
total	5160	2588	50.2

The data set with full documentation (partly in Dutch), is available on the website *DANS/KNAW.nl* - look for *Brabantse zesdeklassers 1952-2010*. It was derived from the combined data of 1993 by selection of variables, construction of new variables and addition of mortality data, and this forms part of the documentation. Technical details of the present analysis are found in Tinbergen Institute Discussion Paper 2011-097/4, available on www.Tinbergen.nl.

2 Method

The effect of various determinants on mortality is established by Maximum Likelihood estimation of the proportional hazard model

$$h(t,i)=h^*(t).exp(x_i'\beta) \quad (1)$$

with h the hazard or age-specific mortality rate, t age (in days), i the individual, and h* the time-dependent hazard; the second factor represents the effect of fixed individual characteristics x_i. In view of the weaknesses of the sample the specification of h* and its time gradient have been borrowed from aggregate statistics. In the age range under review the baseline hazard h*(t) has the same time gradient for men and women - both grow exponentially at a rate of 8% per annum, as in a local Gompertz distribution - but at different levels, with women's hazards only .57 of the men's. Hence

$$h^*(t)=exp(\alpha_0+\alpha_1 t),$$

with α_1 fixed at the equivalent of an increase by 8% per annum, and α_0 estimated separately for men and women. It follows that the intercept of ($x_i'\beta$) is not identified; it is therefore equated to zero, and the other x are taken in deviation from the sample mean. The Maximum Likelihood estimation was done by a scoring algorithm programmed in *Gauss.*

Men and women are treated separately in all analyses to allow for the different values of α_0 and any other differences between the sexes. Incomplete observations are omitted, so that the number of observations varies from case to case. The maximum is the sample size, 1790 for men and 1208 for women; this preponderance of males is due to special efforts in the 1983 survey to boost their response.

The object of the estimation is β of (1). At times x is a logarithm, and then β is the *elasticity* of the hazard with respect to the variable concerned. I gauge the significance of the β_j by their *t* value; significance is established if *t* exceeds 1.96, and values exceeding 1.5 are treated as worthy of note. In the tables, significant estimates are marked with an asterisk and noteworthy estimates with an exclamation mark. I report the standardized hazard ratio HRs, the effect on mortality of an increase in x_j by one standard deviation,

$$HRs_j = \exp(\beta_j \; sd(x_j)),$$

and its 95% confidence interval (c.i.). The precise definition of the determinants x_j is given in Appendix 1 and the Maximum Likelihood estimates of the β_j in Appendix 2.

3. Results for childhood variables

3.1 Family background

From the 1952 survey we know a great deal about the school results of the children and a little about their family background. The scene is set in a rural province with a predominantly Roman Catholic population, a long time ago; families with 10 or 12 children are no exception, and 95% of all children have the usual complement of two parents. The issue of parental divorce does not arise.

We have an indicator of the parental *social class*, initially a threefold classification by the father's occupation, here extended by adding a bottom class of *asocial* households - asocial, that is, by 1952 standards, and presumably by the judgment of the schoolmaster. The variable *working child* is a (0,1) dummy variable for children made to help in their parents' trade, often an indication of farmer families. *Education* of the parents is measured on a six (effectively five) point scale of the highest level attained.

Table 2 gives the hazard ratios for these variables. By the standards I have adopted none of the family background variables is significant. The one exception that deserves mention is a negative effect on mortality of the number of siblings among men. But with no effect of birth rank I do not know what to make of this.

Table 2. Effect of family background variables

variable	scale	n	HRs, c.i.	N	HRs, c.i.
			men		Women
social class	0, 1,3	1622	.93 (.81-1.05)	1095	1.09 (.87-1.32)
working child	0, 1	1575	.98 (.84-1.11)	1058	1.08 (.88-1.28)
# children	1, 2, …	1642	.88 (.76-1.00)!	1170	.99 (.79-1.18)
birthrank	1, 2, …	1635	.94 (.81-1.06)	1172	1.08 (.87-1.28)
edu father	2, 3, ..6	1268	1.07 (.92-1.21)	680	.78 (.50 -1.06)
edu mother	2, 3, ..6	1263	.96 (.80-1.11)	682	.93 (.65-1.22)

3. 2 School performance and intelligence tests

We have four general indicators of scholarly ability or performance, viz. test scores for three different intelligence tests and the teacher's assessment of the child's educational prospects. We also know whether the child has repeated one or more forms because of insufficient progress.

The three tests of intelligence deserve special consideration. Back in 1952 they were chosen in order to distinguish innate abilities from acquired knowledge (Provincial Council of North Brabant, 1957, p.35); unfortunately, the actual tests have not all been reported or preserved. The first or *standard IQ* (by its 1952 designation), is an adaptation of a common performance test for schoolchildren; about two thirds of the items deal with acquired knowledge or the fruits of schooling (grammar, spelling, arithmetic, geography, history), and one third with more sophisticated tests of cognitive ability. The second, presented in the 1952 report as a *test of abstract reasoning*, is the *Progressive Matrices Test* of Raven, 1941. This test is known to reflect fluid or analytic intelligence, the *ability to reason and solve problems involving new information, without relying extensively on ... schooling or previous experience, and demanding such skills as abstract reasoning, goal management in problem solving, and the ability to cope with novel challenges* (Carpenter, Just and Shell, 1990, p.428). We shall also refer to this type of intelligence as *cognitive ability*. The third is a test of *vocabulary*. In view of their skew distributions I take logarithms of the test scores, denoted as *IQs* (s for school), *IQa* (a for analytical) and *VOC* (for vocabulary). The teacher's assessment (*teacher)* is rated on a six-point scale of suitable further education immediately following the primary school, and then there is the number of *forms repeated* by pupils because of insufficient progress. Table 3 shows that all these indicators of ability and school performance are correlated, but not to such an extent that any single one can be regarded as redundant.

Table 3. Correlations of school performance and intelligence tests

variable	scale	*IQs*	*IQa*	*VOC*	*teacher*	*forms rep*
			1411 men			
IQs	logs	1				
IQa	logs	.59	1			
VOC	logs	.63	.38	1		
teacher	1,2, ..6	.50	.33	.48	1	
forms rep	0,1,2	-.21	-.10	-.15	-.36	1
			1055 women			
IQs	logs	1				
IQa	logs	.57	1			
VOC	logs	.65	.37	1		
teacher	1,2, ..6	.55	.35	.51	1	
forms rep	0,1,2	-.26	-.19	-.19	-.29	1

The result of entering each variable in turn, one by one, in the proportional hazards model is shown in Table 4.

Table 4. Effect of intelligence tests and school performance

variable	N	HRs, ci	n	HRs, ci
	Men		women	
ln IQs	1600	.83 (.72-.94)*	1132	.82 (.66-.99)!
ln IQa	1463	.82 (.70-.93)*	1125	.78 (.62-.93)*
ln VOC	1456	.96 (.83-1.09)	1121	.86 (.68-1.04)
teacher	1668	.94 (.81-1.06)	1161	.94 (.75-1.13)
forms rep	1690	1.00 (.88-1.13)	1178	1.07 (.88-1.27)

The two direct indicators of school performance, *teacher* and *forms repeated,* have no significant effect, nor has *VOC*. High scores for the two intelligence tests reduce mortality, but in different degree: analytical *IQa* is significant for both sexes, school *IQs* is significant for men and nearly significant for women. By their correlation, *IQs* is the closest associate of *IQa*; Table 5 shows that if we enter both at the same time *IQa* holds its own but the effect of *IQs* is substantially reduced. If we introduce each of the family background variables of Table 2 in turn along with *IQa,* again none obtains a significant coefficient (with the exception of the number of children among men). Among men, the effect of *IQa* is somewhat strengthened; but among women, controlling for parental social class raises the intelligence coefficient, and education of father and mother substantially reduce it. These estimates are given in Appendix 2.

Table 5. Effect of two intelligence tests

N	ln*IQa*	ln*IQs*
	men	
1463	.82 (.70-.93)*	
1600		.83 (.72-.94)*
1430	.86 (.70-1.01)!	.91 (.75-1.06)
	women	
1125	.78 (.62-.94)*	
1132		.82 (.66-.99)!
1101	.81 (.61-1.00)!	.93 (.71-1.19)

The main conclusion is that in reducing mortality IQa is dominant. Its effect is a little stronger for women than for men, but a single coefficient may be imposed with impunity (Likelihood Ratio with 1 d.f. .19): the common HRs is .80 (ci .71-.90). Since we have taken logarithms, the common β_1 is an elasticity, the elasticity of mortality with respect to intelligence . Its estimate of -1.55 (sd .42) indicates that a 10% higher IQa score reduces mortality hazards by (almost) 16%. In the age range under review hazards increase by 8% per year; their reduction by a 10% higher intelligence score is therefore equivalent to rejuvenation (in this respect) by almost two years. Of course this need not mean a gain of two years lifetime, for there may well be compensating changes in mortality at older ages.

3.3 Comparison with other studies

The present result confirms the association of higher intelligence in childhood with reduced mortality in later life that has been firmly established over the last decade by many independent studies. In the first systematic review of this field Batty, Deary and Gottfredson, 2009 list nine independent studies that arrive at the same conclusion; a more recent review by Calvin et al., 2010 identifies 27 such studies, and provides a meta-analysis of 16 analyses that are based on independent data sets and meet certain technical conditions. This yields an overall HRs of .76. The authors note a small attenuation if intelligence is measured at earlier ages. In Table 6 we therefore list eight studies from this meta-analysis with IQ recorded at ages 10 to 12. Six out of eight report hazard ratios for men between .76 and .83; the present estimate of .80 is well in line with these results. Differences in the intelligence tests employed (no other study makes use of Raven's PMT) and in the age span of recorded deaths apparently do not affect the outcome. But the effect of gender varies. Setting aside the Copenhagen all-male sample and the Aberdeen study, where male mortality is possibly affected by casualties on active service during World War II, there remain six studies with both sexes present. Four report the same hazard ratio for men and women, as here (in some cases equality may have been imposed without testing), but in the Newcastle and the Malmö study the effect among women is weak and not significant. The latter study even reports an association of higher IQ with *increase*d mortality among older women (over 60). Clearly gender can make a difference and the distinction should be respected.

Table 6. Hazard ratios from comparable studies

Reference	sample	IQ recorded in year	IQ recorded at age	age span of recording deaths	HRs	
Whalley and Deary, 2001	2230 children Aberdeen	1932	11	11 to 76	M .83, F .71	1)
Hart et al 2003	831 Midspan participants	1932	11	51 to 75	M + F .85	
Osler et al 2003	7800 boys Copenhagen	1965	12	15 to 49	M .85	2)
Pearce et al 2006	717 children Newcastle	1947	11	11 to 56	M .57, F .79 n.s	3)
Deary et al 2008	1208 children Scotland	1947	11	32 to 67	M + F .70	
Jokela et al 2009	10600 children Britain	1969	11	11 to 46	M + F .76	4)
Kuh et al 2009	4461 children Britain	1957	11	25 to 60	M + F .80	2)
Lager et al 2009	1530 children Malmö	1938	10	10 to 75	M .80, F no effect	
present study	*2898 children Brabant*	*1952*	*12*	*53 to 71*	*M + F .80*	

1) Total mortality over age interval; male HRs possibly affected by WW 2 deaths of intelligent men on active service.
2) Interquartile hazard ratios converted to HRs.
3) Total mortality over age interval.

4 The effect of adult socio-economic status

4.1 Adding adult SES to intelligence

In addition to intelligence, Socio-Economic Status (SES) or its constituent elements - occupation, education and income – are widely known to contribute substantially to health and longevity. For an early survey of SES see Adler et al, 1994, for education Cutler and Lleras-Muney, 2010 and for income Dowd et al, 2011, to name but a few. All three elements of SES are correlated with intelligence: in an exhaustive review, Strenze, 2007 finds correlations of about .56 for education, .43 for occupation and .20 for income (earnings). No doubt these three elements are also correlated among themselves: education brings rewards, and rankings of occupation by social class often reflect levels of remuneration and of education. I shall not try to disentangle these various strands: the question is here whether cognitive ability affects mortality through one or more of these other variables, or directly by a separate effect of its own.

When we add a variable like education to intelligence as a determinant of mortality, the latter's effect will be reduced because of the overlap of the two variables, and its hazard ratio will move towards 1. If HRs is the original hazard ratio for IQ, and HRs* is the ratio after controlling for education, the *effect* of IQ is reduced from (1-HRs) to (1-HRs*), and the percentage reduction or *attenuation* of the effect of IQ is

attenuation = {((1-HRs)-(1-HR*s))/(1-HRs)}*100

(Bosma, Schrijvers & Mackenbach 1999; Batty et al, 2006). The stronger the correlation of the additional variable with IQ, the greater is its attenuating effect for IQ. There is of course symmetry in the sense that if education attenuates the effect of IQ, IQ attenuates the effect of education – but not necessarily to the same extent.

We here add three elements of adult SES to IQa as a determinant of mortality – e*ducation, income* and *wealth.* All are from the 1993 survey, when respondents were about 53 years old; *education* is the highest level attained, *income* is net household income (and we take its logarithm), and *wealth* is the self-reported net wealth position of the household on a scale from 1 to 10 that ranges from heavy debt to a large fortune. All variables are subject to substantial nonresponse, net household income in particular, and this leads to a severe reduction of the sample size. Because of this the analysis is restricted to men, and to only 760 individuals for whom all variables are available. For women the nonresponse is even worse and no viable sample ensues, as the number of observations is reduced to 479 with only 34 deaths (estimates are reported in Appendix 2).

Table 7 shows the correlations among these variables, which are somewhat lower than one would expect, and Table 8 reports their separate and joint effects on mortality hazards.

Table 7. Correlation of IQ, education, income and wealth among 760 men

	ln*IQa*	*education*	ln*income*	*wealth*
ln*IQa*	1			
education	.32	1		
ln*income*	.20	.38	1	
wealth	.13	.19	.27	1

Table 8. Hazard ratios for IQa, education, income and wealth among 760 men

	ln*IQa*	*education*	ln*income*	*wealth*
single variables	.82! (.65-.98)			
		,81! (.63 -.99)		
			.84! (.69-.99)	
				.80* (.66-.95)
paired with	.86 (.68-1.04)	.85 (.65-1.05)		
ln*IQa*	.84! (.67-1.01)		.86! (.70-1.02)	
	.84! (.68-1.01)			.82* (.67-.97)
all four together	.88 (.69-1.06)	.90 (.68-1.12)	.92 (.73-1.11)	.84! (.69-1.00)

In view of the severe reduction in sample size, which is almost halved, we must accept a loss of significance; these estimates are indicative at best. But with these reservations a pattern emerges. One by one, cognitive ability, education, income and wealth each reduce mortality in much the same degree, by 16 to 20%. In pairwise analyses, the effect of intelligence is attenuated by 22% by education, by 13% by income and by wealth, and by 33% by all three variables combined. The sample is small, the evidence is weak, but with these reservations the conclusion is that cognitive ability has a substantial separate effect on mortality of its own and does not operate entirely through the intermediary of socio-economic status.

4.2 Comparison with other studies

Again we may compare this result with other studies. Table 10 lists the attenuation of intelligence by elements of socio-economic status in seven studies, once more taken from the survey by Calvin et al, 2011, this time without regard to the age of recording intelligence. These studies are a mixed bag, with considerable differences in method and in the definition of the variables: in one case education is measured on a scale with twenty levels, in another with four; the classification of occupations that defines social class has six classes in one study and only two - manual and nonmanual labour - in another. On the whole the attenuation of intelligence by SES is greater than in the present study; in one case (Jokela et al 2009) the effect of intelligence is entirely accounted for by SES, here this holds only for a third. This strength of the intelligence effect is possibly due to the use of Raven's Progressive Matrices Test, which provides a better measure of pure cognitive ability than many other tests. But the present evidence is fragile and this is a conjecture rather than a conclusion.

Table 9. Attenuation of IQ in other studies.

reference	sample	attenuation of IQ
Hart et al 2003	831 participants Midspan study	occupation - 24% occupation + deprivation - 29%
Hemmingson et al 2008	549 323 Swedish recruits	occupation+ education -25%
Batty et al 2008	15 288 Vietnam veterans NCO and other ranks	occupation -21% education -28% income -52% all three -72%
Deary et al 2008	1208 Scottish children	occupation -30% education -30%
Batty et al 2009	294 262 Swedish recruits	occupation -25% education -50%
Jokela et al 2009a	10 600 British children	occupation -5% education -25%
Jokela et al 2009b	11 321 US youth	marriage, education, and Income together -100%
Kuh et al 2009	5 372 British children	social class + housing tenure -65%
Lager et al 2009	834 Malmo boys	education -50%
present study	*760 Brabant children*	*education -27%* *income -13%* *wealth -13%* *all three -33%*

5 Discussion

The principal conclusion of the present study is that Dutch data confirm the well-established effect of childhood intelligence on mortality. One standard deviation increase in IQ reduces hazards or age-specific mortality rates by 20%; with IQ calibrated at mean 100 and standard deviation 15, a difference of one standard deviation at the mean equals 15%, and the elasticity of mortality in respect of intelligence is about -1.33. It appears from a substantial literature that this holds quite generally, regardless of the age at which intelligence is recorded or mortality observed.

This raises a number of questions about the nature of intelligence and its effects. If intelligence in childhood predicts mortality until old age, this suggests that it is a permanent characteristic of the individual, or at least that individual *differences* in intelligence persist over the entire lifespan. Deary et al, 2000 found a correlation of .73 for individual scores for identical tests at the ages 11 and 77, after correcting for the restricted range in the re-test; Gow et al, 2011 report a comparable correlation of .61 for ages 11 and 87. This permanence of intelligence has been challenged by Ramsden et al, 2011, who report substantial changes and find a correlation of only .59 for performance tests of teenagers three years apart. Still it would seem that the association of childhood intelligence with mortality up to old age implies that cognitive ability continues to affect the course of adult life.

There is a good deal of speculation how this comes about. Deary, 2008 forcefully argues that this is an unsolved problem that cries out for a solution. While a considerable part of intelligence's effect can be attributed to its relation with elements of Socio-Economic Status like education, status and affluence, there remains a residual direct effect that must still be explained. Broadly, there are three answers. First, intelligence may directly induce safe and healthy behaviour. Batty et al, 2010 show that intelligence reduces unhealthy behaviour like smoking, drinking and eating too much, and they quote an impressive number of related studies to the same effect; yet these relations may of course in turn be attenuated by the effects of education and income or wealth. The second explanation is grander: as a species, man has achieved supremacy by superior cognitive powers, and this may well hold equally for the individual struggling with the misfortunes of life and the hazards of societal strife. There is a school of thought that intelligence pervades all - that it is the root cause of individual success in education, careers, and other pursuits, as well as of the differences between broad social groups - see Jensen, 1998, and Herrnstein and Murray, 1994, or, more recently, Gottfredson, 2004 and Gottfredson and Deary, 2004. The latter write (p.25) *high intelligence is a useful tool in any life domain, but especially when tasks are novel, untutored, or complex, and situations are ambitious, changing, or unpredictable*, thus echoing Carpenter's description (quoted above) of the talents required by the Progressive Matrices Test. They then list situations where this applies with respect to health, but provide no empirical evidence. - Finally, there is a third view to the effect that intelligence is a symptom of an individual's vitality, that it is *an indicator of a well-put-together system* (Deary, 2008, p.175). Offhand I can think of no empirical test of this attractive idea. The issue is unresolved.

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Appendix 1. Definition of variables

Variables from the 1952 school survey

The data from the 1952 school survey were collected in the schools by interrogation of schoolmasters and children.

social class

Initially a classification in three classes 1,2,3, according to the occupation of the father. A fourth class 0 has been added for households that were considered *asocial*, presumably by the schoolmaster's opinion in 1952.

education of parents

The highest level of education attained on a six point scale, ranging from primary school to a university degree. For fathers it ranges from 1 to 6, for mothers from 2 to 6.

working child

A (0,1) dummy variable indicating whether the child is participating in the parents' trade. It is an indication of a parental occupation in agriculture.

 # children, birth rank

Among the predominantly rural and Roman Catholic population of North Brabant in 1952 families with 12 children or more are no exception. The range of the number of children is form 1 to 19, of birth rank from1 to 21; among 2797 observations there are six inconsistent records, with birth rank exceeding the number of children.

teacher's assessment

This is the teacher's assessment of a suitable further education of the child after primary school, rated on a scale from 1 to 6.

forms repeated

In Dutch schools pupils who make insufficient progress are made to repeat a form. This is the number of forms the pupil has repeated by the time he or she is in the sixth form. Its range is 0,1,2.

standard intelligence IQs

The pupils' score in a test of school knowledge and aptitude: grammar, spelling, arithmetic, geography, history, probably with a few tests of interpretation and association added.

abstract intelligence IQa

The pupils' score on Raven's Progressive Matrices Test.

vocabulary

The pupils' score in a vocabulary test.

All three test scores were calibrated at mean 100 and standard deviation 15.

Variables from the 1983 and 1993 surveys

education

This is the highest level of education attained, as reported in either the 1983 or the 1993 survey; combining records from the two surveys reduces nonresponse. Education is rated on the same six point scale as the education of parents, but values 1 and 2 do not occur: the range is 3, 4, 5, 6.

income

This is net family income in Dutch guilders per annum from the 1993 survey. It is a composite constructed from separately reported values of net wages, net profits, assistance payments, and the partner's contribution. For the estimates I use the logarithm.

wealth

This is net family wealth in Dutch guilders as reported in the 1993 survey on a 10-point scale, as follows

1	more than 50 000 negative
2	from 50 000 to 10 000 negative
3	from 10 000 negative to zero
4	zero
5	from zero to 10 000 positive
6	from 10 000 to 50 000 positive
7	from 50 000 to 100 000 positive
8	from 100 000 to 250 000 positive
9	from 250 000 to 500 000 positive
10	over 500 000 positive

Appendix 2. Maximum Likelihood Estimates

This appendix gives the Maximum Likelihood estimates of β_1 of equation (1), with the effective sample size n and the number of dead m. It also records the standard deviation of the explanatory variable X since it enters into the calculation of HRs. The estimates of the intercept α_0 are not shown.

The value of the mean sample loglikelihood logL/n varies with the extent of the right-hand censoring of the observed sample, and this explains why it is so much higher for women than for men.

Table A1. Estimates for Tables 2 and 4

variable	N	m	β_1	s.d. β_1	s.d. X	logL/n
			men			
social class	1622	225	-.1073	.0947	.6807	-1.5850
working child	1575	221	-.0814	.2345	.2936	-1.6023
# children	1642	230	-.0467	.0246	2.7653	-1.6000
birthrank	1635	228	-.0252	.0268	2.5733	-1.5937
edu father	1268	176	.0762	.0858	.8275	-1.5876
edu mother	1253	177	-.0717	.1294	.6288	-1.6022
ln*IQs*	1600	222	-1.3155	.4795	.1400	-1.5843
ln*IQa*	1463	202	-1.4320	.5074	.1408	-1.5770
ln*VOC*	1456	200	-.3078	.5130	.1376	-1.5721
teacher	1668	232	-.0499	.0512	1.3433	-1.5904
forms rep	1690	235	.0009	.0953	.6822	-1.5899
			Women			
social class	1095	93	.1345	.1591	.6622	-1.0157
working child	1058	93	.2183	.2747	.3490	-1.0456
# children	1179	100	-.0046	.0360	2.7782	-1.0203
birthrank	1172	100	.0292	.0383	2.5237	-1.0185
edu father	680	50	-.2831	.2067	.8734	-.8913
edu mother	682	50	-.1100	.2540	.6144	-.8904
ln*IQs*	1132	95	-1.4013	.7364	.1403	-1.0003
ln*IQa*	1125	91	-1.8276	.7553	.1392	-.9658
ln*VOC*	1121	91	-1.0840	.7551	.1389	-.9707
teacher	1161	100	-.0503	.0870	1.1717	-1.0268
forms rep	1178	101	.1165	.1544	.6021	-1.0229
			men and women			
ln*IQa*	2588	293	-1.5549	.4213	.1401	-1.3114

The common estimate of β_1 reported in the text is shown in the last line of Table A1. It was accompanied by separate estimates of the intercept α_0 for men and women.

Table A2 records the estimates for two independent variables, viz. ln*IQa* and one other variable *X*. The lines labelled *IQs* refer to Table 5, the other analyses have only been summarily reported in the text.

Table A2. Estimates for two variables, ln*IQa* and *X*

X	n	m	β_1	s.d. β_1	β_2	s.d β_2	logL/n
				Men			
ln *IQs*	1430	197	-1.1115	0.6386	-0.6997	0.6321	-1.5729
social class	1351	189	-1.4708	0.5301	-0.0210	0.1068	-1.5950
working child	1290	180	-1.6429	0.5371	-0.1656	0.2480	-1.5901
# children	1369	191	-1.6599	0.5299	-0.0678	0.0273	-1.5899
birthrank	1360	189	-1.6387	0.5322	-0.0425	0.0300	-1.5849
edu father	1058	143	-1.4591	0.6238	0.0856	0.1066	-1.5483
edu mother	1054	144	-1.3890	0.6145	-0.0128	0.1456	-1.5641
				Women			
ln *IQs*	1101	91	-1.5259	0.9181	-0.3599	0.9029	-0.9853
social class	1018	83	-2.5746	0.8042	0.0955	0.1703	-0.9717
working child	979	83	-1.8002	0.8028	0.2924	0.2791	-0.9954
# children	1090	89	-1.7170	0.7743	0.0057	0.0382	-0.9745
birthrank	1092	89	-1.6882	0.7743	0.0377	0,0400	-0.9724
edu father	636	41	-1.2266	1.2356	-0.3190	0.2545	-0.7979
edu mother	628	41	-1.5151	1.1916	-0.1184	0.2916	-0.7970

Table A3 records the estimates for Table 8, in the same format as in that Table; standard errors of estimates are given in brackets. The sample standard errors of the four X variables are as follows: ln*IQa* 0.1413, *education* 1.0050*,* ln*income* 0.5891, *wealth* 2.4141. Table 4 gives the same estimates for women, not reported in the text.

Table A3. Estimates for Table 8 (men; n=760, m=98).

	Ln*IQa*	*education*	ln*income*	*wealth*	logL/n
single variables	-1.4157 (0.7231)				-1.4815
		-0.2125 (0.1140)			-1.4915
			-0.2930 (0.1539)		-1.4819
				-0.0909 (0.0378)	-1.4805
paired with ln*IQa*	-1.0821 (0.7579)	-0.1633 (0.1193)			-1.4801
	-1.2175 (0.7328)		-0.2510 (0.1610)		-1.4800
	-1.2080 (0.7287)			-0.0819 (0.0383)	-1.4782
all four	-0.9196 (0.7611)	-0.1070 (0.1242)	-0.1444 (0.1770)	-0.0700 (0.0398)	-1.4774

Table A4. Estimates for 479 women, 34 dead.

	ln*IQa*	*education*	ln*income*	*wealth*	logL/n
single variables	-2.5944 (1.2041)				-0.8540
		-0.3222 (0.2430)			-0.8567
			-0.3430 (0.2613)		-0.8569
				-0.0244 (0.0729)	-0.8587
paired with ln*IQa*	-2.3285 (1.2481)	-0.2177 (0.2477)			-0.8531
	-3.0422 (1.2250)		0.4760 (0.2726)		-0.8505
	-2.5934 (1.2032)			0.0246 (0.0732)	-0.8539
all four	-2.6947 (1.2631)	-0.3214 (0.2574)	-0.5589 (0.2929)	0.0006 (0.0732)	-0.8482