

CHRISTMAS 2009: YOUNG AND OLD

The association of early IQ and education with mortality: 65 year longitudinal study in Malmö, Sweden

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Cite this as: *BMJ* 2009;339:b5282
doi:10.1136/bmj.b5282

ABSTRACT

Objectives To establish whether differences in early IQ explain why people with longer education live longer, or whether differences in father's or own educational attainment explain why people with higher early IQ live longer.

Design Population based longitudinal study. Mortality risks were estimated with Cox proportional hazards regressions.

Setting Malmö, Sweden.

Participants 1530 children who took IQ tests at age 10 and were followed up until age 75.

Results Own educational attainment was negatively associated with all cause mortality in both sexes, even when early IQ and father's education were adjusted for (hazard ratio (HR) for each additional year in school 0.91 (95% CI 0.85 to 0.97) for men and HR 0.88 (95% CI 0.78 to 0.98) for women). Higher early IQ was linked with a reduced mortality risk in men, even when own educational attainment and father's education were adjusted for (HR for one standard deviation increase in IQ 0.85 (95% CI 0.75 to 0.96)). In contrast, there was no crude effect of early IQ for women, and women with above average IQ had an increased mortality risk when own educational attainment was adjusted for, but only after the age of 60 (HR 1.60 (95% CI 1.06 to 2.42)). Adding measures of social career over and above educational attainment to the model (for example, occupational status at age 36 and number of children) only marginally affected the hazard ratio for women with above average IQ (<5%).

Conclusions Mortality differences by own educational attainment were not explained by early IQ. Childhood IQ was independently linked, albeit differently, to male adult mortality and to female adult mortality even when father's education and own educational attainment was adjusted for, thus social background and own social career seem unlikely to be responsible for mortality differences by childhood IQ. The clear difference in the effect of IQ between men and women suggests that the link between IQ and mortality involves the social and physical environment rather than simply being a marker of a healthy body to begin with. Cognitive skills should, therefore, be addressed in our efforts to create childhood environments that promote health.

INTRODUCTION

Previous research suggests that intelligence in childhood and early adulthood is linked to morbidity and mortality.¹⁻⁷ This association exists for a number of diseases and causes of death. Furthermore, a relationship between intelligence and health can be seen across the complete distribution of IQ, including in the especially gifted.⁸

The link between IQ and health seems important for at least two reasons. Firstly, the association may challenge our understanding of socioeconomic differences in health. Linda Gottfredson, for example, suggested in a paper that has attracted much attention that variation in intelligence might be the “fundamental cause of social class inequalities in health.”⁹ Secondly, and perhaps more intriguingly, the findings about early intelligence and health could imply that cognitive skills should be addressed in efforts to promote health. However, the details of the relation between early IQ, socioeconomic circumstances, and health are far from clear.

Early IQ has long been known to correlate with both childhood and adult socioeconomic conditions.¹⁰ Given that IQ is also related to health, differences in IQ could thus offer a way of looking at health inequalities that differs from the “general susceptibility” theory suggested by Cassel—that is, a weakened resistance to diseases in general, stemming from being in a position where you are exposed to negative psychosocial factors¹¹—or the “status syndrome” suggested by Marmot—that is, that health is related to social circumstances in a graded way across the whole social spectrum.¹²

The idea of IQ as the “fundamental cause” of health inequalities is tempting because it has so far been difficult to explain why adult morbidity and mortality from a large number of unrelated diseases are similarly distributed over social groups regardless of whether groups are stratified by education, income, or occupational class.¹³⁻¹⁷ Known risk factors can explain some, but not all, of this pattern.¹⁸ In addition, a more fundamental question remains unanswered, namely why seemingly unrelated risk factors are almost always more common among the socially disadvantaged. The IQ hypothesis suggests that higher intelligence

leads to more healthy behaviour and successful avoidance of risks in all areas of life.

According to another strand of research, it may be that socioeconomic conditions explain the association between early IQ and later health—IQ in itself does not contribute to health but rather varies with those socioeconomic conditions in childhood and adulthood that affect health. Most research into IQ and health has focused on exactly this issue: researchers have tried to isolate the effects of early intelligence on health by controlling for childhood and adult socioeconomic conditions.^{3,4}

There is a need for analyses that simultaneously test the two competing hypotheses: firstly, that early IQ is the fundamental explanation for socioeconomic differences in mortality; and secondly, that socioeconomic conditions in childhood and adulthood are responsible for mortality differences linked to early IQ. Of the three most common measures of socioeconomic status—education, occupational class, and income—education has the advantages of being relatively stable and having a strong relationship with both IQ and health.

This research aimed to answer two questions: whether differences in early IQ can explain why people with longer education live longer; or whether differences in father's or own educational attainment explain why people with higher early IQ live longer. We tracked all cause mortality from the age of 10 years old up to the age of 75 years in individuals enrolled in the Malmö Longitudinal Study, a Swedish cohort study of 1530 unselected boys and girls who took cognitive tests in their third grade.

METHODS

The Malmö longitudinal study

The Malmö Longitudinal Study was started in the middle of the 1930s by the teacher Siver Hallgren. Hallgren had noted that the early selection of Swedish schoolchildren into special or normal classes—and later into the more academic “realskola”—was often on the basis of judgments made by a single schoolteacher and thus was prone to bias; for example, by social class and gender. In February 1938, Hallgren collected data on socioeconomic conditions and IQ tested children in the third grade of school (around 10 years old) in all schools and all classes in the Swedish city of Malmö. This cohort was then followed over many decades by Torsten Husén.¹⁹

Sweden's economic conditions at the time were comparable to those in middle income countries today, and Sweden was shifting from an agrarian society to an industrial society. Malmö had around 150 000 inhabitants in 1938 and was rapidly becoming industrialised, employing workers in such places as shipyards and textile factories. Most of the women in the children's mothers' generation did not have work outside the home, whereas, in contrast, most of the girls in the Malmö Study subsequently did. The city was hit relatively hard by the depression during the 1930s and had high levels of unemployment.²⁰

We linked the data from the Malmö Longitudinal Study through personal identity numbers to the Swedish causes of death register. Our follow-up covers deaths until 31 December 2003 and has a very low dropout: only 12 individuals were excluded owing to missing IQ data or because they were lost to follow-up.

Child's intelligence

The intelligence test used by Hallgren comprised several subtests that had previously been shown to correlate with more extensive one to one testing by psychiatrists and that were not heavily influenced by learnt or memorised material.^{21,22} The test was tried out and successively modified during pilot testing of 860 children in the Malmö region over the course of one year to guarantee that the questions were understandable and had a suitable degree of difficulty, and that the testing time was suitable.

The final version of the intelligence test, which was first piloted among 300 children, consisted of four subtests:

- Antonyms to sixteen words in the vocabulary of a third grade child; for example, “hard,” “sell,” “brave,” “low,” and “increase.”
- Sixteen missing words in a story; for example, “We went on an excursion to the forest. There we *xxxx* flowers. We played, and when we got *xxxx*, we went home.”
- A test of perception with sixteen lines, each with eight simple pictures of which only two were exactly identical.
- Eight sentences with words in the wrong order, each sentence written on two lines to increase complexity; for example, “Swum friend river [new line] my over wide the has.”

Two different versions of the test were administered to reduce the risk of cheating. The test was either administered by Hallgren himself or a graduate student trained by Hallgren. The test was given in the morning because afternoon tests were associated with lower scores in the pilots. Scores were standardised to generate a mean of 100 and a standard deviation of 15 for those of the normal age for that class; that is, those born in 1928. For validation, a sample of children underwent a more extensive and individualised IQ test used in certain schools at the time.²³

In addition, a male sub-sample (n=613) was followed up in 1948 by Torsten Husén, who constructed the intelligence test used in Swedish conscript testing. The correlation between IQ in 1938 and IQ in 1948 was $r=0.72$.²⁴

Socioeconomic conditions

Data on father's education, father's occupation, and parental income were collected from population, tax, and school registers in 1937, before the IQ testing began. Father's education was grouped into four categories: basic (elementary school for six or seven years); short vocational (short on the job training or equivalent); long vocational (longer period of apprenticeship or the equivalent); and theoretical (junior secondary

school or higher). Father's occupation was grouped into four categories: unskilled manual (for example, factory and construction workers); skilled manual (for example, carpenters and house painters); lower non-manual (for example, foremen and policemen); and higher non-manual (for example, managers and engineers). Parental annual income in Swedish crowns was grouped into five categories: 0-1499; 1500-2499; 2500-3499; 3500-4499; and 4500 or more.

Four major sources were used to explore the participants' own educational attainment: school registers with information about elementary school and transfers to secondary school covering the spring term of 1938 and onwards; a questionnaire mailed to the principals of junior and senior secondary schools; the national register of students at universities and equivalent institutions around 1960; and, finally, a questionnaire mailed in 1964.¹⁹ When used as a categorical variable, own educational attainment was grouped into five categories: school dropouts (left elementary school before passing the seventh grade but in most cases after passing the sixth (six years of schooling)); basic (elementary school for seven years); vocational (also includes dropouts from junior secondary school (average eight and a half years of schooling in total)); short theoretical (completed junior secondary school (average 10.5 years of schooling)); and long theoretical (completed senior secondary school (average 14 years of schooling)).

Statistical methods

Mortality risks were estimated by Cox proportional hazards regressions. Survival time was measured as age in days, with day of birth set to the 16th day in the month of birth, or the 15th for participants born in February, and day of death obtained from the Swedish causes of death register. Father's education and

occupation, and family income, were used as categorical variables. IQ and own educational attainment were primarily used as metric variables, with educational attainment measured as number of years of schooling. Results are also given for models where IQ quartiles and educational attainment were modelled categorically. All three models of educational attainment and mortality, as well as those with IQ and mortality, were fitted for the individuals with complete data for all covariates.

RESULTS

A total of 1542 children in the third grade of school in Malmö took an IQ test in 1938 and were included in the study: 708 girls and 834 boys. Military registers suggest that the total number of boys in the third grade in Malmö at that time—that is, the total number of boys eligible for the study—was 948. Assuming that the proportion of missing girls is the same, the sample covers approximately 88% of the eligible population. The missing group consists of children absent from school on the day of testing.²⁴ A total of 12 individuals were excluded owing to missing IQ data or because they were lost to follow-up; therefore, 1530 individuals were included in the analyses (698 women and 832 men). Of the 1530 individuals, 40 were right censored because of migration or loss to follow-up.

Complete information on IQ, father's education, and own educational attainment was available for 1338 individuals (87.5%; tables 1 and 2). The mean IQ was 97.7 (standard deviation 16.0) among men and 98.5 (standard deviation 16.8) among women. Most participants were educated to a basic level (39%) or underwent vocational education (25%). The remaining participants were school dropouts (9%) or underwent short theoretical (15%) or long theoretical (13%) education.

Most participants had fathers who had undergone long vocational education (554/1494 (37%)), whereas fewer had fathers who had received short vocational (367/1494 (25%)), basic (317/1494 (21%)), or theoretical (256/1494 (17%)) education. Fathers largely held unskilled manual (515/1529 (34%)) or skilled manual (521/1529 (34%)) jobs, and fewer had lower non-manual (280/1529 (18%)) or higher non-manual (213/1529 (14%)) roles. Data on father's occupation were only missing for one individual. Regarding parental annual income in Swedish crowns, 15% (226/1520) of parents earned 0-1499, 20% (301/1520) earned 1500-2499, 34% (515/1520) earned 2500-3499, 15% (224/1520) earned 3500-4499, and 17% (254/1520) earned 4500 or more.

Educational attainment and mortality risk

Table 3 shows mortality risks by educational group for both sexes. Higher educational attainment was strongly associated with lower mortality risks for both men and women (hazard ratio (HR) for each year in school 0.88 (95% CI 0.83 to 0.92) and 0.91 (95% CI 0.83 to 0.99), respectively). Adjusting for father's education hardly changed this relation (HR 0.87 (95% CI 0.83 to 0.92) and HR 0.90 (95% CI 0.82 to 1.00) for men and women, respectively). Further adjusting for

Table 1 | Descriptive statistics for men

Background variable	Number of individuals (number of deaths)	Mean IQ 1938 (SD)	Main effect on mortality until 2003 (HR (95% CI))
All males	832 (363)	97.7 (16.0)	1.91 (1.60 to 2.29) with women as ref 1.00
Year of birth			
1927	102 (59)	80.1 (14.3)	1.49 (1.12 to 1.98)
1928	730 (304)	100.2 (14.7)	1.00 (ref)
Father's education 1937			
Theoretical	133 (49)	105.9 (13.5)	1.00 (ref)
Long vocational	318 (127)	98.4 (15.8)	1.09 (0.78 to 1.52)
Short vocational	196 (97)	95.2 (15.5)	1.42 (1.01 to 2.01)
Basic	166 (78)	94.0 (15.6)	1.38 (0.96 to 1.97)
Missing	19 (12)	87.5 (22.9)	—
Own education 1964			
Long theoretical	113 (30)	111.0 (11.4)	1.00 (ref)
Short theoretical	93 (31)	106.1 (12.1)	1.29 (0.78 to 2.14)
Vocational	195 (76)	99.5 (13.2)	1.56 (1.02 to 2.38)
Basic	281 (140)	92.7 (13.1)	2.25 (1.52 to 3.34)
School dropout	73 (47)	75.8 (12.6)	3.07 (1.94 to 4.86)
Missing	77 (39)	102.5 (16.9)	—

A total of 27 boys were born in 1925-6 (here coded as 1927) or 1929-30 (here coded as 1928).

Table 2 | Descriptive statistics for women

Background variable	Number of individuals (number of deaths)	Mean IQ 1938 (SD)	Main effect on mortality until 2003 (HR (95% CI) with men as ref 1.00)
All females	698 (176)	98.5 (16.8)	0.52 (0.44 to 0.63)
Year of birth			
1927	66 (22)	80.5 (14.2)	1.41 (0.90 to 2.21)
1928	632 (154)	100.4 (15.9)	1.00 (ref)
Father's education 1937			
Theoretical	123 (27)	105.4 (16.8)	1.00 (ref)
Long vocational	236 (57)	100.4 (16.4)	1.09 (0.69 to 1.72)
Short vocational	171 (39)	97.8 (15.6)	1.01 (0.62 to 1.65)
Basic	151 (51)	91.4 (16.2)	1.65 (1.04 to 2.63)
Missing	17 (2)	92.6 (16.2)	—
Own education 1964			
Long theoretical	60 (10)	113.0 (11.3)	1.00 (ref)
Short theoretical	106 (23)	108.3 (12.1)	1.37 (0.65 to 2.89)
Vocational	151 (36)	99.0 (16.4)	1.51 (0.75 to 3.05)
Basic	248 (65)	92.7 (13.8)	1.75 (0.90 to 3.40)
School dropout	46 (15)	73.6 (9.9)	2.30 (1.03 to 5.13)
Missing	87 (27)	105.7 (14.4)	—

A total of 26 girls were born in 1925-6 (here coded as 1927) or 1929-30 (here coded as 1928).

grade repeated in school, father's occupation, and family income only affected the estimates for each extra year in school marginally for men (from HR 0.87 (95% CI 0.83 to 0.92) to 0.87 (95% CI 0.81 to 0.92) for those 740 men who had data on all these covariates; change <6%). For women, the estimate also changed very little (from HR 0.91 (95% CI 0.82 to 1.00) to HR 0.92 (95% CI 0.83 to 1.02) for those 593 women that had all data). When own IQ was adjusted for in the model, the effect of educational attainment on mortality was somewhat reduced for men (HR 0.91

Table 3 | Risk of all cause mortality up to the age of 75 by own educational attainment

	All cause mortality (hazard ratio (95% CI))		
	Unadjusted	Adjusted for father's education	Adjusted for father's education and own IQ at age of ten
Men			
By educational attainment			
Long theoretical	1.00 (ref)	1.00 (ref)	1.00 (ref)
Short theoretical	1.31 (0.79 to 2.17)	1.32 (0.79 to 2.18)	1.26 (0.76 to 2.09)
Vocational	1.52 (1.00 to 2.33)	1.52 (0.98 to 2.37)	1.36 (0.87 to 2.14)
Basic	2.22 (1.50 to 3.30)	2.20 (1.45 to 3.35)	1.83 (1.17 to 2.87)
School dropout	2.85 (1.79 to 4.55)	2.82 (1.73 to 4.60)	2.01 (1.14 to 3.54)
By year spent in school			
Each year in school	0.88 (0.83 to 0.92)	0.87 (0.83 to 0.92)	0.91 (0.85 to 0.97)
Women			
By educational attainment			
Long theoretical	1.00 (ref)	1.00 (ref)	1.00 (ref)
Short theoretical	1.31 (0.63 to 2.76)	1.38 (0.65 to 2.93)	1.45 (0.68 to 3.09)
Vocational	1.43 (0.71 to 2.88)	1.50 (0.71 to 3.18)	1.71 (0.79 to 3.73)
Basic	1.66 (0.85 to 3.24)	1.70 (0.82 to 3.54)	2.04 (0.93 to 4.47)
School dropout	2.31 (1.04 to 5.14)	2.34 (0.99 to 5.55)	3.21 (1.19 to 8.68)
By year spent in school			
Each year in school	0.91 (0.83 to 0.99)	0.90 (0.82 to 1.00)	0.88 (0.78 to 0.98)

(95% CI 0.85 to 0.97)). This was not the case for women (HR 0.88 (95% CI 0.78 to 0.98)), among whom educational differences in all cause mortality actually became larger.

IQ and mortality risk

Children who had repeated a grade in school—that is, those born in 1927—had an increased mortality risk as well as lower average IQ compared with those born in 1928, who successfully completed the seventh grade (HR 1.49 (95% CI 1.12 to 1.98) for men and HR 1.41 (95% CI 0.90 to 2.21) for women). There was a positive correlation between IQ and length of own education in both men and women (r=0.51; P<0.001 and r=0.52; P<0.001, respectively).

For both men and women, there was an inverse relation between mortality risk and length of own and father's education, although most estimates did not reach statistical significance for women. Furthermore, IQ was positively related to length of both father's and own education, for men as well as women (tables 1 and 2).

For men, there was a graded association between IQ and mortality risk, with a twofold higher risk of mortality in those in the fourth (lowest) quartile for IQ compared with those in the first (highest) quartile (HR adjusted for father's education 1.99 (95% CI 1.41 to 2.83) v 1.00 (ref); table 4). For each unit decrease in IQ, the risk of dying increased by 1.7%. This means that the mortality risk rose by more than 30% for every one standard deviation reduction in IQ.

A substantial part of the effect of IQ on men's mortality was mediated through their educational attainment, but a clear and significant effect of IQ persisted even once the estimates were adjusted for this variable (HR for one standard deviation increase in IQ 0.85 (95% CI 0.75 to 0.96) and for one standard deviation decrease in IQ 1.18 (95% CI 1.04 to 1.33)). The association between IQ and mortality in men was not confounded either by father's education or by other childhood socioeconomic factors. Adding father's occupation, parental income, and whether the child repeated a grade in school to the model only marginally affected the estimate for a one unit decrease in IQ (from HR 1.017 (95% CI 1.010 to 1.024) to HR 1.018 (95% CI 1.010 to 1.026) for those men that had data on all covariates; change <6%; for women the reduction was <18%, but this estimate is imprecise owing to low numbers).

In contrast, there was no evidence of IQ having any effect on mortality in women (adjusted HR for fourth quartile v first quartile 1.09 (95% CI 0.68 to 1.79) v 1.00 (ref); table 4). When father's and own educational attainment was adjusted for, the mortality risk was highest in the 25% of women with the highest cognitive ability (adjusted HR for first quartile v fourth quartile 1.00 (ref) v 0.80 (95% CI 0.48 to 1.34)). The statistical interaction between IQ and sex in relation to mortality was significant in all three versions of the model with IQ as a metric variable; that is the crude model, the model adjusted for father's education, and the fully adjusted model (P<0.01, P<0.05, and P<0.05, respectively).

Table 4 | Risk of all cause mortality up to the age of 75 by IQ at the age of 10 years old and per IQ unit decrease

	All cause mortality (hazard ratio (95% CI))		
	Unadjusted	Adjusted for father's education	Adjusted for father's education and own education
Men			
By quartile			
First	1.00 (ref)	1.00 (ref)	1.00 (ref)
Second	1.43 (1.00 to 2.05)	1.42 (0.99 to 2.04)	1.21 (0.84 to 1.75)
Third	1.62 (1.14 to 2.30)	1.57 (1.10 to 2.24)	1.24 (0.86 to 1.81)
Fourth	2.08 (1.47 to 2.93)	1.99 (1.41 to 2.83)	1.46 (0.99 to 2.14)
By unit decrease in IQ			
Unit decrease	1.018 (1.011 to 1.025)	1.017 (1.010 to 1.025)	1.011 (1.003 to 1.019)
Women			
By quartile			
First	1.00 (ref)	1.00 (ref)	1.00 (ref)
Second	1.19 (0.75 to 1.87)	1.13 (0.72 to 1.79)	0.98 (0.61 to 1.57)
Third	0.78 (0.47 to 1.28)	0.74 (0.44 to 1.23)	0.60 (0.35 to 1.02)
Fourth	1.21 (0.78 to 1.88)	1.09 (0.68 to 1.72)	0.80 (0.48 to 1.34)
By unit decrease in IQ			
Unit decrease	1.002 (0.993 to 1.012)	1.000 (0.990 to 1.010)	0.993 (0.982 to 1.005)

The first quartile consists of the 25% with the highest cognitive ability.

Net effects of IQ beyond the effect of own education

The similarities between men and women with respect to the effect of educational attainment on mortality and the differences with respect to the effect of IQ led us to conduct additional analyses that used the following information about social career over and above own educational attainment: average grades in school; occupational status at age 36; number and timing of children; and partner's educational attainment. We also used some information on causes of death in these analyses, although the only data available were the chapter in the International Classification of Diseases category (versions 7, 8, 9, and 10) to which the diagnosis belonged. Furthermore, this information was only available for deaths up to the end of 2001.

We found that the higher mortality among women with above average IQ (>100), given a certain education, appeared only in the older ages. When followed until the age of 60 years, the hazard ratio adjusted only for own educational attainment in women with above average IQ was 0.98 (95% CI 0.49 to 1.96). From the age of 60 and onwards, however, the hazard ratio for women with above average IQ increased to 1.60 (95% CI 1.06 to 2.42). In contrast, the hazard ratio for men with above average IQ in a similar model—that is, in those aged 60 or older—was 0.72 (95% CI 0.54 to 0.97). The figure shows the estimated survival functions on the basis of IQ (above or below average) and adjusted for educational attainment for men and women who survived to the age of 60 years.

Next, we checked whether the negative net effect of IQ on mortality among women over age 60 years could be explained by average school marks in the third grade in school, occupational status at age 36, number of children, year of first child's birth, or partner's educational attainment. Adding these measures

of social career over and above educational attainment to the model only marginally affected the hazard ratio for women with above average IQ (from HR 1.35 (95% CI from 0.80 to 2.29) to HR 1.37 (95% CI 0.75 to 2.50); change <5%).

With educational achievement adjusted for, cause specific analyses suggested high mortality risk (that is, hazard ratios higher than 1.0) for all causes of death in women over the age of 60 with above average IQ: tumours (46 cases); circulatory disease (29 cases); respiratory disease (6 cases); gastrointestinal disease (5 cases); and other causes of death combined (6 cases). In particular, the estimate for tumours approached significance (HR 1.71 (95% CI; 0.91 to 3.22); $P < 0.10$).

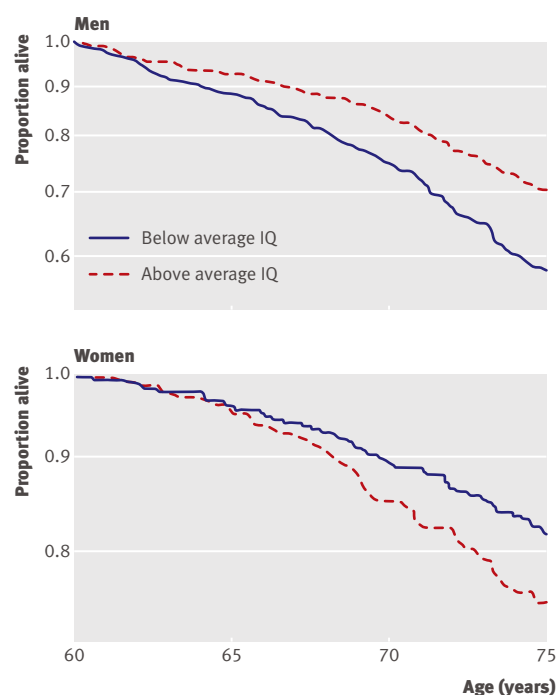
DISCUSSION

Principal findings

In this study, mortality differences among participants by own educational attainment were not explained by childhood IQ, neither for men nor women. Hence, our results do not suggest that differences in early IQ can explain why people with longer education live longer.

Furthermore, we found that childhood IQ was independently linked to male adult mortality, even when childhood social position and own educational attainment were taken into account. Thus, social background or educational attainment seem unlikely to be the primary explanations of health differences by childhood IQ among men. Intelligent men tended to have longer education, and higher cognitive ability also seems to have an additional direct protective effect.

In women, the relation between IQ and mortality was negative when father's and own educational



Survival from age 60 years by sex and cognitive ability, adjusted for own educational attainment

WHAT IS ALREADY KNOWN ON THIS TOPIC

Both intelligence and socioeconomic conditions are linked to disease, and there is a correlation between IQ and socioeconomic conditions

Controversy exists over whether IQ is the fundamental explanation for socioeconomic health differences, or if early socioeconomic conditions are the explanation for health differences by early IQ, or if neither proposition is correct

WHAT THIS STUDY ADDS

Mortality differences by own educational attainment in adulthood were not explained by childhood IQ

Mortality differences by childhood IQ in men were not explained by social position in childhood or own educational attainment

Women aged 60 years or over with above average IQ had an increased mortality risk compared with their less intelligent counterparts when own educational attainment was adjusted for

attainment was adjusted for—that is, the mortality risk was highest in those with the highest IQ—although not significant. This finding suggests that intelligent women may have a greater underlying risk of dying that is masked by their having on average a longer education and, supposedly, a lower mortality risk than women who spent less time in education. The net effect of IQ on mortality risk in women was strongest in older women—that is, women with above average cognitive skills had a higher risk of dying when aged over 60 than other women with the same educational attainment. These findings seem incompatible with the idea that early IQ has an association with health primarily through being a marker of a “well wired”²⁵ or healthy body. According to this hypothesis, the association between early IQ and health may be lead primarily by health, rather than the other way around, in the sense that people who have healthy bodies to begin with—for example, owing to a good genetic makeup—also have higher IQ. However, this seems unlikely to be a good explanation given our finding that early IQ has no clear protective effect for women. Instead, variation in the effect of IQ, between men and women in our study and among women in other studies, points to the role of the environment in a wide sense. This possibility is good news for public health given that environments are modifiable.

Comparison with other studies

Recent studies where IQ has been measured in older individuals support to some extent Gottfredson’s hypothesis that intelligence might be the “fundamental cause of social class inequalities in health.” One of these studies measured cognitive ability at age 56 with mortality until 73 years of age. IQ partly explained socioeconomic differences in health in this study.²⁶ A later study by the same group of authors measured cognitive ability at age 18 and age 38 (“mid life”), with a mean mortality follow-up of 15 years. The authors concluded that mid life IQ has a stronger attenuating effect on socioeconomic differences in mortality than early IQ,²⁷ in line with the results from

our study with IQ measured at age 10—that is, that IQ explains less when it is measured early.

The lack of a protective effect of IQ among women in our study is in agreement with the results from the 1946 British Birth Cohort Study, which found no statistically significant protective effect of IQ for women but did record an effect for men.²⁸ In contrast, the Scottish Mental Survey of 1932²⁹ and the Nun study, which began in 1986,³⁰ found that cognitive ability had protective effects on health in both sexes. Nuns, of course, have a very particular lifestyle that rarely includes smoking or other “male” behaviours. Relatively high mortality during World War II, for women as well as for men, seems to have contributed to the association reported in the Scottish study.

A few studies have suggested that there is an inverse relationship between cognitive ability and health behaviours among women. In the Wisconsin Longitudinal Study, high cognitive ability in childhood was associated with smoking among women, but not men, born in 1928 to 1946.³¹ In a recent study of 19 countries, including Sweden, highly educated women over 60 were more likely to have ever smoked than those with less education, whereas the opposite was true in younger cohorts.³²

The generation of women that we have studied had rights relatively equal to those of men, and they were also the first to adopt the previously male behaviour of smoking. The prevalence of daily smoking among women in Sweden born between 1924 and 1928 was almost 30% in 1953, when participants in our cohort were in their late 20s, and stayed roughly the same until 1983, when they were in their late 50s.³³ We suggest that the association between IQ and mortality in women could be the result of women with above average IQ being quicker in taking up smoking.

Overall, the differences between our study and previous studies suggest that the social and cultural context of female participants could be responsible, in part, for the negative relation between IQ and mortality in women. They also highlight the need for more studies with data on women.

Strengths and limitations

Our final dataset is relatively small, but our study has a much longer follow-up and lower attrition than in a typical epidemiological study. Our study also uses IQ measured at a very early age compared with similar studies in the field. In addition, information is available about both adult and childhood socioeconomic circumstances, including parental and own education, and our study includes both men and women. Admittedly, the participants in our study are from only one city. On the other hand, the study data come from a near total census of that city, namely almost all children in the third grade of school. In relation to other studies, the most important strength of our study is that it includes data on women. Many other studies have drawn broad conclusions without any data on women.

Conclusions and implications

Our findings do not support the view that IQ in early life is the fundamental cause of socioeconomic differences in mortality, because an independent association between educational attainment and mortality persisted after adjusting for early IQ. At the same time, early IQ in itself seems an important determinant of mortality over and above educational attainment. Furthermore, the latter effect differed between men and women.

These findings suggest that IQ is important for mortality risk in ways that involve the social and physical environment rather than simply being a marker of having a healthy body to begin with; for example, owing to a good genetic makeup. Given that environments are modifiable, our findings suggest that cognitive skills should be addressed in our efforts to create childhood environments that promote health.

We thank Sonja Olin Lauritzen for giving us access to the Malmö Longitudinal Study data and Zenia Hellström and Sofia Sandgren for practical help.

Contributors: The study was based on ideas by AL, SB, and DV. AL conducted the data analyses and drafted the first version of the article. SB and DV revised the first draft. All authors have read and approved the final version, have had full access to all data (including intermediate statistical reports and tables), and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors are guarantors for the study.

Funding: The Swedish Council for Working Life and Social Research financed the updating of the Malmö Longitudinal Study database. AL and SB were funded by the Swedish National Institute of Public Health. The funders had no role in the collection, analysis, and interpretation of the data; the writing of the article; or the decision to submit the article for publication.

Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: (1) No financial support for the submitted work from anyone other than their employer; (2) No financial relationships with commercial entities that might have an interest in the submitted work; (3) No spouses, partners, or children with relationships with commercial entities that might have an interest in the submitted work; (4) No non-financial interests that may be relevant to the submitted work.

Ethical approval: The study was approved by the regional ethics board of Stockholm, Sweden (no 2007/1090-31).

Data sharing: The original data and statistical code have been saved for review purposes and future secondary analyses, and can be requested from the corresponding author at anton.lager@chess.su.se.

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Accepted: 13 November 2009