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Low intelligence test scores in 18 year old men and risk of suicide: cohort study

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Abstract

Objective To examine the association between intelligence test scores in men, measured at age 18, and subsequent suicide.
Design Record linkage study of the Swedish military service conscription register (1968-94) with the multi-generation register, cause of death register and census data. Four tests were performed at conscription covering logic, language, spatial, and technical skills.
Setting Sweden.
Participants 987 308 Swedish men followed up for 5-26 years.
Main outcome measure Suicide.
Results 2811 suicides occurred during follow up. The risk of suicide was two to three times higher in those with lowest compared with the highest test scores. The strongest associations were seen with the logic test: for each unit increase in test score the risk of suicide decreased by 12% (95% confidence interval 10% to 14%). Associations were only slightly attenuated when we controlled for parents' socioeconomic position. Greatest risks were seen among poorly performing offspring of well educated parents.
Conclusions Performance in intelligence tests is strongly related to subsequent risk of suicide in men. This may be due to the importance of cognitive ability in either the aetiology of serious mental disorder or an individual's capacity to solve problems while going through an acute life crisis or suffering from mental illness.

Introduction

Impaired neurodevelopment is thought to increase the risk of several psychiatric disorders. In keeping with this, poor performance on tests of cognitive function is associated with an increased risk of depression[1] and psychosis.[2 3] Interpretation of these findings is hampered by the possibility that pre-existing mental illness may influence test performance (reverse causality). Furthermore, performance during psychiatric interviews may be influenced by an individual's intelligence.

Few studies have examined the associations of performance in intelligence tests with suicide, and results have conflicted. A study of conscripts in Israel suggested that people who committed suicide had above average intelligence ratings at conscription,[4] though the opposite was reported among Australian conscripts.[5 6] In a cohort of Swedish men conscripted in 1969-70, "intellectual capacity" was inversely associated with risk of suicide, although this association was attenuated after adjustment for measures of conduct and personality.[7] In a more recent follow up of Swedish conscripts, there was an inverse association between intelligence test performance and non-fatal self harm.[8]

We analysed the association between the results of four intelligence tests, recorded during medical examinations at conscription of Swedish men, and subsequent risk of suicide.

Methods

Dataset examined

In the multi-generation register we used unique personal identification numbers to identify men born in 1950-76 in Sweden for whom we could also obtain information on their biological parents (n = 1 421 326). Of these, 1 223 520 (86.1%) had a record in the military service conscription register between 1968 and 1994 and 1 084 644 (86.6%) had complete sets of data for intelligence test results.

The Swedish military service conscription examination is required by law. The only reasons accepted for non-participation are foreign citizenship, a severe chronic medical condition, or a handicap documented in a medical certificate.

We obtained further information on the men and their parents from additional linkages with the population and housing censuses of 1970, 1980, 1985, and 1990, the 2000 register of education, and the Swedish cause of death register (up to 31 December 1999).

Intelligence tests

The intelligence tests have been described in detail elsewhere.[2 8–10] There are four basic tests: logic/general intelligence test; verbal test of synonym detection; test of visuospatial/geometric perception; and technical/mechanical skills with mathematical/physics problems. A combined ("global") intelligence score is derived from the performance on all four tests, but as this was missing for 145 822 (15%) conscripts we excluded it from our main analyses.

Central training and instruction of the psychologists who undertake the tests and the use of a standard manual helps to ensure consistency. Results from these tests are standardised against data from previous years to give scores from 1 (low) to 9 (high) for each of the four scales.[2] Procedures for carrying out the tests changed in 1980.[10]

Disease outcomes

We identified suicides using ICD-8-10 (international classification of diseases, 8th to 10th revision): codes E950-9 (ICD-8 and 9) and X60-84 (ICD-10). We also investigated associations with undetermined deaths (deaths where it is uncertain whether or not the cause was suicide: codes E980-9 (ICD-8 and 9) and Y10-34 (ICD-10).

Confounding factors

We assessed the possible confounding effects of year of birth, conscription test centre (six centres), the highest socioeconomic

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index of either parent (four categories: blue collar worker, white collar worker, self employed, and other), and duration of each parent's education (six categories: <9 years of primary school, 9 years of primary school, <3 years of secondary school, 3 years of secondary school, <3 years higher education, and ≥3 years in higher education). Similar categories were used for the conscripts' educational level.

Our analyses are based on the 987 308 (91%) conscripts with complete information on all the above confounding factors. The 97 336 individuals with incomplete information were born earlier, had less educated parents, scored less well on the intelligence test (mean logic score 4.8 *v* 5.2, P<0.0001), and had a slightly higher suicide rate (hazard ratio adjusted for age and year of birth 1.11, P=0.06).

Statistical methods

All analyses were carried out in SAS version 8.2. We used Cox's proportional hazards models to assess the influence of the factors listed above on the occurrence of suicide. We used age as the time axis, thus controlling for age. To assess effects of secular changes in suicide rates over calendar time, we adjusted for year of birth by stratifying the Cox model on year of birth (using year in the strata statement of the PHREG procedure in SAS). The follow up period began at the date of conscription (baseline). Men were censored at the time of death from causes other than suicide, emigration, or 31 December 1999, whichever was soonest. Tests for linear trend were based on the continuous term for the factor examined. For ease of presentation we categorised some of the data into three groups according to test scores (low=1-3, medium=4-6, high=7-9). We examined the proportional hazards assumption graphically and found no evidence that it was violated.

To assess possible reverse causation—that is, depression leading to poor performance on the tests—we separately examined associations of intelligence test score with suicide in the first five years' follow up and 5-10, 10-15, and >15 years' follow up. We also examined whether restricting the analysis to men with no psychiatric diagnosis (ICD-8 and 9 codes 290-319) recorded at conscription influenced the strength of associations.

Results

We found strong linear associations with all four intelligence tests (table 1). Better performance on the tests was associated with a reduced risk of suicide. The strongest associations were with the logic test score, with a threefold difference in risk between high and low scorers (figure). The strength of the associations changed little in models that controlled for parents' socioeconomic index and education. Similar associations were seen in the subset of men with a record of their global test score (fully adjusted hazard ratio per unit increase 0.88 (95% confidence interval 0.86 to 0.90).

Correlations between the four test scores ranged from $r=0.43$ to $r=0.69$. We fitted a model including terms for all four of the test scores to see if mutual adjustment attenuated the strength of any of the associations (table 2). Associations with the synonym, technical, and spatial test scores were all greatly attenuated, but the strength of association with the logic test result was not greatly changed. Subsequent analyses were based on the logic test score alone.

Influence of educational attainment on intelligence test-suicide associations

We examined the possible confounding effect of educational attainment in a restricted dataset of 542 283 men (n=1027 suicides) born 1950-65 and alive at the age of 25 years, who had therefore had the opportunity to complete their education. In a model adjusted for age and the other confounders, the hazard ratio per unit increase in the logic test score was 0.90 (0.86 to 0.93), further adjustment for educational level attenuated this association to 0.93 (0.90 to 0.97).

Influence of pre-existing psychiatric illness

Men with a psychiatric disorder recorded at conscription tended to perform poorly on the tests of intelligence; 23.4% (6534/27 901) of those with scores of 1 on the logic intelligence test had a psychiatric diagnosis recorded at conscription compared with only 2.7% (1039/38 905) of those with scores of 9. Exclusion of all 59 163 men with psychiatric disorders recorded at baseline had little effect on the association between intelligence and suicide (fully adjusted hazard ratio per unit increase in logic test score 0.89, 0.87 to 0.91).

To investigate whether our findings might have been influenced by the presence of (unrecorded) psychiatric illness at baseline (reverse causality) we assessed the associations after excluding the first five, the first 10, and the first 15 years of follow up (table 3). There is some evidence that associations were strongest in the first five years of follow up, though associations remained after more than 15 years of follow up.

Interactions with own or parents' education

In the subset of men alive at the age of 25 years the association of intelligence test scores with suicide differed depending on an individual's educational achievement (P<0.005 for interaction, table 4). The gradient of risk in relation to intelligence test score was strongest in those with high or medium levels of education and the gradient of risk in relation to educational levels was highest in those with high intelligence test scores. Among those with only primary level education, intelligence test performance did not seem to be associated with risk of suicide.

There was no strong evidence that the effects of test performance on risk of suicide differed with parents' education (P=0.35 for interaction). The greatest risk of suicide was seen among the men who had low intelligence test scores but had highly educated parents (table 5).

Sensitivity analyses

Associations with undetermined deaths (n=801) were similar to the associations with suicides. The fully adjusted hazard ratio for the association with the logical test score was 0.83 (0.80 to 0.86). The methods for intelligence testing at conscription changed in 1980.[10] The associations with suicide were stronger among those tested in 1981-94 (hazard ratio 0.85, 0.82 to 0.88) than among those tested in 1968-80 (0.90, 0.88 to 0.93). Associations of intelligence test scores with suicide were similar to those with all cause mortality (fully adjusted hazard ratio per unit increase in logic test score based on 12 833 deaths was 0.88 (0.87 to 0.88).

Discussion

We found a strong linear association between results of intelligence tests in early adulthood and subsequent suicide in men. The association seems to be mediated in part by educational attainment, which may perhaps influence subsequent job opportunities and income.

Though the large sample size gave us adequate power to investigate associations with suicide across the range of test results, the findings are restricted to men and patterns of association in relation to intelligence testing may differ in women. Also, the lack of detailed information about the men

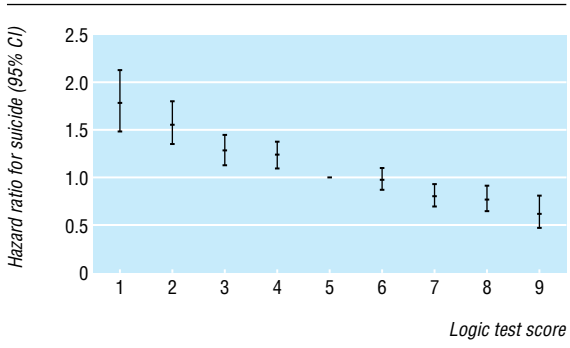
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Table 1 Associations of four intelligence test scores with suicide in age adjusted and fully adjusted models

	No of conscripts (n=987 308)	No of suicides (n=2811)	Hazard ratio (95% CI)	
			Age adjusted	Fully adjusted*
Logic test score:				
1	27 901	140	1.81 (1.51 to 2.18)	1.78 (1.48 to 2.14)
2	65 436	274	1.60 (1.38 to 1.84)	1.55 (1.34 to 1.79)
3	100 143	347	1.30 (1.14 to 1.48)	1.27 (1.11 to 1.45)
4	153 960	523	1.22 (1.09 to 1.38)	1.22 (1.08 to 1.37)
5	231 230	626	1.00	1.00
6	156 296	405	0.96 (0.84 to 1.08)	0.96 (0.85 to 1.09)
7	122 954	252	0.78 (0.67 to 0.90)	0.78 (0.68 to 0.91)
8	90 484	186	0.75 (0.63 to 0.88)	0.76 (0.64 to 0.90)
9	38 905	58	0.60 (0.46 to 0.78)	0.60 (0.46 to 0.79)
Per unit increase			0.88 (0.86 to 0.89)	0.88 (0.86 to 0.90)
Synonym (linguistic) test score:				
1	25 152	109	1.55 (1.27 to 1.90)	1.54 (1.25 to 1.89)
2	57 849	253	1.55 (1.34 to 1.79)	1.51 (1.31 to 1.76)
3	113 943	379	1.17 (1.03 to 1.33)	1.16 (1.02 to 1.32)
4	172 268	542	1.08 (0.96 to 1.22)	1.08 (0.96 to 1.21)
5	225 064	610	1	1
6	178 264	429	0.85 (0.75 to 0.96)	0.86 (0.76 to 0.98)
7	125 845	277	0.78 (0.68 to 0.90)	0.80 (0.70 to 0.93)
8	57 606	140	0.77 (0.64 to 0.93)	0.81 (0.68 to 0.98)
9	31 317	72	0.73 (0.58 to 0.94)	0.78 (0.61 to 1.00)
Per unit increase			0.90 (0.88 to 0.91)	0.90 (0.89 to 0.93)
Spatial test score:				
1	24 923	100	1.46 (1.18 to 1.80)	1.38 (1.12 to 1.71)
2	55 476	195	1.23 (1.05 to 1.45)	1.17 (1.00 to 1.38)
3	102 810	355	1.26 (1.11 to 1.44)	1.22 (1.06 to 1.39)
4	149 092	465	1.11 (0.98 to 1.25)	1.09 (0.96 to 1.23)
5	199 380	603	1	1
6	194 923	522	0.85 (0.76 to 0.96)	0.86 (0.77 to 0.98)
7	133 439	309	0.76 (0.66 to 0.87)	0.77 (0.67 to 0.88)
8	81 282	175	0.72 (0.61 to 0.85)	0.74 (0.63 to 0.88)
9	45 983	87	0.61 (0.49 to 0.76)	0.64 (0.51 to 0.81)
Per unit increase			0.90 (0.88 to 0.91)	0.91 (0.89 to 0.93)
Technical test score:				
1	29 539	140	1.63 (1.35 to 1.96)	1.64 (1.36 to 1.97)
2	66 382	246	1.27 (1.10 to 1.48)	1.26 (1.08 to 1.46)
3	125 751	463	1.24 (1.10 to 1.40)	1.24 (1.10 to 1.41)
4	170 311	563	1.20 (1.07 to 1.35)	1.20 (1.06 to 1.34)
5	199 944	542	1	1
6	178 009	407	0.87 (0.76 to 0.98)	0.87 (0.76 to 0.98)
7	127 904	272	0.80 (0.70 to 0.93)	0.81 (0.70 to 0.94)
8	53 986	104	0.70 (0.57 to 0.86)	0.72 (0.58 to 0.88)
9	35 482	74	0.80 (0.62 to 1.02)	0.81 (0.63 to 1.03)
Per unit increase			0.90 (0.88 to 0.92)	0.90 (0.88 to 0.92)

*Adjusted for age, year of birth, conscription test centre, parents' socioeconomic position, and education.

who committed suicide, including possible confounding factors such as drug and alcohol misuse, means we are unable to fully understand possible causal pathways. Exclusion of those with psychiatric disorder at baseline, however, did not greatly influence the strength of the association.



Fully adjusted suicide hazard ratios by categories of logic intelligence test score (category 5 is reference)

Table 2 Associations with each of four intelligence test scores in fully adjusted model including all four terms simultaneously (hazard ratio suicide per unit increase in test score)

Intelligence test	Hazard ratio (95% CI)		P value
	Age adjusted	Fully adjusted*	
Logic	0.88 (0.86 to 0.92)	0.92 (0.89 to 0.95)	<0.0001
Synonym	0.90 (0.88 to 0.91)	1.00 (0.97 to 1.03)	0.77
Spatial	0.90 (0.88 to 0.91)	0.97 (0.94 to 0.99)	<0.01
Technical	0.90 (0.88 to 0.92)	0.96 (0.94 to 0.99)	<0.005

*Mutual adjustment for other intelligence test score terms and age, year of birth, conscription test centre, parents' socioeconomic position, and education.

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Table 3 Suicide hazard ratios in relation to logic test score over discrete follow up periods

Logic test score	No of conscripts	No of suicides	Hazard ratio (95% CI)	
			Age adjusted	Fully adjusted*
Whole follow up period	987 308	2811	0.88 (0.86 to 0.89)	0.88 (0.86 to 0.90)
0-≤5 years	987 308	554	0.86 (0.82 to 0.89)	0.85 (0.81 to 0.89)
>5-≤10 years	977 292	703	0.88 (0.85 to 0.92)	0.89 (0.85 to 0.92)
>10-≤15 years	774 050	580	0.88 (0.84 to 0.92)	0.88 (0.84 to 0.92)
>15 years	588 232	974	0.88 (0.85 to 0.91)	0.90 (0.87 to 0.93)

*Adjusted for age, year of birth, conscription test centre, parents' socioeconomic position, and parents' education.

Previous studies

Few previous studies have assessed the association of measures of intelligence with suicide. The 1946 British birth cohort study found that suicide was associated with delayed physical development but not with age at first speech, alertness (age 7 years), or measures of intelligence at age 15 years.[11] There were only 11 suicides in that study and so it lacked power to detect potentially important effects. A study of 43 suicides in Israeli conscripts aged 18-21 years suggested that they were of above average intelligence,[4] although patterns of suicide in the context of military service may differ from those in the general population. A study of university students in the United States, however, also found an increased risk of suicide among the offspring of better educated or professional parents.[12]

Suicide rates among Australian army conscripts were strongly associated with a measure of general intelligence, even after adjustment for several other risk markers, but this study was based on only 76 suicides.[5 6] In a previous study of Swedish conscripts, associations with suicide were attenuated after adjustment for measures of conduct and personality.[7]

Several studies have examined the association of childhood IQ with overall mortality. In two Scottish studies low IQ at age 10-11 years[13] and poor mental ability at age 11 years[14] were strongly associated with all cause mortality.[14] In our analysis the strength of the association of test results with overall mortality was similar to that for suicide, although different pathways probably affect the associations with the specific diseases contributing to all cause mortality.

Table 4 Hazard ratios (95% confidence intervals) for suicide in relation to logic intelligence test score grouped in three categories and length of conscripts' education in three categories, adjusted for year of birth, parents' socioeconomic position and education, and test centre (542 283 conscripts, 1027 suicides)*

Logic test score	≤9 years of primary school	≤3 years of secondary school	>3 years of secondary school
Low (1-3)	2.25 (1.65 to 3.07)	2.88 (2.16 to 3.83)	1.55 (0.68 to 3.58)
Medium (4-6)	2.54 (1.90 to 3.38)	1.86 (1.43 to 2.41)	1.37 (1.01 to 1.85)
High (7-9)	2.23 (1.34 to 3.70)	1.60 (1.16 to 2.19)	1 (reference)

*Interaction term, logic intelligence test score×length of education (in above 3×3 categories), P<0.005.

Table 5 Hazard ratios (95% confidence intervals) for suicide by logic intelligence test score in three categories and parents' education in three categories, adjusted for year of birth, parents' socioeconomic position, and test centre

Logic test score	Higher education in parents		
	Neither	One	Both
Low (1-3)	1.68 (1.30 to 2.17)	1.68 (1.17 to 2.42)	2.98 (1.70 to 5.20)
Medium (4-6)	1.26 (0.98 to 1.61)	1.25 (0.95 to 1.65)	1.62 (1.18 to 2.21)
High (7-9)	0.92 (0.71 to 1.20)	0.96 (0.70 to 1.30)	1 (reference)

*Interaction term, logical intelligence test score×parents' education (in above 3×3 categories), P=0.35.

Possible explanations for associations

The strength of the association and the large sample size suggest that our finding is unlikely to be due to chance. The association was little changed when we assessed confounding by mental illness by excluding those with psychiatric diagnoses at baseline. The association was most pronounced in the five years after conscription. If this difference is not simply a chance finding it may reflect the effect of undetected mental illness at conscription on both test performance and subsequent risk of suicide over the initial years of follow up (reverse causality). Alternatively, it is possible that young adulthood (age 18-23 years) is the age of greatest vulnerability to any adverse effects of low mental ability, perhaps in relation to entering the job market or finding a partner.

The strongest associations of intelligence test scores with suicide were among people with highly educated parents. We have previously reported a similar finding with schizophrenia.[3] This association must be interpreted with caution as there is no evidence of statistical interaction (P = 0.35). One interpretation could be that it indicates the adverse effect on mental health of a mismatch between parental aspirations and expectations and an individual's ability. Likewise, the observation that the associations between intelligence test score and suicide were weakest among the least well educated conscripts may be due to a lack of personal career aspirations, and therefore fewer disappointments, in this group. In the absence of such aspirations differences in intelligence may not influence risk of suicide.

There are several possible explanations for the association of intelligence with suicide. Firstly, it is possible that influences on neurodevelopment during childhood (as indexed by intelligence test scores) also increase an individual's susceptibility to mental illness and hence suicide. In support of this possibility, poor intelligence test performance is associated with two of the main disorders contributing to suicide—depression[1] and schizophrenia.[2 3] Exclusion of those men with pre-existing mental disorder at baseline did not, however, greatly influence the strength of the associations. Increased susceptibility to mental illness among those performing poorly on intelligence tests could result either from their reduced ability to compete for jobs, and therefore income and status, or from a direct impact of impaired neurodevelopment, as indexed by low intelligence test score, on particular regions of the brain which are important in the aetiology of mental illness. Secondly, it is possible that in times of crisis, individuals scoring poorly on intelligence tests are less able to identify solutions to their problems and in such situations suicide becomes an aberrant problem solving strategy. The observed lack of association among those with mental illness at baseline may be because this pathway is less important in such people, who may have more severe levels of psychopathology. Lastly, the associations may be confounded by maladjustment and deviant behaviour in childhood. Psychosocial maladjustment in childhood may lead to poor school performance[15] and so poor performance on intelligence tests at conscription. In turn, child-

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What is already known on this topic

The incidence of some psychiatric illnesses is higher among people who perform poorly on tests of intelligence, though mechanisms for this association are unclear

The association of suicide with intelligence is unclear, with some studies reporting positive and others inverse associations

What this study adds

There is a strong inverse association between intelligence test scores and suicide with twofold to threefold higher risks in those with low scores than those with the highest scores

The association with suicide is seen across the whole range of intelligence scores

hood maladjustment is associated with an increased risk of suicide and this, rather than intelligence test performance, may underlie the observed associations.[7] More detailed studies are necessary to investigate possible pathways underlying the observed associations and their clinical implications.

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Contributors: DG, PKEM, and FR developed the core idea. FR and PKEM designed the study. FR prepared the cohort data and did the database linkages. PKEM conducted all statistical analysis. DG conducted the literature search and wrote the first draft of the paper. All authors critically reviewed and contributed to the final draft of the paper and all are guarantors.

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