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Be smart, live long: the relationship between cognitive and non-cognitive abilities and mortality

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Be smart, live long: the relationship between cognitive and non-cognitive abilities and mortality[a]

by

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Abstract
I study the association between cognitive and non-cognitive abilities and mortality, and investigate how well income and education act as proxy measures for ability. The risk of premature mortality is estimated using Cox proportional hazard models with a dataset of 692,303 Swedish men aged 18-20 years, enlisted between the years 1969-1983, and deaths between the years 1969 and 2009. Results suggest that both cognitive and non-cognitive abilities are strongly associated with mortality, independently and through income and education. Non-cognitive ability is a stronger predictor of the risk of mortality than cognitive ability. For middle and high income earners, and individuals with a college education, there are no associations between the abilities and mortality. However, for low income earners and individuals without a college education, cognitive and non-cognitive ability have strong associations with mortality. Results are mainly driven by the bottom of the measured ability distributions.

Keywords: Cognitive ability, Non-cognitive ability, Mortality, Education, Income
JEL-codes: I120, I140 I240, J240

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1 Introduction

Questions on health and longevity are of great personal interest to most of us. We want to know how to live long and healthy. However, these questions are of wider importance than the narrow self-interest. The political debate in many countries revolves around the public health in one way or another; most governments want to know how to improve the general health of the population. There are of course many good reasons for this focus on health. One common argument is that a healthy population is more productive and is less of a burden on the health care. The implications of knowing how to improve the general health of the population may therefore be far reaching.

One of the most important measures of the health of the population is longevity, and in the recent decade researchers have put a lot of effort trying to find the determinants of longevity and its counterpart, mortality. The three main channels discussed in the literature on the determinants of health and mortality are income, education and relative socioeconomic position (e.g. Marmot 2002; Deaton 2003; Cutler, Deaton, and Lleras-Muney 2006; Batty, Deary, and Gottfredson 2007; Vogl, Cutler, and Lleras-Muney 2011).[1] While no one is denying that income, or more general, wealth, is strongly positively correlated with health and longevity[2], the causal relationship is still debated (e.g. Lindahl 2005; Frijters, Haisken-DeNew, and Shields 2005). The same is true for education; while some authors claim a causal effect of education on the risk of mortality (e.g. Lleras-Muney 2005; Kippersluis, O'Donnell, and Doorslaer 2011; Buckles et al. 2013), others find a negligible effect (e.g. Albouy and Lequien 2009; Clark and Roayer 2013). But perhaps these channels are not the fundamental factors. We know from earlier literature that both income and education are related to underlying innate abilities such as cognitive and non-cognitive ability (Lindqvist and Vestman 2011). Income and education could be just mediating factors for the innate abilities rather than causal factors in themselves. It is, for example, possible that cognitive and non-cognitive abilities promotes health behaviors

[1] Other important channels discussed are, among others, nutrition, public health (better water supplies, sanitation systems, etc.), vaccinations and other medical treatments (e.g. Cutler, Deaton, and Lleras-Muney 2006; Batty, Deary, and Gottfredson 2007).

[2] The life expectancy has greatly increased during the last hundred years in wealthy countries, and there is a strong association between the life expectancy in a country and GDP, see Cutler, Deaton, and Lleras-Muney (2006).

which prolong life, such as exercise and non-smoking, commonly ascribed to education.

Cognitive ability is usually defined and measured as IQ or the *g* factor.[3] IQ is considered to be an innate capacity to solve abstract problems, and is a well-established measure of intelligence. Non-cognitive ability, however, is not as well defined. What is often meant is personality and social and emotional traits (Heckman, Stixrud, and Urzua 2006; Cunha, Heckman, and Schennach 2010; Lindqvist and Vestman 2011), and this is how I define it in this paper. In line with the earlier literature I consider non-cognitive ability as an innate ability distinct from what is measured by IQ.[4]

The epidemiological literature suggests a negative association between cognitive ability and mortality (Hemmingsson, Melin, et al. 2006; Deary and Batty 2007; Batty, Deary, and Gottfredson 2007; Batty, Wennerstad, et al. 2009; Batty, Gale, et al. 2009; Hemmingsson, Melin, et al. 2009; Lager, Bremberg, and Vågerö 2009; Calvin et al. 2011). Epidemiologists have also found that cognitive ability is associated with less severe health outcomes than death, such as schizophrenia and psychosis (David et al. 1997), but not with cancer (Batty, Wennerstad, et al. 2007) or coronary heart disease (Hemmingsson, Essen, et al. 2007). An emerging literature in economics has studied the relationship with cognitive and non-cognitive ability for various outcomes, such as success in the labor market (Bowles, Gintis, and Osborne 2001; Nyhus and Pons 2005; Heckman, Stixrud, and Urzua 2006; Lindqvist and Vestman 2011), how teachers abilities can explain student performance (Grönqvist and Vlachos 2008), the intergenerational transmission of the abilities (Grönqvist, Öckert, and Vlachos 2010), and how cognitive ability is related to risk aversion and impatience (Burks et al. 2009; Dohmen et al. 2010; Benjamin, Brown, and Shapiro 2013; Andersson et al. 2013). However, only a few papers have addressed the association between non-cognitive ability and health.[5] Since cognitive and non-cognitive

[3] The *g* factor is a concept introduced by Charles Spearman in the early 20th century reflecting the fact that an individual's performances in different cognitive tasks often are highly positively correlated.

[4] I use "ability" when referring to the innate capacity, both in regards to cognitive and non-cognitive aspects, and "skill" when referring to what is actually measured. It is nearly impossible to measure the innate capacity since the ability to solve more or less any task is affected by training and experience. Also note that in all "non-cognitive" problems naturally some form of cognition must be involved.

[5] Savelyev and Tan (2014) and Savelyev (2014) study socioemotional skills and longevity for high IQ (above 140) individuals, with a focus on the causal effect of education on longevity and health behaviors. The authors find strong effects of personality skills on health and longevity for men but not for women.

abilities to some extent capture the same variation the health literature may lack a potentially influential dimension.

As the growing epidemiological literature suggests, the relationship between cognitive ability and mortality has interested researchers in itself. The relationships tell us something about what is possible to do with policy, and where we should focus health improving policies. But there is another reason to study the relationships between cognitive and non-cognitive ability and mortality as well. A common practice in economics is to use income and education as proxy measures for individual ability. Hence, this paper contributes to the literature in two ways. First, in addition to study the relationship between cognitive ability and mortality, I also include a measure of non-cognitive ability. Second, when I look at the associations between the ability measures and mortality, I also include income and education. This is a test of how well income and education act as proxy measures for the abilities.

I use Swedish military enlistment data for measures of cognitive and non-cognitive ability and link this register with demographic variables and the year of death. The data consists of 692,303 men born between 1950 and 1965, enlisted between 1969 and 1983. This is almost the full male population during the sample period. There are 28,570 deaths in the sample between the years 1969 and 2009. The sample period ends when the oldest individuals are 59 years old and the youngest individuals 44 years old. In that sense I estimate the associations between cognitive and non-cognitive ability and *premature* mortality, as even the oldest possible age for an individual in the dataset is an early age of death in Sweden.

At the time, military enlistment in Sweden was mandatory for all young men. Enlistment usually took place in the year when the individual turned 18 years old and spanned over two days with tests of health status and, most important for this study, cognitive and non-cognitive ability. The cognitive ability test consisted of a non-standard IQ test, aiming at measuring the *g* factor, while the non-cognitive ability was measured by a psychologist during an interview. The aim of the interview was to assess the individual's ability to cope with stress and fulfill military service, and included assessment of, among other things, social skills, emotional stability and persistence.

The main results support the literature on the negative association between cognitive ability and mortality. However, the results suggest that non-cognitive ability is of even greater importance; the Cox proportional hazard models indicate that the association between the risk of mortality and non-cognitive ability is more than two times the association with cognitive ability when controlling for income and education. The abilities are related to both income and education; cognitive ability mainly with education, and non-cognitive ability mainly with income. In addition to the direct associations, results suggest that income and education act as indirect pathways for the abilities relation with mortality. Lastly, cognitive and non-cognitive abilities are important in the relation with mortality for individuals with low income or non-college education. Using income and education as proxy measures for individual ability may therefore miss the large variation within these groups. The results are mainly driven by the bottom of the distributions.

The paper is organized as follows. In the next section I provide a conceptual framework of the causal chains of interest. In section 3, I describe the data and present descriptive statistics. Study limitations are discussed in section 4. Then I turn to the baseline analysis in section 5, followed by a pathway analysis in section 6. I discuss the findings in section 7, and section 8 concludes. The appendix includes tables and figures describing the data in more depth and provides additional results.

2 Theoretical framework

In this section I introduce a conceptual framework and review the literature on the relationships of interest: cognitive and non-cognitive abilities, health, income and education.

Figure 1 presents a framework of the main channels discussed in the literature, including cognitive and non-cognitive abilities.[6] In addition to the two abilities and health, measured as premature mortality, it consists of two mediating paths: income and education. The first thing to note is that some arrows go in both directions; between the abilities and health, and between health and the two mediators. Theoretically, health matters for income and education (Grossman 1972; Deaton 2003). Individuals with very bad health

[6] Relative socioeconomic position is excluded in the framework. It is a relatively common explanation for differences in health, but it is not obvious how to operationalize it. What is the individual socioeconomic position relative to?

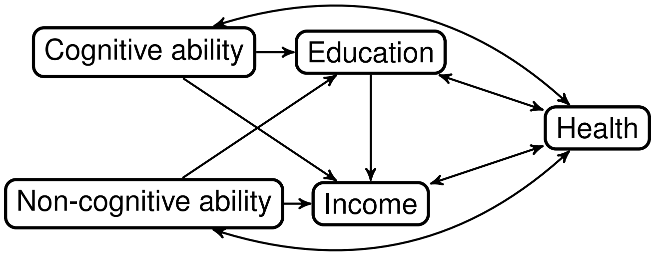


Figure 1: Relationships between cognitive and non-cognitive ability, mediators, and health.

cannot work or receive an education. Health also matters for cognitive and non-cognitive abilities. An extreme example, brain damage, clearly affects both the cognitive ability (Batty, Deary, and Gottfredson 2007; Currie 2009) and the non-cognitive ability.

Empirically, however, whether these are causal effects are not easy to show. To credibly study causal links between the variables in *Figure 1* is nontrivial due to two-way causality, mediators and confounders. It is difficult to find exogenous variation to single out an effect. In addition, studies on cognitive and non-cognitive ability use *skills* as measures for abilities (see section 4). However, both cognitive and non-cognitive skills have been shown to be causally linked with income and education (Bowles, Gintis, and Osborne 2001; Heckman, Stixrud, and Urzua 2006). Savelyev and Tan (2014) and Savelyev (2014) find that non-cognitive skill is linked with health and longevity for men with very high cognitive skill. If we interpret the epidemiological literature causally, cognitive skill has been shown to be linked with health and mortality (e.g. Batty, Wennerstad, et al. 2007, 2009).[7] In addition, Nyhus and Pons (2005) and Lindqvist and Vestman (2011) have shown that cognitive and non-cognitive skills are associated with success in the labor market.

As shown in *Figure 1* cognitive and non-cognitive abilities are not only linked with health and mortality directly, but also through the mediators. If the mediators in fact are causally linked with health, at least a part of this effect stems from the abilities, but as noted in the introduction the causal relationship between income, education and health

[7] The epidemiological literature usually do not discuss the identification problem. To study causal effects epidemiologists often settle with controlling for potential mediators and confounders, a practice normally not endorsed in the econometric literature.

are widely discussed and these questions are far from settled (Lindahl 2005; Frijters, Haisken-DeNew, and Shields 2005; Lleras-Muney 2005; Clark and Roayer 2013; Fischer, Karlsson, and Nilsson 2013; Savelyev and Tan 2014; Savelyev 2014).

Studies have also shown that health and income affect cognitive skill, which means that there could be an arrow from income to cognitive ability (or skill) in *Figure 1* (Currie 2009; Mani et al. 2013). I ignore this link, as the causal evidence mainly focus on severe outcomes such as brain damage or extreme poverty, not common in Sweden. Additionally, there is evidence of an association between birth-weight and nutrition in the childhood and cognitive functions in adult life (Sørensen et al. 1997; Gomez-Pinilla 2008; Bharadwaj, Løken, and Neilson 2013), and that socioeconomic factors or injuries such as head trauma are associated with lower cognitive ability (Batty, Deary, and Gottfredson 2007; Calvin et al. 2011). A number of studies present evidence that health affects both education and income (Contoyannis and Rice 2001; Currie 2009; Ding et al. 2009), and education is causally linked with income (Angrist and Krueger 1991; Card 1999; Acemoglu and Angrist 2001).

Cognitive and non-cognitive abilities may partly be health measures in themselves. This is especially relevant for individuals with low non-cognitive ability, since that could be an indication of psychological ill-health, for example depression. It would therefore not be surprising if we find that individuals with a very low non-cognitive ability have a higher risk of mortality compared with other groups. However, an individual can have a low non-cognitive ability without any psychological health problems.[8]

We do not believe that there is a direct effect of cognitive and non-cognitive abilities on mortality, but rather that the link goes through individual behavior which affects the health. It is likely that an individual with a high cognitive ability in general is more prone to act in a way that promotes health, i.e. invests in health capital (cf. the Grossman model). We should also expect that an individual with a high non-cognitive ability (have a good social life, is calm, can cope with stress etc.) is more prone to engage in behavior which promotes health, or at least is more likely to avoid circumstances that are related

[8] There is no information on, for example, psychiatric diagnoses in the data, but it should be noted that all individuals in the data where healthy enough not to be exempted from the from the enlistment.

with behaviors associated with bad health.

I assume that the cognitive and non-cognitive measures are on abilities rather than skills. However, as noted before, for essentially all studies on the subject – including this one – the observed abilities are only proxies for the true abilities. As the focus in this paper is an overall description this makes no important difference. Rather, this is a question on the scaling of the estimates. I discuss this further in section 4. The reader should note that the terms "abilities" and "skills" often are used interchangeably in the literature.

3 Data

The data comes from several Swedish population-wide registers which are linked by using unique individual identification numbers. The Swedish military enlistment data includes information on cognitive and non-cognitive abilities for all individuals in the sample, described in section 3.1. This register is linked with information on the year of death, mean yearly income at 31-35 years of age and education (from 1985 up till the year 1999 for education, and up till 2000 for income).[9] The income variable is inflation-adjusted with the year 2000 as base.

The data consists of the population of individuals born between 1950 and 1965, who were enlisted between 1969 and 1983 in the year they turned 18-20.[10] Military service was mandatory only for men, therefore the small fraction of women who enlisted for military service are excluded from the data. With these restrictions the sample consists of 692,303 men with records from the military service. However, I do not have full information for income (missing 13,035 observations) and education (missing 8,943 observations). One reason is that about 16 percent of the deaths in the sample (4,562 observations) occurred before 1985, the first year of the demographic variables. In total the

[9] The choice of the 31-35 age bracket was guided by Böhlmark and Lindquist (2005), who found that for men this age bracket is a good proxy for lifetime income. Education is measured at age 30. If education is missing for that age, then the education level at age 29 or 31 is used. If information on education is missing for all these ages, the last record of education is used. For the cohorts born between 1950-54, the income variable for the oldest cohorts is a mean of the available years during the age bracket 31-35, and the education is measured at 31-36 or the last record of education.

[10] Some individuals were older than 20 years at enlistment. These individuals were excluded due to the possible unobserved factors affecting the timing.

dataset includes 28,570 deaths, about 4 percent of the individuals in the sample.[11]

The data on year of death ranges between the years 1969 and 2009, implying that the oldest individuals in the data, born 1950, is at most 59 years old when censored, and the youngest individuals, born 1965, at most 44 years old. The focus in this paper is all-cause premature mortality, which is used as a proxy for health. Data on cause of death is not available. However, the five most common causes of death for men aged 20-59 between the years 1969-2006 in Sweden are, in order: ischemic heart disease; suicide; malignant tumor; "other" accidents; traffic accidents.

3.1 Enlistment data

During the time period military enlistment was mandatory for all men in Sweden, with exemptions only for institutionalized individuals, prisoners, individuals living abroad and individuals with a severe medical condition or disability.[12] Otherwise, practically all men between 18-20 years old were enlisted. Individuals who refused to enlist were punished with a fine or, eventually, imprisonment. Almost 72 percent of the sample enlisted in the year they turned 18, and about 25 percent in the year they turned 19. The mean age of enlistment in the sample is 18.3 years.

Enlistment usually spanned over two days and involved tests of the individual's health status, physical fitness, cognitive ability and non-cognitive ability. There was no incentive to underperform since it was not possible to avoid military service by scoring low on these tests.

The Swedish military has conducted tests of cognitive and non-cognitive abilities since the mid-1940s to help determine the military service of the enlisted. Cognitive ability was measured by a non-standard IQ test, aiming at measuring the g factor.[13] The test consisted by four sub-tests, representing logical, spatial, verbal and technical comprehension. The result at each sub-test was standardized to give a score between 1 and

[11] Before exclusions, the number of observations in the data are 724,748 individuals, so I use about 94 percent of the total number of observations. In the full dataset there were 32,255 deaths, so I use about 87 percent of all deaths.

[12] This could lead to biased estimates, but since almost everyone enlisted the bias should be small.

[13] Carlstedt (2000) provides evidence that the cognitive ability test is a good measure of "general intelligence", in contrast with the US military Armed Forces Qualification Test, AFQT, which focuses on "crystallized" intelligence (Lindqvist and Vestman 2011).

Table 1: Cognitive ability score and IQ.

Stanine	1	2	3	4	5	6	7	8	9
IQ	<74	74-81	82-89	90-95	96-104	105-110	111-118	119-126	>126

Notes: Stanine score and corresponding IQ with a mean of 100 and standard deviation of 15 (David et al. 1997).

9, a so called Stanine distribution.[14] The sum of these four Stanine scores (ranging from 4-36) was, in turn, standardized into a Stanine variable of cognitive ability. Each Stanine score represents a range in IQ in accordance with *Table 1*.[15] As described by Batty, Wennerstad, et al. (2007) and others, the logical test measured how well the individual could understand written instructions and apply them to solve problems. In the spatial test the task was to identify the correct 2D plan drawing from a series of drawings of fully assembled 3D objects. The verbal test measured the individual's knowledge of synonyms. The individual was given a word and four alternatives of synonyms, and the task was to choose the correct synonym. Lastly, the technical abilities test measured the individual's knowledge of physics and chemistry. This test can be considered as a measure of general knowledge.

The non-cognitive ability was measured according to a procedure which remained unchanged during the sample period (Lindqvist and Vestman 2011). The conscripts were interviewed by a certified psychologist for about 25 minutes. The interviewer had information on the results at the cognitive ability test, physical fitness test, the grades in school and answers to about 80 questions about friends and family etc. that the individual had answered before the interview. The interview followed semi-structured rules. The psychologist followed a manual that stated the topics to discuss during the meeting, but no question was specified beforehand. The objective of the interview and the non-cognitive measure was to capture the general ability rather than a specific personal trait. The psychologist had to evaluate the individual's capability to function and fulfill the requirements in a demanding environment, i.e. military duty and armed combat. Motivation for doing

[14] A Stanine ("STAndard NINE") distribution is calculated such that the mean value is 5 and the standard deviation is 2, with 1 as the lowest value and 9 as the highest value. 20 percent of the distribution is centered at 5, and 4 percent at 1 or 9 respectively. Each interval has a 0.5 standard deviation width except the first and the last, which contains the remainder of the distribution.

[15] Note that the Stanine scores and IQ scores are not exactly comparable, since the Stanine scores represents the generalized intelligence.

military service was not judged. A high score was given if the individual was considered to be emotionally stable, willing to assume responsibility (in general), able to cope with stress, and take initiatives etc. (Grönqvist, Öckert, and Vlachos 2010).[16] The final Stanine score of non-cognitive ability was determined, partly, by four different sub-scores which ranged from 1 to 5. These sub-scores only functioned as a guide for the psychologist; two individuals with exactly the same scores could receive different final scores. The details of how the final assessment was done are classified.

3.2 Descriptive statistics

Descriptive statistics are presented in *Table 2* and *Table 3*, and the distribution of deaths by year and cohort in *Figure 2*.

About 4 percent in the sample have died (28,570 individuals). *Table 2* shows that of those who have died, most died at a young age. Around 60 percent (17,231 individuals) of all deaths occurred before the age of 45, and almost 22 percent before the age of 30.

The mean age of enlistment is 18.3 years as shown in *Table 3*. The cognitive and non-cognitive abilities are centered on a score of 5 with a standard deviation close to 2, as they should according to the Stanine distribution (see footnote 14). Individuals with a mean labor income below the 1st quartile earned about 55,000 SEK a year on average, with a maximum of 130,000 SEK, while individuals above the 3rd quartile earned 301,000 SEK a year on average, and at least 232,000 SEK a year. About 4 percent of the sample (26,338 individuals) had an income of 0 SEK, i.e. did not receive any income during their early 30's. 24 percent of the individuals have at most 9 years of education, while 50 percent have between 10-12 years of education (high school education) and 25 percent have at

Table 2: Age and cumulative mortality.

Age	Cum. freq. (dead)	Cum. perc. (dead)	Cum. perc. (full sample)
<30	6,212	21.74	0.90
<40	12,641	44.25	1.83
<45	17,231	60.31	2.49
All	28,570	100.00	4.13

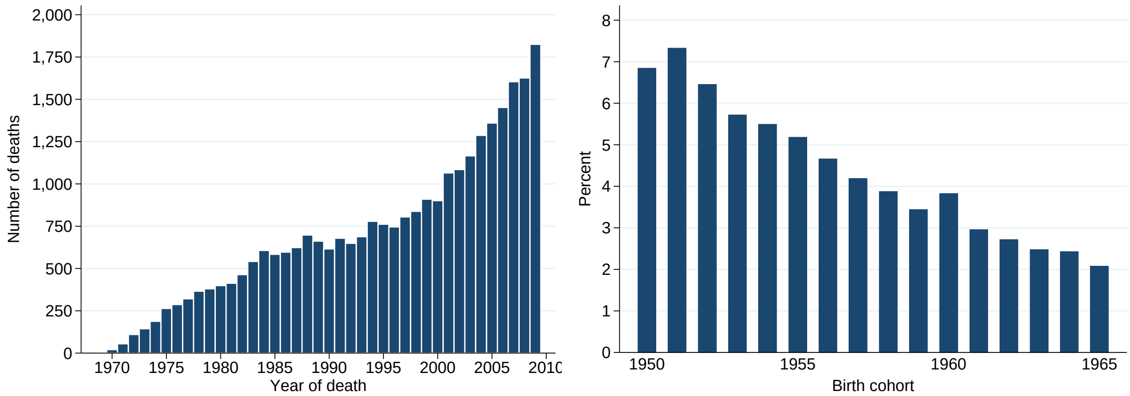
Notes: Every cohort in the sample is followed up till at least 44 years of age (see section 3).

[16] As shown by Lindqvist and Vestman (2011), individuals who score high in this measure are more likely to succeed in the labor market.

Table 3: Descriptive statistics.

	Observations	Mean	Standard dev.
Cognitive ability	692,303	5.18	1.95
Non-cognitive ability	692,303	5.08	1.79
Enlistment age	692,303	18.31	0.52
Deaths[1]	28,570	0.04	
Income	679,268	182.16	106.62
Low income (<Q1)	169,817	54.93	44.45
Middle income	339,634	186.11	26.19
High income (>Q3)	169,817	301.48	108.03
Years of education	683,360	11.68	2.50
At most 9 years of education[1]	169,455	0.24	
At most high school education[1]	344,256	0.50	
College education[1]	169,649	0.25	
N	692,303		

Notes: Data is missing on income and education for 13,035 and 8,943 individuals respectively. Income is measured as the mean yearly labor income at 31-35 years of age, inflation-adjusted with the year 2000 as base, in 1,000's SEK. Years of education is measured around age 30, and ranges from 7.1 to 19.9 years, where *At most high school education* is defined as at most 12 years of education.
[1] Mean in the full sample.



(***a***) Mortality per year.
(***b***) Mortality by birth cohort.

Figure 2: Mortality per year, and per birth cohort.

least 13 years of education (i.e. college education).

Figure 2 presents the distribution of deaths per year (*a*) and per cohort (*b*). Not surprisingly, the number of deaths each year is increasing, and individuals in older cohorts are more likely to have died.[17]

[17] The exception is the 1960 birth cohort which, due to missing observations in the Swedish military enlistment data, includes only 7,229 individuals compared with 48,678 individuals in 1959 and 41,923 individuals in 1961. This is a problem for all studies using this data. However, the cohort closely follows the Stanine distribution in the ability measures, indicating that there is no systematical bias in the missing data.

4 Study limitations

Grönqvist, Öckert, and Vlachos (2010) points out that for essentially all studies on cognitive and non-cognitive abilities the observed abilities are only proxy measures for the true abilities. They identify at least two potential sources of measurement errors. First, the evaluation instruments only test a subset of the true ability, and the individual ability may differ in these specific traits. The subtest of synonyms for cognitive ability, for example, can of course only cover a few words, and an individual may have a good or bad day with these words. Second, individual ability may differ in the respect of taking tests; e.g. high or low motivation, illness or nervousness. As they argue, the measurement error for non-cognitive ability is probably more severe than for cognitive ability, since the evaluation instruments for measuring cognitive ability are more developed than those measuring non-cognitive ability. While I recognize the measurement error problem, I will not try to correct for this. In the setting of this study, as long as this type of measurement error is evenly distributed, it is a question of scaling of the estimates. However, it can of course be the case that the psychologists are better at measuring the tails (very low or high ability).

Another possible measurement error of the non-cognitive ability is that it partly may be a measure of health, such as depression, and that the psychologist know the result on the cognitive ability test (which partly may explain the correlation between cognitive and non-cognitive ability). This is an inherent weakness of the data. However, the individuals in the sample were at least healthy enough not to be exempted from enlistment.

A second problem is the relationship between the variables (cf. *Figure 1*). Cognitive and non-cognitive abilities are related to both income and education. Ideally, a control variable should be fixed when the independent variable of interest is determined. Therefore, in a regression analysis on mortality with cognitive and non-cognitive abilities as independent variables, inclusion of income and education as control variables may result in a bad controls problem (Angrist and Pischke 2009), as they themselves are outcomes of the abilities (i.e. not fixed before the abilities). This may introduce selection bias, and, as a result, biased estimates. However, I will still include them as controls in the regressions in the pathway analysis as this is suggested by the theoretical framework. Income and education are potentially channels for the association between the abilities and mortality, and the regressions can still give us an indication if this indeed is the case. But the selection bias problem means that one must be aware of this when interpreting the estimates for the abilities in section 6.2. The likely consequence is a downward bias. For example, an individual with a high income but low ability is unusual in at least that respect, and is perhaps able to compensate the lack of ability with something unobserved in the data.

Due to lack of data availability for income and education before 1985, observations are missing for individuals who died before this year, so the number of observations in the regressions varies. The result is a downward bias of the estimates for cognitive and non-cognitive abilities when income and education are included. Individuals who died before 1985 have, on average, a lower cognitive and non-cognitive ability (4.6 and 4.3 respectively) compared with individuals who died 1985 or later (5.2 and 5.1 respectively).

5 Baseline analysis

Let us turn to the baseline analysis. In this section I study the association between cognitive and non-cognitive abilities, and the association with mortality. The analyses are conducted both graphically and with regression models.

5.1 Graphical analysis

To begin with we look at the association between cognitive and non-cognitive abilities. The correlation is 0.38, and the relationship is almost linear (cf. *Figure 3*). This indicates that an individual with a high cognitive ability also, on average, have a high non-cognitive ability. Individuals with the lowest cognitive score have, on average, a non-cognitive score of 3, while the highest scoring individuals in cognitive ability have, on average, a non-cognitive score of 6. Individuals with the average cognitive score of 5 have, on average, the same score in non-cognitive ability.

Figure 4 presents the relationships between cognitive ability, non-cognitive ability and mortality at three different ages of death in addition to the full sample. Not surprisingly, not many individuals have died before the age of 30 (*a*). However, even at this age, there is a weak linear association between the abilities and mortality, with a slight upward curve

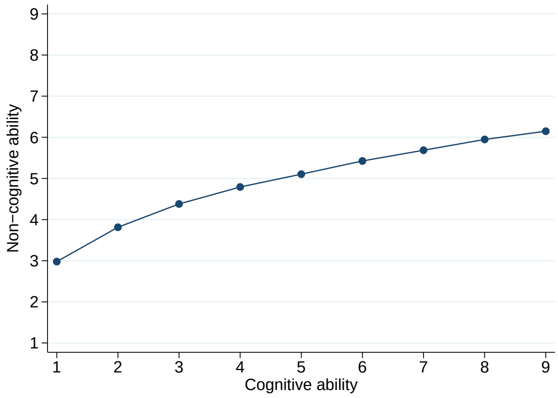
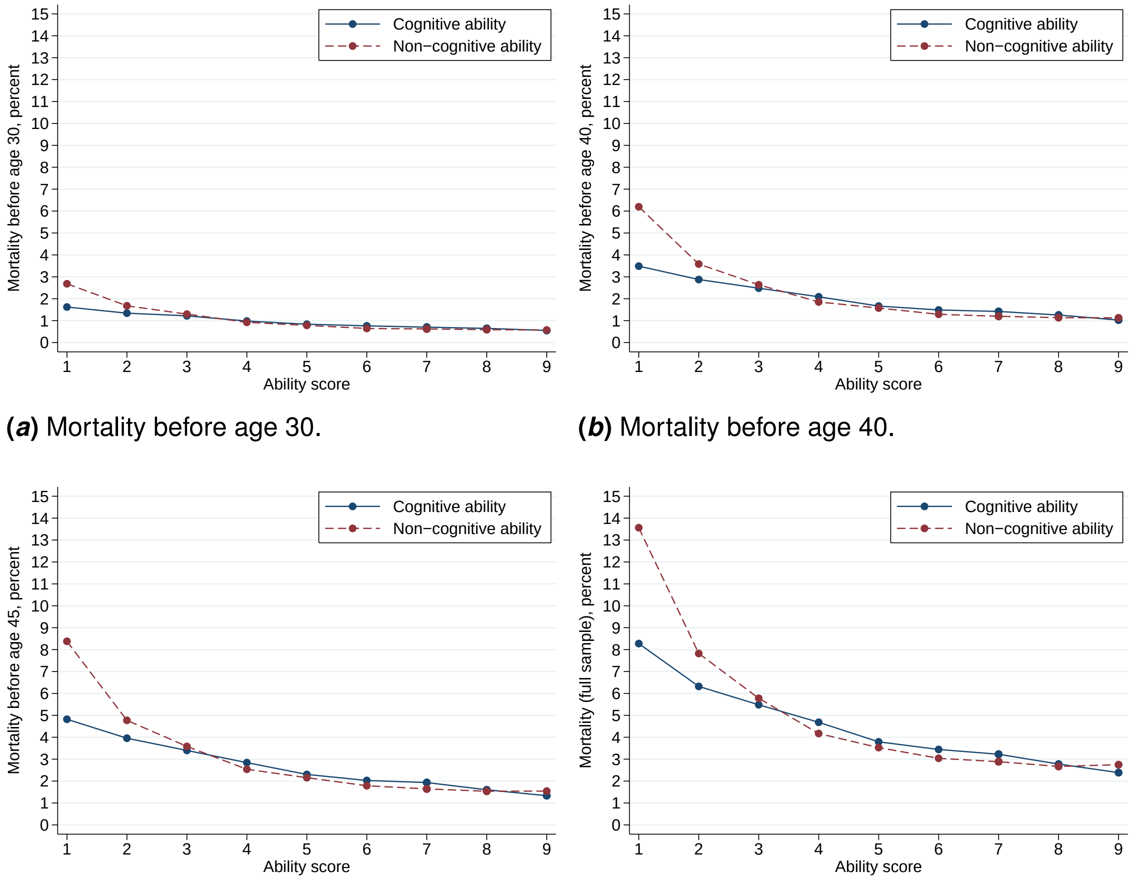


Figure 3: Association between cognitive and non-cognitive ability.

for the lowest scoring individuals in non-cognitive ability. Less than 1 percent of the sample who scored 6 or more in non-cognitive ability have died, compared with almost 3 percent of the individuals scoring 1. The association becomes stronger if we turn to mortality before age 40 (*b*) or mortality before age 45 (*c*). If we look at the latter, there is a clear curvature for non-cognitive ability at the bottom of the distribution. More than 8 percent of the lowest scoring individuals have died, compared with less than 2 percent of the highest scoring individuals. The overall picture is the same in the full sample (*d*).

Figure 4 shows that there are strong relationships between the abilities and mortality. The overall pattern looks the same independent of age of death. The relationships, however, are not linear. This is especially true for the non-cognitive measure; the relationship has more and more of a curvature in the bottom of the distribution the higher the age of death. In the full sample almost 14 percent of the individuals scoring 1 in non-cognitive ability have died, which is almost 6 percentage points more than the individuals scoring 2 in the same measure. The mortality among the highest scoring individuals is only about 3 percent. In addition, non-cognitive ability seems to be a stronger predictor of premature mortality than cognitive ability. This indicates that the interview with the enlisted reveals something about individual ability beyond that of cognitive ability alone.

The large difference between the two lowest scores in non-cognitive ability may indicate that very low non-cognitive ability partly is a measure of health, such as depression (see discussion in section 4). However, if we exclude the lowest scores, the non-cognitive ability is still a stronger predictor than cognitive ability. The abilities have more or less



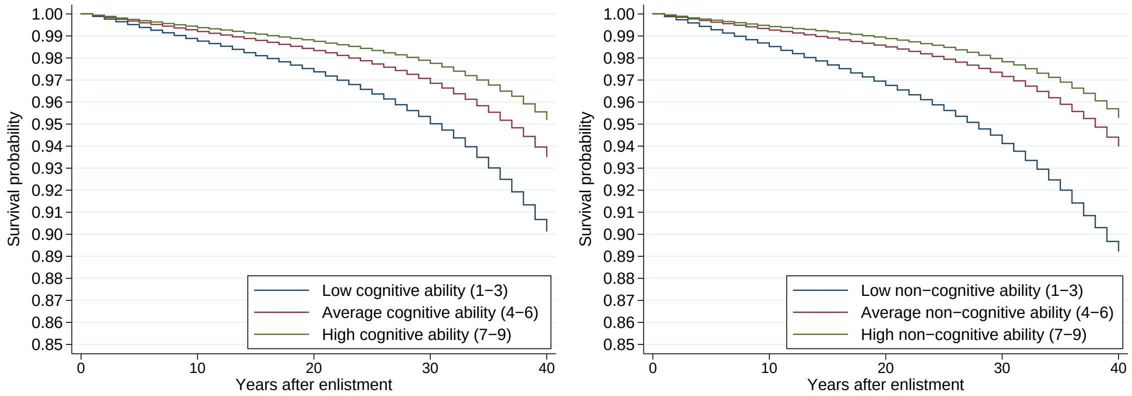
(*a*) Mortality before age 30. (*b*) Mortality before age 40.

(*c*) Mortality before age 45. (*d*) Mortality in full sample.

Figure 4: Associations between cognitive and non-cognitive ability and mortality at different ages of death.

the same strength if the two lowest scores are excluded.

Figure 5 presents Kaplan-Meier survival curves for mortality in the full sample. The figure shows the survival probability each year after the abilities were measured. The ability measures are divided into three groups for the respective ability measure: low, average and high. First, we look at the survival curve for cognitive ability (*a*). At year 0, the probability of survival is 1. As time goes on the probability of survival shrinks. After a few years a distinct pattern emerges for each respective group. At the last period the survival probability for the high scoring individuals is above 0.95, but only about 0.90 for the low scoring individuals. Considering the outcome, premature mortality, the difference is large. Perhaps even more surprising is that the difference between the average scoring individuals and the high scoring individuals is relatively large; the survival probability



(*a*) Cognitive ability. **(*b*)** Non-cognitive ability.

Figure 5: Kaplan-Meier survival curves for the relationships between cognitive and non-cognitive ability and mortality.

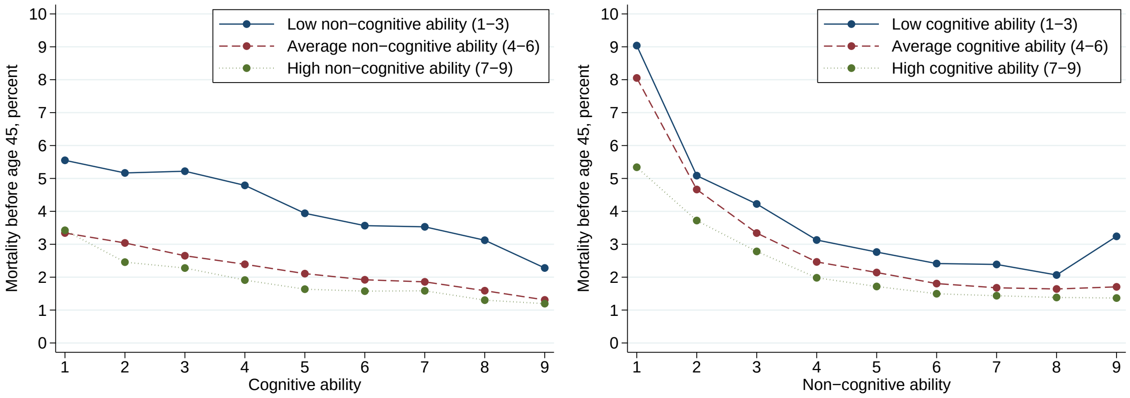
for the average scoring individuals is below 0.94. The same pattern can be seen for non-cognitive ability (*b*). At least for the low scoring individuals, non-cognitive ability has a stronger association with mortality than cognitive ability. Individuals in this group have a survival probability of about 0.89 in the last period, while the high scoring individuals have a survival probability above 0.95 and the average scoring individuals a survival probability of 0.94.

As *Figure 5* shows, there are not only differences in risk of mortality in relation to the ability measures (cf. *Figure 4*); the differences grow over time. The low scoring individuals have a lower survival probability than the average scoring individuals, and the average scoring individuals have a lower survival probability than the high scoring individuals.

Figure 6 concludes the baseline graphical analysis. In this figure, the ability measures are plotted against mortality before age of 45.[18] The individuals are divided into three groups in the *other* ability. Hence, in (*a*), individuals are grouped in non-cognitive ability while plotted at the respective cognitive ability score against mortality. In (*b*), the individuals are grouped in cognitive ability and plotted at the respective non-cognitive ability score against mortality.

We have seen that there is an almost linear relationship between mortality and cogni-

[18] This is to avoid the problem of right censoring. However, as seen in *Figure 4d*, this does not change the pattern.



(*a*) Mortality and cognitive ability. **(*b*)** Mortality and non-cognitive ability.

Figure 6: Mortality by ability, divided into groups in the other ability.

tive ability (cf. *Figure 4c*). The linear relationship still apparent in (*a*), but there are large differences between the groups. Individuals with a low non-cognitive ability have a much higher risk of premature mortality compared with individuals with at least an average score. The difference between individuals with an average or high non-cognitive ability is relatively small, however. In (*b*), the non-linear relationship seen earlier is still clear. With the exception for the individuals with the lowest and highest non-cognitive ability, the differences between the three groups are more or less constant. Individuals with a low non-cognitive ability (3 or below) have a much higher risk of mortality than individuals with a higher score.

Figure 6 strengthens the conclusion that low non-cognitive ability seems to be the more important predictor of premature mortality of the two abilities. The risk is considerably higher regardless of the score in cognitive ability. This suggests that it is not possible to fully compensate a low non-cognitive ability with high cognitive ability.

5.2 Regression analysis

We now turn to the regression results. In this section I present Cox proportional hazard models, mainly due to the right censoring of the data, but report OLS regressions in the appendix.

Table 4 shows the results. The estimated hazard ratio for cognitive ability is 0.8564, i.e., a one point increase in cognitive ability results in a 14 percent lower risk of mortality. The corresponding result for non-cognitive ability is even stronger; a one point increase in non-cognitive ability results in a 19 percent lower risk of mortality, indicating that both measures are important but that non-cognitive ability is a stronger predictor than cognitive ability. These results support the graphical analysis earlier, and are further boosted when both abilities are included in a single regression (column 3). Cognitive ability is associated with a 9 percent lower risk of mortality while the association with non-cognitive is about 16 percent. The attenuation is greater for cognitive ability, indicating that non-cognitive ability captures more unique variation in the data.

The relative risk of mortality is shown in *Table 5*. Using the highest score in the respective ability as the reference point, the models estimate the risk of mortality compared to the reference point. The results confirm the findings in *Figure 4*; the risk of mortality is much higher among individuals with lower scores. The models also confirm the non-linear pattern of the association between non-cognitive ability and mortality, suggested in the graphical analysis, while cognitive ability have more even differences across the gradient.

An individual with a cognitive ability score of 1 has a risk of mortality 3.6 times that of an individual with a score of 9, while the risk of mortality for individuals with a non-cognitive score of 1 is more than 5 times that of an individual with a score of 9. The risk of mortality is considerably lower for an individual with a score of 2 in non-cognitive ability, 3 times that of an individual with a score of 9.

As in the graphical analysis, the lowest non-cognitive score differs a lot from the second lowest, which could be an indication of that low non-cognitive ability partly is a health measure. If we exclude the two lowest scores, cognitive ability is actually a somewhat stronger predictor of mortality than non-cognitive ability.

Table 4: Association with mortality.

	(1)	(2)	(3)
Cog. ability	0.8564***		0.9133***
	(0.0026)		(0.0029)
Non-cog. ability		0.8059***	0.8369***
		(0.0029)	(0.0032)
Observations	692,235	692,235	692,235

Notes: Hazard ratios. Mortality as event. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: Relative risk of mortality.

Score	Cog. ability	Non-cog. ability
1	3.6042***	5.2056***
	(0.1592)	(0.2736)
2	2.8244***	3.0264***
	(0.1165)	(0.1545)
3	2.4305***	2.2474***
	(0.0977)	(0.1130)
4	2.0513***	1.6518***
	(0.0811)	(0.0827)
5	1.6969***	1.4067***
	(0.0668)	(0.0700)
6	1.4785***	1.1940***
	(0.0592)	(0.0605)
7	1.3711***	1.1164**
	(0.0565)	(0.0577)
8	1.1728***	1.0089
	(0.0524)	(0.0562)
9 (ref.)	1	1
Observations	692,235	692,235

Notes: Hazard ratios. Mortality as event. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The Cox proportional hazard models confirm and add to the overall picture given by the graphical analysis. The abilities are strongly associated with mortality, and there are differences in the risk of mortality at every point.

6 Pathway analysis

We will now turn to the pathway analysis. As in the previous section the analyses are conducted both graphically and with regression models. The baseline analysis gave a general picture of how the ability measures are associated with mortality, but did not include income or education. In this section these variables are included in the analysis.

6.1 Graphical analysis

The associations between cognitive and non-cognitive ability and mortality are strong, but the relationships may be driven by differences in income and education. After all, we know that the abilities have strong relationships with these variables (see earlier references, e.g., Heckman, Stixrud, and Urzua 2006; Lindqvist and Vestman 2011).

I begin with looking at the relationship between income and education (*Figure 7*). Up till about 17 years of education there is a strong and linear positive relationship between education and income. Individuals with at least 17 years of education earns, on average, about 100,000 SEK more per year than individuals with the least years of education.

The next question is how income and education are related to the abilities (*Figure 8*).[19] There are strong and more or less linear relationships between income and the abilities, as shown in (*a*). Individuals with low abilities earn, on average, much less than individuals with high scores. The relationships between abilities and education are presented in (*b*). As with income, the relationships are positive and strong. Noticeably, above an average score, cognitive ability becomes a stronger predictor of education than non-cognitive ability. Individuals scoring 5 have, on average, at most high school education, while individuals with higher scores continued to college. The lowest scoring individuals in cognitive ability have, on average, at most nine years of education.

We now turn to the relationships between income, education and mortality (*Figure 9*). The relationship between mortality and income is non-linear below the 50th percentile (*a*). More than 4 percent of the individuals below the 10th percentile have died, but only about 0.5 percent of the individuals above the 90th percentile. Similar differences can be seen for the relation between education and mortality (*b*). About 2.5 percent of the individuals with at most 9 years of education have died, but less than 1 percent of the most educated individuals. Individuals who have studied at least a few years in college

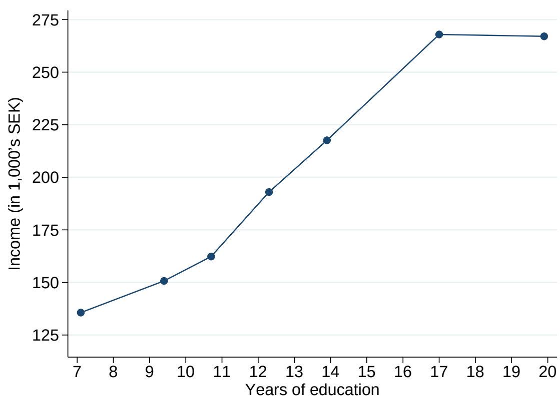
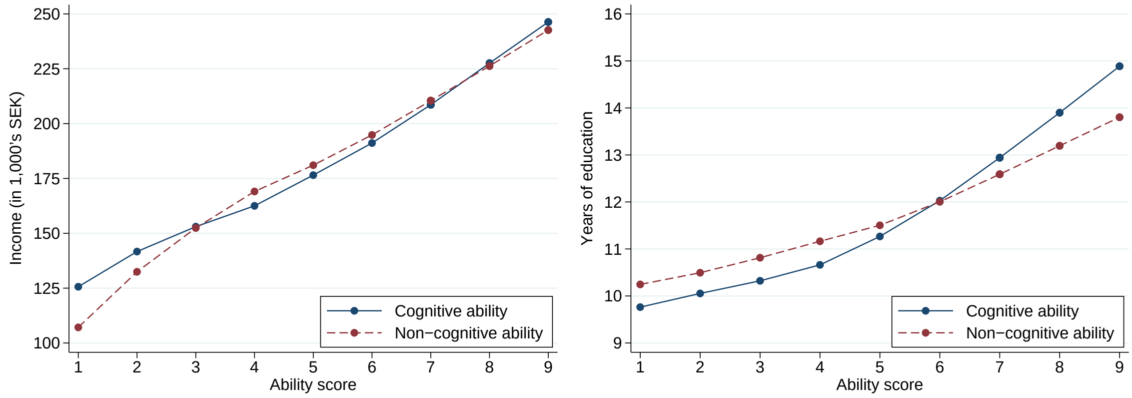


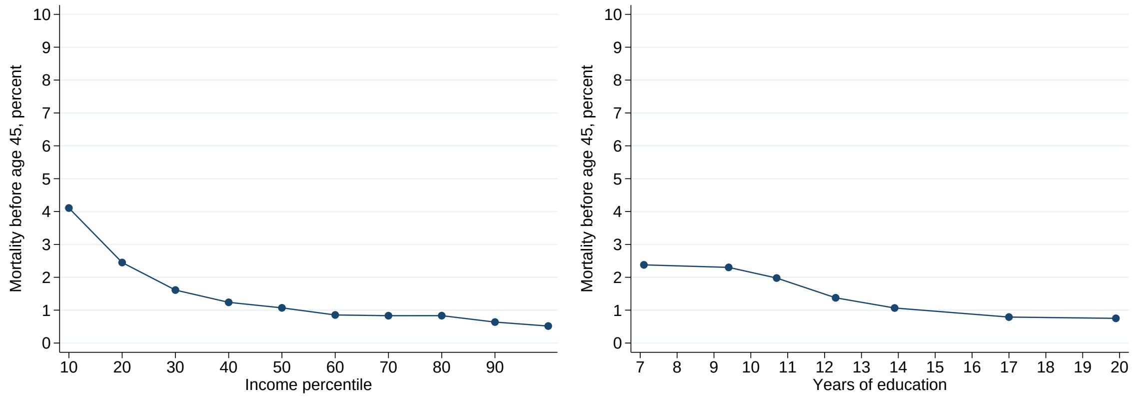
Figure 7: Association between income and years of education.

[19] The relationship between abilities, income and education has been studied earlier by Heckman, Stixrud, and Urzua (2006) and Lindqvist and Vestman (2011).



(***a***) Income and abilities. (***b***) Education and abilities.

Figure 8: Associations between income, education and cognitive and non-cognitive ability.



(***a***) Income and mortality. (***b***) Education and mortality.

Figure 9: Associations between income, education and mortality.

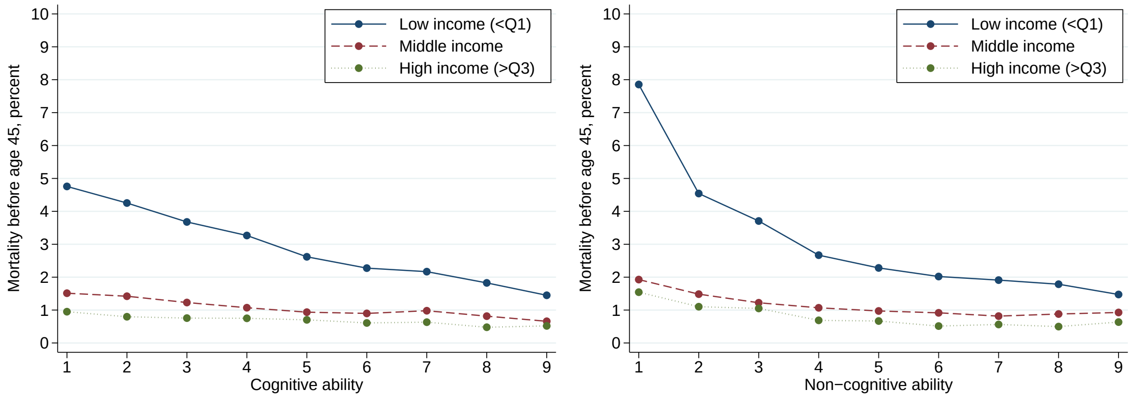
have died in about the same extent. The figure suggests that both income and education are important predictors of mortality, but that it is mainly the lower part of the distributions that are driving these relationships.

The earlier figures show that the abilities are strong predictors of income and education, and that both variables are associated with mortality, but how are these variables interacted?

We start by looking at the interaction with income (*Figure 10*). (*a*) presents the relationship between mortality and cognitive ability when the individuals are divided into income groups. There is still a linear relationship between cognitive ability and mortality, but we can see that it is almost completely driven by individuals with low income. Of the individuals with low income, about 5 percent of those with a cognitive ability score of 1 have died, while less than 2 percent of the individuals with the highest cognitive ability score have died. The middle income group and the high income group have much weaker gradients. About 0.5-1.5 percent in these groups have died. The difference in regards to income and mortality is even more pronounced if we look at non-cognitive ability as shown in (*b*). Almost 8 percent of the individuals with low income and the lowest score of non-cognitive ability have died, but only 1.5 percent of the individuals with the highest non-cognitive score. Again, the gradient is much weaker for the middle and the high income groups.

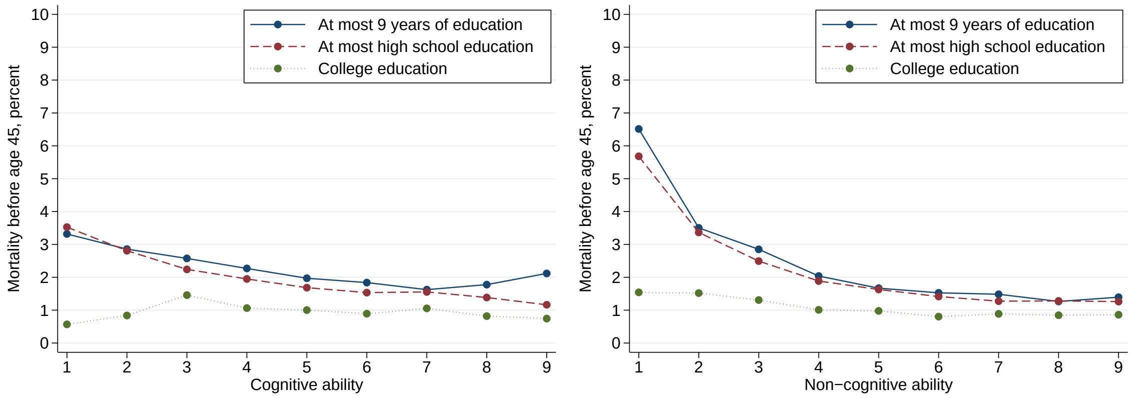
In *Figure 7* we saw that income is related to years of education. We have also seen that education is related to cognitive and non-cognitive ability (cf. *Figure 8b*). But how is education interacted with the abilities and mortality? This is shown in *Figure 11*. If we first look at (*a*), the relationship between cognitive ability and mortality when individuals are grouped by education, it is clear that the non-college educated groups follow the same trend, except for a rise in mortality for the low educated high ability individuals. The college educated group has a lower risk of mortality than the less educated groups. The cognitive ability does not really matter for college educated individuals in regards to the risk of mortality, but there is a decline in mortality for the college educated low ability individuals.[20] The general picture is that there exists a weak linear relationship between cognitive ability and mortality, but it seems that education plays the more important role. (*b*) presents the corresponding association between mortality and non-cognitive ability. There are large differences between the groups, or rather between the college educated group and the less educated groups, in the bottom of the distribution. The non-cognitive ability seems to be an important predictor of mortality for individuals without college education, while it does not matter for those with college education. The same type of curvature seen in earlier figures is present. About 1 percent of the college educated individuals have died regardless of non-cognitive ability. In contrast, almost 7 percent in the least educated low ability group and about 5.5 percent in the high school educated low ability group have died.

[20] The two somewhat surprising changes in the patterns described may be driven by the relatively few number of observations in these groups.



(*a*) Mortality, income and cog. ability. (*b*) Mortality, income and non-cog. ability.

Figure 10: Mortality by income group and ability.



(*a*) Mortality, education and cog. ability. (*b*) Mortality, education and non-cog. ability.

Figure 11: Mortality by education level and ability.

The figures in this section show, first, that income and education are associated with cognitive and non-cognitive abilities. Second, that income and education are important predictors in regards to the risk of mortality, and, third, that cognitive and non-cognitive abilities are important within income and education groups, at least in the low income group and the non-college educated group. This suggests that the use of income and education as proxy variables for abilities miss a large within-group variation. For example, individuals with low education but with high ability do not differ much in regards of the risk of mortality from individuals with high school education.

6.2 Regression analysis

We now turn to the formal regression analysis. I use both OLS models and Cox proportional hazard models depending on the outcome variable. I start with OLS regression

Table 6: Association with income.

	(1)	(2)	(3)	(4)	(5)
Cog. ability	0.1131***			0.0807***	0.0261***
	(0.0008)			(0.0009)	(0.0010)
Non-cog. ability		0.1259***		0.0927***	0.0741***
		(0.0009)		(0.0010)	(0.0010)
Years of education			0.1183***		0.0909***
			(0.0005)		(0.0007)
Birth cohort	Yes	Yes	Yes	Yes	Yes
Observations	679,268	679,268	677,983	679,268	677,983

Notes: OLS. Log of mean inflation-adjusted yearly income between the age of 31-35. To adjust for zero income individuals, the dependent variable is ln(Income+1). Years of education around age 30. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

models using income and education as outcome variables, and then move on to Cox proportional hazard models with mortality as outcome.

Table 6 presents the association between income, abilities and education. All estimated associations are strong; 1 score more in cognitive ability raises the income with 11 percent, 1 score more in non-cognitive ability raises it with 13 percent, and one more year of education raises it with 12 percent. The estimates suggest that non-cognitive ability is a stronger predictor of income than cognitive ability. Cognitive ability is attenuated to 71 percent and non-cognitive ability is attenuated to 74 percent when both abilities are included (column 4). When education is introduced (column 5) the estimate for cognitive ability is sharply attenuated (32 percent of column 4), while non-cognitive ability remains relatively stable (attenuated to 80 percent).[21]

It is clear that cognitive and non-cognitive ability and education are important predictors of income, but the attenuation of cognitive ability when education is included suggests that education may be an important pathway through which cognitive ability influences income. On the other hand, the relative stableness of the estimate for the non-cognitive ability between the different specifications suggest that non-cognitive ability independently is associated with income.

If we turn to the associations with education (*Table 7*), we see that higher cognitive ability is associated with about 0.7 more years of education, while non-cognitive ability

[21] The estimated coefficients of the relationship between the abilities and income are relatively close to earlier reported estimates using a smaller sample of the Swedish military enlistment data (Lindqvist and Vestman 2011).

is associated with about 0.4 more years of education.[22] The attenuation of non-cognitive ability and stableness of cognitive ability (column 3) adds to the previous results and suggests that cognitive ability work partly through education.

After studying the relationships between the pathway variables, we now turn to how they are associated with mortality, using Cox proportional hazard models in *Table 8*.

Both income and education have a strong relationship with mortality. A 1 percent increase in income leads to an almost 24 percent lower risk of mortality, while one more year of education lowers the risk with about 13 percent (column 2 and 3 respectively). The question is, if the abilities are included, how does this affect the associations? We start by looking at income in addition to the abilities (column 4). Compared with the associations for the abilities in the baseline analysis (cf. column 1), the estimate for cognitive ability is stable, while non-cognitive ability is somewhat attenuated. This is in line with the previous results and suggests that non-cognitive ability partly works through income. The corresponding pattern is seen when education instead of income is included (column 5); cognitive ability is attenuated and the non-cognitive ability is stable, suggesting that cognitive ability works through education. Estimates of the full model reveals that income and education have independent associations with mortality, but also that non-cognitive ability is a stronger predictor of mortality than cognitive ability (about two times the strength).

The analyses conducted in this section, both the graphical analysis and the regression analysis, confirm the associations between cognitive and non-cognitive abilities and

Table 7: Association with education.

	(1)	(2)	(3)
Cog. ability	0.6659***		0.5965***
	(0.0013)		(0.0014)
Non-cog. ability		0.4441***	0.1986***
		(0.0016)	(0.0016)
Birth cohort	Yes	Yes	Yes
Observations	683,360	683,360	683,360

Notes: OLS. Years of education around age 30. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[22] In line with the theoretical framework (see *Figure 1*) income is not included in the model.

Table 8: Association with mortality.

	(1)	(2)	(3)	(4)	(5)	(6)
Cog. ability	0.9133***			0.9245***	0.9461***	0.9477***
	(0.0029)			(0.0035)	(0.0038)	(0.0040)
Non-cog. ability	0.8369***			0.8647***	0.8526***	0.8703***
	(0.0032)			(0.0037)	(0.0036)	(0.0038)
Income		0.7646***		0.7904***		0.7967***
		(0.0025)		(0.0027)		(0.0028)
Years of education			0.8728***		0.9265***	0.9518***
			(0.0026)		(0.0031)	(0.0034)
Observations	692,235	679,268	683,360	679,268	683,360	677,983

Notes: Hazard ratios. Mortality as event. Log of mean inflation-adjusted yearly income between the age of 31-35. To adjust for zero income individuals, the variable is ln(Income+1). Years of education around age 30. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

mortality. The analyses also suggest that income and education are pathways for the abilities (cognitive ability mainly through education, and non-cognitive ability mainly through income), in addition to their independent relation with mortality.

7 Discussion

This paper aimed to answer two questions: First, what is the relation between non-cognitive ability and mortality, and how does this compare with the relation between cognitive ability and mortality? Second, are income and education good proxies for individual ability?

What can we say about the first question? While the abilities do not have a direct causal link with premature mortality, it seems that they create possibilities to live a better, or at least longer, life. The baseline and pathway analyses give us the same overall picture. First of all, cognitive and non-cognitive abilities are both negatively related with mortality. Individuals with high cognitive and non-cognitive ability lives, on average, longer. The same is true for income and education; individuals with high income or a long education live, on average, longer. However, non-cognitive ability is a stronger predictor of mortality than cognitive ability. The association between mortality and non-cognitive ability is more than two times the association between cognitive ability and mortality. Both cognitive and non-cognitive abilities are related to income and education, which in turn are associated with mortality. The results suggest that the pathway from cognitive ability to education is stronger than from non-cognitive ability to education, while non-cognitive ability is associated with mortality through income in the same way. In addition, the relationships are not linear. The graphical analyses show that the relationships are driven mainly by the bottom of the distribution, especially in respect to the non-cognitive ability. Partly, this may be due to the possibility that low non-cognitive ability is a health measure for psychological ill-health, for example depression. As noted earlier, however, it is fully possible to have low non-cognitive ability without any psychological health problems, and the individuals were at least healthy enough not to be exempted from the enlistment.

The relative strengths of the associations for cognitive and non-cognitive abilities are in line with what Heckman, Stixrud, and Urzua (2006) finds for various outcomes (e.g. labor market outcomes), namely that non-cognitive ability is generally more than or at least as important as cognitive ability. As shown, this seems to be true also for mortality. The earlier literature, which only looked at the relationship between cognitive ability and mortality, lacks the important dimension of non-cognitive ability.

How good are income and education as proxies for individual ability? The results suggest that cognitive and non-cognitive abilities are important for individuals with low income or without a college education. This suggests that the use of income and education as proxy variables for abilities miss a large within-group variation. Individuals with low income but high ability do not differ much from individuals with a higher income regarding the risk of mortality. By using income or education as a proxy measures, this variation would be hidden and possibly lead to wrong conclusions. Not everyone with low income or below college education have a higher risk of mortality, but that is what we would conclude using these variables as proxy measures. On average, however, they are not misleading; lower income or education leads to a higher risk of mortality.

With the data at hand it is not possible to answer why non-cognitive ability is the stronger predictor of the risk of mortality, or why cognitive and non-cognitive abilities are important for low income and non-college educated individuals. It could be that premature mortality is more about avoiding "failure" (die) rather than achieving "success" (live on). In Sweden, relatively few individuals die prematurely, and for it to happen requires special circumstances. These circumstances are not common among individuals who are college educated, have a "decent" income or in general is "socially functional". Individuals who lack social skills, on the other hand, may have a harder time. This suggests that policies improving social skills, especially for individuals unlikely to continue to college, may be beneficial not only for the individual, but for the public health (Heckman, Pinto, and Savelyev 2013).

8 Conclusions

Using a dataset of 692,303 men from the Swedish military enlistment born between 1950 and 1963 and enlisted between the years 1969-1983, I have in this paper shown that cognitive and non-cognitive abilities are associated with mortality. The associations remain when controlling for income and education for low income and non-college educated individuals. Using income and education as proxy measures for individual ability therefore miss the large variation within these groups. Further, the results suggest that non-cognitive ability is a stronger predictor than cognitive ability, indicating that the literature on the relationship between cognitive ability and mortality have lacked an important dimension. The results are mainly driven by the bottom of the measured ability distributions.

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Appendix

OLS results

Table A1 and *Table A2* presents OLS regression estimates corresponding to the Cox proportional hazard models in the main paper (cf. *Table 4* and *Table 8*). To handle right censoring of the data the mortality outcome variable is defined as death before age 45.

Table A1: Association with mortality.

	(1)	(2)	(3)
Cog. ability	-0.0039***		-0.0023***
	(0.0001)		(0.0001)
Non-cog. ability		-0.0057***	-0.0048***
		(0.0001)	(0.0001)
Birth cohort	Yes	Yes	Yes
Observations	692,303	692,303	692,303

Notes: OLS. Death before age 45 as the dependent variable. Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table A2: Association with mortality.

	(1)	(2)	(3)	(4)	(5)
Cog. ability			-0.0009***	-0.0010***	-0.0009***
			(0.0001)	(0.0001)	(0.0001)
Non-cog. ability			-0.0021***	-0.0031***	-0.0021***
			(0.0001)	(0.0001)	(0.0001)
Income	-0.0077***		-0.0070***		-0.0069***
	(0.0002)		(0.0002)		(0.0002)
Years of education		-0.0021***		-0.0010***	-0.0000
		(0.0001)		(0.0001)	(0.0001)
Birth cohort	Yes	Yes	Yes	Yes	Yes
Observations	679,268	683,360	679,268	683,360	677,983

Notes: OLS. Death before age 45 as the dependent variable. Log of mean inflation-adjusted yearly income between the age of 31-35. To adjust for zero income individuals, the variable is ln(Income+1). Years of education around age 30. Robust standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Additional tables and figures

The tables in this section presents the corresponding number of observations in each group for *Figure 6*, *Figure 10* and *Figure 11*.

Figure A1 shows the distribution of the Stanine ability measures. Both ability measures follow the Stanine distribution relatively closely (see footnote 14).

Table A3: Observations by cognitive ability.

	Non-cognitive ability		
Cog.	Low	Middle	High
1	13,745	6,493	292
2	20,919	23,555	2,483
3	22,185	42,844	7,507
4	23,322	66,314	16,686
5	22,684	92,485	28,432
6	14,891	74,461	32,690
7	9,151	52,431	30,893
8	4,836	29,205	23,043
9	2,413	14,210	14,133
N	134,146	401,998	156,159

Notes: Group frequency of individuals corresponding to *Figure 6a*.

Table A4: Observations by non-cognitive ability.

	Cognitive ability		
Non-cog.	Low	Middle	High
1	8,863	5,836	1,292
2	20,175	17,580	4,219
3	27,811	37,481	10,889
4	29,459	66,040	22,511
5	28,190	94,761	36,447
6	15,243	72,459	36,888
7	7,624	50,018	35,639
8	2,226	21,870	22,912
9	432	5,920	9,518
N	140,023	371,965	180,315

Notes: Group frequency of individuals corresponding to *Figure 6b*.

Table A5: Observations by cognitive ability.

	Income group		
Cog.	Low	Middle	High
1	8,681	10,446	946
2	16,480	25,831	3,761
3	22,184	40,815	8,198
4	29,542	58,848	16,129
5	35,472	74,629	31,138
6	26,156	59,208	34,494
7	17,345	39,766	33,499
8	9,474	20,848	25,481
9	4,483	9,243	16,171
N	169,817	339,634	169,817

Notes: Group frequency of individuals corresponding to *Figure 10a*.

Table A6: Observations by non-cognitive ability.

	Income group		
Non-cog.	Low	Middle	High
1	8,632	5,967	777
2	17,458	20,003	3,447
3	24,521	40,561	9,516
4	30,915	63,774	21,349
5	36,169	84,025	36,678
6	24,849	60,984	36,748
7	17,161	40,640	33,741
8	7,670	18,398	19,847
9	2,442	5,282	7,714
N	169,817	339,634	169,817

Notes: Group frequency of individuals corresponding to *Figure 10b*.

Table A7: Observations by cognitive ability.

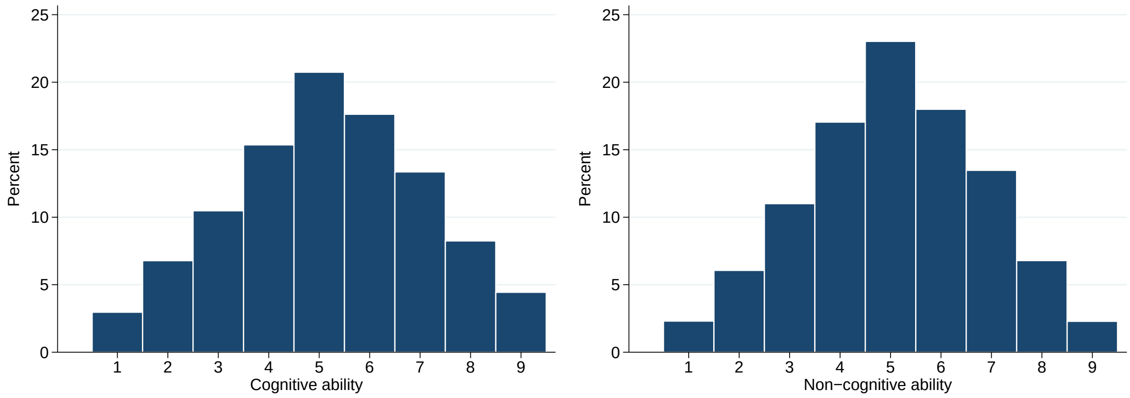
	Education group		
Cog.	Low	Middle	High
1	11,724	8,195	176
2	22,472	22,718	955
3	29,482	38,747	3,223
4	35,523	60,369	9,030
5	34,391	83,381	24,235
6	20,993	64,143	35,502
7	10,220	40,503	40,679
8	3,658	19,067	33,676
9	992	7,133	22,173
N	169,455	344,256	169,649

Notes: Group frequency of individuals corresponding to *Figure 11a*.

Table A8: Observations by non-cognitive ability.

	Education group		
Non-cog.	Low	Middle	High
1	7,708	6,794	908
2	18,124	19,558	3,356
3	28,028	38,022	8,868
4	34,723	62,765	19,125
5	37,551	86,194	33,963
6	23,498	63,285	36,569
7	13,545	43,040	35,710
8	5,059	19,046	22,318
9	1,219	5,552	8,832
N	169,455	344,256	169,649

Notes: Group frequency of individuals corresponding to *Figure 11b*.



(***a***) Cognitive ability.

(***b***) Non-cognitive ability.

Figure A1: Distribution of abilities.

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