A global perspective on cognitive function and educational attainment

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Long Abstract

Introduction

The positive association between education and cognition has been known for a long time having been the focus of several country-level or regional studies (*1-4*). Education is related to higher cognitive functioning at younger, prime, and older ages (*5-7*). Poor cognitive health among many seniors can be a major problem in poorer countries (*8*), which have the largest absolute number of individuals suffering from poor cognitive health and Alzheimer's disease (*9*), and in richer countries, where the elderly shares are greater (*10*). To our knowledge, there has been no study to date on the relation between education and cognitive health that includes the majority of the world's elderly population, although there has been a focus on particular mental health diseases. The current study analyzes standardized cognitive tests for representative samples of people aged 50 and above across the world. We focus in particular on the individual-level and country-level effects of education on cognition.

The causal effect of education is difficult to identify because of the positive selection of individuals with better cognitive ability into higher schooling and other factors related to the outcome variables. Recently, Marcus Richards and Amanda Sacker argued that education does in fact improve cognition (*11*). This was supported by evidence on variations in schooling that are not related to preschool ability (*12*).

The slope of the aging curve, regardless of initial ability or education (*13*), is found to be relatively similar in several studies; including the Berlin aging survey (*14*), the Victoria Longitudinal Study (*15*), and in data from Scotland (*16*) and England (*17*). Other studies, however, find that age variation differs across individuals with different education and ability levels (*18*).

Education may have different effects in different countries. Being highly educated in a poor country, characterized by considerable inequalities in standards of living and health and often low-quality mass schooling, can have different outcomes than being educated in a wealthier nation. A greater selectivity into education could imply a stronger preselection of people enrolling in higher education.

There could also be a country-level education effect on cognition in addition to an individual's education. That is, an individual's cognitive functioning may be influenced by the education levels of the rest of the population, regardless of his/her own education. This has been found in terms of cognitive health self-ratings (*19*) or of school performance, where being socialized with studious, disciplined peers can be beneficial (*20-22*).

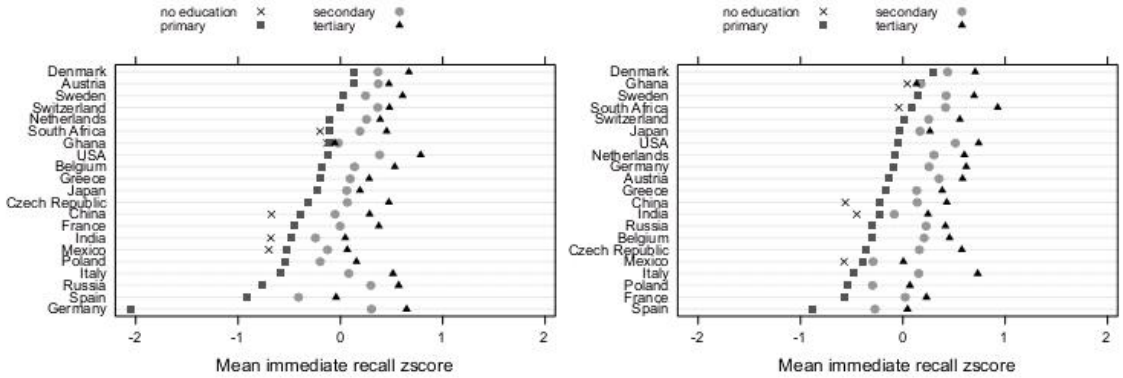
Study population: As datasets we use the surveys HRS, JSTAR, SAGE, and SHARE, which are designed to be comparable and nationally representative of the non-institutionalized population aged 50+. The range of countries we are able to consider in this study offers an overview of various world regions. The Health and Retirement Study (HRS) is a large-scale longitudinal project launched by the University of Michigan in 1992 in the USA; here we use wave 8 data collected in 2006/07 (*23*). In 2007 the Japanese Study of Aging and Retirement (JSTAR) was conducted by the Research Institute of Economy, Trade, and Industry (RIETI) and Hitotsubashi University (*24*). The Survey of Health, Ageing and Retirement in Europe (SHARE) is a multidisciplinary and cross-national panel database of micro data on health, socioeconomic status, and social and family networks of more than 45,000 individuals in 15 European countries (*25*). The second wave, which we use for our analysis, was collected in 13 countries in 2006/07. Developed by the WHO Multi-Country Studies unit as part of a Longitudinal Survey Programme, the Study on global AGEing and adult health (SAGE) compiles

comprehensive longitudinal information on the health and well-being of adult populations and the aging process in six countries (including China, India, Ghana, Mexico, Russian Federation, and South Africa).

Measures: We investigate two cognitive ability measures; first, a memory test (immediate recall), where ten words are read out and the respondents have one minute to recall as many words as possible, and second, a vocabulary size test (verbal fluency), where the task is to name as many different animals as the interviewee can think of within one minute.
We use educational attainment based on the International Standard Classification of Education (ISCED) to compare education across countries. To represent the national education level, it is important to consider the educational distribution within the countries and within two age groups. Therefore we use the shares of tertiary educated as the national education level variable in our models. Being more highly educated in a poorer country can have different implications than being more highly educated in a wealthier one; therefore we include GDP in our models. We control additionally for the following health conditions, which have been shown to influence cognition (*26-27*): currently taking medication for anxiety or depression, ever being told that one has had a heart attack, coronary heart disease, angina, or any other heart problem, or ever being told one has had a stroke or cerebral vascular disease, and self-reported general health status.

Results: With respect to country differences in education we first of all identify large variation between countries in terms of average cognitive performance for those aged 50 and above. International differences in cognitive outcomes and dementia can be affected by factors such as working life experiences, retirement ages, diet, disease exposure, pollutants, physical exercise, and social activity patterns (*28-30*).
The standardized average immediate recall scores of everyone aged between 50-64 and 65-79 years according to level of education are shown in Figure 1. Ranking the countries by performance of the primary-educated, we find that Denmark and Sweden are among the top performers for both age groups, while the Spanish and the Italians perform poorly for both age groups. While the pattern of verbal fluency scores again shows northern European countries, Sweden and Denmark, as leaders, the pattern is different for the bottom of the ranking with the poorest performance in terms of fluency being found in India, South Africa, and Russian Federation.

Figure 1: Average standardized immediate recall score for no education, primary, secondary and tertiary educated 50-64 year-olds (left-hand side) and 65-79 year-olds (right-hand side).



Source: HRS, JSTAR, SAGE, and SHARE; own calculations; note: there are <30 observations for primary educated Germans.

We use multilevel regression models to take into account the effects of both individual level effects and country level effects. We run the models separately for men and women between 50 and 64 and between 65 and 79 years. We use the same model setup for both dependent variables; verbal fluency and immediate recall.
The model includes age, self-reported health, individual education, health conditions influencing cognition, as well as national education level and GDP as explanatory variables. Furthermore, we

assume that there are differences among countries and different effects of individual education across countries; consequently, we include a random intercept as well as a random slope (after a positive likelihood-ratio test for all ages and both sexes). After further likelihood-ratio tests, interactions were not included, as they were found not to be significant.

Education has been found to significantly raise levels of cognitive functioning, such as memory (*5, 31-33*). Countries with better cognitive functioning levels tend to be those with longer average schooling. To give an example resulting from our calculations (see Table1): Chinese women with primary education aged 60 have an immediate recall score of -0.300 (and a -0.403 verbal fluency score), whereas tertiary educated women have an immediate recall score of 0.317 (and 0.295 verbal fluency score). Increasing the share of tertiary educated from the current level of 3.5% by 10% to 13.5% could imply that primary educated women would gain in terms of immediate recall 0.114 (0.147 verbal fluency) and tertiary educated could even reach an immediate recall score of 0.431 (0.442 verbal fluency).

By comparison, in Sweden with a share of 26.7% tertiary-educated 50-64 year-olds, primary-educated women aged 60 reach an immediate recall score of 0.312 (1.263 verbal fluency) and tertiary-educated 0.629 (1.594 verbal fluency).

Hence, the gap between primary- and tertiary-educated is greater for countries with a smaller share of higher-educated people. Therefore, countries may gain more at lower levels than higher levels, as the potential is greater. Strengthening mental health is particularly important in some low- and mid-income countries (like China), where poor cognitive functioning among seniors is a significant problem (*34*).

Table 1: Estimates gained by linear multilevel model for immediate recall abilities for both sexes and both age groups

	females 50-64		**females 65-79**		**males 50-64**		**males 65-79**	
	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.	Estimate	s.e.
Country level								
Share with tertiary educ.	1.140	0.50	1.925	0.69	1.065	0.45	1.105	0.53
GDP	0.058	0.05	0.003	0.04	-0.011	0.04	-0.010	0.03
Individual level								
Education (primary)								
no education	-0.180	0.03	-0.195	0.06	-0.315	0.10	-0.118	0.05
secondary	0.337	0.04	0.324	0.05	0.337	0.04	0.307	0.04
tertiary	0.594	0.06	0570.	0.06	0.630	0.06	0.603	0.05
good self-rep. health	0.243	0.02	0.273	0.02	0.287	0.02	0.286	0.02
Intercept	-0.460	0.40	1.708	0.41	0.228	0.36	1.565	0.32
Random Effects-Variance								
Intercept	0.067		0.063		0.057		0.055	
Education (primary)								
no education	0.002		0.017		0.090		0.007	
secondary	0.023		0.031		0.019		0.015	
tertiary	0.054		0.037		0.052		0.039	
BIC	56799		42659		45934		35347	
Sample size:	21791		16605		17591		13849	

Source: HRS, JSTAR, SAGE, and SHARE;

We control for age as well as for taking medication for anxiety or depression, heart attack or similar, or stroke/cerebral vascular disease

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