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18 Early-life circumstances and cognitive functioning dynamics in later life

- Cognitive decline in later life is partially related to childhood book shortage
- Measuring variations over time on cognitive abilities depends upon test contents
- Women show larger cohort effects because of differences in educational attainment
- Education policies may play a role to explain cognitive decline differences across cohorts

18.1 Childhood and later life cognitive skills

It is universally accepted that there is an inverse association between age and cognitive performance, even though the age at which the cognitive decline begins remains the subject of a large debate (Singh-Manoux et al. 2012). Socioeconomic status has been found to be positively related to better performance by older adults: individuals of lower socioeconomic status and poorer health have shown greater age-related decreases in performance on intellectual measures (Schmitz-Scherzer & Thomae 1983).

Early life conditions are related to cognitive development and abilities in childhood and cognitive function in adulthood. However, the association between early life conditions and cognitive changes in old age is not yet well documented. Everson-Rose et al. (2003) examined the relation between socioeconomic status (SES) and cognitive milieu in childhood and change in cognitive function in a population-based sample of 4,398 community-dwelling adults aged 65 years or older from Chicago, Illinois (USA), between 1993 and 1997. Change in cognitive function was assessed by means of a global cognitive index derived from measures of memory, perceptual speed and overall cognitive function. After controlling for age, sex, race and education, interactions of time with childhood SES and childhood cognitive milieu turned out to be non-significant statistically, indicating that early life conditions were not related to cognitive changes over time. On the other hand, they find that a better SES and a more stimulating cognitive environment in childhood have small but significant effects on absolute level of cognitive function. However, they do not seem to protect against cognitive decline in old age. Similarly, in a study determining whether the socioeconomic environment experienced during childhood has an impact on cognitive functioning in middle age (aged 58–64), Kaplan et al. (2001) found a significant and

graded association between parental SES (as an index) and cognitive function both prior to and after adjustment for respondent's education. Those from more disadvantaged backgrounds exhibited the poorest performance. When the separate components of the parental SES measure were used, father's occupation and mother's education were independently associated with the respondent's score for three and five of the tests respectively (there was no association with father's education and mother's occupation). After adjustment for the respondent's education, father's occupation was no longer associated with the respondent's test score, however, the results were essentially unchanged for mother's education. Hence, higher SES during childhood and greater educational attainment were found to be both associated with cognitive function in adulthood, with mothers and fathers each contributing to their offspring's formative cognitive development and later life cognitive ability (albeit in different ways). Their conclusive recommendation is that improvements in both parental socioeconomic circumstances and the educational attainment of their offspring could possibly enhance cognitive function and decrease risk of dementia in later life.

In an experimental study of the role of various cultural and experiential antecedents on memory development, Wagner (1978) had earlier demonstrated that structural features of memory may be universal, while control processes or information retention in memory are probably culture-specific, or a function of a variety of experiential and cultural factors that surround the growing child. Hence, according to the type of memory that is tested, childhood conditions may play a very different role in changes in late cognitive skills.

An important qualifying point of the 2012 – European Year for Active Ageing and Solidarity between Generations is to seek promoting active ageing in the independent living area: the cognitive status declines as people grow old, but assessing how parental or socio-economic background may affect cognitive functioning in later life might help to better understand the role that public policies might play for coping with this decline.

Hence, this paper aims at enriching this literature on the relationship between cognitive decline in later-life and socio-economic conditions in early-life, exploiting life-history data and longitudinal cognitive test performances collected respectively in SHARELIFE and in three waves of SHARE survey. On the one hand, this richness of information allows to further investigating cohort and time effects measuring cognitive results over time. On the other hand, this contribution aims at showing the difficulties in finding a single reliable indicator of cognitive decline and how relationships measuring variations over time on cognitive abilities may significantly depend upon test contents.

By providing first descriptive evidence on cognitive decline in later life, this work complements the chapter by Mazzonna and Peracchi in this volume.

18.2 The childhood socio-economic status

The SHARELIFE questionnaire allows constructing many childhood indicators. Some of them are expected to be correlated with the economic resources of the household during childhood, such as the number of rooms per capita or the type of occupation of the household's main breadwinner at the age of ten.

However, according to the topics investigated in this contribution, we prefer to focus our analyses on a third indicator, which is correlated with the intellectual/educational background of the household where respondents grew up. It is obtained by the question that asks respondents to provide an estimate of the number of books available in their accommodation at the age of ten. Book availability is measured in terms of number of shelves and bookcases that can be filled (magazines, newspapers and school books are not considered). The information is rearranged to discriminate between respondents who had enough books to fill at least one bookcase and those having fewer books in their accommodation. We expect that the higher the number of books, the higher is the expected average educational level of the parents or other relatives in the household.

18.3 The cognitive measures

In each of the SHARE surveys, a series of brief tests on the individual cognitive abilities is collected, even though the features of some of them have been changed between Wave 2 and Wave 4 (Malter & Börsch-Supan 2013). In this work we are going to focus our attention on two of these measures in particular.

The first measure is a test on verbal fluency that consists of naming as many distinct elements (without repetitions or proper nouns) as possible from a particular category (in SHARE, animals) in a specific time interval (one minute). The second measure (the ten word-list-learning test) is a standardised modified version of the Rey's Auditory Verbal Learning Test-RAVLT: it is a test of verbal learning and memory, where the respondent is asked to learn a list of ten common words. The respondent may hear the list only once and then will be asked to recall the words immediately (immediate recall) and again later on (delayed recall), after an interference period. The original RAVLT consists of five consecutive trials each followed by an immediate recall and one delayed recall (Trial 6), which enables to compute several indices from the outcomes (Estévez-González et al. 2003). The SHARE version of the RAVLT differs as in each wave the collected test consists of only one immediate recall trial and one delayed recall (the lists of ten words used in Wave 4 are however different with respect to those used in the previous waves).

It is known that some respondents may improve their cognitive performances over time because of a learning effect of the administrated test. The features of the RAVLT test in SHARE should prevent from this problem, while the verbal fluency measure could be potentially affected.

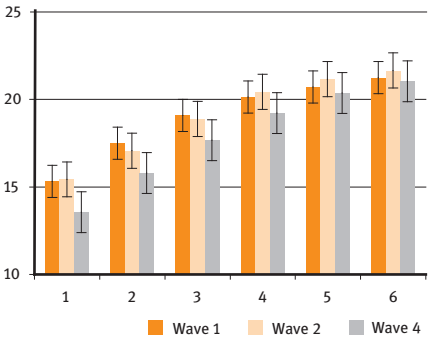
Since three waves are so far available in SHARE, three different time spans can be computed (this allows testing for the presence of time effects): two years (on average) comparing Wave 1 and Wave 2, four years comparing Wave 2 and Wave 4 and six years comparing Wave 1 and Wave 4.

We consider only those respondents who completed all SHARE interviews. The total number of observations is then equal to 9,561. Six cohorts are then created according to the respondent's year of birth:

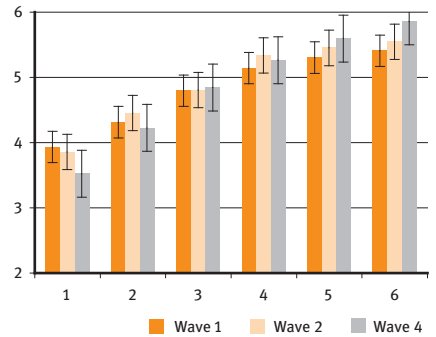
- before 1931
- between 1931 and 1935
- between 1936 and 1940
- between 1941 and 1945
- between 1946 and 1950
- between 1951 and 1955.

In Figure 18.1 we plot results of each cognitive test by cohort and wave. Investigating the longitudinal component of the SHARE sample only, there is a clear evidence of cohort effects: the younger the cohort, the better the cognitive performances. At the same time, this figure highlights some interesting time effects: for the older cohorts, the larger the time span, the worse the performances; for the younger cohorts, the larger the time span, the better (or at least no worse) the performances. Similar evidence are in Zamarro et al. (2008) who compare test score results between the first two SHARE waves. Disaggregating the results by country, a large cross-country heterogeneity also appears.

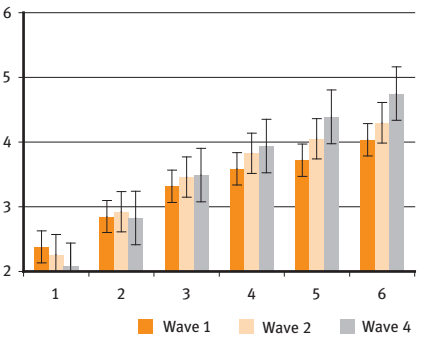
Moreover, there are also some important differences according to the analysed cognitive indicator: the delayed recall test shows the largest differences across cohorts and over time, while the animal test (fluency) presents some patterns over time which could be quite difficult to interpret. This result is partly expected, since each test aims at evaluating a different area of the individual cognitive functioning. Indeed, the verbal fluency test in SHARE is used as a semantic/category subtest, which is quite effective in measuring execute functioning and language ability and it is often used as a screen for dementia. The RAVLT may evaluate a wide set of cognitive functions, from a short-term auditory-verbal memory and rate of learning (the immediate recall) to retention of information and differences between learning and retrieval (the delayed recall).



(a) Animal test (n=9476 in Wave 1; 9450 in Wave 2; 9349 in Wave 4)



(b) Immediate recall test (n=9503 in Wave 1; 9481 in Wave 2; 9370 in Wave 4)



(c) Delayed recall test (n=9505 in Wave 1; 9485 in Wave 2; 9379 in Wave 4)

Figure 18.1: Scores of each cognitive test by cohort and wave
Source: SHARE Wave 1 release 2.5.0, Wave 2 release 2.5.0; Wave 4 release 1

18.4 Measuring cognitive decline

Figure 18.1 signals that the decline of cognitive performances over time is not systematic for all cohorts and for all tests. It is mainly true for the older cohorts and the ten words recall tests. This highlights that measuring a cognitive decline over time is not an easy task. Cognition is a multidimensional concept and several issues are related to longitudinal variations of the cognitive performances (Morris et al. 1999). First, cognitive test results are affected by many factors other than the process under study, from educational attainments to emotional and physi-

cal states, from the environment to cultural experiences, as well as measurement errors, like for instance interviewer errors in collecting the respondents' answers. Education and age may be both confounders and risk factors for cognitive decline and often it could be very difficult separating cohort, age and time effects. Second, several brief tests have some floor and ceiling effects, due to the features of these administrated tests. Then, in any longitudinal analysis of cognitive change there is the need of taking into account the amount of the initial level of the cognitive performances. This is particularly important analysing the RAVLT results, because variations over time of the performances may partly be due to poor initial learning rather than to different abilities to retain information over time.

In order to reduce overall measurement errors, Wilson et al. (1999) combined all cognitive tests in their study in a single factor by means of a factor analysis approach. However, several reasons could support the idea that a global measure does not adequately summarise all individual test performances. First, a global index may be affected by severe educational or cultural biases that characterise only a few of the combining tests, leading to over/under evaluations of specific relationships of the cognitive decline. Then, each test usually measures a different aspect of the cognitive concept and a single indicator could mix up different patterns of these aspects. Finally, a combined index does not necessarily normalise skewed distributions.

Based upon all these considerations and the SHARE data specificities, we opt for a separate analysis of the three cognitive test results (animals, immediate recall and delayed recall) and we compute three different indices of cognitive variations over time calculating the *per cent variation* across waves of the corresponding respondent's test results. In particular, this approach allows to take into account individual differences in the initial level of the cognitive performances.

We first define a respondent having a cognitive decline with respect to a particular index if his/her per cent variation in the analysed time span of that index is negative. Since very small per cent variations might not reveal true cognitive decline and could be affected by different sources of measurement errors, we decide to focus our attention on high negative per cent variations. We then define a respondent having a *high cognitive decline* if his/her per cent variation in the analysed time span is lower than –20 per cent. In the literature there are no standard thresholds to discriminate across different levels of cognitive decline. Hence, our choice of–20 per cent roughly means that, from one wave to another, in the RAVLT a respondent forgot about two words (if the initial level was high) or one word (if the initial level was middle or low), while in the verbal fluency test he/she cited four animals less, if the initial level was equal to 20 reported animals. Moreover, the cognitive decline distributions for each test by time span show about –20 per cent as 25th percentile (as expected the decline tends to be higher for older cohorts and lower for younger cohorts).

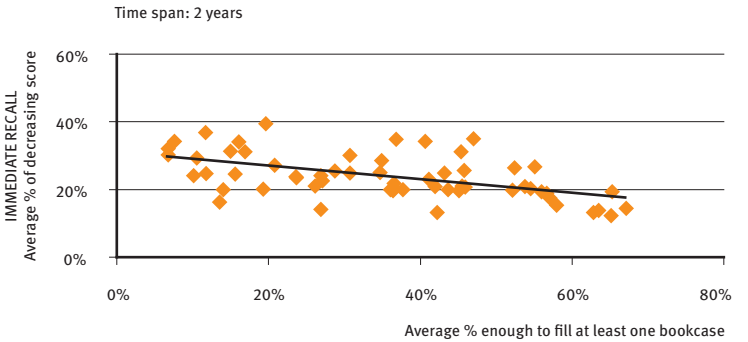
For the rest of this contribution the term "cognitive decline" has to be meant as "high cognitive decline" and, according to the evidence of Section 3, the units of the following analyses will be the country cohorts. Moreover, because of space constraints, any relationships involving the verbal fluency test will be just commented.

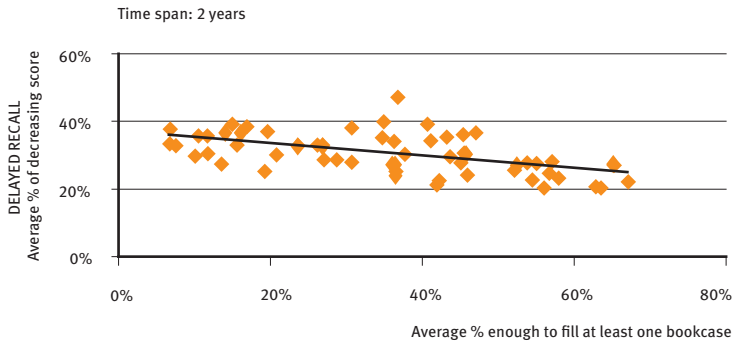
18.5 Early-life conditions and cognitive decline

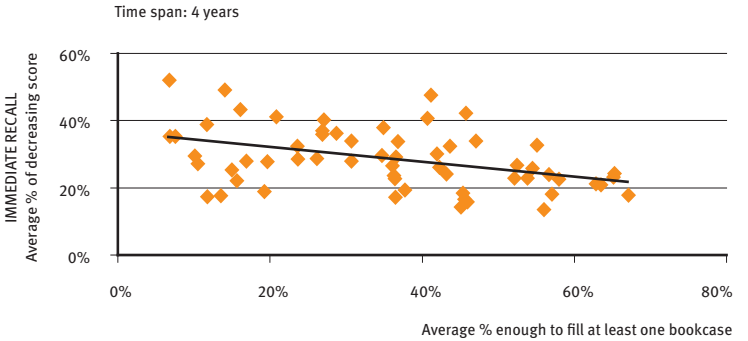
Figure 18.2 shows how the cognitive decline varies with the availability of books in the parental accommodation. More precisely, at the country cohort level, the proportion of respondents with a cognitive decline (according both to the immediate and the delayed recall test) is plotted against the proportion of respondents with abundance of books in their childhood accommodation.

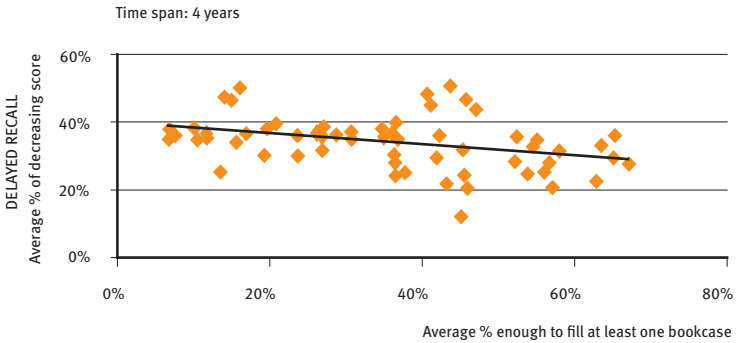
As expected, cross-country cohorts with higher proportions of individuals grown up in households with availability of many books are those with lower rates of cognitive decline, regardless the time span. In other words, the cognitive decline measured by means of both the immediate recall and the delayed recall test is positively correlated with book shortage. This relationship does not suffer from time effects in a way that it does not weaken or strengthen enlarging the span across waves. However, it is interesting to note that data variability increases together with the length of the time span. While findings based on the immediate recall and the delayed recall test are basically the same (we can just underline that the scatter plots for the immediate recall test show a larger variability than those for the delayed recall test), conclusions according to the verbal fluency test are characterised by a singular pattern over time: there is a strongly positive correlation between decline and scarcity of books in the shortest and largest spans, but only a weak relationship investigating the middle span.

Schneeweis et al. (2012) provide evidence of a causal link between SHARE respondents' education (measured by their number of years of schooling) and cognitive functioning in old-age, stronger in delayed memory, but weaker (or even null) on verbal fluency, numeracy, orientation to date and dementia. Moreover, as shown by Cavapozzi et al. (2011), countries where individuals spend on average more years in full-time education are also those where children are more likely to grow up in better educated and richer households. Hence, the link between individual schooling and cognitive decline might be driven by this positive correlation between socio-economic condition of parental household and educational attainment of respondents. To address this issue we study the relationship between cognitive decline in later life and education (measured by the number of years in full-time education), disaggregating the sample by gender and childhood background (Figures 18.3 and 18.4).


Time span: 2 years
IMMEDIATE RECALL
Average % of decreasing score
60%
40%
20%
0%
0%
20%
40%
60%
80%
Average % enough to fill at least one bookcase


Time span: 2 years
DELAYED RECALL
Average % of decreasing score
60%
40%
20%
0%
0%
20%
40%
60%
80%
Average % enough to fill at least one bookcase


Time span: 4 years
IMMEDIATE RECALL
Average % of decreasing score
60%
40%
20%
0%
0%
20%
40%
60%
80%
Average % enough to fill at least one bookcase


Time span: 4 years
DELAYED RECALL
Average % of decreasing score
60%
40%
20%
0%
0%
20%
40%
60%
80%
Average % enough to fill at least one bookcase

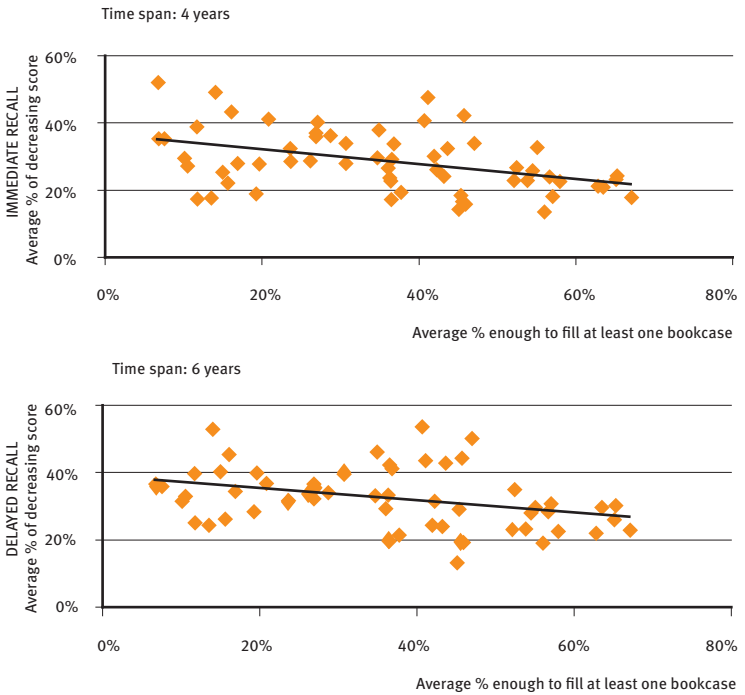
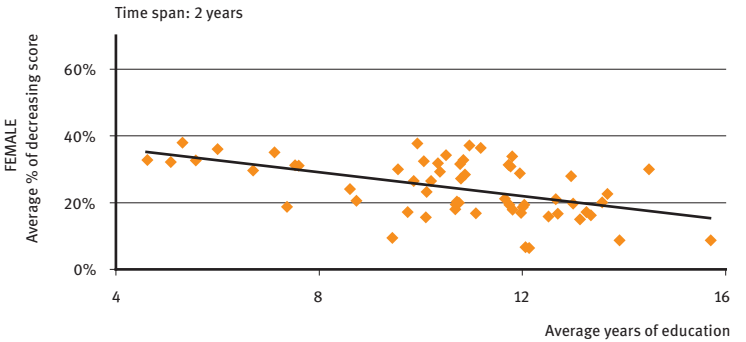
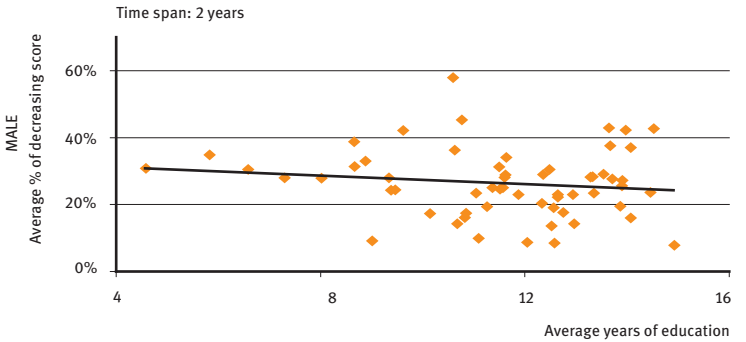
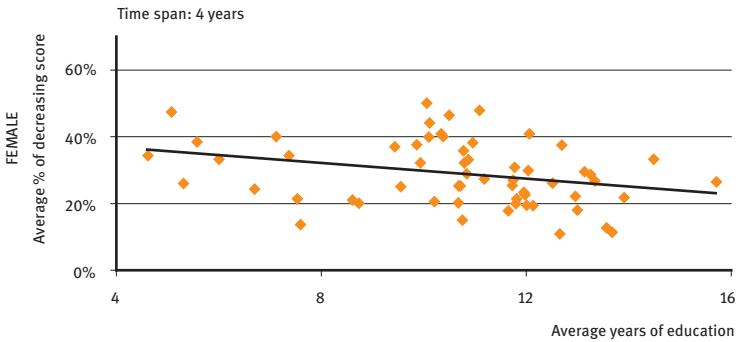


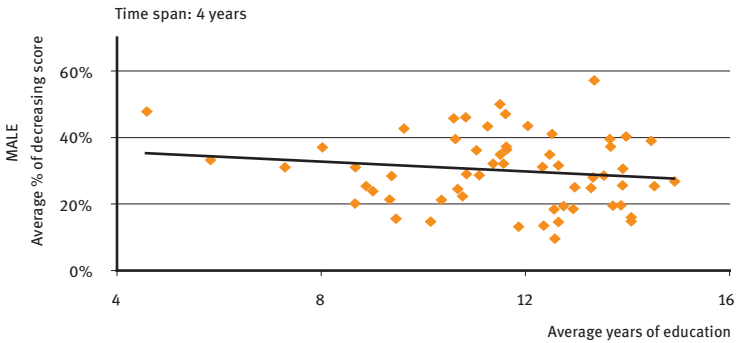
Figure 18.2: Relationships between cognitive decline and number of books in the accommodation at the age of ten, over time, by type of ten word-list-learning test (immediate and delayed recall)
Notes: Each dot denotes a country cohort. Number of observations: 60.
Source: SHARE Wave 1 release 2.5.0, Wave 2 release 2.5.0; Wave 3 release 1; Wave 4 release 1

Our results partly confirm Schneeweis et al.'s findings, that is, even controlling for the cultural background of the parental household, cognitive decline and education are strongly (negatively) related in some facets of the cognitive functioning (e. g. delayed recall), while in others (e. g. immediate recall) this relationship is more pronounced than in Schneeweis et al.'s conclusions. However, there are interesting issues related to the heterogeneity in the sample composition. For males experiencing book shortage at the age of ten, a marginal increase in the average years of education is not statistically associated with a decrease in the cognitive decline, measured neither according to the immediate recall test nor to the delayed recall test, regardless the time span. The opposite relation appears for women: according to both the immediate recall and the delayed recall test, females experiencing book shortage in the accommodation at the age of ten show a negative relationship between education and cognitive decline, regardless the time span. These relationships are stronger looking at the delayed recall test (i. e.,


Time span: 2 years
FEMALE
Average % of decreasing score
60%
40%
20%
0%
4
8
12
16
Average years of education


Time span: 2 years
MALE
Average % of decreasing score
60%
40%
20%
0%
4
8
12
16
Average years of education


Time span: 4 years
FEMALE
Average % of decreasing score
60%
40%
20%
0%
4
8
12
16
Average years of education


Time span: 4 years
MALE
Average % of decreasing score
60%
40%
20%
0%
4
8
12
16
Average years of education

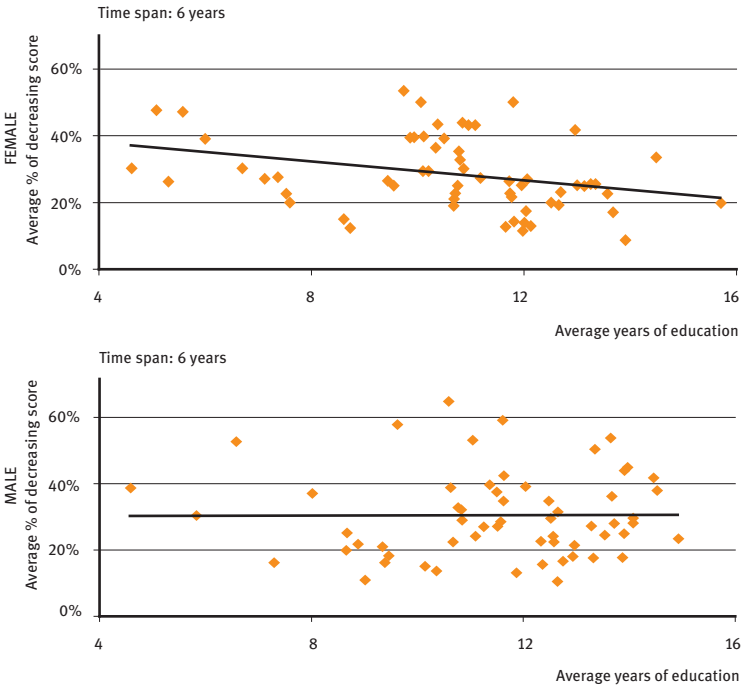
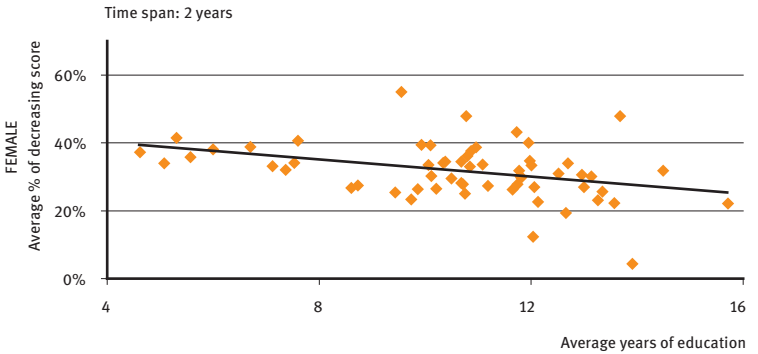


Figure 18.3: Individuals experiencing book shortage in the accommodation at the age of ten: relationship between cognitive decline according to the immediate recall test and years of education over time, by gender
Notes: Each dot denotes a country cohort. Number of observations: 60.
Source: SHARE Wave 1 release 2.5.0, Wave 2 release 2.5.0; Wave 3 release 1; Wave 4 release 1

they are always statically significant at one per cent level) than looking at the immediate recall test (where relationships are statistically significant at the five per cent level).

The analysis based on the verbal fluency test is a little bit different: controlling for scarcity of books at the age of ten, males show a statistically significant relationship between years of education and cognitive decline in the shortest span but not in the others, while females show a statistically significant relationship in all spans but the middle.


Time span: 2 years
FEMALE
Average % of decreasing score
60%
40%
20%
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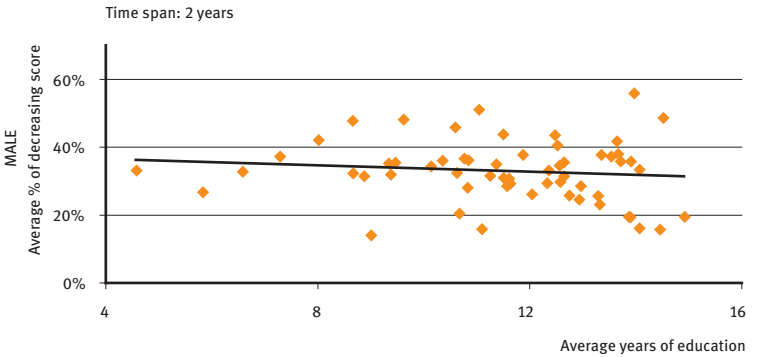
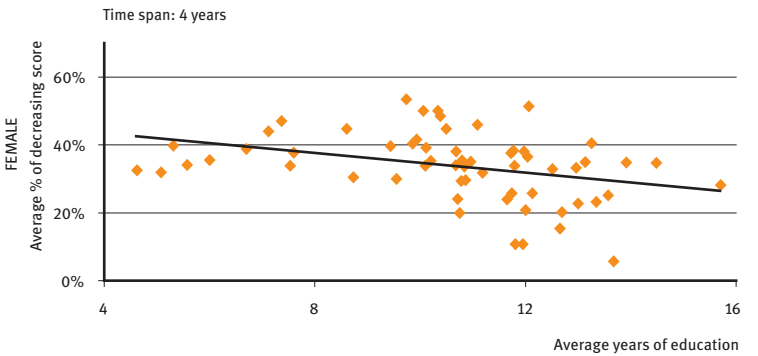
16
Average years of education


Time span: 2 years
MALE
Average % of decreasing score
60%
40%
20%
0%
4
8
12
16
Average years of education


Time span: 4 years
FEMALE
Average % of decreasing score
60%
40%
20%
0%
4
8
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16
Average years of education

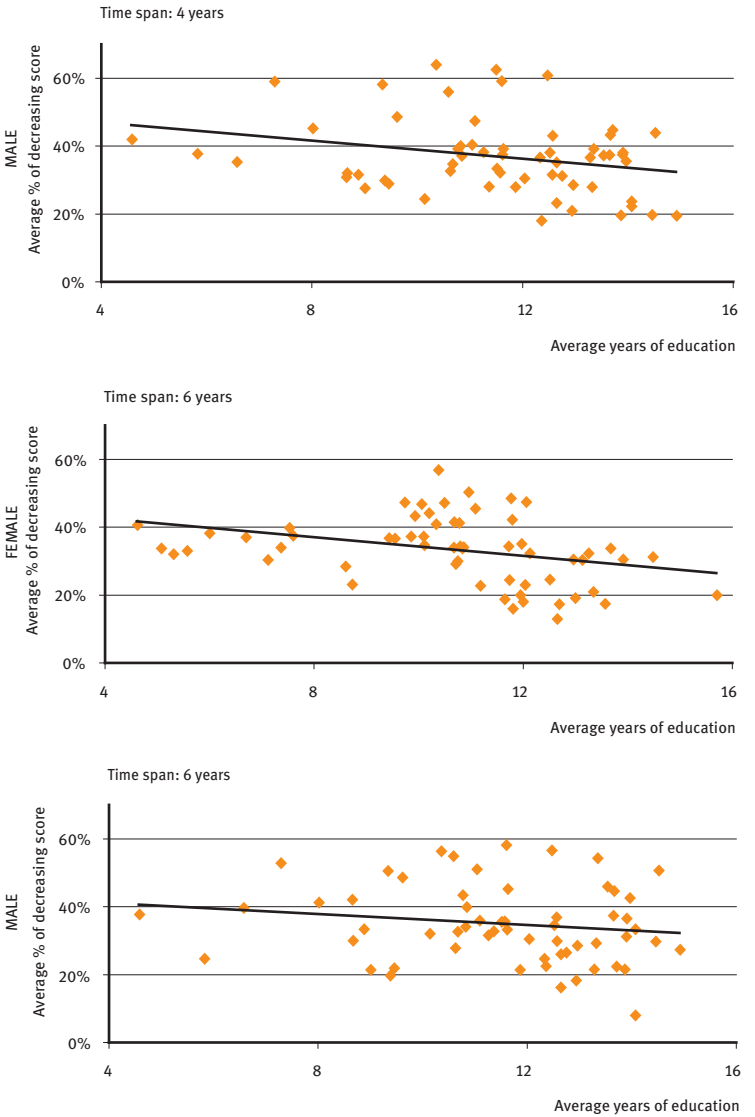

Figure 18.4: Individuals experiencing book shortage in the accommodation at the age of ten: relationship between cognitive decline according to the delayed recall test and years of education over time, by gender

Notes: Each dot denotes a country cohort. Number of observations: 60.

Source: SHARE Wave 1 release 2.5.0, Wave 2 release 2.5.0; Wave 3 release 1; Wave 4 release 1

18.6 The multidimensional nature of the cognitive decline

In this contribution we provide descriptive evidence that cognitive decline in later life is partially related to some early-life conditions. Two main findings may be underlined.

First, since the cognitive decline is a multidimensional phenomenon, performances in cognitive abilities depend upon test contents. The measurement of the ability to retain and retrieve information is the cognitive functioning whose decline shows the strongest relationships with childhood conditions, regardless the time span. Higher education is associated with lower cognitive decline even if individuals grew-up in socio-economically disadvantaged households. This is true also when short-term auditory-verbal memory and rate of learning is measured, even though these relationships are generally weaker than those obtained looking at the previous cognitive functioning test.

Second, there is evidence of gender effects. Controlling for socio-cultural background in early-life, males do not show statistically significant relationships between education and cognitive decline, regardless the time span, while the opposite appears for women. Our findings support Singh-Manoux et al. (2012), who find "larger cohort effects in women because of differences in educational attainment across the birth cohorts in our study population". This issue might be further investigated controlling for the education of the respondents' parents, rather than their book shortage at the age of ten. This information will be collected in the next wave of SHARE.

The language ability is the cognitive functioning which results are more difficult to interpret, because of the lack of a clear pattern over time and by gender. One explanation could be that the related test is likely to suffer from learning effects by the respondents.

Our findings reveal that education policies may play only a partial role in explaining directly the observed differences in cognitive decline across countries and cohorts. This suggests the need to investigate the role played by other factors, probably occurred in adulthood and affected by education in other ways, like occupational paths or household fertility patterns.

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