The Role of Early-Life Conditions in the Cognitive Decline due to Adverse Events Later in Life

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Abstract: Cognitive functioning of elderly individuals may be affected by events such as the loss of a (grand)child or partner or the onset of a serious chronic condition, and by negative economic shocks such as job loss or the reduction of pension benefits. It is conceivable that the impact of such events and shocks is stronger if conditions early in life were adverse. In this paper we study this with Dutch longitudinal database that follows elderly individuals for more than 15 years and contains information on demographics, socio-economic conditions, life events, and health. We exploit exogenous variation in early-life conditions as generated by the business cycle and singular life events. We also examine to what extent the cumulative effect of consecutive shocks later in life exceeds the sum of the separate effects, and whether economic and health shocks later in life reinforce each other in their effect on cognitive functioning.

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Keywords: cognitive functioning, business cycle, bereavement, developmental origins, retirement, health, long-run effects, dementia.

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1. INTRODUCTION

Cognitive functioning of older individuals is affected by events such as the loss of a (grand)child or partner or the onset of a serious chronic condition, and by negative economic shocks such as job loss or the reduction of pension benefits (see van den Berg, Lindeboom, Portrait 2002, 2006 and references therein, for evidence). The onset or relapse of a life-threatening or disabling disease may affect mental health. A move to an institution due to a need for assistance and care is likely to result in a further deterioration of mental or physical health as well. The death of the spouse and the concurrent changes in the lives of widowed persons have regularly been shown as most important sources of psychosocial stress - a factor associated with increased morbidity and mortality. Moreover, a small, but growing, body of evidence, suggests that adverse life events also may perpetuate poverty (Dercon, Hoddinott, Woldehanna, 2005, and references therein). As such, an indirect effect on health may be expected as well.

The costs of care for cognitively impaired individuals are high and are expected to increase in the upcoming decades. From a policy point of view, it is thus important to know the determinants of cognitive decline. Adverse events are easily observed by care takers and are therefore a potentially informative red flag for an upcoming decline. (The theory of cognitive reserve suggests that a decline in cognitive ability can be delayed or mitigated by enhancing brain reserve capacity; see Kuh and Ben Shlomo, 2004.) It is therefore useful to have a systematic account of the magnitude of effects of adverse life events later in life. In addition, it is useful to obtain insights into interaction effects between different types of life events. This will be one of the contributions of the present paper.

At the same time, an emerging literature stresses the importance of early-life conditions for the aetiology of cognitive impairment at older ages. One underlying hypothesis is that adverse conditions during the brain development early in life may affect cognitive development and cognitive functioning later in life (see Section 2 for references). A number of studies strongly suggest a causal relationship running from insults at developmental ages to the incidence of cognitive limitations at adult ages. The insults are mostly nutritional, but exposure to high levels of stress or cold could also partly explain the observed link. Much of this evidence concerns cognitive outcomes among prime-aged adults. However, early life exposures could also be important for cognitive disorders at older ages, like dementia or Alzheimer's disease, which are most important in ageing populations.

In the present paper we examine the role of early life exposures on cognitive functioning at old ages. In particular, we aim to detect whether favorable conditions early in life have a mitigating effect on the effects of adverse events later in life on cognitive ability (see Figure 1.1). It is conceivable that the impact of such events and shocks is weaker if conditions early in life were favorable. For instance, initial economic positions may influence the extent to which persons can cope with the stressful event of bereavement or conflicts with important persons throughout their lives. Possibly, conditions early in life may also influence the impact of health-related events, like the onset of chronic diseases, on mental health.

From a methodological point of view, it has some advantages to focus on shocks and events later in life when studying long-run effects of early-life conditions. After all, if an important part of the over-all effect of early-life conditions on cognitive decline works through the effects of shocks then an analysis that focuses on these shocks should have a higher identifying power than a reduced-form study of early-life conditions on cognitive outcomes across the full population including those who never experience adverse shocks. Moreover, we can deal with the possible endogeneity of such shocks by using longitudinal data with multiple measurements of shocks and cognitive outcomes over time.

Our empirical analysis consists of several stages, capturing the interplay between early-life (economic) conditions, adverse life events later in life, and cognitive functioning at old ages (see Figure 1.2). In a number of descriptive analyses, we inquire to which extent early-life (economic) conditions are associated with cognitive status at old ages. Second, we examine whether individuals exposed to adverse conditions early in life are more prone to face adverse life events later in life. Third, we investigate the cognitive effects of adverse events later in life, and we assess whether the effect of such events is stronger if conditions early in life were adverse, using panel data analyses with fixed effects. We use a Dutch longitudinal database that follows older individuals for more than 15 years and that contains detailed information on demographics, socio-economic background, health, and mortality.

To capture exogenous variation in early-life conditions, we use business cycle fluctuations in the birth year. This follows van den Berg, Lindeboom, and Portrait (2006) and van den Berg, Doblhammer and Christensen (2008), who focus on the causal effect of the prevailing economic conditions at birth on individual mortality rates and cause-specific mortality rates later in life.

The outline of the paper is as follows. Section 2 discusses some relevant branches of literature. Section 3 presents the data, and Section 4 contains the results.

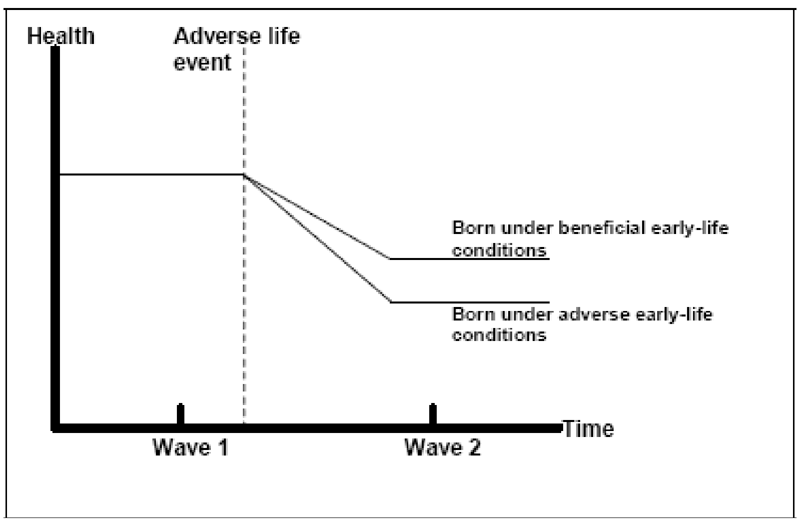

Figure 1.1. Mitigating role of early-life conditions on the effect of adverse events later in life on cognitive ability.

2. SOME RELEVANT LITERATURE

Our paper is related to a number of bodies of work, from different disciplines. One relevant branch of literature studies the role of early-life conditions in the aetiology of cognitive impairment at older ages. The underlying hypothesis is that adverse conditions during the brain development early in life may affect cognitive development and cognitive functioning later in life. See Factor-Litvak & Susser (2004) for a recent overview of the literature on long-term effects of early-life insults on cognitive functioning. Cognitive dysfunctions are of course very diverse, ranging from small deficits in intellectual performance to severe disorders like neural tube defects, schizophrenia and Alzheimer's disease. Concerning less severe cognitive limitations, the INCAP study (and its follow-up) demonstrates positive long-term effects of nutritional supplementation in early childhood on intellectual performance in adult ages for both genders (Martorell 1995). This experimental study invalidated to some extent the findings of Stein et al. (1975), who showed no detectable effects on cognition (measured by IQ) of caloric deprivation during the Hunger Winter by men. The INCAP study also shows that improved early-life nutrition is associated with improved intellectual performance after controlling for differences in educational attainments (Stein et al. 2008). With respect to personality disorders, Neugebauer et al. (1999) show increased risk for antisocial personality behaviour after exposure to severe nutritional restrictions during the first stages of pregnancy for men. Regarding more severe cognitive disorders, an extended literature reports the role of prenatal folate deficiency in increasing the risk for neural tube defects (Prevention of Neural Tube defects 1991). Schizophrenia is the most-studied severe cognitive disorder in this area of research (e.g. Susser & Lin 1992). Recent studies confirm the link between early prenatal insults and elevated risks of schizophrenia at adult ages for both genders (Saint-Clair, Xu, Wang 2005; Brown & Susser 2008 and references therein). In sum, there seems to be evidence of a causal relationship running from insults at developmental ages to the incidence of cognitive limitations at adult ages. These insults are mostly nutritional, but exposure to high levels of stress or cold could also partly explain the observed link.

Our paper can also be embedded in the recent literatures on causal chains in the life course and the effects early-life conditions on health later in life. The "critical period" model (also known as "fetal origins hypothesis", Barker 1992) postulates that exposure to adverse (nutritional and pathogen) stimuli during the first stages of life may hinder the development of vital organs and immune system, with irreversible negative effects on health at adult ages. This pathway is mainly biological. The "accumulation of risk" model assumes that health at old ages is the result of exposures to risk factors not only in early life but also across lifetime (Kuh and Ben-Shlomo, 2004). These risk factors may be independent of each other or be linked to each other. Adverse environment in early life may set individuals on trajectories that negatively affect their health and/or socio-economic status through life. For instance, individuals born in poor families may be more likely to be ill, with adverse consequences on their health later in life. They may also be less likely to go to school and to learn appropriately (Black, Devereux and Salvanes, 2005; Case, Fertig and Paxson, 2005). This may affect their future educational attainments, labour market skills, later earnings, and adult health (Alderman, Hoddinott and Kinsey, 2006; Case, Fertig and Paxson, 2005; Case, Lubotsky and Paxson, 2002; Glewwe and King, 2001). Similarly, individuals exposed to poor conditions in early life may be more prone to adverse life events at later ages, which may exacerbate the long-term effects of early life exposures. Clearly, all mechanisms may operate simultaneously.

A growing number of studies aim to identify causal effects, and most of them focus on demonstrating the long-term effects of early-life conditions on health and mortality at older ages. For instance, Doblhammer (2004) demonstrates that survival at ages older than 50 is significantly affected by the season of birth. Other studies use variation in food prices and infant mortality early in life (e.g. Bengtsson, Lindstrom 2000, 2003). The effect is often significant. Van den Berg, Lindeboom, and Portrait (2006) and van den Berg, Doblhammer and Christensen (2008) demonstrate a significant causal effect of the prevailing economic conditions at birth (as captured by the business cycle) on the individual mortality rate and cause-specific mortality rate. All these studies have in common that they exploit modest fluctuations in early-life conditions, and therefore the results are not driven by extreme events like severe famines or epidemics.

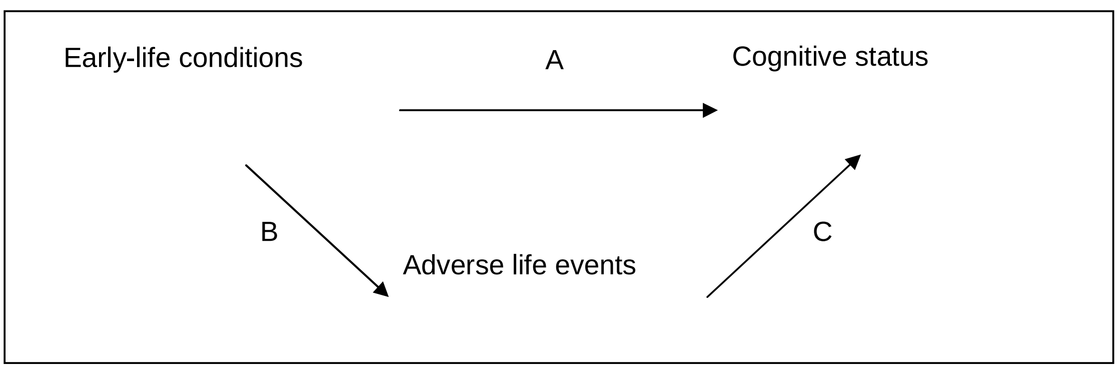

Figure 1.2. Early-life conditions, adverse life events and later-life cognition

3. DATA AND MEASURES

3.1 THE LASA DATA

The Longitudinal Aging Study Amsterdam (LASA) is an ongoing study which follows a representative sample of Dutch older institutionalized and non-institutionalized individuals born in 1908-1937. The design and purposes of the LASA study are described in detail elsewhere (Deeg 1994,1998). Five waves are currently available, hold in 1992-93, 1995-96, 1998-99, 2002-03 and 2005-06. Note that there are no refreshment sample after wave I. Table 1 describes the non-response at successive waves. Individuals can leave the sample for several reasons. About 75% of the respondents who leave the sample between two waves died. 14% of them refused to participate in the study anymore, 6% were too frail to participate, and 3% could not be contacted.

Table 1 – SPECIFICATION OF THE NON-RESPONSE IN THE LASA DATA

	Wave I	Wave II	Wave III	Wave IV	Wave V
Data present:	**3,107:**	**2,545:**	**2,076:**	**1,691:**	**1,257:**
Normal	2,925	2,204	1,717	1,340	932
Short / Telephone interview	182	341	359	351	325
Deceased		**417**	**344**	**290**	**355**
Refusals / Ineligible / Not contacted		**145**	**125**	**95**	**79**

Respondents with a telephone or a short interview are excluded from the study as no sufficient information is available on them to address the research question.

3.2 HEALTH MEASURES

Table 2 provides summary measures on health and demographic measures. We measure in our analyses the cognitive status by the Mini Mental State Examination (MMSE) score (Folstein et al. 1995). The MMSE score is a widely used method for assessing cognitive status of older individuals. It provides a total score that places the individual on a scale of cognitive functioning. The lower the score, the higher the cognitive impairment. The variable ranges between 0 and 30 and usually a cut-off point of 23/24 is used to indicate cognitive impairment. Figure 1. provides the distribution of the MMSE scores at waves I-V. The MMSE score is positively associated with the level of education.

The CES-D indicator is used to measure emotional functioning of older individuals. The total score ranges from 0 to 60 and respondents with scores higher than 16 display clinically relevant symptoms of depressions (Radloff 1977). Figure 2. provides the distribution of the CES-D scores at waves I-V.

Physical health is measured by an indicator on functional limitations, disability, and the presence of seven most important chronic diseases. Functional limitations are measured in the LASA study by self-reports on mobility activities in daily life (McWhinnie 1981). These self-reports include the ability of respondents to: (1) cut one's own toenails, (2) walk up and down a 15-steps staircase without stopping, and (3) make use of private or public transportation (McWhinnie 1981, van Sonsbeek 1988). The score takes on value 0 when all items are performed without any difficulty, and 1, 2, and 3, when 1, 2, or 3 items respectively are performed with difficulty. Disability is measured by asking the respondents whether he or she experiences difficulties in performing daily activities because of health problems. The variable can take the value "1" if health problems severely affect daily activities, the value "2" if health problems slightly affect daily activities and the value "3" when the respondent does not experience any difficulties with daily activities because of health problems. Finally, the presence of chronic diseases is assessed by asking the participants whether they have or have had any of the following diseases: chronic obstructive pulmonary diseases (COPD), heart diseases, arteriosclerosis, diabetes, stroke, cancer, and arthritis (osteoarthritis and rheumatoid arthritis).

Table 2 and Figure 1 show that, at wave I, about two-third of the LASA respondents have no physical limitations and that about 4% of the population suffer from severe cognitive impairment and is clinically depressed.

3.3 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

Besides information on gender and age, the following demographic characteristics are included in our analyses: marital status, urbanisation degree of the municipality where the respondent lives (categorical variable ranging from "1"= low to "5"= high), education (categorical variable ranging from "1"= elementary education not completed to "9"= university education), income and the prestige code of the longest occupation. Income was ascertained by asking the respondents to assign their monthly net income to classes ranging from less than €454 to more than €1.818. The total income of the respondent and his/her possible partner is asked and a correction factor equal to 0.7 is applied if the respondent has a partner (adult equivalent adjusted). Missing values for income were relatively frequent (about 16%). The occupational prestige of the longest job is measured using the classification described in Sixma and Ultee (1983) (categorical variable ranging from 0 = ``never had job" till 87 = ``high prestige").

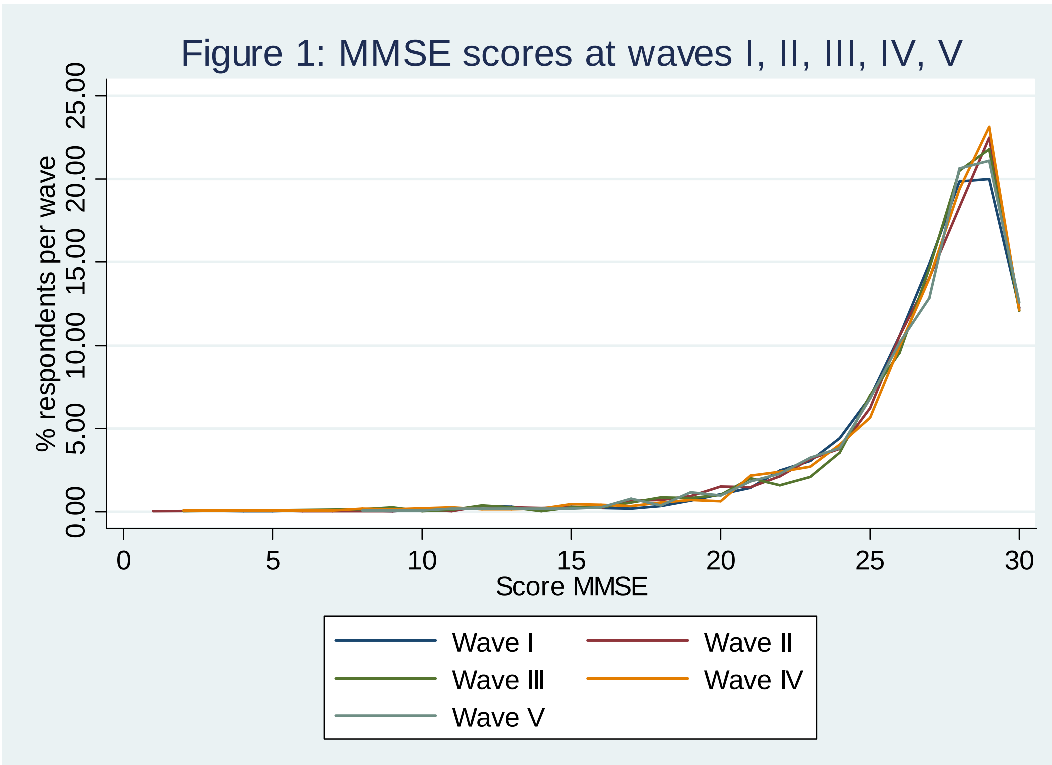

Table 2 – MEAN / FREQUENCY OF RELEVANT VARIABLES AT WAVE I

VARIABLES	SCORE	Mean / Frequency
HEALTH		
MMSE	mean	26,8
CES-D	mean	8,0
Functional Limitations	no difficulty	58,6%
	one with difficulty	19,1%
	two with difficulty	11,7%
	three with difficulty	10,7%
Disability	no	68,0%
	yes, slightly	19,1%
	Yes severely	12,9%

Chronic diseases	COPD	11,6%
	Heart diseases	19,6%
	Arteriosclerosis	9,8%
	Diabetes	7,9%
	Stroke	5,7%
	Cancer	9,3%
	Arthritis	34,8%
Total Chronic diseases	mean	0,98
DEMOGRAPHICS		
Age	mean	70,8
Gender	female	51,5%
Marital status	never married	6,1%
	married	62,5%
	divorced	5,2%
	widowed	26,2%
Urbanisation level	low	48,5%
Education	elementary or less	33,9%
	intermediate	44,2%
	high	11,4%
Monthly net income	missing	16,1%
	<€681	18,9%
	€682-€1.136	32,9%
	€1.137-€1.818	21,0%
	>1.818	11,1%
Prestige code Sixma & Ultee	mean	36,1

3.4 LIFE EVENTS

Table 3 presents frequencies of the life events occurring between successive waves. 4% of the respondents on average lose their spouse between successive waves. A negligible number of respondents divorced during the observation window. Furthermore, with respect to chronic diseases, arthritis, and heart diseases are the most commonly observed chronic conditions and we also observe their onset (or relapse) most frequently. On average 10% 0f the respondents experience a surgery between two waves. A substantial fraction of the respondents loses at least a parents, a brother, a sister, a child or a grand child during the observation period. Illness of partner and relatives is also a common phenomenon. Finally, the onset of severe financial problems, having a conflict with an important person and being a victim of a crime is observed for a small, yet non-negligible, fraction of respondents.

Table 3 – FREQUENCY OF LIFE EVENTS

BETWEEN	WAVE I & II	WAVE II & III	WAVE III & IV	WAVE IV & V
% Widowed	4,4	3,5	3,4	3,4
% Divorced	0,1	0,1	0,1	0

Incidence or relapse Chronic diseases:				
% Respiratory diseases	2,5	3,0	2,1	1,8
% Heart diseases	5,6	4,8	4,8	5,7
% Arteriosclerosis	3,0	2,2	3,1	2,4
% Diabetes	1,7	2,0	2,1	3,5
% CVA (Stroke)	2,8	2,2	2,6	3,3
% Arthritis	11,1	8,9	7,5	8,7
% Cancer	3,6	3,8	3,6	4,6
% Surgery	9,4	10,1	9,2	12,7
% Death parent, brother, sister, child & grand-child	22,1	18,6	18,5	16,0
% Illness partner & relatives	36,4	35,4	26,6	24,9
% Financial problems Conflict & Victim of crime	10,1	7,5	6,7	5,7
% Move to Semi-independent House, Institution or hospital	4,9	4,2	4,0	5,2

3.5 MACRO INDICATORS

In this section, we present an analysis of the cyclical component of the macro-economic development over the birth years of our respondents (1908 - 1937). A Hodrick-Prescott filter with smoothing parameter 500 is used to decompose log annual per capita GDP into a trend and a cyclical component (Hodrick and Prescott, 1997). The data on GDP come from Maddison (2003). Figure 2 shows the log(real annual per capita GNP) and the detrended series. The cyclical development is in line with important historical events. First, there is a severe recession around the end of World War I and at the arrival of the Influenza Pandemic (October – November 1918) (Vugs, 2002). Second, the Dutch economy developed positively alongside a global economic upturn in the 1920s, which resulted in an increase of the average living standards. Third, there is a clear recession during the Great Depression, which reached the Netherlands relatively late (1931) and lasted unusually long (till about 1936). This was partially caused by a refusal of the Dutch government to let go of the gold standard. This recession had substantial impact on the daily-life of civilians. For instance, the number of unemployed individuals rose from 50.000 to 414.500 between 1929 and 1936 (Beishuizen and Werkman, 1968).

We may accordingly define two intervals each consisting of a boom and a subsequent recession (group A (1909 - 1921) and group B (1924 - 1936)). The respondents belonging to these two intervals are selected for some simple explorative analyses (Table 4, to be discussed below). We construct three measures for the state of the business cycle at birth. First, the value of a Boom dummy equals one when log GDP is above its trend level and zero otherwise. A second variable corresponds to the actual value of the cyclical component. This variable is, in contrast to the recession dummy, able to take the size of booms and recessions into account. Third, two dummy variables measuring the peak years (years belonging to the 4^{th} quartile of the cyclical component) and trough years (years belonging to the 1^{st} quartile of the cyclical component) of the boom and recession, respectively. We recognize that an individual born during a recession is more likely to encounter a boom during later childhood, because good and bad economic times succeed each other. The following analyses does not take this periodicity of business cycles into account, contrary to the study by van den Berg et al. (2006).

Figure 2: Cyclical fluctuations Log(real per capita annual GDP)

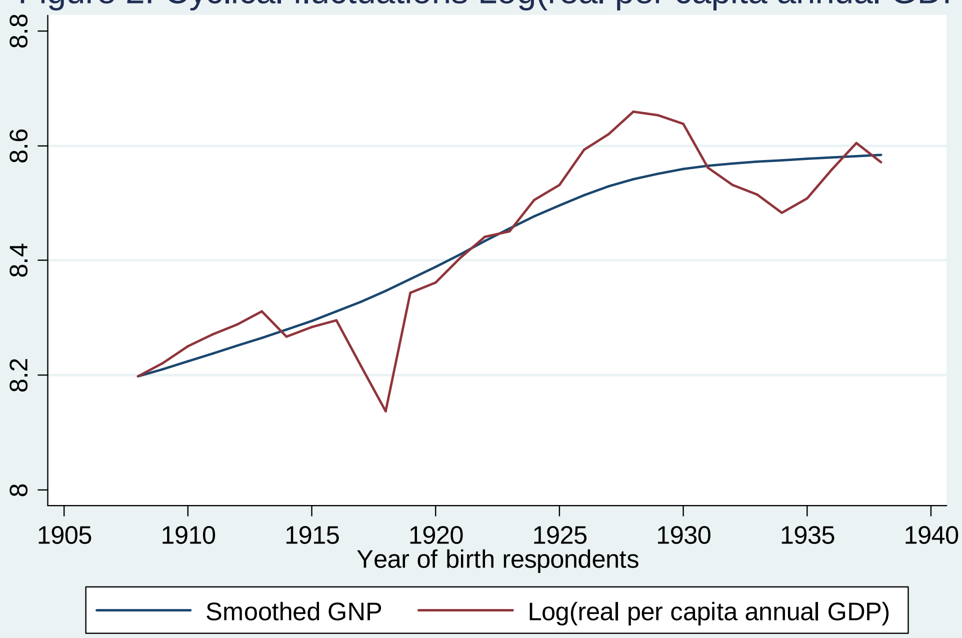

Table 4 below present the results of the first exploratory analyses. The maximum of the MMSE score is equal to 30 and we transform the cognition score to the logarithm of 31-MMSE score. This is to assure that the results do not depend too much on extreme low values of the MMSE score. High values are therefore associated with bad cognitive functioning, low values with good cognitive functioning. Age measured exact up to days and is recorded at the date of the interview. His explains why both the cohort year and the age can be included in the analyses of table 4. The simple analyses indicate that the state of the business cycle may have an effect on cognitive functioning at later ages. More specifically, those born in a boom have better cognitive health and those born trough years have worse cognitive health.

Table 4 The effect of the business cycle at birth on cognition at the first wave

Variables	I	II	III
Birth year	0.053	0.055	0.053
	(0.035)	(0.035)	(0.035)
Age	0.080**	0.080**	0.081**
	(0.035)	(0.035)	(0.035)
Boom dummy	-0.056**		
	(0.028)		
Cyclical component of business cycle		-0.232	
		(0.181)	
Trough years (1st quartile of cyclical component)			0.076*
			(0.040)
Peak years (4th quartile of cyclical component)			0.013
			(0.034)
Constant	-5.664*	-5.740*	-5.745*
	(3.202)	(3.205)	(3.203)
Observations	1937	1937	1937
R-squared	0.118	0.117	0.118

Cognition is measured by log(31- mmse). High values are associated with worse cognition.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4. EMPIRICAL ANALYSES AND RESULTS

The first preliminary analyses were based on observations of the two boom and recession periods alone (Periods A and B) and the variable was measured at the first wave. Below we perform some more analyses based on the entire sample and the cognitive score for all waves. We start with simple regressions where we pool the panel information. Subsequently, we perform a panel data analysis with fixed effects, where the outcome is the cognitive score, and the explanatory variables include the shocks since the previous wave of the panel, and their interactions with the early-life indicators.

Our range of empirical analyses is somewhat restricted by the fact that the sample is drawn from the stock of those alive in 1992 who were born in 1908-1937. First, notice that this sample excludes those born in those years who have died before 1992. The association of early-life effects and later events may then be weakened because of dynamic selection. With panel data analyses one may deal with this by assuming that the dynamic selection is driven by the same unobservable as the fixed effect in the outcome of interest.

Secondly, there is a negative linear relation in the sample between age and birth year. Any restriction on birth years thus necessarily entails a restriction on the age window. For example, a restriction to early birth cohorts entails a restriction to older individuals. This complicates a direct comparison of favorable and unfavorable birth cohorts as in e.g. van den Berg, Lindeboom and Portrait (2006). In the case of shocks at higher ages, it also means that among the elderly we only observe shocks at very high ages, whereas among the younger respondents most shocks are observed at (relatively) lower ages only.

Tables 5a present the results of a model where the cognitive score is related to a range of observed demographic characteristics, the occurrence of life events and the cyclical components of the business cycle at the time of birth. Table 5b presents the results of the same model, but in this specification the cyclical component is replaced by the peak and trough values of the cyclical component (the values of the first quartile and the fourth quartile of the cyclical component). The dependent variable is the transformed cognitive score (logarithm of 31 – MMSE score) and therefore negative coefficients are therefore associated with better cognitive outcomes. Both tables include three different specifications of the levels equation. The first specification (I) includes a base specification where the onset of new chronic conditions are aggregated into a single indicator. In the second column (specification II) we add the lagged dependent variable. In the third specification (III) we extend on specification II by making a distinction between the different kinds of health shocks. We start with a brief discussion of the results in table 5a.

<Insert table 5a around here>

<Insert table 5b around here>

We find strong effects of the demographic variables across all specifications and most of these effects are as expected. For instance, age has a positive and significant effect, implying that cognitive functioning decreases with age. It is remarkable to see that the age coefficient only reduces slightly in magnitude when the lagged dependent variable is added in the specification. The negative education coefficient indicates that those with more years of education have higher cognitive skills at later ages. Females also have higher cognitive skills. The effect of education and gender is reduced to about half when the lagged dependent variable is added to the specification, but these two variables remain strongly significant.

Concerning the life events variables, no effects are found for a bereavement indicator and for the number of new chronic conditions. We do however find effects for experiencing the death of family members (parents, siblings and (grand)children) and illness of a family member or relative. The latter effect indicates that an illness of a family member or relative is associated with better cognitive outcomes. It remains to be seen whether this somewhat surprising effect remains in the fixed effects specifications (to be discussed below). However, an illness of a close relative may involve the provision of care by the respondent and this in turn may have a (temporary) health preserving effect. In earlier work (Lindeboom et al, 2002) we found strong negative effect on the mental health of the illness of a family member or a relative. We find some effect for an indicator whether the individual experienced financial difficulties in the past period, but this effect is only significant at the 10% level in the static model. Finally, the onset of new chronic conditions does not have an impact in either the static (I) or the dynamic model (II), but we do find a significant effect of a stroke on cognition (specification III).

The coefficient of the cyclical component of the business cycle at birth has the expected sign, but it is not significant at the standard levels. We do find significant effects for the peak variable in Table 5b and the effect is in the expected direction: those born in peak years have better cognitive outcomes. The effects of the other demographic and life events variables in Table 5b are similar to those in Table 5a.

Tables 6 and 7 report the results of a model in first differences of the transformed cognitive score and therefore allows for unobserved individual fixed effects. This also means that additive effects of the business cycle indicators cancel from the specification. The first column (specification I) of Table 6 reports the results for the full sample, the second and the third column are estimated on samples of individuals who are born in a period where the cyclical component of the GDP is negative (‘Recession’) and positive (‘Boom’), respectively. The sample sizes did not permit us to estimate separate models for ‘peak’ and ‘trough’ years.

<Insert Table 6 around here>

<Insert Table 7 around here>

The results reported in column 1 are in line with the results of the life events variables presented in Tables 5a and 5b. A stroke has a strong effect on the cognitive health score and the positive coefficient indicates that cognitive skills deteriorate after the onset of a stroke. The negative coefficient of the ‘illness of a family member or a relative’ also remains when we control for unobserved fixed effects and implies that cognitive skills improve after the onset of this life event. The results in column 1 also show us somewhat surprisingly that the onset of Arteriosclerosis has a positive impact on cognitive skills, but this effect is only significant at the 10% level.

<Insert Table 8 around here>

We calculated the fixed effects of this model and regressed these on a set of time constant variables. The results of this exercise are reported in Table 8. Of course it is difficult to give a pure causal interpretation to the coefficients. The results indicate that those born in peak years have better cognitive skills. The effect of the demographic variables is (as expected) very similar to those in tables 5a and 5b. The negative birth year variable indicates that those born later have better cognitive skills. Furthermore we find better cognitive skills for females, those who are married and those who have more years of education. Again the stroke indicator (defined here as whether or not one has experienced the event prior to the first wave) has a strong impact on the fixed effect. The positive coefficient indicates that the stroke is associated with worse cognitive skills.

The results of column 1 in Table 6 provide an aggregate effect of the life events variables. In column 2 and 3 of table 6 and in table 7 we estimated the model on separate subsamples. With these analyses we aim to detect whether individuals exposed to different conditions early in life respond differently to life events later in life. Also, earlier work Koupil et al. (2007) show that adverse conditions earlier in life may have differential effects for males and females. The results of columns 2 and 3 of Table 6 and the results of Table 7 show that the impact of shocks later in life may vary with respect to conditions that individuals have been exposed to earlier in life and that this differs for men and women. More specifically, column 2 and 3 of Table 6 reveal that the effect of a stroke is driven by those who are born in a recession. The stroke has no impact on the cognitive skills for those who are born under more favourable conditions at the time of birth. We furthermore learn from column 2 and 3 of Table 6 that the positive effect of the 'illness of a family member or relative' variable is entirely driven by those born in a boom: the (temporary) health preserving effect of giving care is only present for those born in favorable economic conditions. The results of table 6 also show that the 'death of parents, siblings and (grand)children' has a negative impact on cognitive skills. A further disaggregation with respect to gender show that the 'stroke' effect and the effect of a death of a relative is primarily important for the development of the cognitive skills of women born in recessions. The health preserving effect of an 'illness of a family member or relative' is present for both men and women born in booms.

5. CONCLUSIONS

Cognitive functioning of elderly individuals may be affected by events such as the loss of a (grand)child or partner or the onset of a serious chronic condition, and by negative economic shocks such as job loss or the reduction of pension benefits. It is conceivable that the impact of such events and shocks is stronger if conditions early in life were adverse. In this paper we study this with Dutch longitudinal database that follows elderly individuals for more than 15 years and contains information on demographics, socio-economic conditions, life events, and health. We exploit exogenous variation in early-life conditions as generated by the business cycle and singular events.

Our results show that economic conditions can have an impact on cognitive functioning of older persons and that the impact of life events on cognitive functioning varies with conditions at around the time of birth and that this differs for men and women. Our findings are relevant for public and health care policies. The costs of care for cognitively impaired individuals are high and are expected to increase in the upcoming decades. It is thus important to know the determinants of cognitive decline. Adverse events are easily observed by care takers and are therefore a potentially informative red flag for an upcoming decline in cognitive functioning of older persons.

LITERATURE

Alderman H, Hoddinott J, Kinsey B (2006) "Long-term consequences of early childhood malnutrition", Oxford Economic Paper 58:450-474.

Almond DV (2006) "Is the 1918 Influenza Pandemic over? Long-term effects of in utero Influenza exposure in the post 1940 U.S. population", Journal of Political Economy 114:672-712.

Alter G, Dribe M, van Poppel F (2007) "Widowhood, Family Size, and Post-Reproductive Mortality: A Comparative Analysis of Three Populations in Nineteenth Century Europe." Demography, 44(4):785-806.

Barker DJP (1992) "Foetal and infant origins of adult diseases", London BMJ Publishing Group.

Beishuizen J, Werkman E (1968) Nederland in de crisistijd 1929-1939. A.W. Slijthof: Leiden.

Bengtsson T, Lindstrom M (2003) "Airborne infectious diseases during infancy and mortality in later life in southern Sweden, 1766-1894.", International Journal of Epidemiology 32:286-294.

van den Berg GJ, Doblhammer G, Christensen, K. (2008) "Being born under adverse economic conditions leads to a higher cardiovascular mortality rate later in life: Evidence based on individuals born at different stages of the business cycle", IZA discussion paper No 3635.

van den Berg GJ, Lindeboom M, Portrait F (2007) "Long-run longevity effects of a nutritional shock early in life: the Dutch potato famine of 1846-1847" IZA discussion paper No 3123.

van den Berg GJ, Lindeboom M, Portrait F (2006) "Economic conditions early in life and individual mortality", American Economic Review 96:290-302.

van den Berg GJ, Lindeboom M, Portrait F (2006) "The effect of conjugal bereavement on health status and mortality of older individuals", Working paper.

van den Berg GJ, Lindeboom M, Portrait F (2002) "An econometric analysis of the mental-health effects of major events in the life of older individuals" Health Economics 11:505-520.

Black SE, Devereux PJ, Salvanes K (2005) "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes", NBER working paper No 11796.

Brown AS, Susser ES (2008) "Prenatal Deficiency and Risk of Adult Schizophrenia" Schizophrenia Bulletin 34(6) 1054-63

Case A, Fertig A, Paxson C (2005) "The lasting impact of childhood health and circumstance", Journal of Health Economics 24:365-389.

Case, A, Lubotsky M, Paxson C (2002) "Economic Status and Health in Childhood: the origins of the gradient", American Economic Review 92(5):1308-1334.

Chen Y, Zhou L (2007) "The Long-term Health and Economic Consequences of the 1959-1961 Famine in China", Journal of Health Economics 26:659-681.

Dercon S, Hoddinott J, Woldehanna T (2005) "Vulnerability and Shocks in 15 Ethiopian Villages, 1999-2004", CRSP working paper, University of Wisconsin-Madison.

Doblhammer G (2004) "The late legacy of very early life." Demographic Research Monographs, Rostock: Max Planck Institute for Demographic Research.

Deeg DJH, Westerdorp de Serière (1994) Autonomy and well-being in the aging population, report from the Longitudinal Aging Study Amsterdam 1992-1993, VU university Press Amsterdam

Deeg DJH, Beekman ATF, Kriegsman DMW, Westerdorp de Serière (1998) Autonomy and well-being in the aging population, report from the Longitudinal Aging Study Amsterdam 1992-1996, VU university Press Amsterdam

Factor-Litvak P, Susser E (2004) "A life course approach to neuropsychiatric outcomes" in Kuh D, Ben-Shlomo Y "A life course approach to chronic disease epidemiology", 2nd edition, Oxford Medical Publications.

Folstein, M.F., S.E. Folstein, and P.R. McHugh (1995) Mini-mental state: a practical method for grading the cognitive state of patients for the clinician, Journal of Psychiatric Research, vol. 12.

Heijmans BT, Tobi EW, Stein AD, Putter H Blauw GW, Susser ES, Slagboom PE, Lumey LH (2008) "Persistent epigenetic differences associated with prenatal exposure to famine in humans" PNAS 105(44) 17046-9.

Hodrick R, Prescott EC (1997) Postwar U.S. business cycles: an empirical investigation. Journal of Money, Credit and Banking, 29, 1 - 16.

Kannisto, V, Christensen K, Vaupel JW (1997) "No Increased Mortality in Later Life for Cohorts born during Famine", American Journal of Epidemiology 18:158-74.

Koupil I, Shestov DB, Sparén P, Plavinskaja S, Parfenova N, Vågerö D (2007) "Blood Pressure, Hypertension and Mortality from Circulatory Disease in Men and Women who Survived the Siege of Leningrad", European Journal of Epidemiology 22:223-234.

Kuh D, Ben-Shlomo Y (2004) "A life course approach to chronic disease epidemiology", 2nd edition, Oxford Medical Publications.

Lumey LH, Stein AD, Kahn AS, van der Pal-de Bruin KM, Blauw GJ, Zybert PA, Susser ES (2007) “Cohort Profile: The Dutch Hunger Winter Families Study” International Journal of Epidemiology 36(6):1196-1204.

Maddison A. (2003) The world economy: historical statistics. Development Centre Studies: OECD.

Martorell R (1995) “Results and Implications of the INCAP Follow-up Study” Journal of Nutrition 125(4):1127-1138

Moore SE, Cole TJ, Collinson AC, Poskitt EM et al. (1999) “Prenatal or early postnatal events predicts infectious deaths in young adulthood in rural Africa” International journal of Epidemiology 28:1088-95.

Neugebauer RWijbrand Hoek H, Susser E (1999) “Prenatal Exposure to Wartime Famine and Development of Antisocial Personality Disorder in Early Adulthood” JAMA 282(5) 455-462.

Radloff LS (1977) The CES-D scale: a self-report depression scale for research in the general population, Applied Psychological Measurement, vol. 1.

Richards M, Sacker A (2003) “Lifetime antecedents of cognitive reserve” Journal of Clinical Experimental Neurophyschology 25(6):614-24.

Saint-Clair D, Xu M, Wang P et al. (2005) “Rates of adult schizophrenia following prenatal exposure to the Chinese Famine of 1959-61” JAMA 294:557-562.

Sixma H, Ultee WC (1983) Occupational prestige score for the Netherlands in the eighties (in Dutch). Mens & Maatschappij 58:360-382.

Stein ZA, Susser M, Saenger G, Marolla F (1975) “Famine and Human Development: the Dutch Hunger Winter of 1944-45” New-York: Oxford University Press.

Stein AD, Wang M, DiGirolamo A, Grajeda R, Ramakrishnan U, Ramirez-Zea M, Yount K, Martorell R (2008) “Nutritional supplementation in early childhood, schooling, and intellectual functioning in adulthood: a prospective study in Guatemala” Archives of Pediatrics and Adolescence Medicine 162(7):612-18

Prevention of Neural Tube defects: results of the Medical Research Council Vitamin Study, MRC Vitamin Study Research Group Lancet 338:131-7.

Susser ES, Lin SP (1992) “Schizophrenia after prenatal exposure to the Dutch Hunger Winter of 1944-45” Arch Gen Psychiatry 49:983-8.

Vugs R. (2002) In veel huizen wordt gerouwd. De Spaanse griep in Nederland. Aspekt: Soesterberg. (in Dutch).

McWhinnie JR (1981) Disability assessment in population surveys: Results of the OECD common development effort. Revue Epidémiologique et Santé Publique 29:413-419

Table 5a Levels equations for cognition with the value of the cyclical indicator of GNP at birth as a measure for early life conditions

VARIABLES	I	II	II
Lagged log mmse		0.470***	0.469***
		(0.014)	(0.014)
Birth year	-0.015***	-0.006***	-0.007***
	(0.003)	(0.002)	(0.002)
Age	0.015***	0.013***	0.013***
	(0.003)	(0.003)	(0.003)
Number of chronic conditions at wave 1	0.015	0.011	0.010
	(0.010)	(0.007)	(0.007)
Educaton	-0.089***	-0.047***	-0.047***
	(0.005)	(0.004)	(0.004)
Married	-0.015	-0.004	-0.005
	(0.021)	(0.020)	(0.020)
Female	-0.102***	-0.059***	-0.059***
	(0.021)	(0.014)	(0.014)
Life events (onset)			
Bereaved	-0.008	0.011	0.013
	(0.032)	(0.029)	(0.029)
Death of a parent, sibling, (grand)child	0.031*	0.023*	0.023
	(0.017)	(0.014)	(0.014)
Illness of partner or relatives	-0.121***	-0.088***	-0.087***
	(0.016)	(0.013)	(0.013)
Financial problems	0.106*	0.054	0.060
	(0.059)	(0.046)	(0.046)
CVA (stroke)			0.114***
			(0.040)
Heart disease			-0.006
			(0.025)
Respiratory diseases			-0.031
			(0.035)
Arteriosclerosis			-0.058*
			(0.034)
Diabetes			0.034
			(0.042)
Cancer			-0.036
			(0.029)
# of Chronic conditions	-0.017	-0.006	
	(0.012)	(0.011)	
Conditions at birth			
Cyclical component of Business cycle	-0.183	-0.097	-0.100
	(0.156)	(0.102)	(0.101)
Constant	0.903***	0.097	0.134
	(0.279)	(0.242)	(0.242)
Observations	6490	6478	6481
R-squared	0.227	0.380	0.382

Cognition is measured by log(31- mmse). High values are associated with worse cognition
*** p<0.01, ** p<0.05, * p<0.1 Robust clustered standard errors in parentheses

Table 5b Levels equations for cognition with the peak and trough years as variables for coinditons at birth (1st and 4th quartile of the cyclical component)

VARIABLES	I	II	II
Lagged log mmse		0.469***	0.469***
		(0.014)	(0.014)
Birth year	-0.014***	-0.006**	-0.006**
	(0.003)	(0.002)	(0.002)
Age	0.015***	0.014***	0.013***
	(0.003)	(0.003)	(0.003)
Number of chronic conditions	0.016	0.011*	0.010
	(0.010)	(0.007)	(0.007)
Educaton	-0.090***	-0.047***	-0.047***
	(0.005)	(0.004)	(0.004)
Married	-0.015	-0.004	-0.005
	(0.021)	(0.020)	(0.020)
Female	-0.102***	-0.059***	-0.059***
	(0.021)	(0.014)	(0.014)
Life events (onset)			
Bereaved	-0.006	0.012	0.014
	(0.032)	(0.029)	(0.029)
Death of a parent, sibling, (grand)child	0.032*	0.024*	0.023*
	(0.017)	(0.014)	(0.014)
Illness of partner or relatives	-0.121***	-0.088***	-0.087***
	(0.016)	(0.013)	(0.013)
Financial problems	-0.018	-0.006	-0.006
	(0.012)	(0.011)	(0.011)
CVA (stroke)			0.112***
			(0.040)
Heart disease			-0.007
			(0.025)
Respiratory diseases			-0.032
			(0.035)
Arteriosclerosis			-0.058*
			(0.034)
Diabetes			0.034
			(0.042)
Cancer			-0.036
			(0.029)
# of Chronic conditions	0.106*	0.054	0.060
	(0.059)	(0.046)	(0.046)
Conditions at birth			
Trough years	-0.025	-0.012	-0.010
	(0.028)	(0.018)	(0.018)
Peak years	-0.062**	-0.032**	-0.030*
	(0.025)	(0.016)	(0.016)
Constant	0.906***	0.100	0.137
	(0.279)	(0.242)	(0.242)
Observations	6490	6478	6481
R-squared	0.228	0.381	0.382

Cognition is measured by log(31- mmse). High values are associated with worse cognition
Robust clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6 First differenced equation for cognition.

VARIABLES	I	Recession (cyclical indicator <0) IIa	Boom (cyclical indicator >0) IIb
Age	-0.161***	-0.168***	-0.152***
	(0.016)	(0.021)	(0.025)
Age squared	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Life event (onset)			
CVA (Stroke)	0.111***	0.150***	0.071
	(0.043)	(0.055)	(0.066)
Arteriosclerosis	-0.075*	-0.090	-0.063
	(0.041)	(0.057)	(0.059)
Heart diseases	0.030	0.025	0.039
	(0.029)	(0.041)	(0.042)
Diabetes	-0.018	-0.006	-0.025
	(0.049)	(0.072)	(0.068)
Cancer	0.009	-0.062	0.084
	(0.037)	(0.052)	(0.053)
Respiratory diseases	-0.011	-0.010	-0.003
	(0.041)	(0.058)	(0.059)
Rheuma	-0.003	-0.023	0.019
	(0.024)	(0.033)	(0.034)
Surgery	-0.015	0.026	-0.060*
	(0.024)	(0.032)	(0.035)
Illness of partner or relatives	-0.053***	-0.022	-0.087***
	(0.015)	(0.020)	(0.021)
Death of a parent, sibling, (grand)child 2	0.015	0.036*	-0.011
	(0.016)	(0.022)	(0.023)
Financial problems	0.001	-0.025	0.035
	(0.051)	(0.063)	(0.082)
Bereaved	0.031	0.034	0.031
	(0.034)	(0.049)	(0.048)
Observations	6482	3368	3114
R-squared	0.045	0.039	0.055

Cognition is measured by log(31- mmse). High values are associated with worse cognition
*** p<0.01, ** p<0.05, * p<0.1 Robust clustered standard errors in parentheses

Table 7 First differenced equation for cognition (males and females born in recession and boom)

VARIABLES	Males: Recession (cyclical indicator <0) dlogmmse	Males: Boom (cyclical indicator >0) dlogmmse	Females: Recession (cyclical indicator >0) Dlogmmse	Females: Boom (cyclical indicator >0) dlogmmse
Age	-0.158***	-0.180***	-0.179***	-0.128***
	(0.031)	(0.038)	(0.030)	(0.035)
Age squared	0.001***	0.002***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Life event (onset)				
CVA (Stroke)	0.092	0.134	0.211***	-0.022
	(0.075)	(0.086)	(0.081)	(0.105)
Arteriosclerosis	-0.136	-0.126	-0.027	-0.013
	(0.083)	(0.095)	(0.079)	(0.076)
Heart diseases	0.039	0.029	0.010	0.039
	(0.059)	(0.058)	(0.059)	(0.062)
Diabetes	-0.093	-0.020	0.055	-0.016
	(0.102)	(0.112)	(0.100)	(0.084)
Cancer	-0.085	0.128	-0.041	0.036
	(0.069)	(0.079)	(0.078)	(0.072)
Respiratory diseases	-0.054	0.002	0.029	-0.002
	(0.077)	(0.078)	(0.087)	(0.093)
Rheuma	-0.047	0.016	-0.006	0.022
	(0.050)	(0.059)	(0.043)	(0.042)
Surgery	0.001	-0.080	0.054	-0.046
	(0.046)	(0.052)	(0.046)	(0.050)
Illness of partner or relatives	-0.027	-0.124***	-0.017	-0.056*
	(0.031)	(0.031)	(0.026)	(0.029)
Death of a parent, sibling, grand)child	-0.013	-0.023	0.081***	-0.002
	(0.031)	(0.036)	(0.031)	(0.029)
Financial problems	0.078	-0.125	-0.110	0.170
	(0.086)	(0.111)	(0.087)	(0.116)
Bereaved	0.017	0.065	0.050	0.008
	(0.089)	(0.082)	(0.059)	(0.060)
Observations	1520	1419	1848	1695
R-squared	0.040	0.071	0.045	0.047

Cognition is measured by log(31- mmse). High values are associated with worse cognition
*** p<0.01, ** p<0.05, * p<0.1. Robust clustered standard errors in parentheses

Table 8 Fixed effects regressed on indicator of early life conditions and other time constant variables

VARIABLES	I	II
Birth year	-0.014***	-0.014***
	(0.001)	(0.001)
Education	-0.091***	-0.091***
	(0.005)	(0.005)
Female	-0.103***	-0.104***
	(0.023)	(0.023)
Married	-0.069***	-0.070***
	(0.024)	(0.024)
Education	-0.091***	-0.091***
Presence of Chronic condition at wave 1		
Respiratory diseases	-0.024	-0.024
	(0.034)	(0.034)
Heart diseases	0.027	0.027
	(0.028)	(0.028)
Arteriosclerosis	0.041	0.042
	(0.039)	(0.039)
CVA (Stroke)	0.129**	0.127**
	(0.054)	(0.054)
Diabetes	0.022	0.024
	(0.047)	(0.047)
Cancer	0.004	0.008
	(0.039)	(0.039)
Rheuma	-0.009	-0.009
	(0.019)	(0.019)
Conditions at birth		
Cyclical component of business cycle	-0.201	
	(0.157)	
Trough years		-0.007
		(0.029)
Peak years		-0.051**
		(0.026)
Constant	1.807***	1.816***
	(0.042)	(0.042)
Observations	2264	2264
R-squared	0.189	0.190

*** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in parentheses