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An econometric analysis of the mental-health effects of major events in the life of older individuals

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Abstract

Major events in the life of an older individual, such as retirement, a significant decrease in income, death of the spouse, disability, and a move to a nursing home, may affect the mental health status of the individual. For example, the individual may enter a prolonged depression. We investigate this using unique longitudinal panel data that track labor market behavior, health status, and major life events, over time. To deal with endogenous aspects of these events we apply fixed effects estimation methods. We find some strikingly large effects of certain events on the occurrence of depression. We relate the results to the health care and labor market policy towards older individuals.

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1 Introduction

Individual health at advanced ages is determined by endowed genetic factors, by consumption, smoking, drinking, and exercising, by health care, and by so-called *life events*. With the latter term we mean major events in the life of the individual that occur more or less suddenly. Older individuals are relatively likely to face certain types of life events, like retirement, a significant decrease in income, death of the spouse, disability, onset of a serious illness, and a move to a nursing home. These may have a particularly large effect on the *mental* health status of the individual, and this is what we investigate in the present paper.

Let us examine some of these life events in more detail. The onset or relapse of a life-threatening or disabling disease may affect mental health. A "forced move" to an institution for older individual 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 (14, 18, 25, 28). For instance, significant increases in rates of (chronic) depression or anxiety have been observed after the death of the partner. Bereavement or work loss may also induce a reduction of the number of social contacts, so that the individual may experience feelings of loneliness. Presumably, the death or a serious illness of a close friend or kin will affect health status in a comparable way. Additionally, there is evidence that widowhood is often associated with more poverty (22), which in turn may affect health. Labor market status and changes in labor market status at the working ages (below 65 in the Netherlands) may affect mental health as well. There may be a direct effect, for instance because inactivity associated with retirement may affect an individual's mental health. Moreover, retirement is in general associated with a drop in income and as such an indirect effect on health may be expected.

The demand for mental health care and the expenditures on mental health care are directly determined by the distribution of mental health in the population. As a consequence, insight into the factors that determine mental health is desirable. Major life events are easily observable to health care workers. That means that they are potentially very useful "red flags" that may trigger action by the health care workers. If a life event has a large effect on mental health then it is useful for health care workers to focus on the occurrence of such events, and to undertake action in the form of intensified mental health care if such events are observed.

To look at this from another point of view, the availability of a partner, children, or a close person, may be crucial in determining the demand for professional long-term care services. Informal care – the non-organized care provided from within the social network of the individual – is an essential supplement or substitute to professional long-term care in most countries. The death or illness of a major informal caretaker may result in an increase in costly professional care firstly to replace the care provided by the deceased person and secondly to meet the increase in needs of the survivor if bereavement induces a decline in health status. As such, insight in the effect of bereavement on mental health is important to monitor future needs in long-term care services of the older population.

Additionally, major changes in labor market policies towards older individuals have recently been suggested and implemented in most OECD countries, in light of the growing concern for reduced labor force participation rates of older individuals and foreseen changes in the demographics in these countries. Any policy aimed at the labor market positions of older individuals should be aware of the social costs or benefits associated with work or non-work states, such as unemployment, disability insurance, or early retirement schemes, and with the concurrent changes in incomes. Finally, from the early 1980s onwards, the Dutch government has strongly encouraged the older population to maintain an independent lifestyle for as long as possible. This study allows us to assess the effect on mental health – after controlling for health status – of moving to an institution for older individuals. As such, the present paper brings to light the consequences on mental health of the older population of the ongoing policy of substitution of extramural for intramural long-term care. In sum, this study is of interest to economic policy and health care policy.

Empirical studies on the relation between life events and health have to address the potential endogeneity of life events. The occurrence of a life event may be affected by factors that also have a direct effect on health. If such factors are not observed, and the analysis does not take account of their presence, then the estimated coefficients of behavioral models may be mistaken. For example, an individual with a genetic predisposition towards mental illness may move into the disability program before retirement, and he may also frequently display periods of mental illness. In that case the data show a positive relation between the occurrence of a transition into disability on the one hand, and the occurrence of mental illness on the other. However, this should not necessarily be taken as evidence of a causal effect from disability to mental illness.

As far as we know, studies on the relationships between morbidity and partner status generally assume that the stochastic processes underlying morbidity of

both spouses are independent. Nevertheless it seems plausible that the probabilities of lifetime partners of suffering from health disorders are associated through unobserved or not well-documented individual characteristics (e.g. they may have similar health-related behaviors, eating patterns, material circumstances, or life history). In that case, parameter estimates obtained from analyses that ignore this possible correlation may be biased. Similarly, it is often found that higher incomes are associated with better health, even if one controls for education and other measures of ability (see, for instance, 3, 10, 11). It is, however, difficult to assess to what extent the estimates found in these studies represent the true causal effects of income on health. There may be a direct effect of income on health (individuals with higher income may have better access to health care services, or may be better informed about the hazards of specific health related behavior). Alternatively, health problems may affect the individual's productivity. Finally, there may be unobservables such as life style variables, risk aversion, and frailty that govern both health status and income. Often, studies that assess the impact of income on health either assume that income is strictly exogenous to health or rely on untestable instruments.[1]

Impairment in mental health may prevent people from working, and unobservables associated with health and work (for instance previous investments in income and health) may relate both. The endogeneity between health and work has been acknowledged in the labor supply literature, but little work exists that takes account of this. Exceptions include Bazzoli (2), Stern (27), Bound et al. (4), Kerkhofs and Lindeboom (17) and Lindeboom and Kerkhofs (20).

The present paper adds to the different strands of literature mentioned above, by dealing with the possible endogeneity of life events. We rely on a framework where the simultaneous nature of the life events and of mental health is determined by time-invariant individual factors. In addition, we use longitudinal data in which the timing and sequence of life events and health deterioration are observed. This enables us to observe which occurs first and to control for the role of joint determinants. Concerning the latter, we use so-called fixed-effect estimation methods for panel data. Advantages of fixed-effect methods are (i) we do not need to rely on the specification of a model explaining occurrence of life events, and (ii) we do not need instrumental variables that affect life events but do not have a direct effect on mental health. Obviously, such instruments are hard if not impossible to find. By first-differencing the observations on mental health

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[1]Exceptions include the studies by Lindahl (19) and Case (5), who use monetary lottery prizes and unanticipated changes in the South-African pension system, respectively, as sources of exogenous variation in income.

indicators over time, we get rid of the unobserved individual heterogeneity and, consequently, of the possible correlation between mental health and life events. The first-difference equations can be correctly estimated using simple OLS methods. The method assumes that the occurrence of life events is independent of the remaining time-varying residual term in the regression. It is therefore important to allow for a broad range of variables accounting for shocks occurring during the sample period.

We use a unique panel data set of Dutch older individuals that includes a wide range of socio-demographic variables as well as detailed information on health and the occurrence of major life events that older persons are often confronted with. For instance, death of partner, parents, siblings or offspring of respondents are observed during the sample period, as well as changes in labor market states, moves, major shocks in income, and the onset of chronic diseases. Of relevance for our analyses is that we observe a significant fraction of respondents to die during the sample frame. We check whether the attrition is non-random and conclude that it is. We subsequently develop and apply a way to deal with this attrition problem.

The remainder of this paper is organized as follows. Section 2 describes the data used in the analyses. Section 3 presents the statistical model and includes a discussion of alternative methods to estimate the model in the case that the data are subject to attrition. Section 4 presents and discusses the results and Section 5 concludes.

2   The data

2.1   Description and summary statistics

The data from the Longitudinal Aging Study Amsterdam (LASA) (8, 9) follow a representative sample of the Dutch institutionalized and non-institutionalized population of individuals aged 55–85 over an extended period of time. Currently three waves are available (the 1992–1993 wave, the 1995–1996 wave, and the 1998–1999 wave). It should be noted that no refreshment samples are drawn at wave II and wave III. A specification of the non-response in the LASA data is given in Table 1.

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

	Wave I	Wave II	Wave III
Number of individuals	2,925	2,204	1,717
Deceased	-	417	344
Short interviews	182	98	157
Refusals	-	145	125
Interviews by telephone	-	243	202
Attrition between Wave I and II	-	-	562
Total	3,107	3,107	3,107

Respondents with a short interview or a proxy interview are excluded from our analysis, for the simple reason that we do not observe the relevant variables for these respondents. We realize that the resulting sample – after exclusion of these respondents – may be selective with respect to (mental) health. In previous work, we compare health status of respondents with a complete interview with the one of respondents that refuse to participate in the second wave (see 24). Individuals who remain in the sample are in general slightly more healthy than their counterparts. Respondents were submitted either to a complete interview or to a short interview according to their ability to sustain a lengthy interview. Therefore it can be expected that respondents with a short interview are generally less healthy than the ones of the rest of the sample. On the other hand, there is evidence that individuals with an interview by telephone are healthier than the remaining respondents (see 9). Therefore, the possible selectivity of the resulting sample – i.e. after exclusion of respondents with a short interview or an interview by telephone – compared to the initial sample may not be too serious. Table 2 gives information on the reduced sample.

Table 2: ATTRITION DUE TO MORTALITY IN THE REDUCED SAMPLE

	Wave I	Wave II	Wave III
Number of individuals	2,253	1,894	1,643
Deceased between wave I and II	-	359	359
Deceased between wave II and III	-	-	251

The data are individual data and not household data, which means that relatively little information on the other members of the household is available in the data set. Information has been collected on physical, emotional, cognitive, and social functioning. Each of these components is assessed by a broad set of

subjective and objective measures. In addition, information is collected on characteristics that are expected to be of influence for one or more components of functioning mentioned above. Of interest for our study is that these characteristics include information on major life events. Table 3 presents sample means and/or frequencies for each of the three waves on a set of relevant variables.

Table 3 also includes means of tests and indicators of health. We use the MMSE (see 12) and the CES-D (see 26) variable as dependent variables in our analyses. The Mini Mental State Examination (MMSE) is a widely used method for assessing cognitive status. Five sections are included in the MMSE test. In the first one, respondents have to give the correct date and their correct address in order to make an assessment of their ability of orientation. The second part of the test tests the ability to remember immediately three words. The third part is on the ability to concentrate on a difficult task: counting backwards from 100 subtracting 7 at each time, and spelling a word backwards. In the fourth section, the respondent has to recall the three words mentioned in the second part. The final part of the test assesses the ability to speak – the respondent is asked to repeat a difficult sentence –, to follow instructions – the respondent is asked to fold in a specific way a piece of paper –, to write – the respondent is asked to write a short sentence – and to copy a geometric figure. The MMSE test 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.

The Center for Epidemiological Studies Depression Scale (CES-D) is used to measure current levels of depressive feelings of older individuals. The test includes questions on negative feelings (like having the blues, experiencing life as a failure, feeling lonely or sad, crying), on positive thoughts (as being hopeful about the future, feeling happy, enjoying life), on somatic activity (like losing appetite, suffering from a restless sleep, talking less), and on social contacts (experiencing other persons as unfriendly, and thinking that people dislike the respondent). The total score ranges from 0 to 60 and respondents with scores higher than 16 display clinically relevant symptoms of depression.

<u>Table 3</u>: Mean / Frequency of relevant variables

	Score	Wave 92/93 (%)	Wave 95/96 (%)	Wave 98/99 (%)
Deceased		-	18.9	16.3
Health variables				
MMSE (test on cognitive ability)	mean	26.8	26.7	26.8
CES-D (test on depressive feelings)	mean	8.0	8.0	8.6
Functional limitations	no difficulty	58.5	49.7	44.6
(based on three items)	one with difficulty	19.1	22.9	22.8
	two with difficulty	11.7	13.4	16.4
	three with difficulty	10.7	14.0	16.2
Performance test:				
Time cardigan	under median	53.1	50.0	53.4
	above median	43.5	46.5	42.6
	not done[1]	3.4	3.5	4.0
Time walk	under median	49.2	51.4	55.1
	above median	47.7	45.0	41.2
	not done[1]	3.1	3.6	3.7
Time chair	under median	55.2	49.9	47.1
	above median	36.6	39.6	42.8
	not done[1]	8.2	10.5	10.1
Chronic diseases:				
Respiratory diseases (COPD)	Yes	11.2	12.4	14.9
Heart diseases	Yes	19.5	21.9	26.4
Peripheral artery disease	Yes	9.7	11.6	11.5
Diabetes	Yes	7.8	7.2	8.9
Stroke	Yes	4.6	6.3	6.9
Arthritis	Yes	32.5	42.7	48.2
Cancer	Yes	8.5	11.0	12.9
Demographics				
Age	mean	69.9	71.8	73.7
Gender	female	50.0	50.2	52.4
Marital status	never married	5.6	5.4	5.1
	married	64.7	57.9	55.3
	divorced	5.0	5.4	5.5
	widowed	24.7	31.3	34.1
Institutionalized	Yes	3.8	4.6	5.1
Education	elementary	41.0	40.0	39.4
	intermediate	43.7	45.5	45.8
	high	15.3	14.5	14.8
Monthly net income	missing	16.1	18.8	20.9
	< 1.500	18.8	13.1	8.6
	1.501 − 3.000	42.6	40.5	39.2
	3.001 − 4.500	14.8	17.6	18.9
	> 4.501	7.7	10.0	12.4
Paid job	Yes	13.0	8.4	5.9
Disability Insurance Recipients	Yes	7.1	1.1	0.6
Early Retirement	partly	0.8	0.5	0.8
	completely	5.9	2.1	1.5
Degree of urbanization	low	13.3	13.9	13.2
(only observed at wave I)	medium	27.8	28.0	28.1
	high	58.9	58.1	58.7
Sample size		2.253	1.894	1.284

[1]: The respondents were not able to perform the test.

Physical functioning is measured by a self-reported indicator on mobility in daily life and by a performance test of physical ability. The first variable assesses the ability of the respondent to walk up and down 15 steps of a staircase without stopping, to use public or private transport and to cut one's own toenails. The score for each component of the variable ranges from 0 to 4. A score of 0 indicates that the respondent is not able to perform the action, a score of 1 shows that he or she is able to do it but only with help, a score of 2 and 3 points out that he or she can perform the activity with much and some difficulty respectively. Finally a score that takes on value 4 indicates that the respondent experiences no difficulty with performing this activity. All three items are included in our analyses. The performance test measures in seconds the time needed to take on and off a cardigan, the time needed to walk three meters back and forth along a rope, and the time needed to get up from a kitchen chair five times with arms folded (9).

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, peripheral artery diseases, stroke, diabetes, arthritis, and cancer.

From Table 3 it is clear that most changes in the means of the dependent variables are small, although the score of the CES-D variable is somewhat higher at the third wave. Figures 1 and 2 show that the entire distribution of the scores does not change much across the different waves. This may indicate that sample attrition is not selective with respect to the variables of interest. Of course this is not a formal test and more needs to be done in order to assess whether or not the sample selection is selective with respect the endogenous variables. We check this more closely in the next subsection. The cut-off points for MMSE and CES-D are 23 and 16 respectively and hence the figures show that only a small fraction of our sample can be called cognitively impaired or depressed.

The development of the distribution of the self assessed functional limitation variable indicates that physical health deteriorates over time. About 27% of the respondents die during the observation period and it is therefore somewhat remarkable to still find such marked declines in physical health. This result can be refined by a look at the figures with respect to the objective test on physical ability. The figures on the cardigan test and on the chair test show a slight deterioration of the physical ability over time; the figures on the walking test are more ambiguous and could demonstrate some improvement of the mobility over time. At least, the results on the performance test do not validate the results based on the examination of the figures regarding subjective physical health. Therefore it

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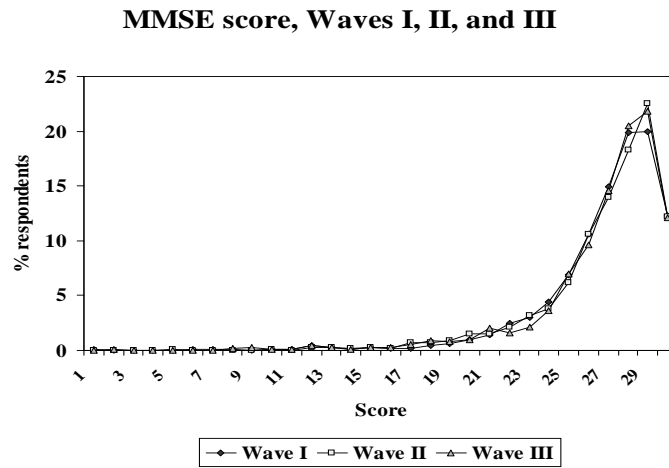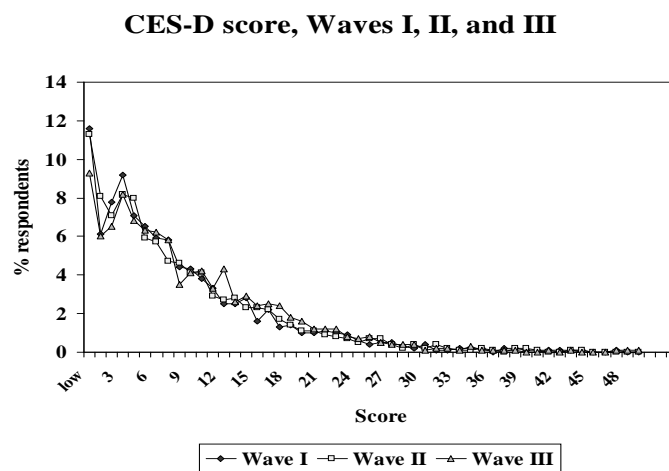
Figure 1: Distribution of MMSE scores

MMSE score, Waves I, II, and III

Figure 2: Distribution of CES-D scores

CES-D score, Waves I, II, and III

is difficult to give a definite conclusion on the evolution of physical health status over the sample period. It should be mentioned that, in the interest of conciseness, percentages above and under the median as well as of respondents who were not able to perform the test only are reported in Table 3. In the empirical part of the paper we use the recorded time in seconds as outcome of the three items of the performance test. The respondents who were not able to perform the test are arbitrarily given a score equal to twice the maximum time required to perform the test.

Note that the sample ages with almost 4 years during the 6 to 7 years that we follow them. In the empirical part of the study, age is recorded in years minus 55. As expected, the fraction of females, widowers, and people living in an institution increases over time. The examination of figures regarding education and income indicates that, regardless of the aging of our sample, the average socioeconomic status increases over time. This is not completely surprising as lower educated individuals and individuals with lower incomes are known to have a higher probability of dying than their counterparts (see, for instance, 16). It is important to notice the high numbers of missings with respect to income. Altogether, about 500 respondents refuse to mention their income in at least one wave. As a consequence, in the empirical part of the study, we decided to exclude the variable measuring income from our analyses. Henceforth, information on (changes in) income is captured by the binary variable: "Did you experience serious financial problems since the last interview?". The fraction of individuals with a paid job, participating in a Disability Insurance program or in an Early Retirement program decreases over time, this arising primarily from the aging of our sample. Unfortunately, because of limitations of the data, we were not able to exactly identify whether or not an individual could be considered as being unemployed.

Table 4 presents frequencies of life events occurring between successive waves. More than 6% of the respondents lose their partner between wave I and II. This is about 10% of the relevant group of married individuals (6.4%/0.647). Due to aging of our sample, this fraction reduces to 3.1 between wave II and wave III. Furthermore, regarding changes in incomes, the onset of severe financial problems is observed for a small, yet non-negligible, fraction of respondents. Finally, with respect to chronic diseases, arthritis and heart diseases are the most commonly observed chronic conditions and we also observe their onset most frequently. A substantial fraction of the respondents loses at least a brother or a sister during the observation period. Illness of partner and relatives is also a common phenomenon. It remains to be seen how all these factors affect the evolution of an individual's mental health, as measured by changes in the MMSE and CES-D

scores.

Table 5 pictures the changes observed in the scores measuring cognitive impairment and (chronic) depression during the period intervening successive waves.

Table 5 shows that although the cognitive health of a substantial proportion of the respondents decreases over time (42.9% between I and II, and 40.5% between II and III), 32.6% (between I and II) and 35% (between II and III) of our respondents experience an improvement of their cognitive status. This may be partly explained by a "learning" effect, i.e. in the second and third wave the respondents know how the test develops and can therefore pay more attention to specific parts of it. With respect to the CES-D test scores, examination of the figures also shows that emotional health varies considerably over time. Still, a large fraction of the respondents experience a decrease of the CES-D test score over time.

The longitudinal nature of the data will help us in assessing the causal effect from possibly endogenous variables such as changes in labor market status and other life events on CES-D and MMSE tests. The longitudinal nature of our data also introduces the problem of sample attrition (see Table 1), a problem, that given the nature of our endogenous variable – mental health – has to be dealt with. Below we discuss this issue and its consequences for our statistical model.

2.2   A test on non-random attrition

Table 2 indicates that about 27% of the initially selected respondents die between wave I and III. This is of particular relevance in the context of our problem, where we are interested in the (dynamics) of mental health. Morbidity and mortality are clearly related and is moreover conceivable that there exists factors that are usually not observed (such as an individuals proneness to engage in risky activities) that relate both. As a result, an initially random sample may end up as a selective sample where the relatively healthy individuals are overrepresented – with consequences for the measurement of the effect of life events on health. Note, however, that mental impairment may not necessarily be associated to higher mortality rates, as long as it is not directly associated to other impairments that reduce life expectancy. There is however, some evidence that this might indeed be the case (see for instance 14, 28, 18, 25).

To proceed, we perform some simple checks to see if attrition is selective. As a first check we examine the distribution of mental health as observed in wave I and see if there exists an association with future attrition/death. This boils down to a regression of, for instance, CES-D on a range of personal characteristics, a

Table 4: FREQUENCY OF LIFE EVENTS

	Score	Between 92/93 and 95/96	Between 95/96 and 98/99
DECEASED		18.9	16.3
DEMOGRAPHICS			
Change partner status	Widowed	6.4	3.1
	Separated	1.7	1.3
Move to an independent dwelling	Yes	10.9	9.8
Move to an institution	Yes	1.8	1.5
Severe financial problems	Yes	2.9	1.6
Loss of paid job	Yes	5.2	2.4
New Disability Insurance Recipients	Yes	0.6	0.3
New "early" pensioners	Partly	0.7	0.9
	Completely	3.1	1.3
CHRONIC DISEASES[1,2]			
Respiratory diseases (COPD)	Onset	3.0	4.0
Heart diseases	Onset or Relapse	6.1	4.6
Peripheral artery diseases	Onset	3.1	2.1
Diabetes	Onset	2.0	2.7
Stroke	Onset or Relapse	3.5	2.7
Arthritis	Onset	14.2	10.6
Cancer	Onset or Relapse	3.9	3.9
OTHERS			
Surgery[3]	Yes	7.2	10.0
Death parent	Yes	6.2	3.4
Death brother or sister	Yes	23.8	23.0
Death children	Yes	1.7	1.9
Death grandchildren	Yes	1.4	1.0
Illness partner	Yes	13.7	12.5
Illness relatives	Yes	45.3	44.5
Severe conflicts with others	Yes	9.3	8.7
Victim of crimes	Yes	1.6	2.4

[1] Onset was recorded when the respondent mentioned at wave $(t-1)$ no presence of a specific disease and he or she is observed to suffer from this specific disease at wave (t).

[2] Relapse was recorded when the respondent mentioned one or several myocardial infarctions (for heart diseases), strokes (for stroke), or tumors (for cancer) since the previous interview.

[3] The variable "Surgery" was given a score 1 when the respondent has had a surgery for at least one of the diseases mentioned above.

Table 5: OBSERVED CHANGES IN VARIABLES THAT MEASURE MENTAL HEALTH

Changes in score (in %)	< -5	$[-5, -2[$	$[-2, -1[$	-1	0	1	$]1, 2]$	$]2, 5]$	> 5
MMSE									
- betw. I & II	1.9	9.7	11.3	20.0	24.5	16.7	9.8	5.7	0.4
- betw. II & III	2.1	9.1	10.4	18.9	24.6	19.4	9.0	6.1	0.5
CES-D									
- betw. I & II	12.5	13.9	7.2	7.6	11.7	8.1	6.8	16.7	15.2
- betw. II & III	9.1	8.7	5.6	7.6	10.9	8.4	7.9	13.8	15.4

measure of physical health and an indicator for future attrition[2]. This informal test gives an indication of the relevance of attrition, in particular when attrition is governed by determinants that are themselves invariant over time. One can judge this by the significance of the attrition indicator, as well as by stability of the other coefficients of the model, under alternative specifications (see 29).

Results of specifications with CES-D and MMSE as measures for mental health reveal that the attrition dummy is significant in a specification of CES-D/MMSE on a range of exogenous variables (gender, age, education level, marital status, and degree of urbanization of the municipality where the respondent lives) and an attrition dummy. The coefficient of the attrition dummy in the CES-D specification is negative, which means that "stayers" in the sample have, ceteris paribus, a better emotional health than the deceased individual. In the MMSE specification, the dummy coefficient is negative which boils down to a better cognitive health of survivors compared to the deceased respondents. The attrition dummy is not significant if one adds a measure for physical health to the equation. Note however, that this regression is invalid if unobservables affect both mental and physical health. Moreover, there are some changes in the coefficients of the CES-D and MMSE regressions if one excludes the attrition dummy variable. One may conclude from these exercises that attrition is most likely to be selective with respect to mental health and that ignoring this most likely will have consequences for the coefficients of interest. Consequently, we have to deal with this attrition problem in the empirical analysis.

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[2]Results regarding regressions with respect to attrition are available on request from the authors.

3   The empirical model specifications

3.1   Regression equations with fixed effects

Consider the following equation relating mental health H_{it} to a range of socio-economic and demographic variables X_{it}, a set of life event variables Z_{it}, a time-invariant individual-specific effect d_i, and an idiosyncratic shock u_{it},

$$H_{it} = X_{it}'\beta + Z_{it}'\gamma + d_i + u_{it} \tag{1}$$

Here, H_{it}, X_{it} and Z_{it} are observed, whereas d_i and u_{it} are unobserved. We assume that X_{it} and Z_{it} are orthogonal to u_{it} (we return to this below). The elements of γ capture the effect of the life events Z_{it} on mental health H_{it}, so they are the parameters of interest. Obviously, OLS estimation of γ is complicated by the fact that d_i is unobserved, so that X_{it} and Z_{it} may not be orthogonal to the residual term $d_i + u_{it}$. For instance, as in the emerging economic literature on the relationship between socio-economic status and health, labor market status and/or income (which both influence Z_{it}) may well be related to d_i. Recall the discussion on endogeneity in Section 1.

One can deal with this endogeneity (or simultaneity) problem by (i) extending model (1) with equations for the elements of Z_{it}, (ii) specifying the correlation between d_i and Z_{it} directly (see for instance Mundlak (23) or Chamberlain (6)), or (iii) using a fixed-effect approach. Extending equation (1) with separate equations for Z_{it} may not be convenient in our case, as Z_{it} includes a relatively large number of elements. Moreover, this approach requires valid instruments in order to identify the true causal effect from Z_{it} on H_{it}. That is, the equations for Z_{it} need to contain explanatory variables that are not in X_{it}. Approach (ii) is less cumbersome to implement. However, valid instruments are still required, and the results may be sensitive to the specification chosen for the correlation between Z_{it} and d_i. Since we have longitudinal panel data at our disposal, we may apply fixed-effect methods, where some transformation is used to eliminate the nuisance parameters (d_i) from the regression equation (see e.g. 15). This approach does not rely on functional-form or exclusion restrictions, which is a marked advantage.

The fixed-effect approach that we use is based on first differences of equation (1) over time, rather than the within transformation. Let Δ denote the first difference operator, so e.g. $\Delta X_{it} := X_{it} - X_{i,t-1}$. We have

$$\Delta H_{it} = (\Delta X_{it})'\beta + (\Delta Z_{it})'\gamma + \Delta u_{it} \tag{2}$$

Note that in case $Z_{it} = 1$ corresponds to a more or less unique and irreversible event (like death of the partner), $Z_{it} = 1$ is equivalent to $\Delta Z_{it} = 1$.

Clearly, in equation (2), the time-invariant individual effects are eliminated, and the regressors are orthogonal to the residual term.[3] One could in principle rely on simple ordinary least squares estimation of this equation. Simple OLS, however, ignores the correlation between Δu_{it} and $\Delta u_{i,t-1}$, and hence efficiency could be improved. Note that the correlation disappears if the following specification is assumed:

$$u_{it} = u_{i,t-1} + \eta_{it}$$

where η_{it} is i.i.d. normally distributed with mean zero and variance σ^2. This specification accounts for persistence of unobserved shocks across periods, which is likely in the context of our application where we analyze the effects of major life events on the mental health of older people. In this case,

$$\Delta u_{it} = \eta_{it}$$

and simple OLS estimation of equation (2) yields unbiased and efficient parameter estimates.

One possible drawback of the fixed effect approach is that the time-invariant regressors (i.e. sex, education, degree of urbanization where the respondent lives) drop out of the model. However, in the present paper, we are interested in assessing the effect of life events – which by definition vary over time – on mental health.

Now let us return to the requirement that Z_{it} is orthogonal to u_{it}. Most applications of fixed-effect methods tacitly assume this. This assumption may be violated if there are unobserved transitory shocks that affect mental health and that affect or are affected by Z_{it}. For instance, the sudden onset of a life-threatening disease like cancer may have direct instantaneous effects on mental health and on labor supply and income (e.g. through medical consumption). Similar arguments may apply in the case that the partner, a parent, or a child

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[3]This holds, of course under the assumption that u_{it} is orthogonal to Z_{it} and X_{it}.

of the individual becomes very ill. Likewise, the onset of a disease, a surgery, or a move in an institution for older individuals could affect mental and physical health simultaneously. These shocks may affect or be affected by X_{it}, Z_{it} and d_i. To deal with this, the shocks have to be included as explanatory variables. It is therefore of importance to include as many time-varying determinants of mental health as possible. We are in the fortunate position to have access to data that observe events like moves, surgeries, the onset of life threatening chronic conditions, such as cancer, heart problems, stroke etc, and whether or not deaths or sudden shocks to the health of partner or close relatives have taken place. Of course, these are also "life events" in their own right. In sum, it is of importance to include as many life events as possible as explanatory variables, and our data are well suited to this, as they record an unusually large variety of them. As a result, in the absence of non-random attrition, equation (2) is correctly estimated by using simple OLS methods.

3.2 Non-random attrition in the model framework

However, as noted in Subsection 2.2, 27% of our sample is observed to die between waves I and III and this is likely to be selective. We need to correct for this in the context of our fixed effects model. Suppose that attrition is governed by a latent index M_i^*: if it exceeds zero then the respondent i participates in all three waves of the survey. In most practical situations one specifies a model for M_i^* and estimates this along with equation (1). Alternatively one could employ a two-stage procedure, where the model for M_i^* is used to construct conditional moments of d_i to correct for selectivity. This two-stage procedure produces an interesting result in the case that we condition on survival in a fixed number of waves. Let us start with the condition that the respondents survive in all waves of our panel survey and suppose that this is governed by:

$$M_i^* = W_{i0}'\alpha + v_i$$

where W_{i0} is a set of strictly exogenous explanatory variables observed at the initial wave and v_i is an individual stochastic component. In line with much of the research in this area (Hausman and Wise (13), Ridder (1993) and Gottschalk and Moffitt (1996), we assume conveniently that there exists an association between v_i and d_i, rather than between v_i and u_{it}, for some or all t. In this case, conditioning on presence at all waves implies for the mean of our health variable H_{it} that:

$$E[H_{it}|M_i^* > 0] = X_{it}'\beta + Z_{it}'\gamma + E[d_i|M_i^* > 0] \tag{3}$$
$$= X_{it}'\beta + Z_{it}'\gamma + f(W_{i0}'\alpha)$$

where $f(W_{i0}'\alpha)$ is an arbitrary function for the conditional mean $E[d_i|M_i* > 0]$, that boils down to the (standard) inverse of Mill's ratio under the assumption of joint normality of d_i and v_i. Of interest for our purposes is that $f(W_{i0}'\alpha)$ varies over individuals but not over time. Therefore, differenced regressions of mental health H_{it} only depend on differences in X_{it}, Z_{it} and u_{it}, as in equation (2). The above reasoning justifies the use of the fixed-effect specification in models using panel data sets that are subject to non-random attrition.

So far we conditioned on all waves, but it may be clear that we need not to restrict ourselves to samples of individuals that survive in all waves. Using similar arguments one could construct other similar subsamples, where we condition on presence in all but the last wave, all but the last two waves etc. Note that this is in principle equivalent to a model with wave specific selection (i.e. attrition) equations. Given the model assumptions, this will only affect $E[d_i|M_i^* > 0] = f(W_{i0}'\alpha)$ in equation (3), but, as these cancel out while differencing, it will not affect the estimates of β and γ. Estimation remains therefore very simple: select all individuals who remain in the sample for at least two waves and estimate a first-difference equation, hereby controlling for any correlation that might exist between the time persistent components v_i and d_i in our model. Apart from its simplicity, the procedure proposed is attractive, as estimates of β and γ do not depend on exclusion restrictions or (equivalently) instruments, usually imposed in a random effects framework.

The procedure outlined above fails in the case that, apart from a correlation between v_i and d_i, also a correlation between v_i and u_{it} exists. In this case the relevant conditional expectation in equation (3) equals $E[d_i + u_{it}|M_i^* > 0]$, which will generally vary over time. As a consequence, differencing the data may not eliminate all correlation between the included regressors and the stochastic component due to non-random attrition. A pragmatic way to deal with this is to include a dummy for each specific subsample of respondents participating in a range of consecutive interviews. In our case, where we have access to three waves, this means that we include those individuals in the sample who remain for two waves and those who remain for three waves and to add a dummy to the specification identifying the three wave participants. This variable is aimed to capture

all relevant correlations between observables and unobservables that remain after differencing the health equation.

4   The results

Tables 6 and 7 below report the results with respect to cognitive health (MMSE) and depression (CES-D) respectively. Low scores of the MMSE variables are associated with low cognitive skills. The reverse holds for CES-D: high scores are associated with greater feelings of depression.

A quick glance at Tables 6 and 7 reveals that life events have a larger effect on emotional status than on cognitive health, at least in the (relatively) short run. At the most, we follow the respondents during 7 years. Firstly, it is reasonable to assume that not all cognitive damage will show up immediately after occurrence of life events and that deterioration of cognitive health will take more time to arise than feelings of depression. There is for instance evidence that spousal bereavement increases the rate of depression of the survivors already in the first year of the widowhood and that the effect decreases after approximately four years. During the same period of time (i.e. four years), no effect of bereavement on cognitive skills could be demonstrated (see for instance 7, 21). Possibly, in the current study, the sample period is too short to be able to witness all transitions in cognitive health due to major life events. Secondly, genetic factors or physiological dysfunctions (like inadequate cellular development), rather than environmental conditions (like life events), may play a more important part in cognitive decline than in the occurrence of emotional disabilities.

With respect to health variables, onset of chronic diseases is found to have a less debilitating effect on cognitive health than increases in physical limitations (see performance test and indicator of Functional Limitations With difficulties). We did not really expect a deterioration of cognitive health due to onset or relapse of chronic diseases, except for diseases that are directly related with cognition. We do observe a decrease – though not statistically significant – of the MMSE score for respondents that have recently experienced episodes of strokes. The deterioration of cognitive skills as a result of increases in physical and emotional disabilities may be explained by a lowering of social contacts: older individuals may stay at home more often (due to mobility impairment or lack of zest in life). The component of the FLW indicator that significantly decreases the MMSE score is the one concerning use of own and public transport; this supports the previous argumentation. Lowering of social contacts is likely to induce a reduction

Table 6: Results MMSE ($\sim$ high cognitive mental state)

Variables	Parameters	T-values
Constant	0.141	0.2162
HEALTH VARIABLES		
Δ(Time cardigan)	-0.002	-2.095
Δ(Time walk)	0.001	1.269
Δ(Time chair)	-0.001	-1.947
Δ(Functional limitations / Stairs)	0.037	0.953
Δ(Functional limitations / Transport)	-0.076	-1.917
Δ(Functional limitations / Toenails)	-0.056	-1.633
Δ(COPD)	0.092	0.449
Δ(Heart diseases)	-0.021	-0.144
Δ(Peripheral artery diseases)	0.183	0.927
Δ(Diabetes)	0.104	0.423
Δ(Stroke)	-0.348	-1.551
Δ(Arthritis)	0.107	1.014
Δ(Cancer)	0.053	0.278
Surgery	-0.077	-0.499
DEMOGRAPHIC VARIABLES		
Δ(Age)[a]	-0.104	-0.493
Δ(Age^2)	-0.006	-6.925
Widowed	0.029	0.179
Separated	0.434	1.564
Move to an independent dwelling	0.091	0.753
Move to an institution	-1.106	-3.708
Severe financial problems	0.037	0.954
Loss of paid job	0.161	1.024
New Disability Insurance Recipient	0.192	0.345
New "early" retired	-0.089	-1.297
OTHERS		
Death parents	-0.312	-1.812
Death brothers and sisters	-0.037	-0.420
Death children	-0.349	-1.284
Death grandchildren	-0.232	-0.693
Illness partner	0.383	3.484
Illness relatives	0.040	0.544
Severe conflicts with others	-0.068	-0.532
Victim of crimes	-0.132	-0.633
DUMMIES		
Wave dummy	0.370	2.365
Sample dummy	0.087	1.086

[a] Interviews of each wave are held at different points in time. The exact date of the interview is known for each respondent. Therefore, we can correct our analysis for the precise amount of time between two consecutive interviews. The variable $\Delta(age)$ varies therefore between two years and almost four years.

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Table 7: RESULTS CES-D ($\sim$ HIGH DEPRESSION)

Variables	Parameters	T-values
Constant	0.764	0.377
HEALTH VARIABLES		
Δ(Time cardigan)	0.002	0.833
Δ(Time walk)	0.002	1.131
Δ(Time chair)	0.008	4.072
Δ(Functional limitations / Stairs)	-0.042	-0.352
Δ(Functional limitations / Transport)	-0.274	-2.226
Δ(Functional limitations / Toenails)	-0.167	-1.550
Δ(COPD)	-0.418	-0.657
Δ(Heart diseases)	1.273	2.861
Δ(Peripheral artery diseases)	0.017	0.027
Δ(Diabetes)	-1.329	-1.736
Δ(Stroke)	0.916	1.310
Δ(Arthritis)	0.528	1.603
Δ(Cancer)	0.903	1.523
Surgery	-1.039	-2.153
DEMOGRAPHIC VARIABLES		
Δ(Age)[a]	-0.076	-0.116
Δ(Age^2)	0.003	1.122
Widowed	3.475	6.832
Separated	-1.148	-1.326
Move to an independent dwelling	0.039	0.105
Move to an institution	1.367	1.471
Severe financial problems	1.198	1.562
Loss of paid job	0.344	0.703
New Disability Insurance Recipient	3.442	1.989
New "early" retired	-0.087	-0.406
OTHERS		
Death parents	-0.159	-0.296
Death brothers and sisters	0.059	0.216
Death children	1.112	1.314
Death grandchildren	2.781	2.666
Illness partner	1.222	3.564
Illness relatives	0.601	2.607
Severe conflicts with others	0.015	0.037
Victim of crimes	-0.225	-0.345
DUMMIES		
Wave dummy	-1.569	-3.217
Sample dummy	0.828	3.314

[a] : see footnote Table 6.

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of intellectual stimuli and some cognitive apathy. Furthermore, there are some evidences – even not always highly conclusive – in the gerontological literature of a positive relationship between physical activity and cognitive health: older individuals who regularly exercise appear to have a better cognitive functioning than their counterparts. Consequently, variations in the level of physical activity may affect to some extent the cognitive skills of older individuals. An additional result of our analyses – which at a first glance may appear quite singular – is the strong positive effect on cognitive health of the occurrence of a severe illness of the partner. In this case, the reverse reasoning may apply: the level of intellectual stimuli may increase as the respondent has to take care of his or her own life, but also of the one of his or her partner. She or he may have to deal with unusual situations and this may induce a sharpening of his or her cognitive abilities.

Regarding the effects of demographic characteristics on cognition, two major results are found. Firstly, there are strong age effects that imply declining cognitive abilities of people when they age. We opted for a quadratic specification of age. The quadratic variable appears to be strongly significant. This indicates that growing old with three years at for instance age 80 has a highly different effect on the evolution of cognition than at younger ages. Secondly, moving to an old people's home seemingly has a negative effect on cognitive abilities: new residents are found to be more cognitively impaired after than before their institutionalization – after prior adjustment for physical health. Therefore the deterioration of cognitive health can not be explained by an increase in physical limitation. The further deterioration of cognitive skills may arise from two factors. First it may indicate that the cognitive ability of new residents was already declining before institutionalization and that the process is proceeding. This argues in favor of the decision of institutionalization. Secondly, the further decline of the cognitive ability of new residents may primarily arise from the traumatic effect of changing environment and from the concurrent changes in daily life (e.g. diminution of social contacts, less physical exercise). Alternatively, this may be due to the fact that older institutionalized persons feel more dependent and rely more on the staff of old people's home to perform daily activities. Again, this boils down to a decrease in intellectual stimuli that may lead to some cognitive apathy. This result is somewhat offset by the fact that our analyses are not corrected for the exact timing of occurrence of life events. This information is not available in the data set. Therefore, it could be that the new resident has experienced a decline in cognitive ability prior to his or her institutionalization. Finally, it can be noted that changes in labor market status, in incomes (measured by the occurrence of serious financial problems), the death of a close person are not found to induce

significant transitions in MMSE scores.

The effects of declines in physical health are found to be much higher on emotional health than on cognitive status. Firstly, the onset of life-threatening diseases like heart diseases, arthritis, and cancer – though the coefficients with respect to arthritis and cancer are not significant – is responsible for higher feelings of depression. An increase in physical limitations (see results on ability of using own and public transport and of cutting his or her own toenails of the FLW indicator and results on the performance test) has a high significant negative effect on emotional health. On the other hand, a positive effect of undergoing heart surgeries (like valves or dotter surgery, bypass, pacemaker), joint surgeries (like replacement of knee or hip joints), or surgical removals of tumors is observed. Presumably, the patient anticipates an improvement of his or her health, which positively affects his or her emotional status.

Not surprisingly, strong negative effects of conjugal bereavement, death of grandchildren, illness of the partner or of a close relative are found. The effects of the variables regarding the partner are larger than the other variables associated with bereavement, and also, remarkably, than other variables included in our study. Therefore, widowed individuals should be considered as a frail group; they are likely to suffer from serious emotional disorders after death of their spouse. Public policy may focus on this group and offer bereaved persons psychological help immediately after the death of the close person to help them recover and retrieve zest in life. This may affect their future needs in formal long-term care services.

Strikingly a separation has a positive effect (though not statistically significant) on both aspects of mental health. It may be explained, on the one hand, by an increase in cognitive stimuli (singles have to take care of themselves), and, on the other hand, by some feelings of relief.

No negative effects of aging on the occurrence or aggravation of depression are found: the coefficient of the quadratic age variable, albeit positive, is not statistically significant. One may conclude that being depressed is not specifically associated with old ages, when controlling for changes in physical health status.

Finally, examination of the coefficients with respect to income and work status shows that experiencing serious financial problem and participating in a Disability Insurance program significantly deteriorate emotional health.

Two dummies are also included in our models for mental health. First a dummy variable, denoted by "Wave dummy", is added to the matrix of regressors to control for time effects. Second a dummy variable, denoted by "Sample dummy", indicating whether a respondent participated in two or three waves is

included as well. This variable is aimed to capture all relevant correlation between the observed regressors and the unobserved heterogeneity that remains after differencing the health equations (see last paragraph of Subsection 3.2). The "Wave dummies" are significant in both regressions, which indicates the presence of some time effects during the sample period. The "Sample dummy" is significant in the CES-D regression only. However there is very little difference between the coefficients of regressions with or without these dummies (Results of the regressions without dummies are available on request by the authors).

Since mental illness is in many ways persistent, a dynamic model might be more in place then the static models presented in section 3.1 and discussed above. We therefore also estimated a dynamic version of equation (1), i.e. an equation that includes a lagged health variable on the right hand side. First differencing of this model eliminates the time persistent component d_i from the model, but still the change in the lagged endogenous variable $\Delta H_{i,t-1}$ will be correlated with u_{it}. A common way to deal with this problem, is to use $H_{i,t-2}$ as an instrument for $\Delta H_{i,t-1}$, (see for instance 1). The coefficients for $H_{i,t-2}$ were insignificant and small. Furthermore, there were some changes in the other coefficients, but these were small and the significance of most other variables was reduced. The latter could be due to the fact that the sample size was reduced, as only those individuals could be included who remained in all three waves. We tested also whether $H_{i,t-2}$ was a good instrument for $\Delta H_{i,t-1}$, by running a regression of the latter on the former. The regression revealed that for both the MMSE and the CES-D variable the association was very weak[4]. We therefore did not pursue this any further.

5 Conclusions

This paper focuses on the effect on mental health of older persons of major life events like death or illnesses of their partner or of a close person, changes in work status (such as (early) retirement, or participation in Disability Insurance programs), the concurrent changes in income, or a move to a nursing home. Mental health is measured by two indicators: the Mini Mental State Examination (MMSE) and the Center for Epidemiological Studies Depression Scale (CES-D), two widely used tests in the field of gerontology to assess the cognitive status and emotional status of older persons respectively.

The large majority of studies on this topic (or on the effect of one specific life event, like spousal bereavement or retirement) do not take into account the

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[4]The results of these analyses are available upon request by the authors.

possible endogeneity between these life events and (mental) health. In the present paper, we rely on a framework where the simultaneous nature of the life events and of mental health is determined by time constant individual factors. Fixed effects methods are used to control for this kind of simultaneity. The resulting first-difference model can be correctly estimated using simple OLS methods. In order to capture possible relations between life events and idiosyncratic time-varying residuals, our empirical specifications include a broad range of explanatory variables accounting for shocks occurring in the time between successive waves of the survey.

Major life events have a larger effect on depressive feelings than on cognitive skills. Concerning the effect of physical health on depression, we find particularly large significant effects for heart diseases. Signs of physical deterioration (accounted by lower scores on the performance test and the self-reported variables on physical mobility) also have an effect. On the other hand, undergoing surgery has a positive mood effect. Conjugal bereavement, death of grandchildren, illness of the partner or of a close relative are crucial triggers of (chronic) depression. Of these, not surprisingly, conjugal bereavement has the largest and most significant effect. Therefore, governments should consider widowed individuals as a frail group and undertake actions to help them retrieve zest in life. This may directly affect their future needs for costly formal long-term care services. It is interesting to point out that the second largest and most significant effect among the above concerns the death of a grandchild. This has a much stronger effect on depression than death of a child.

Declines in income and inflow into a Disability Insurance program significantly deteriorate emotional health. The former may be taken as an argument in favor of income support for older individuals after retirement or loss of a partner. Higher depressive feelings are not found after participation in Early Retirement schemes. This has some policy relevance, as it is presumable that employers use Disability Insurance programs to dismiss older workers.

Institutionalization has negative effects on both emotional well-being and cognitive abilities. Concerning cognitive abilities, we also find a negative effect of physical health deterioration. Furthermore, our study shows an increase of the rate of cognitive decline as people age. Changes in work status and serious financial problems do not have an effect on cognitive abilities.

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