

## The Association between Age and Depressive Symptoms among Older Men and Women in Europe. Findings from SHARE

Isabella Buber, Henriette Engelhardt

**Abstract:** Empirical evidence of the effects of age on depressive symptoms is mixed, ranging from positive to zero to negative effects, depending on the modelling of the age-depression profile. This paper uses internationally comparative data to analyse the association between age and the prevalence of symptoms of depression, controlling for well-known determinants of mental health. Based on the first wave of the Survey of Health, Ageing and Retirement in Europe (SHARE), depressive symptoms of 28,538 persons aged 50 to 89 from eleven European countries and Israel are analysed using a negative binomial regression model. The results indicate that the number of depressive symptoms measured by EURO-D scores increase with age and are higher among women than among men. When including socio-demographic characteristics, health conditions and economic strains, the association between depressive symptoms and age vanishes for men, and even reverses for women. Thus, the association between age and mental health is mediated by the health and living conditions of older persons; age by itself has no explanatory power.

**Keywords:** Depressive symptoms · Older persons · SHARE · EURO-D · Negative binomial model

### 1 Introduction

"There is no health without mental health" (*EC* 2005: 4). Mental health is an indivisible part of health and mental problems, and can drastically reduce the quality of life of those effected and of their families. Good mental health is important for individuals as well as for society. At individual level, it enables people to achieve their intellectual and emotional potential and to find their roles in social and working life. At societal level, good mental health is important for social and economic welfare.

Mental disorders are common. Estimates for the adult population in the EU affected by some form of mental ill-health and mental disorder within the past 12 months range between 20 % and 27 % (*EC* 2004b; *Wittchen/Jacobi* 2005). In the

near future, depression will become the disease group with the second heaviest toll globally (EC 2004a). Accordingly, there is an increasing interest in the mental health of the EU population, and a strong political commitment to action in this field.

The most important forms of mental disorder are depression, specific phobias, somatoform disorders and alcohol dependence (Wittchen/Jacobi 2005). Depression and dementia constitute the two most important mental problems in later life (Copeland et al. 1999b). Increasing life expectancy may contribute to a rise in prevalence among the aged. However, empirical evidence of the association between age and depressive symptoms is varied. Analyses of depression in later life (i.e. above age 65) reveal a strong positive association between the prevalence of symptoms of depression and age (Stordal et al. 2001; Castro-Costa et al. 2007), a modest association with age (Prince et al. 1999b), or a lack of an overall tendency towards depression rising with age (Trollor et al. 2007; Korten/Henderson 2000; Litwin 2002; Verropoulou/Tsimbos 2007), except among the oldest old (Copeland et al. 1999b). Controlling for mediating effects, Blazer et al. (1991) and Berkman et al. (1986) found an inverse association between age and depression. Mediating variables generally transmit the effect of an independent variable on a dependent variable (Baron/Kenny 1986; MacKinnon et al. 2007). The different results presented in the literature, ranging from negative to zero to positive effects, may be due to selective samples or caused by different modelling methods of the age-depression profile, in particular due to adjustments for different sets of covariates that have different influences on the age effect of depressive symptoms (Yang 2007).

In this paper, we analyse the association between age and depression, controlling for well-known determinants of mental health, using a representative sample of older persons in several European countries. In contradistinction to previous studies, we pay particular attention to the underlying statistical model and analyse systematically the change in the effect of age on depressive symptoms when controlling for these mediating variables. We also want to stress that the present study is not a psychiatric or gerontological contribution targeting physicians or psychiatrists, but addresses sociologists, demographers and the broad group of those who are interested in ageing.

## 2 Literature review

Mental health has two dimensions: positive mental health and negative mental health. The positive dimension refers to the concepts of well-being and ability to cope in the face of adversity. The negative dimension includes psychological distress and psychiatric disorders, and relates to the presence of symptoms. Positive and negative mental health cover different aspects. (EC 2004a).

There are several measures for analysing mental health. Some instruments measure more generic factors, such as psychological distress, by recording the presence or absence of certain symptoms such as anxiety or depression. This type of instrument produces a mental health score, and for some of them, cut-off points can be used to categorise people into groups such as "probable cases" with mental

health disorders.<sup>1</sup> Other instruments are designed to produce answers which correspond to diagnoses of mental disorders (e.g., mood disorder, anxiety disorders and drug and alcohol disorders) and generate estimates of the prevalence of particular disorders<sup>2</sup> (EC 2004a).

There is a great wealth of literature on mental health, focussing *inter alia* on clinical aspects and treatments (e.g., Beck 1987; Beck 1991; Adam 1998; Drake *et al.* 2001; Amber *et al.* 2006), social and economic costs of mental health (e.g. Hamilton *et al.* 1997; Stephens/Joubert 2001; Whooley *et al.* 2002), health care services and their use (e.g., Alonso *et al.* 2004c, Harris *et al.* 2006) and the relation between mental and physical health (e.g., Braam *et al.* 2005; Opolski/Wilson 2005).

The determinants of mental condition are multiple, including biological (e.g., genetics, sex), individual (e.g. health, personal experiences), familial and social (e.g., family status, social support), economic and environmental conditions (e.g., social status and living arrangements). The following brief overview of the literature focuses on central variables associated with depression.

In general, a higher number of depressive symptoms is typically found among women (Prince *et al.* 1999b; Alonso *et al.* 2004a; Lehtinen *et al.* 2005; Carta *et al.* 2005; Barry *et al.* 2008; Hopcroft/Bradley 2007; Zunzunegui *et al.* 2007). Copeland *et al.* (1999a) assessed the prevalence of depression among individuals aged 65 and over in nine European centres, and found that also women outnumber men among older persons with signs of depression. Their meta analysis shows an overall prevalence of diagnostic depression of 12.3 % (14.1 % for women, and 8.6 % for men).

Marital status is an important determinant of depressive symptoms: Widowed and divorced persons have poorer mental health (Dean *et al.* 1992; Lehtinen *et al.* 2003; Carta *et al.* 2005). Mental disorders are more common among persons who were either never married or who were previously married and currently have no partner (Alonso *et al.* 2004b; Buber/Engelhardt 2008; Schaan 2009). Having a trust-based relationship seems to have a protective effect.

Several studies identify links between the prevalence of mental disorders and socio-economic disadvantages. In general, relatively high frequencies of mental disorders are associated with a poor level of education, material disadvantage, low family income, unemployment and living on a pension (e.g. Beekman *et al.* 1999; Alonso *et al.* 2004b; Fryers *et al.* 2005; Lehtinen *et al.* 2005; Carta *et al.* 2005; Ladin 2008; Litwin/Sapir 2008). Consistent with analyses of European data, Kessler *et al.* (1994) finds elevated rates of affective and anxiety disorders among women and individuals with lower socio-economic status for the US. Other studies show a statistically significant relationship between place of residence and mental health, with the lowest values being registered in large cities (Ayuso-Mateos *et al.* 2001; Lehtinen *et al.* 2003; Lehtinen *et al.* 2005).

<sup>1</sup> Instruments in this category include Mental Health Index MHI-5, GHQ (General Health Questionnaire) or EURO-D.

<sup>2</sup> As an example we mention the CIDI (Composite International Diagnostic Interview) instrument.

Poor physical health is one of the most important risk factors for depression in older adults. Physical health problems are demonstrated to be a predictor of both the onset and the persistence of depression (e.g. Berkman *et al.* 1986; Katz 1996; Geerlings *et al.* 2000; Lenze *et al.* 2001; Fiske *et al.* 2003; Braam *et al.* 2005; Jang *et al.* 2007). Moreover, cognitive health also turns out to be associated with mental health (e.g. Jorm 2000; Reischies/Neu 2000; Scogin/Rohling 1989). Berkman *et al.* (1986) show that the addition of functional disability to a multivariate model substantially weakens the association between age and depressive symptoms. Based on US data, Blazer *et al.* (1991) and Mirowsky and Ross (1992) show that the upward trend of depression in later life reverses after including as covariates mediating variables such as marital, employment, economic and sociodemographic status. More recently, Cairney and Krause (2005) show that depressive symptoms in later life are associated with age, gender, living arrangements and education. They suggest that key social factors are related to depressive symptoms in later life. Thus, the question arises as to whether there is a true causal link between age and depressive symptoms. We hypothesize that this relationship is mediated by special circumstances associated with the ageing process. The different and even contradictory findings on the age-depression profile in the literature may be due to different the consideration of different socio-demographic characteristics, health conditions and economic strains.

To answer this question, we take advantage of the multifaceted structure of the Survey of Health, Ageing and Retirement in Europe (SHARE), a representative European dataset that allows the comparison of health status in a variety of countries as well as the analysis of the determinants of health in a very broad context. SHARE includes representative samples of the total population of eleven European countries and Israel. It makes it possible to study symptoms of mental health of Europeans aged 50 and older.

In this paper, we analysed the association between age and depressive symptoms – measured by EURO-D score – of persons aged 50 to 89, adjusting for living arrangements, education, economic constraints, limitations in activities of daily living, cognitive orientation, functional impairments and chronic diseases in a representative sample in eleven European countries and Israel. The SHARE data permit us to take into consideration these various dimensions which might be responsible for an age-specific increase in symptoms of depression.

### **3 Data, Variables And Method**

#### **3.1 Data**

The study is based on the first wave of the *Survey of Health, Ageing and Retirement in Europe* (SHARE), which includes detailed cross-national information on health, well-being, economic circumstances and social networks for twelve countries, namely Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, the Netherlands, Sweden, Switzerland and Spain. The data of the first wave which we utilize

were collected between 2004 and 2005. SHARE covers the non-institutionalised population aged 50 and older. "Release 2.0.1" of wave 1 comprises data on 31,115 individuals in 21,176 households, the weighted average response rate being 61.6 % (*Börsch-Supan/Jürges 2005; see also <http://www.share-project.org>*).

The focus of the present study is on depressive symptoms of persons aged 50 to 89. Respondents aged 90 or older are excluded due to low numbers (285 persons aged 90 to 104). The current sample includes 28,538 persons (13,068 men and 15,470 women) with complete information on depressive symptoms, education and living arrangements. The mean age is 64 for men and 66 for women.

### **3.2 Variables**

Our central variable is depressive mood measured by the number of depressive symptoms. Our study measures mental health on the EURO-D scale. This is an instrument which is symptom oriented, based on the presence or absence of depressive symptoms, but does not generate diagnoses of different mental disorders (e.g., mood disorder, anxiety disorders and drug and alcohol disorders). EURO-D was developed in an 11-country European collaboration to compare symptoms of depression in 14 European centres. Five depression measures<sup>3</sup> are harmonised to form a 12-item scale (*Prince et al. 1999a*). The reliability of EURO-D has been reported to be good. In terms of its validity, it has been shown to correlate well with other well-known health measures (*Prince et al. 1999a*). The EURO-D is an internally consistent scale, captures the essence of its parent instruments, has been validated in a cross-European study of depression prevalence, and facilitates a valid comparison of risk factor associations between centres (*Prince et al. 1999a*). The 12 contributing items for the EURO-D scale are: depression, pessimism, suicidality (wishing death), guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment, tearfulness. The time frame of the symptoms refers mostly to the month preceding the interview. The EURO-D is a discrete measure of depressive symptoms; the core ranges from 0 to 12, with higher scores indicating higher levels of depression. *Dewey and Prince (2005)* suggest to set a threshold at a score of 3 and define clinically significant depression as a EURO-D score greater than 3. In the current sample, EURO-D was internally consistent for all countries, with Cronbach alpha being 0.74 for the current pooled sample, ranging from 0.62 (in Switzerland) to 0.78 (in Spain). Thus, EURO-D is a feasible instrument for evaluating different dimensions of mental health. However, we are not able to distinguish between mild and severe mental disorders.

To allow for a flexible, non-parametric association between age and the number of depressive symptoms, 5-year age groups are included in the regressions. Based on the literature, we include in the analyses socio-demographic characteristics and

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<sup>3</sup> Geriatric Mental State-AGECAT (GMS-AGECAT), SHORT-CARE, Centre for Epidemiological Studies Depression scale (CES-D), Zung Self-Rating Depression Scale (ZSDS), Comprehensive Psychopathological Rating Scale (CPRS).

health conditions that were found to have an effect on mental health. The current study includes the following covariates:

- (a) living arrangements: alone; as a couple; alone with other persons; as a couple with other persons,
- (b) highest level of education: primary school (ISCED 0-1); lower secondary (ISCED 2); higher secondary (ISCED 3-4); tertiary education (ISCED 5-6),
- (c) cognitive orientation based on the orientation to date, month, year and day of week; ranging from 0 (bad orientation) to 4 (good orientation),
- (d) limitations in the following activities of daily living (ADL): dressing; walking across a room; bathing or showering; eating; getting in and out of bed; using the toilet,
- (e) chronic diseases: no chronic diseases; mild chronic diseases (i.e. high blood pressure, high blood cholesterol, diabetes, asthma, osteoporosis, stomach, duodenal or peptic ulcer, cataracts or hip fracture), and severe chronic diseases (i.e. heart attack or chronic lung disease) (*Kalwijn/Vermeulen 2008*), and
- (f) economic strain: subjective indicator of financial distress, based on the question of how respondents make ends meet: with great difficulty; with some difficulty; fairly easily; easily.

The distribution of these variables for the pooled sample is listed in Tables 2a and 2b below. With increasing age, the number of respondents goes down both for men and women. The vast majority of men and women live with a spouse or partner; while about one-third of women live alone, only 17 % of men do so. Differentiating by the highest educational level attained, it turns out that 56 % of all men and 42 % of women have completed higher secondary or tertiary education. Women report economic constraints more frequently than men (34 % of women and 28 % of men). When it comes to health, about 10 % of respondents report one or more limitations in their ADL; 15 % have a less than good cognitive orientation, and about 25 % of men and 21 % of women suffer from severe chronic diseases.

### **3.3 Statistical procedure**

In a first step, the association between age and depressive symptoms is analysed by comparing means of EURO-D by age as well as by confidence intervals. To complement the first descriptive results, t-tests are used to estimate mean differences in EURO-D scores between men and women, with 95 % confidence intervals. Next, multivariate regression models are applied to analyse the association between age and depressive symptoms, controlling for socio-demographic indicators (living arrangements, education and economic constraints), as well as diverse dimensions of health (cognitive orientation, limitations in activities of daily living, chronic diseases). To account for country-specific heterogeneity, we include country dummies in all models. Covariates are included stepwise so as to detect possible changes in the magnitude as well as in the direction of associations between age and depressive symptoms. As a general rule, the reference category is the largest group in each covariate. For the variable highest level of education, the largest group contains

persons with a basic level of education. Since all respondents in Denmark have at least lower secondary education, "basic education" cannot be the reference group in this country. In order to have the same reference group in all countries, "higher secondary or tertiary education", i.e. the highest educational level, is chosen as the reference group. Analyses are carried out separately for men and women to allow for a different shape of the association between age and the number of depressive symptoms, for a different constant in the estimated model, and for a different association between the explanatory variable and the covariates included in the model.

The explanatory variable of the current study is the number of depressive symptoms, a discrete variable ranging from 0 to 12. It can be classified as a count variable indicating how many depressive symptoms a respondent reported. In principle, we were able to analyse these data using standard multiple linear regression. However, the preponderance of zeros ( $n = 6,760$ ; i.e. 24 %) and the small values indicate that the dependent variable is clearly discrete. The Poisson regression model accounts for these characteristics and is used widely to study such data. A common problem with the standard Poisson model is that the equidispersion assumption ( $E(Y|X) = V(Y|X) = \lambda$ ) is violated, i.e. the conditional mean does not equal the conditional variance. To solve this problem, different approaches are proposed, including the generalised event count model, the generalised Poisson model and the negative binomial model to account for overdispersion ( $E(Y|X) < V(Y|X)$ ) and underdispersion ( $E(Y|X) > V(Y|X)$ ), with X and Y being random variables (Winkelmann 2003). A statistical test for dispersion reveals strong and significant evidence of overdispersion, i.e. the conditional variance exceeds the conditional mean in the full sample. Therefore, we estimate a negative binomial model which accounts for overdispersion and for the prevalence of zero counts in the data (Winkelmann 2003).

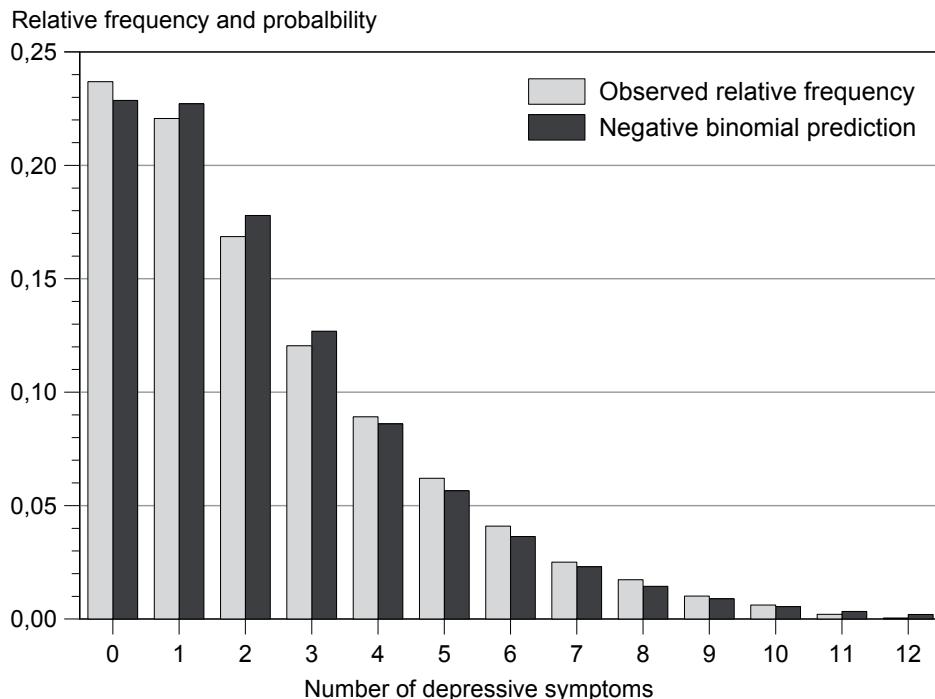
In this model, the probability  $Pr(y|x)$  of observing any observed count  $y$  is given by

$$Pr(Y = y | X = x) = Pr(y | x) = \frac{\Gamma(y + \alpha^{-1})}{y! \Gamma(\alpha^{-1})} \left( \frac{\alpha^{-1}}{\alpha^{-1} + \mu} \right)^{\alpha^{-1}} \left( \frac{\mu}{\alpha^{-1} + \mu} \right)^y,$$

where X and Y are random variables,  $x$  is the vector of observed characteristics,  $\Gamma()$  is the gamma function and  $\alpha$  and  $\mu$  are parameters to be estimated empirically. The parameter  $\alpha$  reflects unobserved heterogeneity and determines the degree of dispersion in the predictions. Systematic variation can be introduced in the parameter  $\mu$  as in a log-linear model:  $\mu = \exp(x'\beta)$ . The coefficients in this model cannot be interpreted directly; only the sign of a coefficient indicates the direction of an effect. We refer to Long and Freese (2006) and Winkelmann (2003) for further mathematical details.

To visualise the fit of the current count model with a negative binomial regression model, the observed relative frequencies, both the variable (number of depressive symptoms) and the predicted probabilities are plotted for each value of the count. Figure 1 clearly shows that the negative binomial distribution fits the data well and is an appropriate tool for the current study.

**Fig. 1:** Observed relative frequencies and predicted probabilities for the number of depressive symptoms

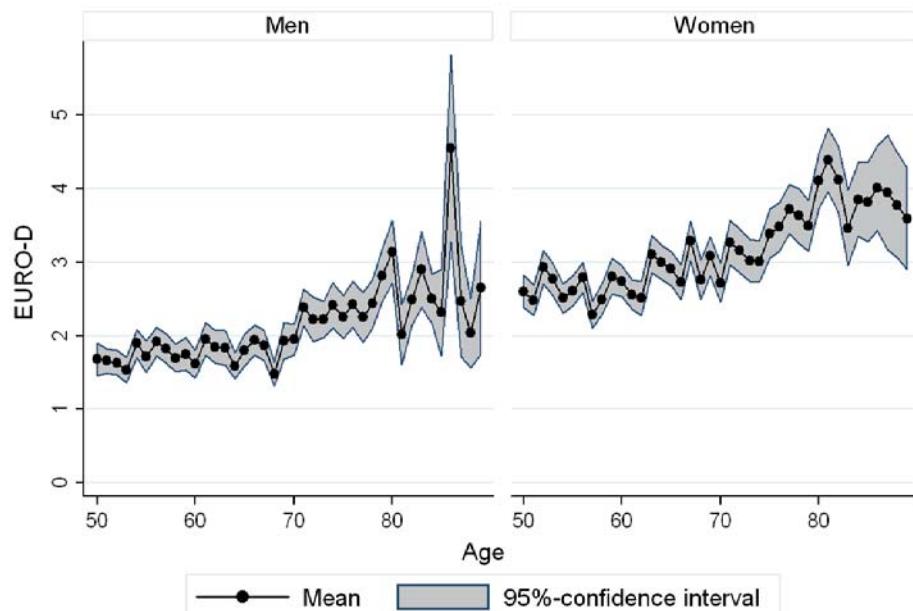


Source: SHARE 2004-05, Release 2.0.1

#### 4 Results

At first sight, the prevalence of depressive symptoms appears to increase with age among men and women, with women reporting more depressive symptoms compared to men. Figure 2 depicts the mean EURO-D scores for men and women. Roughly speaking, the mean EURO-D score increases between ages 50 to 89 from 1.6 to 3.0 among men and from 2.5 to 3.8 among women. Confidence intervals become broader at older ages, indicating a considerable variation in the number of depressive symptoms at older ages.

Table 1 includes the mean number of depressive symptoms among men and women within 5-year age groups and t tests estimating mean differences in EURO-D scores between men and women, as well as confidence intervals indicating the difference. The results show that women reported significantly more depressive symptoms than men, and, moreover, the gender gap widens with rising age (50-54: difference of 0.85 symptoms; 80-84: difference of 1.05 symptoms). It is therefore appropriate to run the analyses separately for men and women to allow for a different shape of the association between age and the number of depressive symptoms,

**Fig. 2:** Mean number of depressive symptoms by age and gender

Source: SHARE 2004-05, Release 2.0.1

**Tab. 1:** Mean number of depressive symptoms by age groups and gender

	Men	Women	Mean difference (95%-Confidence Interval)
50-54	1.72	2.57	-0.85 (-0.97; -0.74)
55-59	1.70	2.47	-0.77 (-0.88; -0.66)
60-64	1.63	2.56	-0.92 (-1.04; -0.81)
65-69	1.77	2.66	-0.89 (-1.02; -0.77)
70-74	1.94	2.84	-0.90 (-1.05; -0.75)
75-79	2.29	3.25	-0.97 (-1.16; -0.76)
80-84	2.46	3.50	-1.05 (-1.29; -0.81)
85-89	2.63	3.46	-0.82 (-1.23; -0.42)

Source: SHARE 2004-05, Release 2.0.1

for a different constant in the estimated model, and for a different association between the explanatory variable and the covariates included in the model.

For the multivariate analysis, we apply negative binomial regression models as described in the previous section. Tables 2a and 2b give the estimated non-exponentiated coefficients of the various variables separately for males and females, with the respective reference group having a value of zero. Positive coefficients imply an increase in the number of depressive symptoms; negative coefficients stand for a

**Tab. 2a:** Coefficients of a negative binomial regression model for the associations between EURO-D scores and age, living arrangements, education, ADL limitations, cognitive orientation, health and economic strain, male respondents

	Model 1	Model A	Model B	Model C	Model D	Model E	Model F	Distrib. in %
<b>Age</b>								
50-54 <sup>a</sup>	0	0	0	0	0	0	0	20
55-59	0.01	0.03	-0.00	0.01	0.00	0.01	-0.04	19
60-64	-0.00	0.02	-0.03	0.01	-0.02	-0.01	-0.11*	17
65-69	0.07	0.11*	0.03	0.08+	0.05	0.05	-0.06	16
70-74	0.19***	0.22***	0.13*	0.20***	0.14**	0.18**	0.03	12
75-79	0.30***	0.32***	0.23***	0.34***	0.20***	0.25***	0.10+	9
80-84	0.41***	0.43***	0.34***	0.43***	0.21**	0.35***	0.19**	5
85-89	0.53***	0.50***	0.44***	0.55***	0.30**	0.43***	0.34**	2
<b>Living arrangements</b>								
Couple <sup>a</sup>	0							52
Ego alone		0.22***						17
Couple with others		0.08*						28
Ego with others		0.34***						3
<b>Highest level of education</b>								
Primary school			0.27***					29
Lower secondary			0.11*					15
Higher secondary or tertiary <sup>a</sup>			0					56
<b>Make ends meet</b>								
With great difficulty				0.77***				8
With some difficulty				0.40***				20
Fairly easily				0.14**				27
Easily <sup>a</sup>				0				19
Missing answer				0.21***				26
<b>ADL limitations</b>								
None <sup>a</sup>					0			91
1 and more limitations					0.77***			9
<b>Cognitive orientation</b>								
0 (bad orientation) to 3						0.33***		15
4 (good orientation) <sup>a</sup>						0		85
<b>Chronic diseases</b>								
No							-0.31***	34
Mild <sup>a</sup>							0	41
Severe							0.30***	25
Constant	0.49***	0.40***	0.43***	0.24***	0.44***	0.78***	0.60***	
MacFadden's R <sup>2</sup>	0.012	0.014	0.014	0.022	0.027	0.015	0.024	
N	13,017	13,017	13,017	13,017	13,015	13,010	13,017	

Notes: All models additionally include country dummies. The number of N differs in the various models due to missing data.

<sup>a</sup> Reference category. + p<0.10; \* p<0.05; \*\* p<0.01; \*\*\* p<0.001.

Source: SHARE 2004-05, Release 2.0.1; own calculations

decrease. All models include additionally country dummies to account for country heterogeneity in the number of depressive symptoms (results not reported here).

The association between age and number of depressive symptoms is approximated with a piecewise constant function for 5-year age groups. This modeling procedure allows a flexible form and does not imply a specific association between the

**Tab. 2b:** Coefficients of a negative binomial regression model for the associations between EURO-D scores and age, living arrangements, education, ADL limitations, cognitive orientation, health and economic strain, female respondents

	Model 1	Model A	Model B	Model C	Model D	Model E	Model F	Distrib. in %
<b>Age</b>								
50-54 <sup>a</sup>	0	0	0	0	0	0	0	18
55-59	-0.04	-0.03	-0.06+	-0.04	-0.05	-0.04	-0.11**	16
60-64	0.00	0.01	-0.04	-0.00	-0.03	-0.01	-0.09**	15
65-69	0.06+	0.05	0.00	0.05	0.03	0.05	-0.07+	15
70-74	0.08*	0.07+	-0.00	0.06+	0.01	0.06	-0.06+	13
75-79	0.24***	0.20***	0.14***	0.24***	0.15***	0.19***	0.06	11
80-84	0.34***	0.28***	0.23***	0.33***	0.18***	0.25***	0.15**	9
85-89	0.30***	0.22***	0.19***	0.30***	0.04	0.19***	0.14*	3
<b>Living arrangements</b>								
Couple <sup>a</sup>	0							40
Ego alone	0.14***							33
Couple with others	0.04							17
Ego with others	0.18***							10
<b>Highest level of education</b>								
Primary school		0.28***						37
Lower secondary		0.20***						21
Higher secondary or tertiary <sup>a</sup>	0							42
<b>Make ends meet</b>								
With great difficulty			0.55***					11
With some difficulty			0.35***					23
Fairly easily			0.12***					25
Easily <sup>a</sup>	0							14
Missing answer			0.17***					27
<b>ADL limitations</b>								
None <sup>a</sup>				0				89
1 and more limitations				0.54***				11
<b>Cognitive orientation</b>								
0 (bad orientation) to 3					0.31***			15
4 (good orientation) <sup>a</sup>					0			85
<b>Chronic diseases</b>								
No						-0.33***		29
Mild <sup>a</sup>						0		50
Severe						0.30***		21
<b>Constant</b>	0.92***	0.86***	0.83***	0.71***	0.89***	1.20***	1.05***	
MacFadden's R <sup>2</sup>	0.016	0.017	0.019	0.024	0.027	0.020	0.027	
N	15,399	15,399	15,399	15,399	15,396	15,389	15,399	

Notes: All models additionally include country dummies. The number of N differs in the various models due to missing data.

<sup>a</sup> Reference category. + p<0.10; \* p<0.05; \*\* p<0.01; \*\*\* p<0.001.

Source: SHARE 2004-05, Release 2.0.1, own calculations

number of depressive symptoms and age. This would be the case if, for example, age was entered for a linear relationship or age and age squared for a quadratic one. The sole association between age and depressive symptoms is confirmed by the estimated significant coefficients for ages 70 and above (Tab. 2a and 2b, Model 1).

Thus, whilst controlling for country-specific heterogeneity, our results reveal in a first step slightly higher levels for men and women aged 65-69, and significantly higher levels of depressive symptoms in the age groups 70-74, 75-79, 80-84 and 85-89, compared to the reference group of respondents aged 50-54. The increase with age is more pronounced among men compared to women.

In a next step, variables that are found to be correlated with depressive symptoms are included separately in the models to analyze the change in size of the age coefficients, whilst controlling for these characteristics. Models A, B and C in Tables 2a and 2b include living arrangements, education, and economic constraints as covariates separately, while Models D, E and F take health conditions into consideration.

First of all, all covariates are significantly associated with the number of depressive symptoms with the expected signs both for men and women. Living alone as well as living with people other than a partner, low levels of educational attainment, increased economic strains, ADL limitations, less than good cognitive orientation and severe chronic diseases are associated with an increased number of depressive symptoms.

The best model fit is measured by McFadden's R<sup>2</sup> results for financial constraints, chronic diseases and ADL limitations for both genders. For women, whilst controlling for each single covariate, the age effects diminish, with the exception of economic constraints. A significantly increased number of depressive symptoms can only be observed for age 75 and older (Models A to E) and age 80 and older in Model F. For males, we observe only reduced age effects, whilst controlling for health conditions (ADL limitations, cognitive orientation, and chronic diseases). Living arrangements, level of education and economic strain do not alter the age effects in the way we observe for females.

Most interestingly, though, the estimated constant effect increases remarkably both for males and females in Models E and F, where cognitive impairment and chronic diseases are controlled for. Thus, the average number of depressive symptoms increases, while the effects for the different age groups decline compared to Model 1. Moreover, controlling for chronic diseases, only men aged 75 and older and women aged 80 and older have significantly increased numbers of depressive symptoms.

The coefficients for age change significantly with the stepwise inclusion of different covariates. First, the initial strong positive association between age and the number of depressive symptoms weakens if one includes socio-demographic characteristics (Tab. 3, Model 2). Second, including as covariates diverse dimensions of health virtually eliminates the age-depressive symptoms association among men, and even reverses the association among women. While men and women aged 70 and above initially have significantly higher levels of depressive symptoms compared to those in their early fifties, in the model including health indicators (Model 3) the estimated coefficients in the male sample are small and no longer significant (for age 70 and above). For females, all estimated coefficients turn negative and are even significant for ages 55 to 74 and 85 to 89, the corresponding levels being between -0.09 and -0.13. The final model includes socio-economic determinants as

**Tab. 3:** Coefficients of a negative binomial regression model for the associations between EURO-D scores and age, living arrangements, education, ADL limitations, cognitive orientation, health and economic strain

	Men			Women		
	Model 2	Model 3	Model 4	Model 2	Model 3	Model 4
<b>Age</b>						
50-54 <sup>a</sup>	0	0	0	0	0	0
55-59	0.02	-0.04	-0.03	-0.05+	-0.11***	-0.12***
60-64	0.00	-0.10*	-0.09+	-0.03	-0.11***	-0.13***
65-69	0.08	-0.07	-0.05	-0.00	-0.09**	-0.14***
70-74	0.18***	0.00	0.02	-0.02	-0.12***	-0.19***
75-79	0.31***	0.03	0.06	0.14***	-0.03	-0.09*
80-84	0.40***	0.03	0.06	0.21***	-0.03	-0.11*
85-89	0.47***	0.12	0.11	0.16**	-0.13**	-0.22***
<b>Living arrangements</b>						
Couple <sup>a</sup>	0		0	0		0
Ego alone	0.16***		0.16***	0.11***		0.11***
Couple with others	0.04		0.04	0.03		0.02
Ego with others	0.28***		0.28***	0.10**		0.07*
<b>Highest level of education</b>						
Primary school	0.15***		0.09**	0.22***		0.17***
Lower secondary	0.05		0.02	0.16***		0.13***
Higher secondary or tertiary <sup>a</sup>	0		0	0		0
<b>Make ends meet</b>						
With great difficulty	0.71***		0.60***	0.48***		0.40***
With some difficulty	0.37***		0.33***	0.30***		0.26***
Fairly easily	0.13**		0.13**	0.10**		0.10**
Easily <sup>a</sup>	0		0	0		0
Missing answer	0.22***		0.17***	0.17***		0.15***
<b>ADL limitations</b>						
None <sup>a</sup>	0		0	0		0
1 and more limitations	0.63***		0.57***		0.45***	0.41***
<b>Cognitive impairment</b>						
0 (bad orientation) to 3	0.24***		0.21***		0.23***	0.20***
4 (good orientation) <sup>a</sup>	0		0		0	0
<b>Chronic diseases</b>						
No	-0.28***		-0.27***		-0.30***	-0.28***
Mild <sup>a</sup>	0		0		0	0
Severe	0.20***		0.25***		0.19***	0.18***
Constant	0.16***	0.53***	0.25***	0.62***	1.00***	0.75***
MacFadden's R <sup>2</sup>	0.025	0.037	0.047	0.027	0.039	0.047
N	13,017	13,008	13,008	15,399	15,386	15,386

Notes: All models additionally include country dummies. The number of N differs in the various models due to missing data.

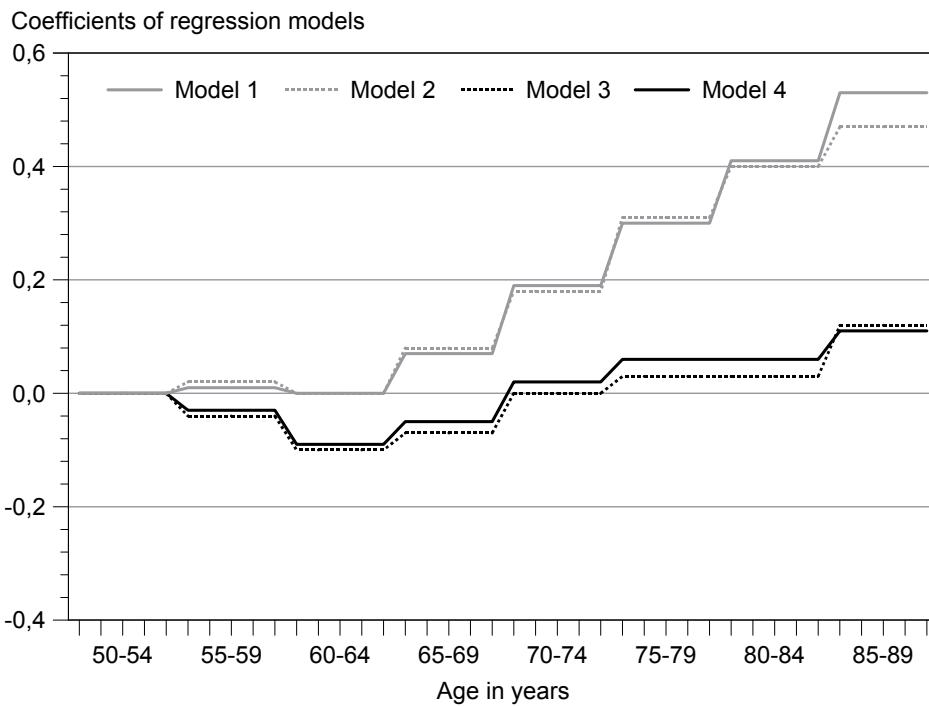
<sup>a</sup> Reference category. + p<0.10; \* p<0.05; \*\* p<0.01; \*\*\* p<0.001.

Source: SHARE 2004-05, Release 2.0.1; own calculations

well as health indicators (Model 4). Whereas no age effect is observed for men, the estimated coefficients for women are all negative and significantly different from zero, indicating a lower number of depressive symptoms for ages 55 to 89 compared to women in their early fifties.

Figures 3a and 3b depict the association between age and depressive symptoms for the stepwise setup of models. Figures 3a and 3b provide unambiguous evidence of the importance of socio-demographic characteristics and indicators of physical and cognitive health for depressive symptoms for both men and women, especially in advanced age. The piecewise constant functions representing the final multivariate model reveal that the increase in depression with age initially observed almost disappears for men, and even reverses for women. Our results indicate that socio-demographic characteristics and physical as well as cognitive health absorb, and even go so far as to reverse, the association between age and EURO-D scores among older persons. Moreover, the separate analysis of men and women reveals gender-specific differences in the association between age and living arrangements on the one hand and EURO-D scores on the other. The association between educa-

**Fig. 3a:** Estimated association between age and the level of depression with and without covariates for socio-demographic and health characteristics, men

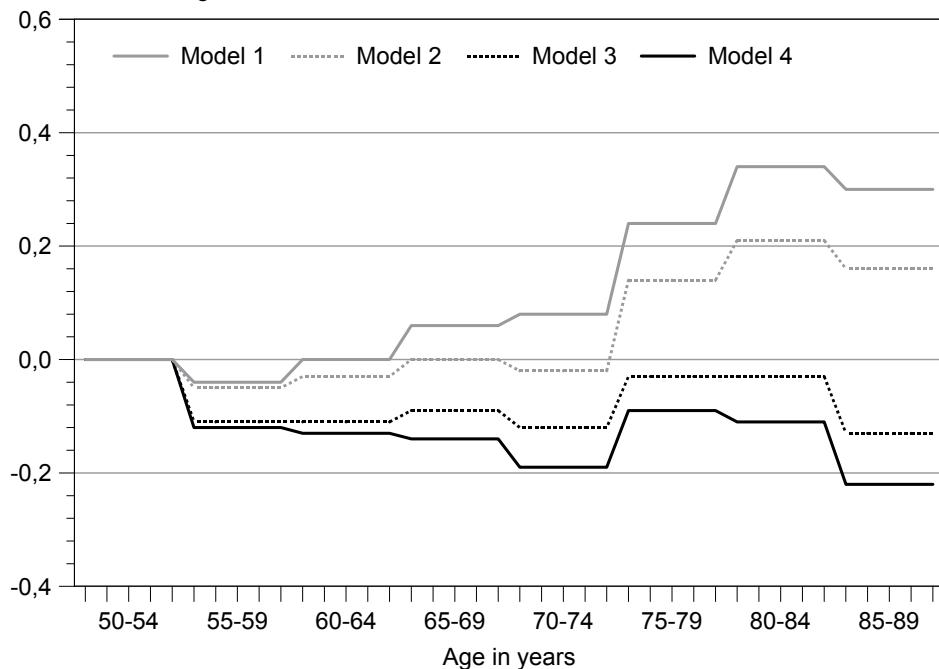


Note: The models refer to Tables 2a and 3.

Source: SHARE 2004-05, Release 2.0.1

**Fig. 3b:** Estimated association between age and the level of depression with and without covariates for socio-demographic and health characteristics, women

Coefficients of regression models



Note: The models refer to Tables 2b and 3.

Source: SHARE 2004-05, Release 2.0.1

tion and depressive symptoms is stronger among women, whereas the estimated coefficients for economic constraints, ADL limitations and chronic diseases are higher among men.

To test whether health, demographic characteristics and economic circumstances are mediating variables as they carry the influence of our independent variable (age) on our dependent variable (mental health), we apply a Sobel-Goodman mediation test. We find that the mediation effect of ADL limitations is highly significant, with approximately 49 % of the total effect (of age on depressive mood) being mediated. In other words, age influences physical health, which in turn influences mental health. Gender-specific analysis reveals a more pronounced mediating effect among women than among men (52 % versus 42 %). Also, educational status can be regarded as a significant mediator, with 40 % of the total effect being mediated. Cognitive impairment and chronic diseases, but also living arrangements and economic constraints, turn out to carry to a lesser degree the influence of age on mental health.

## 5 Discussion

In this study we analyze the association between the prevalence of depressive symptoms and age, including as covariates socio-economic characteristics and health. In contrast to existing studies which provide mixed empirical evidence, SHARE allows the analysis of depressive symptoms of persons living in private households in various European countries based on a representative sample and a standardised questionnaire. In order to assess depressive symptoms, we use the EURO-D scale and estimate the effects of age, whilst controlling for well-known determinants of mental health using a negative binomial regression model as an innovative tool in analysing the number of depressive symptoms.

The present study reveals at first sight a significant increase in the number of depressive symptoms with age among both sexes. After including socio-economic characteristics and health conditions, the association almost disappears for men and even reverses for women. Living arrangements, educational level, financial strains, limitations in activities of daily living, chronic diseases and cognitive orientation are major determinants of depressive symptoms among older persons. Depressive symptoms are highly correlated with circumstances that are associated with old age, such as health problems, financial strains or the loss of one's partner. Once we had included these socio-demographic characteristics and health as covariates, age itself no longer had any explanatory power for men, and turns out to be positively correlated with depressive symptoms among women.

Our findings for European data are in line with findings for the US by *Berkman et al.* (1986), *Blazer et al.* (1991), *Mirowsky and Ross* (1992) and *Cairney and Krause* (2005). In addition, gender-specific analyses reveal that the association between the number of depressive symptoms and age reverses for women, whereas it "only" vanishes for men.

In a recent study based on the Greek SHARE data, *Verropoulou and Tsimbos* (2007:178) state that the positive association between age and depressive symptoms may be "spurious and mainly due to the older suffering from disabilities and stressful life events such as bereavement". Our evidence supports this hypothesis and additionally even reveals for women an inverse association with age, socio-demographic, economic and health indicators being included as covariates.

The outcomes of the covariates are in line with previous research (e.g. *Dean et al.* 1992), but they also reveal remarkable gender differences related to education and living arrangements and ADL limitation. For example, the impact of education is more marked among women than among men. Additional analyses for men and women not shown here reveal that divorce and widowhood have a different impact on the mental health of persons aged 50 and older. For men, it is widowhood that had a stronger negative impact on mental health, while for women it is divorce (see also *Buber/Engelhardt* 2008).

The stepwise introduction of covariates reveals that physical health is indeed an important aspect of mental health, in particular in old age. Accounting for socio-economic status attenuated the positive association between the number of depressive symptoms and age; only part of the increase observed with age can be

explained by living arrangements, education and economic situation. The association between age and mental health is mediated by health determinants, especially among women. With the inclusion of health determinants the initially positive association vanishes for men and even turns negative for women, indicating a falling number of depressive symptoms with increasing age. Moreover, the measures for model fit indicate that the differences observed with age are mainly due to physical health (*Verropoulou/Tsimbos 2007*). Nevertheless, the direction of causality between physical and mental health is not clear.

In the current analysis we first include as covariates socio-demographic characteristics, followed by health conditions. Alternatively, the covariates are introduced in a different order. It turns out that when including first limitations in activities of daily living as well as cognitive orientation and later living arrangements, the results remain stable. Therefore, both aspects – socio-demographic characteristics and health conditions – are independent determinants of mental health, association with the one group not being absorbed by the other.

The unreflected use of gender, or sex, as a technical category is criticised by researchers on gender studies who argue that one must not neglect the substantial differences between being a man and being a woman (*Jylhä 2007*). The current study does not include gender as a covariate, but men and women are analysed separately, allowing different associations between the number of depressive symptoms on the one hand, and age as well as socio-economic and health factors on the other. Indeed, the results for age, living arrangements, educational level, economic strain, ADL limitations and chronic diseases differ among men and women, either in size or in direction.

Two limitations have to be mentioned. First, our analysis is based on self-rated health, not on diagnoses by psychiatrists or general practitioners. Regarding the structure of our data, we use a cross-sectional sample, and are therefore not able to disentangle period and cohort effects. As SHARE is designed as a longitudinal study, it will allow us to address this issue in the near future, when several waves are available to the scientific community. What is more, we are not able to investigate dynamic aspects and causalities with our cross-sectional data.

Although the current analysis covers a range of different aspects, other dimensions such as social support, working conditions or transition to retirement are left out. Another potential confounder in the study of the association of age and depressive symptoms in a cross-sectional analysis is the cohort effect (*Yang 2007*). Moreover, the analysis of the first wave of SHARE does not allow us to detect causalities but only associations.

A compression of morbidity is being observed as Europe ages (*Vaupel 2010*). Due to the increasing relative time spent in good health, the rise in the number of individuals suffering from depression should be less pronounced compared to a situation with prolonged morbidity. This holds true as long as economic strains and socio-demographic characteristics remain constant.

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Dr. Isabella Buber-Ennser (✉). Vienna Institute of Demography (Austrian Academy of Sciences), Wittgenstein Centre for Demography and Global Human Capital, A-1040 Vienna, Austria.  
E-Mail: [isabella.buber@oeaw.ac.at](mailto:isabella.buber@oeaw.ac.at)  
URL: [www.oeaw.ac.at/vid](http://www.oeaw.ac.at/vid)

Prof. Dr. Henriette Engelhardt-Wölfle. Chair of Population Studies, Otto Friedrich University Bamberg, 96052 Bamberg, Germany.  
E-Mail: [henriette.engelhardt-woelfler@uni-bamberg.de](mailto:henriette.engelhardt-woelfler@uni-bamberg.de)  
URL: [www.uni-bamberg.de/demografie](http://www.uni-bamberg.de/demografie)

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