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October 2013 HEG working paper 13-04

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Keywords: Living arrangements, cognitive decline, co-residence, re-test effect

JEL Codes: J12, J14

Abstract

Family resources may play an important role in the wellbeing of the elderly. In this paper, we examine the association between living arrangements and cognitive decline among people over 65 in nine European countries under the hypothesis that living with others (i.e. spouse or/and children) vis –à- vis living alone may have positive effects on maintaining cognitive functioning. To this end we used data from the first two waves of the Survey of Health, Ageing and Retirement in Europe (SHARE), which provides five indicators of cognitive functions: orientation, memory, recall, verbal fluency, and numeracy. Net of both the potential biases due to the selective attrition and the re-test effects, the evidence shows that the impact of living arrangement on cognitive decline depends on both the country and the type of cognitive examined.

[1] We would like to thank all of the seminar participants in San Francisco (PAA 2012), Stockholm (EPC 2012), New Orleans (PAA 2013), Busan (IUSPP 2013). Toffolutti gratefully acknowledges support from SOPHIE (Evaluating the Impact of Structural Policies on Health Inequalities and their Social Determinants, and Fostering Change) Seventh Framework Programme (FP7/2007-2013) under grant agreement n. 278173. Usual disclaimers apply.

1. Introduction

The rapid rise in ageing population of Western countries has generated much interest in the recent literature with the specific focus on cognitive decline in older people and on factor which might prevent it. In such a context, the amount of older people with cognitive impairments is increasing, thus producing – especially in the most serious cases (i.e. Alzheimer's disease) - high social and economic costs, both for the individuals and for the societies. The literature has shown that beside genetic factors (Emery et al., 1998), even structural conditions may influence the cognitive health of the elderly, as individual behavioural or contextual characteristics (Cagney and Lauderdale, 2002; Bonsang et al., 2012; Mazzonna and Peracchi, 2012). Some studies have, for example, suggested that being active and socially integrated, protect older people from cognitive decline (Engelhardt et al., 2010). In this study we focus on the link between cognitive status and a specific contextual aspect: the older adults' living arrangements.

In recent decades, the living arrangements of the elderly have greatly changed. In the recent years, the proportion of the elderly living alone has become non-negligible, particularly in European countries (United Nations, 2005, 2009). In the future decades the rise in older people living alone could be reduced considering the increasing of life expectancy (individuals are less likely to end up in a widowhood, and thus they are more likely to enjoy their partners' support for longer). Recent forecasts support the view that in some countries the elderly will be more likely to live with a partner and less likely to live alone than they currently do (Keilman and Christiansen, 2010). In contrast, in the future the elderly living alone are expected to further increase due to the increasing marital instability (not always accompanied by the re-partnering processes - particularly for older women, see Carr and Bodnar-Deren, 2009) and the decreasing fertility (Keilman and Christiansen, 2013). In the context of this rapid transformation, it is important to examine whether living arrangements affect cognitive functioning. Indeed, if it affects significantly mental health of elderly, we could predict whether the future living circumstances will have repercussions on the well-being of the future elderly population.

Theoretically, living with others should protect older people against cognitive decline with respect to living alone. Living in a one-person household is not a risk condition for elderly people if they are in good health and have satisfactory social interactions. However, not all individuals living alone are in this situation and thus, living alone is often considered as a "social frailty" indicator (see, for example, van Campen, 2011 and Casale-Martínez et al., 2012). Living with others implies, instead, a minimum of social relations which may have a double positive effect on cognitive status: on the one hand, it stimulates social integration and healthy lifestyles for the elderly; on the other hand, it may be linked to less anxiety and fear of loneliness for the older people. Social integration,

healthy behaviours, and anxiety are, indeed, found to be associated (the former two negatively and the latter positively) to cognitive health (Merrill and Small, 2011; Arpino and Bordone, 2012; Agrigoroaei and Lachman, 2011).

However, empirical findings in the literature on this topic are not clear-cut. In line with the economic (Casey and Yamada 2002) and psychological benefits (De Jong Gierveld et al., 2012) of living with a partner in older age, some studies suggest a positive effect on cognitive functioning of being in a partnership vis-a'-vis being single (Van Gelder et al., 2006; Håkansson et al., 2009; Mousavi-Nasab et al., 2012). Rather less clear is the effect of living with children on maintenance of cognitive functioning. The only study which considers the relation between (adult) children and older people's cognitive health shows a negative association of living with adult children (Bordone and Weber, 2013). Further studies about the influence of children on other psychological aspects of older people which may mediate the effect of co-residence do not suggest possible hypotheses since they present mixed results (Buber & Engelhard, 2008; De Jong Gierveld et al., 2012). However, it should be pointed out that analysing the potential effect of co-residence with adult children on elderly well-being is not easy. First of all, co-residence with children is not very common in several European countries (mainly the Nordic ones), thus few sample cases tend to be used for the analyses of these countries. Second, living with children presents different kind of confounding factors to control for. On the one hand, especially in cross-sectional studies, there is greater heterogeneity in the situations (co-residence may be also due to necessity of children and, in this case, it may lead to intergenerational tensions and conflicts with negative effects on parents' well-being; see De Jong Gierveld et al., 2012). On the other hand, it is more difficult to isolate the correct direction of causation as elderly living with children are clearly more likely to be selected, i.e. those with worse health are less likely to be left alone.

This study aims to fill, at least partly, this gap in the literature by examining the effect of living arrangements on cognitive decline in older ages in nine European countries: Sweden, Denmark, The Netherlands, Belgium, France, Germany, Austria, Italy, and Spain. We might expect that, in general, living with a partner has positive effects due to the different forms of support obtained, and this should lead to beneficial effects resulting in a reduced decrease of elderly cognitive functioning in comparison with that of older people living alone. For some countries, where co-residence with children is a common arrangement (such as in the Southern Europe), the effect of living with children could, as well, have beneficial effects. Even if it is unlikely that adult children lends to the elderly the same benefits provided by the partner (de Jong Gierveld, Dykstra and Schenk 2012), we may expect that adult children provide, at least partly, physical and emotional protection and support. This should bring about beneficial effects and a consequently slower decline of cognitive functioning in comparison with that of elderly living alone.

Data come from the first two waves (in 2004 and 2006/2007) of the Survey of Health, Ageing, and Retirement in Europe (SHARE), which provides information on five cognitive abilities (orientation, memory, recall, verbal fluency, and numeracy). Cognitive decline is measured taking into account the differences in the several abilities, between the first and the second wave for individuals aged 65 or over at the first wave. In order to assess the impact of living arrangements on cognitive decline, if any, separate multivariate analyses are carried out, by cognitive domain and country. In doing these analyses particular attention is paid to the potential selection due to attrition and to another potential source of bias arising from what is generally referred to as "re-test effect" (Ferrer et al., 2004).

The remaining of this paper is organized as follows. Section 2 reviews the existing literature on the association between family circumstances and cognitive health of older adults. Section 3 describes the data and the methodology used to analyse the effect of living arrangement on the cognitive decline. Section 4 presents both methodology and results of the analyses aiming to examine whether a re-test effect exists in the different data-sets. Section 5 describes the main findings. Finally we conclude and discuss possible further directions in the research.

2. Background

Several reasons have been suggested to explain why living arrangements are important for elderly physical and psychological health. Presumably, living with others is a protecting factor due to the availability of social support, regulation of health behaviour, supply and consumption of economic resources (in economy of scales), and demands on individual roles (Lund et al., 2002). In addition, from the viewpoint of cognitive functioning, a high level of social and intellectual stimulation can characterize elderly living with others and this stimulation may increase neuronal growth and maintenance, and thus protect the brain from deterioration and subsequent cognitive decline (Coyle, 2003)[2].

There does not appear to be any existing literature analysing specifically the effect on cognitive status of living with others in comparison with living alone. If we consider the effect of living arrangements on other health aspects, empirical literature has shown mixed evidence (Hays, 2002). Some studies report that older persons living alone were at greater risks for poor physical and psychological health (Kharicha et al., 2007; Buber and Engelhardt, 2008) than those living with others. Others studies found that there were no differences in health according to the living arrangements (Hughes and Waite, 2002); still others reported that living alone could have some

[2] However, it could be that older people in good health living alone may be more prone than the others to have active behaviours and this might prevent them from cognitive decline.

health advantages (Michael et al., 2001). In sum, the literature, to date, does not provide clear evidence on whether elderly living alone is detrimental. Further evidence on this area clearly needs to be included and who the person co-habits, is, for instance, an important information that should be considered.

The literature has shown that living with a partner is an important factor associated with individual's well-being. Economic, social, and psychological advantages connected with this living arrangement have positive effects on various health factors, such as physical diseases, pain, mental health, and self-reported overall health and longevity (for studies focused on the elderly, see Waite, 2009). The few empirical studies that have specifically examined the relationship between having a partner and cognitive functioning in older age appear to conclude that living with a partner could have positive effects on cognitive function later in life: people without a partner were found to have higher risks of developing cognitive impairment compared with people living with a partner. In particular, Van Gelder et al. (2006) compared married and unmarried men's cognitive decline over a period of 10 years and found that married ones have a smaller cognitive decline than men who were unmarried. Similarly, Håkansson et al. (2009) showed that single, divorced and widowed persons had twice the risk of developing cognitive impairment than married persons. Mousavi-Nasab et al. (2012) found a lower risk of memory decline for the elderly living with a partner in comparison with single people or even with other non-married groups (divorced and widowed). Researchers have suggested that the social and intellectual stimulation offered by a partner may protect the brain from deterioration, stimulating the growth of neurons (Van Gelder et al., 2006). Moreover, some of the literature shows that living alone may be associated with unhealthy lifestyles or even psychological distress, which in turn could lead to adverse health effects. A relatively unhealthy lifestyle, for example with a reduced physical activity or excessive smoking and alcohol drinking may have a negative effect on cognitive functioning (Van Gelder et al., 2004). Similarly, stress and depressive symptoms can also impact negatively on cognitive abilities by leading to an increase in cortisol production, which may damage hippocampus (the part of the brain where memory is located) and this may result in memory problems (see Kalmijn et al., 1998).

There is much less conclusive evidence on the effect of living with children. Even if it is unlikely that adult children, living with their parents, provide the same (at least psychological) benefits provided by the partner (de Jong Gierveld, Dykstra and Schenk 2012), at least, there should be the opportunity for exchange of social, emotional, practical, and financial support. Thus, one should expect that co-residence with children may be positively associated with elderly cognitive functioning. In fact, a recent study has shown that having at least one child living in the same household was negatively or not at all associated with cognitive abilities of elderly (Bordone and Weber, 2013). Other studies regarding the influence of co-residence with adult children on further

psychological aspects of the parents provides mixed empirical evidence. For example, de Jong Gierveld, Dykstra and Schenk (2012) found that older people living alone in some countries in Eastern Europe were on average lonelier than those living with adult children. However, de Jong Gierveld and Van Tilburg (1999) reported lower loneliness for elderly living with their children compared to those living alone for their Italian sample, but higher loneliness for their Dutch sample. Thus, at least to date, the empirical literature does not seem to support the hypothesis that co-residence with children may, for example, lead to a greater sense of purpose with direct neurohormonal benefits (Fratiglioni et al., 2004) and/or a remainder to take care of oneself. Indeed, in the case of children cohabiting with elderly parents is harder to isolate the effect net of other disturbing effects. For example, co-residence with children may be due to health problems of parents and in this way co-residence selects less healthy older adults. In addition, co-residence with children may imply conflicts, which may contrast possible positive psychological or social effects. In this paper we take into account some of these disturbing factors.

3. Data and methods

a) The data

The data used in this paper come from the first two waves (in 2004 and 2006/2007) of SHARE. This dataset provides longitudinal information on health and socio-economic status, and social and family networks of non-instituzionalized[3] adults aged 50 or over representing the various European countries (Börsch-Supan et al., 2005). The sample, utilized in this paper, is based on individuals living in nine of the countries who were 65 or over in the first wave and were again interviewed in the second wave. Thus, the paper focuses on 8,400 individuals (61.4% of the sample was aged 65 or over in the first wave) still alive in the second wave (516 individuals corresponding to 3.8% died before the second wave and 4,756 – 34.8%, individuals were not re-interviewed for an undisclosed reason).

Five different measures of cognitive function reflecting the different domains of the multidimensional concept of cognitive ability (Dewey and Prince, 2005; Bernstein et al., 2006) were available, namely: orientation, memory, recall, verbal fluency and numeracy. Orientation is a basic cognitive functioning indicator measuring orientation for time (date, month, year and day of the week). Memory and recall refer to the ability to recall certain words from a list of ten items immediately after the list was given and then again after a delay. Verbal fluency is an indicator of

[3] The focus only on a non-instituzionalized population clearly leads to an overestimation of physical and cognitive wellbeing of the sampled population.

executive function, in this case referring to the number of different animals that the interviewee can recall within one minute. Numeracy measures the ability to perform numerical operations.

Each dimension of cognitive ability was measured with different tests each providing different measures: orientation and numeracy are described by five-category variables; memory and recall range from 0 to 10, and verbal fluency has values ranging from 0 to 60[4]. For all abilities a higher score implies a higher ability. As argued by Salthouse (1985) and suggested by Mazzonna and Peracchi (2012), these dimensions of cognitive functioning are generally based on different combinations of fluid and crystallized intelligence. The first concerns performance in learning, remembering, and processing new material and comprising perceptual speed and reasoning abilities. These cognitive abilities tend to decline substantially over an adult lifespan. The second type of cognitive ability is entirely related to accumulated knowledge and skills, such as the meaning of words and size of vocabulary, they tend to increase or remain at a high functional level until late in life (Verhaegen and Salthouse, 1997). Orientation, memory and recall can be considered as fluid abilities indicators, whereas verbal fluency and numeracy as crystallized skills markers (as suggested by Fuscaldo, 2012).

Cognitive decline was measured considering the differences between the scores in the first and second wave[5], carried out separately for each of the five indicators of cognitive ability and measured for individuals aged 65 or over. Thus, separate multivariate analyses, in which the differences at ability level are the response variables, were used.

We use two key independent variables: elderly people's living arrangement along with their baseline cognitive functioning. The living arrangement variable distinguishes whether the individual lives alone or with others. Those living with others were further distinguished between living with the partner (only) and living with (adult) children (with or without a spouse)[6]. The latter is mainly represented by elderly people living with their children only. However, this living

[4] In fact, we do not consider in the analyses eight individuals having a score higher than 60, given the extremely low probability of getting them. Hence we have interpreted them as implausible values.

[5] In order to allow for a decline in cognitive functioning between the first and the second wave, the analysis was restricted to healthier respondents, excluding those who were severely cognitively impaired at baseline (individuals with cognitive abilities in wave 1 equal or under the 5th percentile). This threshold corresponds to a score of 0 for orientation (in this way, 143 observations were neglected), 1 for memory (543 observations were excluded), 0 for recall (1,219 individuals were not considered), and 1 for numeracy (870 observations were neglected) and finally 7 for verbal fluency (408 individuals were not considered). For the sake of clarity, for orientation we use a threshold the 25^{h} percentile, instead of the 5th one. The reason behind this change is due to the high concentration among the low scores and hence the extremely small sample size having higher values than the 25th percentile. Clearly, missing data for one of the variables retained in the analysis was another criterion for exclusion.

[6] Other more complex family forms (for example, living with other relatives) were ignored because of the few cases.

arrangement is extremely rare in some European countries leading to the impossibility to be distinguished from living with the partner only. In particular, we refer to Sweden (only 8 observations), Denmark (11 observations) and the Netherlands (26 observations). In addition, the baseline cognitive functioning (measured at wave 1, for each of the five abilities) is considered: memory, recall, and verbal fluency at wave 1 are considered as continuous covariate, whereas orientation and numeracy are dichotomized[7]. The baseline cognitive function is of interest not only because it allows to control for the cognitive health at the start of the period, but also because we are interested in studying whether the association between living arrangements and cognitive decline might be influenced by health of the elderly.

Other covariates included in the models control for factors which are relevant, according to the literature, for cognitive decline (see the review by Engelhardt et al., 2010) and living arrangement. Firstly, health is one of the most significant determinants of living arrangements: individuals living alone are probably those who are the healthier. Aside from baseline cognitive functioning, health status is measured also considering the diagnosis of certain chronic diseases (heart disease, stroke, and diabetes), the level of difficulty in performing eight Instrumental Activities of Daily Living (IADL), and mental health (measured by the EURO-D scale – Prince et al., 1999). Physical function was categorized as normal (without any difficulty), mild disability (with difficulty in one or two activities of IADL) and severe disability (with difficulty in more than two activities of IADL). Respondents with EURO-D scores ranging from 0 to 3 were defined as "no depressed", those with 4 or 5 as "mildly depressed", while those with more than 5 as "severely depressed". Further socio-economic and socio-demographic background factors were taken into account including age, gender, and educational level. Education was divided into three categories: low (illiterate or elementary), middle (secondary school), and high (high school or above). Household economic situation was accounted for through household total net worth[8]. Differences in the number of household members were considered by dividing wealth by the square root of household size (Avendano et al., 2009), wealth was then collapsed into quartiles. A measure of social involvement was also considered (being connected with better cognitive performance, see, for example,

[7] Respondents having a score in orientation less than 4 were distinguished from those with a score equal to 4; likewise, those having numeracy score of 4 or lower were distinguished from the others. The reason behind the dichotomization is to have homogenous cells according to the sample size. We split the individuals according to the median level of these two cognitive.

[8] Following the definition used by others in the literature (see Avendano et al., 2009): "the sum of all financial (net stock value, mutual funds, bonds, and savings) and housing wealth (value of primary residence net of mortgage, other real estate value, own business share, and owned cars) minus liabilities". Missing items were imputed using the methodology of multiple imputation (see SHARE Release Guide 2.5.0 waves 1& 2, Mannheim Research Institute for the Economics of Aging, 2011).

Engelhardt et al., 2010), and measured by considering whether the respondent had undertaken at least one social activity[9] within the previous month prior to the interview.

Furthermore, we added geographical controls: both the region of residence[10] and the type of area (a big city, the suburbs or outskirts of a big city, a large town, a small town, a rural area or village).

Lastly, in order to control for the quality of the answers, we took into account the presence of individuals during the cognitive section of the interview both in the first or in the second wave of the survey.

b) Methodology of analysis

A specific linear regression model was estimated for each country and cognitive ability, paying attention to the potential selection effect due to attrition. Respondents experiencing a heavier cognitive decline might experience a higher risk of death, institutionalization, or health decline, and so they are less likely to be interviewed in the second wave, leading to a missing outcome for those who are interviewed only once. Therefore we might expect that the effect of living arrangements on cognitive decline (if any) would be biased if this kind of selection is not properly taken into account. This selection effect was addressed by weighting individuals in the regression models. In particular, calibrated longitudinal weights were used (for details on the weights and on the calibration procedure see SHARE Release Guide 2.5.0 waves 1& 2, Mannheim Research Institute for the Economics of Aging, 2011).

4. A potential drawback: the re-test effect

a) Re-test effect and our approach

Measures of cognitive decline in panel surveys are plagued by the fact that at each assessment of cognitive ability, people might learn from tests performed in the previous interview. This is generally referred to as "re-test effect" (Ferrer et al., 2004) and according to the literature it produces an upward bias in cognitive abilities measurement. In our case, if a re-test effect exists and if it varies across living arrangement, this is an issue in assessing the effect of living arrangement on cognitive decline. In addition, the re-test effect may vary across countries, thus it could be the case

[9] Seven types of social activities are considered in the questionnaire: voluntary or charity work, care provided for sick or disabled adults, help provided to family, friends or neighbours, educational training, participation in a sport, social or other kind of club, participation in a religious organization, and participation in a political or community organization

[10] Defined by the the so-called NUTS areas.

that it constitutes a problem only for some of them. Therefore, we needed to net out the measurement of cognitive decline from the bias introduced by the re-test effect.

The literature has suggested some methods to tackle this issue (Ferrer et al. 2004) although, unfortunately given our data limitation (we have only two waves), none of these can be applied here.

Thus, we followed an alternative approach. Re-test effects were estimated using data from wave 2, comparing cognitive abilities of individuals who were interviewed also in the first wave with those of individuals who are interviewed for the first time (refresh sample). The differences in term of observable characteristics were net out via Propensity Score Matching (Rosenbaum and Rubin, 1983). We assumed that differences between these two groups – once they have been aligned in terms of background characteristics were only determined by the re-test effect.

Further, we defined as "treated" all the individuals who are observed for the second time in wave 2 (2006/2007)[11] and as "control" the refresh sample. Then separately by living arrangement (i.e. living alone, couple alone, living with children) and country, we perform a 1-to-n matching to align the distribution of the "treated" with the "control". In order to ensure a good match between treated and controls a caliper of 1% is applied. To this end, we also stratify the sample by two dimensions (education and gender), thus generating 4 cells. We, then, aligned the cells according to the geographical region, the health status (no problems in Activity Daily Living activities vis-à-vis at least one problem) and cohort (born before or after 1930).

The estimates of re-test effects were computed net of these variables controlling for basic background characteristics and conditioning to household structure. For the sake of clarity, after having dropped the observables differences between the "treated" and the "controls", we regress the cognitive ability on year of birth, years of education, gender, geographical region, health status (defined as above), year dummies (more precisely the interview year 2006 vs. 2007) and the probability of being interviewed for the second time in the second wave vis-à-vis belonging to the refresh sample (the afore defined "treated").

b) Results

The results (Table 1) show that there is a significant (positive) re-test effect in many countries which varies from one living arrangement to another. For example, in Sweden we find a significant re-test effect in recall ability for people living alone, while the same effect is not significant for people living in couple. Similarly, Italy and Spain show a positive re-test effect for elderly living alone, in orientation, and, for Spain, also memory. Belgium, Denmark, the Netherlands, and Spain

[11] Eight (five in wave 1 and three in wave 2) respondents with verbal fluency score higher than 60 are excluded from the analyses, since it is probably a not plausible value (see footnote 3).

show a positive re-test effect among the elderly living with others. We also find an odd negative re-test effect (i.e. people interviewed twice have a worse performance with respect to people interviewed once) in Austria (for memory for elderly living with children), France (for numeracy for elderly living alone) and Germany (for verbal fluency for elderly in couple). This may be explained by noting that in the last two countries the interview approach has changed from the first to the second wave (Blom and Korbmacher, 2011).

Table 1. *Re-test effects in different abilities and countries by living arrangements.*

	Orientation	Memory	Recall	Verbal fluency	Numeracy
Austria					
Living alone	-0.1184	-0.6099	0.4753	-2.8459	-0.0026
Couple alone	-0.0830	-0.7189	-0.1565	0.3139	-0.0617
Living with children	0.0315	-2.5772**	-1.6378	-5.6387	-0.8079
Belgium					
Living alone	-0.1018	0.6239	0.5337	0.7493	-0.1539
Couple alone	0.0656	0.3453	0.1972	2.1236	0.3539**
Living with children	--	--	--	--	--
Denmark					
Living alone	-0.3570	-0.1554	-0.4623	0.7975	-0.0478
Couple alone	-0.0275	1.0468***	0.6316	-1.9669	0.2019
Living with children	--	--	--	--	--
France					
Living alone	-0.0824	0.1208	0.4121	0.7415	-0.5337***
Couple alone	0.0576	-0.2289	-0.0972	1.5078	-0.0157
Living with children	-0.4702	-0.1988	0.0640	2.6326	-0.0517
Germany					
Living alone	-0.2376	-0.3105	-0.0102	-0.8988	0.0855
Couple alone	-0.2221	0.0335	0.1192	-3.1960***	-0.2852
Living with children	0.0115	-0.8678	-1.3535	-5.3959	0.0971
Italy					
Living alone	0.4197**	0.4541	-0.0472	1.6217	-0.2509
Couple alone	-0.3402	-0.3987	-0.3781	1.0075	-0.1958
Living with children	-0.2708	-0.0684	0.6835**	-1.6619	-0.0484
Netherlands					
Living alone	0.1444	0.4132	0.4344	-1.6478	0.3594
Couple alone	-0.1122	0.4125	0.9180**	-0.7517	-0.1919
Living with children	--	--	--	--	--
Spain					
Living alone	0.7138**	1.0185***	0.4249	1.2533	-0.0485
Couple alone	0.4526	0.6252**	0.5267	0.5224	0.0385
Living with children	0.3420	0.2842	-0.0013	1.9114	0.2982**
Sweden					
Living alone	-0.1139	0.3204	0.7509**	1.1569	-0.0547
Couple alone	0.1916	0.1819	0.0707	1.9597	-0.0269
Living with children	--	--	--	--	--

We stratify individuals by country of residence then, via PSM, we align the distribution by cohort (born before 1939) and health (with or without problems in Activity Daily Living), gender and educational level (2 dummies) and regions of residence (NUTS2)
Bootstrapped SE-values in parentheses (500 replications)
** p<0.05, *** p<0.01
(-- = given the small sample size we were not able to compute the estimation for elderly living with children in Sweden (18 obs), Netherlands (20), Denmark (20), Belgium (68)).

For our purposes, it is interesting to document that no re-test effect was identified for certain countries in at least some cognitive dimensions (e.g. orientation in Austria or verbal fluency in Spain). This can make us more confident that regression of living arrangements on cognitive decline is not biased by this issue. For example, in Sweden it seems that all abilities except recall are not affected by the re-test effect, so the effect of living arrangement, if any, on these outcomes can be interpreted without concerns about re-test effect.

5. Analysing the influence of living arrangement on cognitive decline

As described above, cognitive decline was measured by the differences between the scores in the first and in the second wave at cognitive ability level. Results of the multivariate analysis reported in Table 1 refer to the coefficients describing differences, thus, positive values indicate a coefficient associated with an increased deterioration of cognitive ability between the first and the second wave, and a negative value implies a reduced cognitive decline with respect to the reference category. For example, in Belgium living only with a partner reduces the memory decline by 1.022 points compared to the elderly living alone. Potential bias introduced by re-test effect should considered when referring to table 2, thus significant coefficients which might be plagued by this problem (i.e. those referring to abilities of countries where a significant re-test effect has been found – see Table 2) are reported in italics.

Empirical evidence shows that living with the partner or a child might be a protective factor but only in some countries and for certain specific abilities.

According to table 2, Belgium, the Netherlands, and Sweden all report the evident protective effect of living with others. In particular, in Belgium a protective effect of living only with a partner is observed for memory, and, this effect is even stronger for those who already had low memory performance in the first wave. A protective effect of living with children vis-à-vis living alone has been observed for numeracy (since the re-test effect is not available this result should be considered with caution). In the Netherlands, similar protective effects of living with a partner are observed for orientation and memory, and of living with children for orientation; in each of these situations effects are stronger in the case of low cognitive ability (due to the significance of interaction terms). Lastly, in Sweden a protective effect of living only with a partner is observed for numeracy. A similar protective effect -which also interacts with baseline recall level is found. Such an effect could be even stronger, but it could have been moderated by the re-test effect, considering that those living alone show a significant performance improvement between the two waves. In Sweden we also find an unexpected greater decline in orientation for the elderly living with children in comparison with that of those living alone. However, these findings should be considered with

caution due to the small group of individuals living with children in Sweden in our sample (see Section 3a). Due to the re-test effect identified for the elderly living alone for recall ability, a protective effect of living with children cannot be excluded for recall.

For other countries a potential effect in some dimensions cannot be excluded considering the effect of living arrangements jointly with re-test effect. In Austria, results of Table 2 suggest that living with others does not lead to a lower decline in any cognitive abilities in comparison with living alone; in fact, the non-significant effects of living with children on memory decline might depend on the negative re-test found among the elderly living alone, and thus, a potential protective effect of living with children on memory cannot be excluded. In Spain, due to the significant re-test effect among the elderly living alone for orientation and memory, potential protective effects of living with others might be obscured. Potential protective effects cannot be excluded also in Germany for verbal fluency among elderly living only with a partner.

Lastly, as an exception to the general trend, living with others implies a greater decline in verbal fluency in comparison with living alone in Italy (the same result found for orientation should be considered with caution, due to the significant positive re-test effect of living alone). However, due to the significance of the interaction term, a protective effect of living with others is observed for individuals with high verbal fluency at the start.

With regards to co-residence with children, some countries no effect on elderly cognitive decline is observed not only in Nordic countries (and Western ones) (such as Denmark[12], Germany, France, and Austria), where the residential independence of older parents and adult children is valued and feasible, but also in a Mediterranean country, namely Spain.

Table 2. ***Estimates of coefficients related to living arrangements in models describing cognitive decline.***

	Orientation	**Memory**	**Recall**	**Verbal fluency**	**Numeracy**
Austria					
Couple alone (ref: *living alone*)	-0.1618	0.1530	-0.2196	1.0579	0.0511
Living with children (ref: *living alone*)	0.6373	0.4967	-0.4080	1.0461	-0.0315
Baseline cognitive function	0.8770***	0.5855***	0.4764***	0.6827***	1.0993***
Interactions					
Baseline cognitive function*couple alone	0.1922	-0.0242	0.1266	-0.0430	-0.2172
Baseline cognitive function*with children	-0.6965	-0.1388	0.0847	-0.0629	0.0710
Belgium					
Couple alone (ref: *living alone*)	0.0083	-1.0220***	-0.0636	-1.5992	-0.7662
Living with children (ref: *living alone*)	-0.2494	-0.1202	0.6596	0.7178	-0.3284**
Baseline cognitive function	0.8786***	0.4841***	0.5887***	0.4238***	0.7590***
Interactions					
Baseline cognitive function*couple alone	0.0124	0.1726**	-0.0376	0.0736	0.0097
Baseline cognitive function*with children	0.2977	0.0005	-0.2519***	-0.0551	0.0750

[12] In Denmark the number of people living with children is very limited (20 observations), thus this result should be taken with caution.

Denmark					
Couple alone (ref: *living alone*)	-0.3000	-0.3408	-0.5716	-0.7818	-0.1374
Living with children (ref: *living alone*)	0.1646	-0.1497	-0.0268	3.6001	-0.2233
Baseline cognitive function	0.6780***	0.5318***	0.5317***	0.4501***	0.8138***
Interactions					
Baseline cognitive function*couple alone	0.1590	0.0019	0.0134	-0.0152	0.2890
Baseline cognitive function*with children	-0.3112	0.0438	-0.1517	-0.1412	-0.1529
France					
Couple alone (ref: *living alone*)	0.3811	-0.1637	-0.3883	-2.2019	-0.2189
Living with children (ref: *living alone*)	0.2046	-0.1326	-0.3211	0.9950	-0.1025
Baseline cognitive function	1.0110***	0.5609***	0.4546***	0.3650***	0.7940***
Interactions					
Baseline cognitive function*couple alone	-0.4768**	0.0030	0.1674*	0.0878	0.1317
Baseline cognitive function*with children	-0.1340	-0.1103	0.0919	-0.0767	-0.0137
Germany					
Couple alone (ref: *living alone*)	0.0164	1.0006	0.7791	-1.7910	-0.0488
Living with children (ref: *living alone*)	0.1989	-0.1137	-0.0918	0.5732	0.0742
Baseline cognitive function	0.9097***	0.8826***	0.8981***	0.5575***	1.1064***
Interactions					
Baseline cognitive function*couple alone	0.0333	-0.2546**	-0.3081**	*-0.0103*	-0.1424
Baseline cognitive function*with children	-0.3084	0.0939	0.1471	-0.0383	0.1690
Italy					
Couple alone (ref: *living alone*)	*0.4895***	0.2444	-0.4591	5.7203***	-0.1198
Living with children (ref: *living alone*)	*0.7330***	0.3871	0.2004	7.3145***	0.0203
Baseline cognitive function	1.5345***	0.7784***	0.7049***	0.8661***	0.9500***
Interactions					
Baseline cognitive function*couple alone	*-0.5867***	-0.1309	0.0135	-0.3745***	0.0794
Baseline cognitive function*with children	*-0.8504****	-0.0628	-0.1591	-0.4410***	0.1518
Netherlands					
Couple alone (ref: *living alone*)	-0.4632**	-1.5183***	*-1.1393****	-0.3928	0.0115
Living with children (ref: *living alone*)	-0.9066***	-0.7387	-1.5107	-0.3235	0.2766
Baseline cognitive function	0.4198	0.5528***	0.4823***	0.4671***	1.2872***
Interactions					
Baseline cognitive function*couple alone	0.4854**	0.2873***	*0.2598****	0.0010	0.2140
Baseline cognitive function*with children	0.9060***	0.1650	0.4495	-0.0655	-0.5074
Spain					
Couple alone (ref: *living alone*)	0.2910	-0.7034	-0.0767	-0.2321	-0.1754
Living with children (ref: *living alone*)	0.1745	-0.4941	0.1800	-0.9868	-0.1685
Baseline cognitive function	1.0783***	0.4365**	0.7017***	0.5657***	1.2149***
Interactions					
Baseline cognitive function*couple alone	-0.1717	0.3046	0.0743	-0.0323	-0.1534
Baseline cognitive function*with children	-0.1293	0.1623	-0.0986	0.0688	0.0623
Sweden					
Couple alone (ref: *living alone*)	-0.2613	-0.4650	-0.8003**	0.5234	-0.2307**
Living with children (ref: *living alone*)	0.8167**	-0.7004	-7.516	-10.1327	-0.1004
Baseline cognitive function	0.9891***	0.6345***	0.4620***	0.4154***	0.8775***
Interactions					
Baseline cognitive function*couple alone	0.3062	0.0591	*0.1699***	-0.0251	0.2520
Baseline cognitive function*with children	-0.8751**	0.1447	1.8178	0.3452	0.2868

Significance levels: *** = 0.01; ** = 0.05

All models control also for the covariates described above: health (through the diagnosis of heart disease, stroke, and diabetes, the physical functioning, and the mental health), socio-demographic and economic factors (age, gender, education, social involvement, wealth, and residence), and the presence of other individuals during the interview.

6. Discussion and conclusion

The aim of this study was to assess whether living with others (partner and/or children) has a protective effect on cognitive health of elderly people. Despite of an increasing life expectancy in both sexes, one might expect to observe an increasing share of the elderly living alone, given the changes brought about by processes like the Second Demographic Transition. Thus it is important to know whether this trend will have consequences on future elderly cognitive health. The methodological approach we used was aimed at controlling for all potential disturbing factors and selection effects which may arise in this type of analysis. First, we use a longitudinal approach (considering cognitive decline between two waves) rather than a cross-sectional one. To our knowledge, this approach has not been used in other studies concerning European countries. Second, we consider the potential selection due to the attrition between the first and the second wave. Third, baseline health is controlled for and individuals in conditions of very poor health are not considered. In this way, we take into account a possible selection effect (i.e. those who live alone - because of their higher health level). Lastly, in the paper we also try to quantify the so-called re-test effect. For those countries and cognitive dimensions where no re-test effects have been found, results on the influence of living arrangements on cognitive decline can be considered with more confidence, since they are not biased by re-test. However, some other heterogeneity components between countries are not controlled for (such as the different level of co-residence with adult children and of residence in institutions).

In comparison with other studies in this area, this is the first attempt to verify this hypothesis in an European comparative perspective and to distinguish between co-residence with children and with a partner. Moreover, we measure cognitive functioning with a specific focus on addressing certain cognitive domains, whereas most of the previous studies have focused on global cognitive functioning (e.g., using the Mini-Mental state Examination test as a screening cognitive task, Håkansson et al., 2009; Van Gelder et al., 2006). Only a few authors have considered specifically different types of cognitive ability (such as those connected with memory tasks, Mousavi-Nasab et al., 2012), and to the best of our knowledge, none of them includes a more extensive cognitive test battery or focuses on specific cognitive domains.

Our results confirm suggestions by the current literature (Van Gelder et al., 2006, Håkansson et al., 2009, Mousavi-Nasab et al., 2012), that living with the partner is a protective factor particularly for memory and orientation (which, as suggested in section 3a, are both indicators of fluid abilities). The effect of living with children is less clear-cut (also due to low prevalence of co-residence with adult children in several countries). However, we make a substantial contribution to the literature by showing that living with children may lead to some beneficial effect (e.g. orientation). Moreover,

we find that the protective effects (both of living with children and with the partner) are, in some cases, stronger for low baseline cognitive ability.

Italy is an outlier with respect to other countries, since it is the unique country to show a negative effect of living with others. We cannot identify an explanation for this result. We could hypothesize that the Italian sample in SHARE is more selected than in other countries or it could be an effect of the lower use of retirement homes in Italy, so that seniors living with others are less healthy with respect to other countries. In any case, Italy is an isolated case, all other countries that have been considered show a positive (or null) effect of living with others.

Further, no clear explanation for the differences among countries is identified. Thus, our paper should be considered as a descriptive analysis of the association between living arrangement and cognitive health. Despite the fact that we made several efforts to approach a causal inference analysis, this paper recommends that other studies can overcome some of the limitations in this study. For example, contacts with non-co-resident children, because of small sample size, and reasons for adult children to co-reside with their parents, because this information is missing, have not been considered but it might be interesting to look at. In addition a theoretical explanation of cross-country differences should be found, by focussing on the contextual differences bringing about a varying effect of living arrangement on cognitive decline across countries.

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