Living arrangements and cognitive decline among the elderly in Europe

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Preliminary Draft, please do not quote without permission

Paper to be presented to the Population Association of America 2013 Annual Meeting, New Orleans, Louisiana (April 11-13, 2013)

Abstract

Family ties 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 some European countries, the hypothesis being that living with others (i.e. spouse or/and children) vis –à-vis living alone may have positive effects on maintaining cognitive functioning in comparison with living alone. 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. Cognitive decline is measured by considering the differences between the first and the second wave in each of these five indicators. 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 depends on either the country or the type of ability.

1. Introduction

Increasing ageing of developed populations has drawn the attention of the scholars on the factors which protect older people' cognitive health. With the increase of longevity in older ages, the amount of older people with cognitive deficits is increasing, thus producing - especially in the most serious cases (i.e. Alzheimer) - high individual, social and economic costs for the societies. The literature has shown that beside genetic factors (Emery et al., 1998), even structural conditions may influence the cognitive health of elderly, as individual behavioural or contextual characteristics (Cagney and Lauderdale, 2002; Bonsang et al., 2012; Mazzonna and Peracchi, 2012). For example, it has been suggested that being active and socially integrated protect from cognitive decline (Engelhardt et al., 2010).

The aim of this paper is to analyse the link between cognitive status and a specific contextual characteristic: the living arrangements. This might be of particular interest in ageing societies, characterized by many transformations on the living circumstances of elderly. In recent decades, indeed, the proportion of elderly living alone is not negligible, particularly in European countries (United Nations, 2005, 2009) and in the next decade could further increase: future elderly will have narrower kinship networks due to decreasing fertility and increasing divorce rates. In fact, in ageing societies, with the increase of life expectancy and survivorship, individuals in couples are less likely to lose a partner to death in comparison with the past, and thus, elderly may have the support of a partner for a longer time. Although, due to increasing divorce rate, not always accompanied by re-partnering processes (particularly for older women, see Carr and Bodnar-Deren, 2009), the period of life spent with a partner might decrease, some recent forecasts have indicated that in some countries the elderly should be more likely to live with a partner and less likely to live alone than they do at present (Keilman and Christiansen, 2010). In this context of transformations of living arrangement of elderly, it is important to examine whether living arrangement has effects on cognitive functioning. Indeed, if it would significantly affect mental health of elderly, this might have repercussions in the wellbeing of the future elderly population.

Theoretically, living with others should protect older people against cognitive decline with respect to living alone. Living in a single person household is not a risk condition for the elderly people if they are in good health and have satisfactory social interactions. However, not all individuals living alone are in this situation and 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 be stimulating for the elderly. Moreover, especially for older people, living with others may be linked to less anxiety and fear of

loneliness. Social relations and anxiety are, indeed, found to be associated (the former negatively and the latter positively) to cognitive health (Arpino and Bordone, 2012; Agrigoroaei and Lachman, 2011).

However, the extremely rare literature on this topic is not clearly consistent with these assumptions. Studies have found several benefits of living with a partner in older age. There are economic advantages associated to economies of scale (Casey and Yamada 2002); moreover, as they need less formal care (Grundy and Jital 2007) and a partner is a source of emotional and practical support, living with a partner prevents loneliness (De Jong Gierveld et al., 2012). Little is, however, known on the effects of the partner on the cognitive functioning, even if indirectly we may assume a positive association. Studies on the association between cognitive impairment and marital status document indeed a positive effect of married status with respect to other marital status (Van Gelder et al., 2006; Håkansson et al., 2009; Mousavi-Nasab et al., 2012). Less clear is instead the effect of living with children on maintenance of cognitive functioning. The only study (at least at our knowledge) which consider the relation between children and older people‘s cognitive health shows a negative association of co-residence, but a positive association of frequent contacts with children, with some cognitive abilities (Bordone and Weber, 2013). Other studies about the influence of children on other psychological aspects of older people do not suggest possible hypotheses since they present mixed results (Buber & Engelhard, 2008; De Jong Gierveld et al., 2012). The inconsistency may be explained by different sources of disturb. First, elderly living with children are clearly more likely to be selected, i.e. those with worse health are less likely to be left alone. Second, 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' wellbeing (De Jong Gierveld et al., 2012). Finally, the institutional and cultural contexts in which old aged people are living should be considered since co-residence with adult children is more common in some developed countries than in others (Wang et al., 2001; Cui, 2002; De Jong Gierveld et al., 2012).

This paper aims to fill at least part of this gap in literature examining the association between living arrangements and the cognitive decline among people over 65 living in nine different European countries: Sweden, Denmark, the Netherlands, Belgium, France, Germany, Austria, Italy, and Spain. We might expect that, in general, living with the 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 Southern Europe), further considerations is needed. Even if it is unlike that offspring confer to old people the same benefits provided by the partner (de Jong Gierveld, Dykstra and Schenk 2012), we may expect

that the physical and emotional protection and support provided by a partner might be, at least partly, replaced by those by children, and thus, leading beneficial effects and consequently a lower decrease of elderly cognitive functioning in comparison with that of elderly living alone.

The data, we use, 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 considering the differences in the several abilities, between the first and the second wave for individuals aged 65 or over. In order to assess whether there is an effect of living arrangement on cognitive decline, separate multivariate analyses are carried out for each cognitive domain and for each of the nine countries. In doing these analyses a particular attention is paid to the potential selection due to attrition. The presence of another potential source of bias arising from what is generally referred to as "re-test effect" (Ferrer et al., 2004), that is the improved performance over time because of repeated test exposure, is preliminary tested with an innovative approach. It permits to isolate, for each country and each ability, the possible biased results and focus our attention on those free of re-test effect.

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, the methodology used to analyse the effect of living arrangement on the cognitive decline and the methodology examining whether a re-test effect exists. Section 4 describes the main findings. Finally we conclude and discuss possible further progresses in the research.

2. Background

Several reasons have been suggested to explain why living arrangements are important for health. Presumably, co-residential arrangements should be better than living alone in protecting health for elderly because of the availability of social support, regulation of health behaviour, higher 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 leading to a lower brain deterioration and subsequent cognitive decline (Coyle, 2003)[1].

[1] 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.

In fact, the literature has shown mixed evidence (Hays, 2002). Some studies have reported that older persons living alone were at greater risks for poor physical health (Kharicha et al., 2007) and cognitive decline (Van Gelder et al., 2006) than those living with others. However, others found that there are no differences in health according to the living arrangements (Hughes and Waite, 2002), and still others reported that living alone may have some health advantages (Michael et al., 2001). In sum, the literature is not consistent on the beneficial effects of living alone in older age. Probably, more information on who are co-residents should be considered.

The literature has shown, indeed, that living with a partner is an important factor associated with health and longevity in comparison with living alone (for studies focused on elderly, see Waite, 2009). This is motivated by the economic and social advantages connected with being in couple. Despite the association between living with the partner and various health factors, such as physical diseases, pain, mental health, and self-reported overall health, there are few studies that have specifically examined the relationship between having a partner and cognitive functioning in older age. In general, there is a substantial agreement on the association between living with a partner and 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 unmarried ones. Similarly, Håkansson et al., (2009) have shown that single, divorced and widowed people had twice the risk of developing cognitive impairment than married persons. Mousavi-Nasab et al. (2012) found a lower risk of memory decline for elderly living with a partner in comparison with singles or even with other non-married groups (divorced and widowed). Researches have suggested that the social and intellectual stimulation offered by thepartner may protect the brain from deterioration, stimulating the growth of neurons (Van Gelder et al., 2006). At the opposite, living alone, particularly after the partner's loss, may be associated with changes in lifestyle or even psychological distress, which in turn could lead to adverse health effects. From one hand, indeed, changes in lifestyle such as a decrease in physical activity or an increase in smoking and alcohol drinking may have a negative effect on cognitive functioning (Van Gelder et al., 2004). From the other hand, stress and depressive symptoms lead to an increase in cortisol production, which may damage hippocampal, the part of the brain where memory is located (and this may result in memory problems, see Kalmijn et al., 1998).

Less clear is the effect of living with children. Even if it is unlike that offspring confers to their older parents the same (at least psychological) benefits provided by the partner (de Jong Gierveld, Dykstra and Schenk 2012), they should be for their parents a potential vehicle of exchange of

social, emotional, practical, and financial support. Thus, one should expect that co-residence with children may be negatively associated with elderly cognitive decline. In fact, some authors have shown that having at least one child living in the same household is negatively associated with cognitive abilities (Bordone and Weber, 2013). This may be explained by the fact that closer involvement with children may imply more conflicts, or by the selection of elderly moving together with a child as less healthy. The same study found, however, also that fewer contacts with children are associated with lower cognitive abilities: parent-child relationships may lead to a higher sense of purpose with direct neurohormonal benefits (Fratiglioni et al., 2004) and/or a remainder to take care of oneself. Other studies about the influence of children on other psychological aspects of their older parents presented similar 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 Italy, but higher for the Netherlands. Similarly, Gaymu and Springer (2010) found that having frequent contacts with children was positively associated with life satisfaction for women living alone in Southern Europe, but the same was not true for those living in Central and Nordic European countries. The inconsistency may be connected with the institutional and cultural contexts in which old aged people are living and which define constraints and opportunities available in different societies (Wang et al., 2001; Cui, 2002; De Jong Gierveld et al., 2012).

3. Data and methods

a) The data

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[2] adults aged 50 or over representing the various European regions (Börsch-Supan et al., 2005). The sample we use is based on individuals aged 65 or over in the first wave, who are interviewed also in the second wave: in this way, the present paper focuses on 8,400 individuals (61.4% of the persons 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 have not been re-interviewed but we do not why).

Five different measures for cognitive functions are available, namely: orientation, memory, recall, verbal fluency and numeracy. Orientation is a basic cognitive functioning indicator

[2] The focus only on non-instituzionalized population clearly leads to an overestimation of wellbeing.

measuring orientation for time (date, month, year and day of the week). Memory and recall refer to the ability to recall some words from a list of ten items, immediately after the list was given and then after a certain delay, respectively. Verbal fluency is an indicator of executive function. More precisely, it is defined by the number of different animals that the interviewee can recall within one minute. Numeracy measures the ability to perform numerical operations. Each ability was measured with different tests leading to different measures: orientation and numeracy are described by five-categories variables; memory and recall range from 0 to 10, and verbal fluency has values ranging from 0 to 60[3] in the current sample. For all abilities higher score implies higher ability. These measures of cognitive functioning assess the so-called fluid intelligence (Engelhardt et al., 2010), that reflecting performance in learning and processing new material and comprising perceptual speed and reasoning abilities tends to decline substantially over the adult lifespan (Verhaegen and Salthouse, 1997).

Cognitive decline was measured considering the differences between the scores in the first and in the second wave[4], separately for each of the five indicators of ability measured for individuals aged 65 or over. Thus, separate multivariate analyses, in which the differences at ability level are the response variables, are used.

The key independent variable is the living arrangement, and, in particular, whether the individual live alone or with the partner (only). Individuals living with children (with or without a spouse) are also considered[5]. This category is mainly represented by elderly living with their children only, a condition extremely rare in some European countries leading to the impossibility to be distinguished from the presence of the partner only. More precisely, we refer at Sweden (only 8 cases), Denmark (11 observation) and the Netherlands (26 observation). Because of the small sample size, the results concerning people living with children in these three countries are not robust. In addition, the baseline cognitive functioning (measured at wave 1, for each of the five

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

[4] In order to exclude greater declines in cognitive functioning as a result of very poor health, 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 are neglected), 1 for memory (543 observations are excluded), 0 for recall (1,219 individuals are not considered), and 1 for verbal fluency (870 observations are neglected). For sake of clarity, for verbal fluency we use a threshold the 5th percentile, instead of the 25th 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.

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

abilities) is considered: memory, recall, and verbal fluency at wave 1 are considered as continuous covariate, whereas orientation and numeracy are dichotomized[6]. This covariate 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 study whether the effects of living arrangements depend on the health of the elderly.

Other covariates included in the models control for factors which literature has revealed to be important for cognitive decline (see the review by Engelhardt et al., 2010) and which can be source of bias, being connected with living arrangement.

First of all, health is one of the most significant determinants of living arrangements: individuals living alone are probably those healthier. Besides the baseline cognitive functioning, health status is measured also considering the diagnosis of some chronic diseases (heart disease, stroke, and diabetes), the level of difficulty in performing eight Instrumental Activities of Daily Living (IADL), and the 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".

Similarly, other socio-economic and socio-demographic background factors should be taken into account. Socio-demographic factors include age, gender, and educational level. A measure of social involvement is also considered (being connected with better cognitive performance, see, for example, Engelhardt et al., 2010). Education was divided into three categories: low (illiterate or elementary), middle (secondary school), and high (high school or above). Social involvement is measured considering whether the respondent has undertaken at least one social activity[7] within the previous month before the interview. In addition, the household economic situation is, as well, accounted for through the household total net worth[8]. The differences in the number of household

[6] Respondents having a score in orientation less than 4 are distinguished from those with score equal 4; likewise, those having numeracy score of 4 or lower are distinguished from the others.

[7] Seven types of social activities are considered in the questionnaire: voluntary or charity work, care provided for sick or disable 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

[8] Following the definition used by other researches (see Avendano et al., 2009), this is "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).

members are considered by dividing wealth by the square root of household size (Avendano et al., 2009). In the following analyses, wealth is collapsed into quartiles.

Furthermore, we add geographical controls: both the region of residence 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, we control for the presence of individuals during the cognitive section of the interview both in the first and in the second wave of the survey.

b) Methodology of analysis

A different linear regression model is estimated for each country and for each ability. In these models, a potential selection effect, which should be kept in mind is due to the attrition. Respondents experiencing a heavier cognitive decline might experience an 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 alone or with the partner 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).

c) Re-test effect

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 that it constitutes a problem only for some of them. Therefore, we need 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 issues (Ferrer et al. 2004) although, given our data limitation (we have only two waves), none of these can be applied here.

Thus, we follow an alternative approach. Re-test effects are estimated using data from wave 2 and comparing cognitive abilities of individuals who have been interviewed also in the first wave with those of individuals who are interviewed for the first time (refresh sample), having net out the differences in term of observable characteristics via Propensity Score Matching (Rosenbaum and

Rubin, 1983). We assume that differences between these two groups – once they have been aligned in terms of background characteristics, are only determined by the re-test effect.

More in detail, we define as "treated" all the individuals who are observed for the second time in wave 2 (2006/2007)[9] 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" one. To this end, we stratify the sample by two dimensions (education and gender), thus generating 4 cells. We, then, aligned the cells according to the geographical region and to 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 sake of clarity, after having got rid the observables differences between the "treated" and the "controls", we regress the cognitive ability on year of birth, years of education, gender, geographical region and to the 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"). Results (see table 1 in appendix) show that there is a significant retest effect in many for all countries and in all countries this effect varies from one living arrangement to another. For example, in Sweden we find a significant re-test effect for people living alone while the same figure is negligible for people living in couple. 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, France and Germany, but it should be noted that in the last two countries the interview approach has changed from the first to the second wave (Blom and Korbmacher, 2011). For our purposes, it is interesting to show that for some countries and for some cognitive dimension no re-test effect has been found. This can make us more confident that regression of living arrangements on cognitive decline are biased by this issue. For example, in Sweden it seems that numeracy is not affected by re-test effect, so the effect of living arrangement, if any, on this outcome can be interpreted without worrying about re-test effect.

4. Analysing the influence between living arrangement and cognitive decline

As described above, cognitive decline was measured by the differences between the scores in the first and in the second wave at ability level. Results of multivariate analyses reported in Table 1

[9] 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).

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. When looking at the figures in Table 1, the bias introduced by re-test effect should be borne in mind, so coefficients which might be plagued by this problem (i.e. those referring to countries where a significant re-test effect has been found – see Table 1 in the Appendix) are reported in italics.

Our evidence is that living with the partner or a child might be a protective factor only in some countries and for some specific abilities.

In particular, for some countries there are not significant effects of living arrangements: in Austria, Denmark and Spain, living with others does not lead to a lower decline in any cognitive abilities in comparison with living alone (it should be noted, however, that for Austria and Denmark re-test effects might have had a role in determining this result). A similar effect can be observed in Germany and France, even if for memory and recall (for Germany) and for orientation (for France) the significance of the interaction term suggests a protective factor of living with the partner for elderly with higher baseline cognitive functioning.

Instead, living only with the partner implies a lower cognitive decline in comparison with elderly living alone in terms of some specific abilities in some other countries: in Belgium, in the Netherlands, and in Sweden. In particular, in Sweden a protective effect of living only with a partner is observed for numeracy, and, for recall, particularly for elderly with low recall (interaction term); a similar effect (stronger in case of low ability due to the significance of interaction terms) is found in the Netherlands for orientation and memory, and in Belgium, for memory. As an exception to the general trend, living with the partner implies a greater decline in verbal fluency in comparison with living alone in Italy. However, it should be noted that the net effect of living arrangement on cognitive decline is given by the sum of the main coefficient and the interaction terms, which appear to be significant and which go in the direction of decreasing verbal fluency decline. Thus, a protective effect of living with only their partners is observed for individuals with high cognitive function (in orientation or in verbal fluency) at the start.

As regards to co-residence with children, in some countries it has no effect on elderly cognitive decline; and this happens not only in Nordic countries (and Western ones) (such as Denmark[10], 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. In the Netherlands (for orientation and for elderly with low ability at start) and in Belgium (for numeracy),

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

a protective effect of living with children vis-à-vis living by themself has, instead, been observed. Again, the results for Italy appear to be in opposition to what we get for other countries: for verbal fluency, the protective effect of co-residence with children is found only for elderly with high cognitive function.

Table 1. ***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	1.04606	-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
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
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
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
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

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*
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
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

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.

5. Discussion and conclusion

The present work is the first attempt to explore the impact of living arrangements of the elderly on their cognitive decline within a European comparative perspective With respect to other studies on the topic, we make several contributions. We use detailed measures of cognitive functioning assessing specific cognitive domains, more precisely, orientation, memory, recall, verbal fluency, and numeracy. Most previous studies have focused, indeed, 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 some authors considered different types of cognitive ability (such as those connected with memory tasks, Mousavi-Nasab et al., 2012), and there are not studies including a more extensive cognitive test battery and focusing on specific cognitive domains. A further strength of the paper is that it considers the potential selection due to attrition. Lastly, the paper tries also to give a measure of 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.

The results have shown that living with the partner or a child is a protective factor only in some countries and for some specific cognitive abilities. In particular, living only with the partner implies

a lower cognitive decline in comparison with elderly living alone in Sweden for numeracy, and, for recall, particularly for elderly with low recall; a similar effect (stronger in case of low ability due to the significance of interaction terms) is found in the Netherlands for orientation and memory, and in Belgium, for memory. As regards the co-residence with children, a protective effect of living with children has been observed in the Netherlands for orientation and for elderly with low ability at start, and in Belgium for numeracy. An unexpected result refers to Italy, where living with others does not seem to be a protective factor: living either with the partner or with a child implies a greater decline for individuals with low verbal fluency in comparison with living alone.

Clearly, further studies are needed to study more in detail these aspects. Since in old age transitions in living arrangement as well as cognitive decline are very common, an analysis which takes into account also the changes in the living arrangements between the first and the second wave should be considered; although, the sample size does not allow to apply this approach. In addition, the definition of the living arrangement should be studied more in depth. For example, the conditions characterizing those living alone should be examined; similarly, the partner's conditions for elderly living with the partner and the motivation of co-residence with children for elderly living with their children should be considered.

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APPENDIX

Table 1. *Re-test effects in different abilities and countries according to the living arrangements (-- = 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)).*

	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
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
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	--	--	--	--	--
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**
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
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
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	--	--	--	--	--
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	--	--	--	--	--

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<0.1, ** p<0.05, p<0.01

To match the individuals we apply a 1:N matching, using as goodness of fit a caliper of 1%. In other words when the Propensity Score – between treated and controls – differs more than 0.01 the matching would be discarded.