Nursing Homes and Mortality in Europe: Uncertain Causality

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Abstract

The current health crisis has particularly affected the elderly population. Nursing homes have unfortunately experienced a relatively large number of deaths. On the basis of this observation and working with European data (from SHARE), we want to check whether nursing homes were lending themselves to excess mortality even before the pandemic. Controlling for a number of important characteristics of the elderly population in and outside nursing homes, we conjecture that the difference in mortality between those two samples is to be attributed to the way nursing homes are designed and organised. Using matching methods, we observe excess mortality in Belgium, France, Germany Luxembourg, Switzerland, Estonia and Czech Republic but no statistically significant excess mortality in Sweden, the Netherlands, Denmark, Austria, Italy or Spain. This raises the question of the organisation and management of these nursing homes, but also of their design and financing.

Keywords: Nursing homes, mortality, propensity score matching, SHARE

JEL codes: C21, I10, J14

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1. Introduction

With the current COVID-19 pandemic, one has discussed a lot the high mortality of elderly living in nursing homes. According to CIHI (2020), the number of COVID-related death in nursing homes during the first wave in spring 2020 represented about 66% of total COVID-related death in Spain, 48% in France, 34% in Germany and only 15% in the Netherlands. Although these numbers do not allow to draw any causal effect, it has been argued that due to the low quality of care and the physical proximity of nursing homes residents, life expectancy was lower than in private homes. This has pointed out that the differences across countries in terms of quality and the institutional features of the nursing homes could be an explaining factor of differential mortality observed in residential housing across European countries.

Using data from the Survey on Health, Ageing and Retirement in Europe (SHARE[6]), the aim of this paper is to determine whether there are excess mortality differences across countries depending on whether or not one is in a nursing home. Our analysis takes place in years before the COVID 19 pandemic in order to look at the effect of nursing home in normal times. We use propensity score matching in order to construct a sample in which treated (being in a nursing home) and untreated individuals (living at home) have similar characteristics in terms of age, gender, degree of dependence, state of health, availability of informal help (partner and children) and assets. We conjecture that, after controlling for the determinants of entry into a nursing home, the difference in mortality between those two samples is to be attributed to the way the nursing homes are designed and organised or alternatively to the quality of aid and services one finds staying home. This allows us to determine whether there is a causal link of being in a nursing home on the probability of death.

Excess mortality due to age, health or dependency should not be a cause for concern. It is a societal choice that induces senior citizens to end their life in nursing homes. We could reflect on this choice but it is not the subject of this paper. We argue that, if this excess mortality is due to the structure and organisation of nursing homes, then there is room for reform. It is difficult to distinguish between the two types of factors with SHARE data, because information on the characteristics of nursing homes, housing and staff is not available. We therefore start from the idea that each country has its own conception of what the specific objectives of a nursing home should be: care, entertainment, socialisation, ensuring privacy, etc. These objectives may vary from one country to another. Moreover, their achievement will depend on the resources that are devoted (average expenditure) and the more or less efficient way in which they are used (productive efficiency). We are well aware that we do not necessarily have data to evaluate these factors of "*design, spending and efficiency*", but if we have two comparable samples, one from individuals in nursing homes and one from individuals at home, comparing

[6] *This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6, 7 and 8 (DOIs: 10.6103/SHARE.w1.710, 10.6103/SHARE.w2.710, 10.6103/SHARE.w3.710, 10.6103/SHARE.w4.710, 10.6103/SHARE.w5.710, 10.6103/SHARE.w6.710, 10.6103/SHARE.w7.711, 10.6103/SHARE.w8cabeta.001), see Börsch-Supan et al. (2013) for methodological details.(1)*

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both could give some insights on the *mortality ratio*. If the nursing homes sample has a higher mortality rate, this excess mortality can be attributed to them without necessarily knowing which one is more important.

Although many studies have investigated the determinants of the choice of housing at old age as well as the quality of nursing homes, few studies have provided causal evidence on mortality (see the next section dedicated to a review of the empirical literature on this topic). One important aspect of our paper is to compare the situation in several countries and thus to identify institutional and organizational differences that may lead potential reforms. While the choice of housing at old-age is often driven by price and different individual characteristics (health status, daily life limitations, loneliness…), the predictors of nursing home entry may also be diverging across countries because of country-specific institutional alternatives (Angelini and Laferrère, 2012; Laferrère et al, 2013; Schmitz and Stroka-Wetsch, 2020).

Our results show an overall negative impact of being in a nursing home on life expectancy. Looking at European countries separately, we observe excess mortality in Belgium, France, Germany, Luxembourg and Switzerland but also in Estonia and Czech Republic. We also find no statistically significant excess mortality in Sweden, the Netherlands, Denmark, Austria, Italy and Spain. This allows to draw preliminary conclusions about potential differences in terms of the quality of these care facilities and the consideration given to nursing homes. Looking at possible mechanisms behind these results, we identify the role of public spending for long-term care and the overall resources devoted to nursing homes. Furthermore, the share of for-profit nursing homes in a country seems to be correlated with the effect on mortality. In order to confirm our matching empirical strategy and these results, we investigate the effect of the violation of the conditional independence assumption by simulating the effect of relevant unobserved confounders affecting both the treatment and the outcomes of interest. It results that the existence of such confounders is unlikely to affect the results.

After a quick review of the existing empirical literature in Section 2, Section 3 presents the data and the selected sample. Descriptive statistics are also presented. Section 4 presents the propensity score matching method used to overcome selection bias along with a sensitivity analysis performed to test the robustness of our estimation assumptions. Results are presented in Section 5 and Section 6 discusses the mechanisms that can explain the effect of being in a nursing home on mortality. It raises the question of the organisation (private vs public) as well as the role of these nursing homes. Section 7 concludes.

2. Literature review

This paper is closely related to the important literature that deals with long-term care (LTC) issues. Especially, as pointed by Spasova *et al.* (2018), LTC provision in Europe has been characterised by significant differences between (and within) countries, mainly in the way it is organised (by public, for-profit or non-governmental providers), delivered (home care versus institutional care), financed (cash benefits, in kind benefits or out-of-pocket payments) and how resources are generated (via general taxation, mandatory social security and voluntary private insurance). One important question is how this care is provided. The role of informal care across Europe has been highlighted in extensive research (see Klimaviciute *et al.*, 2017 for a survey) and the substitution between formal and informal care has also been studied (Van Houtven and Norton, 2004; Bolin et al, 2008; Bonsang, 2009). In particular, previous findings suggest that

informal care substitutes for nursing home entry (Lo Sasso and Johnson, 2002; Charles and Sevak, 2005). Another issue that is directly related to our paper is that the place of residence is likely to have an impact on the type of care that is received by the elderly. Degavre and Nyssens (2012), by comparing Belgium, England, Germany and Italy, have shown that there are structural differences across countries in terms of the organisation of LTC received at home but also in institutions.

Several studies have tried to determine the factors that induce people to enter nursing homes. Using European data, Angelini and Laferrère (2012) and Laferrère *et al.* (2013) attempted to identify predictors of nursing home entry based on country-specific institutional alternatives. They point to the importance of functional limitations, the absence of partner or the low socio-economic status in the decision (or the need) to enter a nursing home. The impact of low assets on the probability of entering a nursing home has also been pointed out in the US context by Lindrooth *et al.* (1993) who also showed also that expectations about nursing home entry were reasonably close to the actual probability of entry. Using German data, Schmitz and Stroka-Wetsch (2020) find that the probability of choosing a nursing home depends on distance from home and price. However, they find no economically significant effect of reported quality on individuals' choice of nursing homes. In a recent study, using longitudinal data from SHARE, Laferrère and Arnault (2021) show that for given levels of health, disability, living arrangements and housing conditions, the more educated and wealthy individuals are less likely to move into a nursing home. This ex-post "objective check" corroborates the idea that the desire to "age in place" is the preferred option, as opposed to living in a community, such as a nursing home. The quality and the organisational structure of the nursing homes, that often diverge across countries and welfare systems, are also determinants in the choice of housing.

Our paper is also related to the literature dedicated to identify the factors of mortality or excess mortality, if any, within the nursing homes. Depending on the countries and the methods used, several authors show that co-morbidity is the main marker of mortality, while others point to the primary role of functional limitations. Both definitely play a role on mortality in nursing homes. Braggion *et al.* (2020) pointed out that the first months after admission represent a period at high risk of mortality, especially for patients with a recent hospitalization. The quality of the nursing home institutions has also been pointed out for its impact on mortality. Using a sample of California nursing homes, Antwi and Bowblis (2018) have shown that the nursing turnover has a positive effect on mortality. Lin (2014) also showed that nurse staffing has a large and significant impact on the quality of care and thus on health outcomes. Recently, Cronin and Evans (2020) highlighted the role of quality of the nursing home institutions on mortality during the pandemic. Quality does not predict the ability to prevent any resident or staff COVID-19 cases, but higher-quality establishments prevent the spread of resident infections conditional on having one. Studies on the link between respiratory illnesses and mortality in nursing homes did not originate with COVID-19. Using a population-based national survey in US nursing homes, Beck-Sague *et al.* (1993) have demonstrated that residents with pneumonia were more likely to die than those with other infections. They also pointed out that lack of mobility (functional status) is a risk factor, as does Sung (2014) who also highlights the role of the dyspnea for elderly Korean people. The role of respiratory diseases on mortality in nursing homes and co-morbidity in general is clarified and debated in various research studies (Sung, 2014; Levy *et al.*, 2015; Falcone *et al.*, 2018).

Our research goes one step further and seeks to determine whether there is a difference in mortality due to the very fact of being in a nursing home. There is relatively limited research on the specific issue of the role of the institutionalization on potential excess mortality. Based on longitudinal French data on people aged 60 and more, Giudici *et al.* (2019) have estimated that people living in institutions live on average 10 years less that those living in private households. However, they did not take into account the potential issue of endogeneity, as people in nursing home differ from people staying at home. On the contrary, relying on Dutch administrative data, Bakx et al. (2020) found nil impact of being in a nursing home on mortality, although with large heterogeneity of effects among the population. Also, they do not observe a decrease in financial costs if care is provided at home rather than in a nursing home (especially following hospital admissions). Aging-in-place policies would come at the cost of increased curative care, especially hospital admissions, but would not reduce total healthcare spending, suggesting they may not be a win-win after all (when compared to the costs incurred in institutions).

3. Data & descriptive statistics

The Survey of Health, Aging and Retirement in Europe (SHARE) is an international, interdisciplinary and longitudinal survey of people aged 50 and over. About 380,000 in-depth interviews with 140,000 people aged 50 or older from 28 European countries and Israel have been conducted. Every two years since 2004, the questions relate to the health status (objective and subjective) of the respondents and their potential spouses, as well as to the economic and social situation of the household, including relations with their children and close relatives.

In this paper we use the last four waves 4, 5, 6 and 7 of the survey because it has been specifically designed to include nursing homes residents since wave 4[7]. The nursing home is clearly defined in SHARE: "*A nursing home provides all of the following services for its residents: dispensing of medication, available 24-hour personal assistance and supervision (not necessarily a nurse), and room & meals*". Because our research question is to determine whether there is a causal link from being in a nursing home on mortality, our sample is composed of people for whom we have information on the place of residence at time *t* but also on the status (alive or dead) at time *t+1*[8]. We thus look at the transitions from wave 4 to wave 5, from wave 5 to wave 6 and from wave 6 to wave 7 and in our analysis we pool these transitions together. Because the health status and the choice of housing may be simultaneously determined, we restrict our sample of analysis to individuals aged 65+ who present at least one limitation in activities of daily living (ADL)[9]. The use of ADL limitations for defining our

[7] Nursing home residents have always been eligible to participate in SHARE. Interviewers began to register the respondents' place of residence as either a private or a nursing home since wave 2 of the study. However, since the wave 4, it was decided to allow sample (refreshers) also in nursing homes residents to participate, not only after a transition but as a first participation (refresher sample) to the survey. The questionnaire is adapted. Sampling of nursing home residents is not compulsory but and in particular only a few countries recording undercoverage by design.

[8] The successive waves of SHARE are not taking place every year. There is an average of two years between each interview so that, here, t+1 should be understood as wave + 1. The distribution of the sample in terms of transition is as follows: 29.1% from wave 4 to wave 5, 37.0% from wave 5 to wave 6 et 33.9% from wave 6 to wave 7.

[9] A person is usually considered dependent if two or more difficulties in performing the following daily tasks (ADLs) are met: 1) dressing, including putting on shoes and socks; 2) walking across a room; 3) bathing or showering; 4) eating, such as cutting up your food; 5) getting in or out of bed; 6) using the toilet, including getting up or down. We decide to deviate a little from this threshold and to consider people with at least one limitation.

sample has two main advantages. First, these are rather objective measures of dependency that can be controlled by the survey interviewer. Second, by taking a measure of physical limitations, we focus on a factor that may explain the difference in use of a nursing home or not.

We also drop countries for which the time frame "*t / t+1*" is not respected (Hungary for instance) or because there are too few observations in nursing homes. We have made an arbitrary choice to eliminate those countries for which, once the observations had been pooled, fewer than 25 survey participants were registered in nursing homes. This is the case for Greece (2), Poland (3), Croatia (4), Portugal (19), Slovenia (22) and Israel (25). The resulting data set contains 13,340 observations among which 863 observations correspond to individuals living in nursing homes. Let us add that the rate of nursing home residency in SHARE is close to what we can observe in the general population[10]. Based on the European Census of 2011 (Eurostat, 2016), Schanze and Zins (2019) have shown the share of individuals residing in nursing homes in SHARE is close to the share of institutionalized residents in the general population. Table 1 summarises our sample selection in each country, restricted to people aged 65+ and dependent at time *t*. The grey areas in the table illustrate the absence of the SHARE survey for the country and the wave concerned.

Table 1: Waves, original data and selected sample

		W4	W5	W6	W7	Pooled Obs. of 65+ & 1 ADL at time *t (#)*	NH if 65+ & 1 ADL at time *t (%)*
North	Denmark	x	x	x	x	566	16.4
	Netherlands	x	x			200	8.5
	Sweden	x	x	x	x	760	10.1
Central	Austria	x	x	x	x	1018	6.7
	Belgium	x	x	x	x	1708	11.6
	France	x	x	x	x	1236	6.7
	Germany	x	x	x	x	823	6.1
	Luxembourg		x	x	x	164	16.5
	Switzerland	x	x	x	x	417	9.1
South	Italy	x	x	x	x	1134	1.8
	Spain	x	x	x	x	1761	4.4
East	Czech. Rep.	x	x	x	x	1331	5.4
	Estonia	x	x	x	x	2222	1.9
All						13340	6.5

[10] In our data, there is some heterogeneity in European countries in terms of the use of nursing home-type institutions (from 0.4% of the 65+ in Italy to more than 4% in Luxembourg). On average, 1.6% of the 65+ population is a nursing home resident. The reasons for entering in a nursing home (care, entertainment, socialisation, ensuring privacy, etc.) may vary from one country to another. A first glimpse at the people with at least one daily limitation and living in nursing homes shows the variation in the actual design of the nursing home across the different European countries. We observe, for example, that only 42% of Dutch residents in nursing home have at least one limitation while this number climbs to more than 80% in Denmark and Spain (the sample average is 66%). Appendix A.1. summarizes information about gross data (before restriction to people aged 65+ and having at least one limitation in activities of daily living) and representativeness of nursing homes respondents' samples.

When we look at our sample of elderly with at least one limitation, we observe differences in the rate of nursing home residency: while only 1.8% of Italians reside in a nursing home, more than 16% of Luxembourgians or Danes are registered in institutions. More than 10% of the Belgians and Swedes in our sample are also in nursing home. On average, 6.5% of the respondents in our sample are in nursing homes.

Table 2 provides a description of our two main variables of interest, i.e., living in a nursing home (as defined previously) or at home at time *t* and being alive or not at time *t+1*. In total, we observe a probability to die of 20.2% in *t+1*. However, this rate hides very different situations according to the place of living with 41.5% of the elderly living in a nursing home being dead in *t+1* while it is 18.8% of the elderly living at home. When we look at countries separately, we note a variation both in terms of general mortality (from 11.5% in the Netherlands to 25.4% in Spain and 26.3% in Denmark) but also in terms of mortality conditional on housing type. It is interesting to look carefully at the *mortality ratio*, which is the proportion of people who died while in nursing over the proportion of people who died at home. This varies between 1.0 in Italy and almost 3.6 in Switzerland, for an average value of 2.2 in our sample.

Table 2: Mortality rates ratio in SHARE countries

		Deceased at time *t+1 (%)*			
		Both NH & AH at time *t*	Nursing Home at time *t*	At Home at time *t*	*Mortality ratio* (NH/AH)
North	Denmark	26.3	46.2	22.4	2.1
	Netherlands	11.5	29.4	9.8	3.0
	Sweden	19.6	48.0	16.4	2.9
Central	Austria	19.4	33.8	18.4	1.8
	Belgium	19.1	42.4	16.0	2.6
	France	17.3	42.2	15.5	2.7
	Germany	19.7	44.0	18.1	2.4
	Luxembourg	20.1	40.7	16.1	2.5
	Switzerland	15.3	44.7	12.4	3.6
South	Italy	19.6	20.0	19.6	1.0
	Spain	25.4	39.7	24.7	1.6
East	Czech Rep.	21.9	41.7	20.8	2.0
	Estonia	18.9	38.1	18.6	2.0
All		20.2	41.5	18.8	2.2

However, these first descriptive results need to be taken cautiously since they do not take into account the potential selection bias, i.e., that people in nursing home differ from people staying at home. Also, the sample sizes do not allow us to investigate heterogeneity within countries and the fact that the populations using nursing homes in Germany differ fundamentally from the Belgian or Spanish populations. It might be the case that depending on region, education or former occupation, these statistical trends diverge between countries because they are the result of different histories and institutional frameworks. However, the aim of our study is to assess if there is excess mortality in some countries and not in others and suggest reasons for it.

Table 3 summarises the information on the demographic and household variables according to the type of dwelling. We observe important differences on average between the two

subsamples. This also motivates the use of propensity score matching method to control for the differences between the two subsamples of dependent elderly and determine a potential impact of nursing homes on mortality. The table should be read as follows: among the people in nursing homes, 12.4% are between 65 and 74 years old, 7.6% have a partner and 38.5% have 5 to 6 limitations in their daily life activities. Most of residents of nursing homes are in the 1st tercile of wealth (these terciles have been created by country and by wave on the whole population present in the survey). 69.1% of nursing home respondents are women when they are only 60.4% at home residents. Besides, we note that women are more represented in our sample. They are 61.0%.

Table 3: Summary statistics of covariates (65 + and dependent)

		Both NH & AH at time *t (%)*	Nursing Home at time *t (%)*	At Home at time *t (%)*
Covariates				
Sex	Men	39.0	30.9	39.6
	Women	61.0	69.1	60.4
Age	65-74	34.0	12.4	35.5
	75-84	42.3	32.9	42.9
	85+	23.7	54.7	21.6
In couple	Yes	47.8	7.6	55.2
	No	52.2	92.4	44.8
Wealth	1st tercile	50.0	89.6	47.3
	2nd tercile	29.7	7.5	31.2
	3rd tercile	20.3	2.9	21.5
ADLs	1 or 2	67.4	41.1	69.2
	3 or 4	17.6	20.4	17.4
	5 or 6	15.0	38.5	13.4
At least one child	Yes	89.0	78.0	89.7
	No	11.0	22.0	10.3
At least two chronic diseases	Yes	81.4	75.1	81.8
	No	18.6	24.9	18.2
		100%	100%	100%
Observations		13340	863	12477

Finally, we notice and highlight the important role of children in the LTC issue and their status as informal carers. Indeed, people in nursing homes are less likely to still have a living child than those who remain at home (78% vs. 89.7%). These descriptive results are a good reminder of the role of family carers on help given at home. These carers are therefore essentially the partner, particularly the wife helping her dependent husband, and the daughter, helping her dependent parents and mainly her mother once she is widowed (see Canta *et al.*, 2021). Finally, differences in housing type between those with two or more chronic conditions and those without appear to be less important (75.1% in nursing home and 81.8% at home).

4. Methods

In order to evaluate the causal effect of nursing homes on mortality, it is important to control for the possible simultaneous determination of health and housing. This is why we select a sample of individuals aged 65+ who have at least one ADL limitation but, as presented in the

previous section, the characteristics of people in nursing homes can differ significantly from those still at home. Therefore, to control for the selection bias due to observables, we use a propensity score matching method. That is, every individual in a nursing home is matched to a set of individuals living at home with similar observable characteristics. It allows us to condition on sufficient observable information to obtain a counterfactual against which we can measure the effect of being in a nursing home[11].

Following the common terminology of the method, being in a nursing home is assimilated to being treated. We thus need to find individuals who are similar to treated individuals in terms of pre-treatment characteristics and are not in nursing home. The goal is to match similar individuals from the two groups so that the differences in outcomes of these matched pairs can then be attributed to the treatment, i.e. being in a nursing home. Our outcome of interest is the mortality at time *t+1* while the treated units are residents of nursing home and control units are people still living at home. The main advantage of the method is that it does not require specifying a functional form of the outcome equation and is therefore not susceptible to misspecification bias along that dimension. The matching method goes further since the idea is to compare two individuals who, based on observables, have a very similar probability of being treated, but one of them had received treatment and the other did not.

4.1. Propensity scores and matching

Our analysis relies on the conditional independence assumption (CIA) that the mortality of the individuals in the control group and in the treated group are independent of the residence status once we control for a set of observable characteristics. As shown by Rosenbaum and Rubin (1983, 1985), instead of conditioning the matching on the whole set of individual characteristics, it suffices to concentrate on a summary index, a balancing score. The most prominent balancing score is the conditional probability of selection into treatment, i.e. the propensity score of being into a nursing home.

To obtain propensity scores, we use Probit regressions where the dependent variable is being in a nursing home and covariates influencing simultaneously the fact of being in a nursing home and the probability of dying at time *t+1*, are gender, age categories, partnership situation, country wealth terciles, number of ADLs, the fact of having at least on child and the fact of suffering from at least two chronic diseases. As presented in the literature review, these are strong predictors of entering a nursing home[12]. The estimations of propensity scores are done for the total sample and for each country separately. Table A.2. in the Appendix presents the results, controlling for the different waves. Estimations achieve balance on covariates between treated and controls[13]. The probit regressions of residential status on covariates show that being

[11] See Imbens (2015) for a detailed presentation of the matching method or Angrist & Pischke (2008) for a popularized explanation.

[12] Other covariates could not be kept for two reasons. Either they invalidated one of the conditions of validity of the empirical method (i.e., including only covariates that influence simultaneously the treatment (nursing home) and the outcome (mortality) or they did not allow the balanced condition to be respected (for instance *education* when added to the seven selected covariates).

[13] If the balancing property is not satisfied, the treatment and comparison groups are unlikely to be sufficiently similar to reduce selection bias in your treatment effect estimate. Now, if we have a single unbalanced covariate in one block of a propensity score constructed from several covariates, we may still be able to proceed with the analysis. We met this issue of one single unbalanced covariate in 3 cases: for the "all countries" specifications, the variable *Wealth* was not balanced respectively for block 7 while for the "France" specification, the variable *Binary first wave* was not balanced for block 4. Finally, the variable *Chronic Diseases* was not balanced for block 1 in the

a woman, being wealthy, living with a partner and having at least a child or 2 chronic diseases is negatively associated with entering a nursing home. Being older or having a high number of ADL limitations increase the probability of residing in a nursing home.

As usual with matching analysis, there is a clear trade-off between bias and efficiency when it comes to choosing a matching algorithm. In our main analysis we match observations using the Kernell matching method with replacement. That is, weighted averages of individuals in the control group are used to construct the counterfactual outcome of the treated individuals. This method has the advantage of reducing the variance that is achieved since more information is used compared with other matching methods. However, it possibly uses observations that are not very good matches so in addition, as robustness checks, we also present in the Appendix estimates using nearest-neighbour, radius and stratification matching methods to compare our results to different matching methods.

4.2. Sensitivity analysis

The plausibility of the CIA relies on the possibility to match treated and control individuals on the basis of an informative set of observed variables. In order to assess whether our average treatment effects are robust to possible deviations from the CIA, we implement a simulated sensitivity analysis as proposed by Ichino et al (2008). The idea is to assume that the CIA is not satisfied given the considered observables but would be if one could observe an additional binary variable. This potential confounder can be simulated in the data and used as an additional covariate in combination with the matching estimator. By comparing the results obtained with and without matching on the simulated confounder, we can show to what extent the baseline results are robust to specific sources of failure of the CIA[14].

The assumption of the analysis is that the CIA no longer holds given the set of covariates X but it holds given X and an unobserved binary variable U. This means that as long as U is not observed, the outcome (i.e. the mortality) of the control individuals cannot be used to estimate the counterfactual outcome of the treated individuals. We assume that U may impact both the treatment and the outcome and that the distribution U can be fully characterized by four probabilities p_{ij} given the treatment T (being in a nursing home) and the outcome Y (being alive or not):

$$p_{ij} = \Pr(U = 1 | T = 1, Y = j)$$

with i,j $\in \{0,1\}$, which give the probability that U = 1 in each of the four groups defined by the treatment status and the outcome value. Given arbitrary values of the parameters p_{ij}, a value of U is attributed to each individual according to its belonging to one of the four groups defined by the treatment status and the outcome value. U can then be treated as any other observed covariate and is included in the set of variables used to estimate the propensity score and to compute the effect of the treatment (i.e. being in a nursing home).

The difference $d = p_{01} - p_{00}$ can be interpreted as a measure of the effect of U on the untreated outcome, and the difference $s = p_1 - p_0$ [15] as a measure of the effect of U on the selection into

"Italy" specification. The grey zones correspond to situations where all the people in nursing home are not in couple or only in the first tercile of wealth.

[14] See Nannicini (2007) for a detailed presentation of the simulation method.

[15] The expression p_1 and p_0 correspond to the probability of being treated (in a nursing home) given the value of U and controlling for the set of covariates W: $p_1 = \Pr(T = 1 | U = 1, W)$ and $p_0 = \Pr(T = 1 | U = 0, W)$.

treatment. As explained in Ito et al. (2018), one can define the selection effect Λ as the effect of U on the relative probability to be assigned to the treatment and the outcome effect Γ as the effect of U on the relative probability to have a positive outcome in the absence of treatment.

$$\Lambda = \frac{\frac{\Pr(T=1|U=1,X)}{\Pr(T=0|U=1,X)}}{\frac{\Pr(T=1|U=0,X)}{\Pr(T=0|U=0,X)}}$$

and

$$\Gamma = \frac{\frac{\Pr(Y=1|T=0,U=1,X)}{\Pr(Y=0|T=0,U=1,X)}}{\frac{\Pr(Y=1|T=0,U=0,X)}{\Pr(Y=0|T=0,U=0,X)}}$$

By measuring the two effects Γ and Λ, one can characterize the simulated confounder U. If Γ > 1(< 1), it means that the unobserved U positively (negatively) affects mortality. Similarly, if Λ > 1(< 1), it means that the unobserved U increases (decreases) the probability of being in a nursing home.

Ichino et al. (2008) propose two approaches to pick the parameters p_{ij}. One approach makes the assumption that the distribution of the unobserved variable U is similar to the empirical distribution of important binary covariates. We thus fix p_{ij} according to their values for a set of covariates used in the propensity score model. A second approach aims at searching for values for p_{ij} such that if U were observed, the estimated average treatment effect would be driven to zero. If the parameters leading to such a result can be considered unlikely, the exercise support the robustness of the estimates derived under the CIA.

5. Results

5.1. Effects of being in a nursing home

Table 4 presents the Average Treatment of the Treated (ATT) estimates for the total sample and for each country separately. We present the results according to the Kernell matching method but results obtained with other matching methods are presented in Table A.3. in the Appendix. Estimates are qualitatively similar when looking at the sample of 13 countries altogether.

Overall, the effect of being in a nursing home on excess mortality is positive and significant at 1% level. We find that for the 13 countries consolidated sample, elderly in a nursing home are almost 10.9 percentage points more likely to die in the next wave of the survey than those staying at home. The full sample mean is 20.2 implying an increase of about 54%. Although we test the validity of the CIA in the next subsection, we also looked at the effect of our various covariates on the ATT. Appendix A.4. shows how much each of the existing observables impact the treatment effect. The ATT is rather stable once we take into account several of our explaining variables; comforting us in our approach. However, these results may be misleading because they are potentially comparing very different population, e.g. an Italian and a Danish woman, who are known to live in different institutional situations. In the rest of Table 4, we present estimates for each country separately.

With the exceptions of Italy and Spain, in all countries, the individuals who live in a nursing home are more likely to die than those who are in their own home. However, these positive differences are only significantly different from zero in Belgium, France and Estonia at 10% level and in Luxembourg, Germany, Switzerland and Czech Republic at 5%. The highest effect is observed in Luxembourg and the lowest in Belgium. In Sweden, the Netherlands, Denmark and Austria but also in Spain and Italy, the estimated ATT is not statistically significant.

Table 4. Average Treatment Effects of the Treated (ATT)

		# treated	# control	ATT	Boot. S.E.
All		863	11455	0.109***	0.018
North	Denmark	93	427	0.056	0.067
	Netherlands	17	39	0.200	0.172
	Sweden	77	413	0.064	0.096
Central	Austria	68	514	0.051	0.067
	Belgium	198	996	0.083*	0.047
	France	83	430	0.112*	0.067
	Germany	50	314	0.211**	0.084
	Luxembourg	27	41	0.275**	0.130
	Switzerland	38	275	0.230**	0.095
South	Italy	20	826	-0.063	0.115
	Spain	78	807	0.033	0.060
East	Czech Rep.	72	790	0.122**	0.059
	Estonia	42	764	0.140*	0.083

Note: ***, ** and * stand for statistically significant at the 1%, 5% and 10% levels respectively.

These differences between countries will be further investigated in Section 6 but sample sizes do not allow us to investigate the heterogeneity of the effects within the countries[16]. It might be the case that depending on region, education or former occupation, the results presented above differ. However, in order to confirm these results, we conduct a sensitivity analysis such as presented in Section 4.

5.2. Sensitivity analysis

We conduct the sensitivity analysis suggested by Ichino et al. (2008) to test whether our results are robust to the violation of the CIA. Indeed, one may think of one unobserved variable that would simultaneously influence the decision to go into a nursing home (selection effect, Λ) and the probability to die (outcome effect, Γ). For example, actual informal care may influence simultaneously the decision to enter a nursing home and the health of the elderly. The former would be related to a selection effect and the later would have an outcome effect.

In order to investigate how sensitive our estimates are with respect to the possible existence of this unobservable variable, we perform two simulation exercises. In a first step, we simulate an unobserved variable which would have a distribution similar to the empirical distribution of important binary covariates. Table 5 presents the results for four binary covariates giving

[16] In addition, there are differences in the country analyses with the Nearest Neighbor method without replacement, but the sample sizes drop sharply as presented in Appendix A.3. Stratification matching method gives same results than the Kernell one.

important selection and outcome effects: being a woman, having at least one child, having at least 2 chronic diseases or having a living partner. This does not confound our results and the ATTs for the total sample are very close to the ones presented in Table 4. The selection effect and the outcome effects differ according to the simulations.

We also perform the same analysis for each country separately by simulating an unobserved variable which would have a distribution similar to binary covariates. Table A.5. in the Appendix presents the results for cofounder like being a woman, having one child and having at least two chronic diseases. The ATT is close to the baseline and overall, we find that any unobserved variable with similar treatment and selection effects as those three covariates already introduced in the propensity score matching do not confound our results.

Table 5. Sensitivity analysis: confounder-like and killer confounder

	Outcome Effect Γ	Selection Effect Λ	ATT
PSM (Kernell)	-	-	0.109
Confounder-like			
Being a woman	0.654	1.577	0.116
Having at least one child	0.965	0.401	0.106
Having at least 2 chronic diseases	0.919	0.674	0.108
Having a living partner	0.844	0.069	0.085
Killer confounder			
U' (d = 0.1 & s = 0.68)	1.725	30.062	0.031
U'' (d = 0.2 & s = 0.56)	2.343	16.518	0.015
U''' (d = 0.3 & s = 0.44)	3.516	9.713	0.019
U'''' (d = 0.4 & s = 0.32)	9.044	5.539	0.028

Table 5 presents also the results of the second simulation exercise where we look at a set of distribution parameters such that the size of the outcome and selection effect of the unobserved variable would kill our results. That is, we want to find parameters such that if the confounder were observed the estimated ATT would be driven to zero[17]. To reduce the dimensionality of the problem, we fix $p_{11} = p_{10} = 0.9$. Since these quantities are not expected to represent a real threat for the baseline estimate, they can be held fixed and the simulated confounder can be fully described by the differences *d* and *s*. We make *d* increase by 0.1 and let *s* being automatically estimated with respect to *d*. The values of *s* and *d* are associated with the estimated values of Λ and Γ, respectively. Table 5 displays some examples of outcome and selection effects for which our main result would disappear[18]. Results show that in order to find a effect of being in a nursing home on the probability to die that tends to zero, the potential confounder should have an outcome effect and a selection effect that are much higher than what we observe in the covariates distribution. In order to "kill" our results, the outcome and selection effects should be almost 10 and 15 times bigger which is very implausible.

[17] For the sake of simplicity, we do not present the second simulation by country but results by country are available upon request and give similar conclusions.

[18] For d = 0.1 and until s = 0.58, for d = 0.2 and s = 0.46 or for d = 0.3 and s = 0.34, we still observe a significant effect of being in nursing home on the probability of dying next wave.

6. Mechanisms

The difference in terms of causal effect of being in a nursing homes on mortality across countries is an important result. One may wonder what the mechanisms at work behind these effects are. Can we find country-specific channels or characteristics that might explain these results?

There are potentially several mechanisms behind those results. One may think of differences across countries in terms of level of general health but we already control for health level and individual limitations. Other explanations may consist of differences across countries as to long-term care such as for example the presence of informal care, the quality of the nursing homes or their access. Indeed, European countries are rather different in the way they organize the care of the elderly. Unfortunately, we do not have micro data on nursing homes that would allow looking in details for differences across countries. However, Table 6 reports aggregated indicators which shed light on differences across countries on formal and informal long-term care. Being careful about issues of reverse causation and thus without concluding of any causal effects, we present some empirical evidence that may be interpreted as supporting mechanisms behind the cross-country mortality difference in nursing homes.

Table 6 shows that countries from Central Europe in our sample, where the effect on mortality of being in a nursing home is the highest, present some specific features compared to the other countries.

Table 6: Information about Formal and Informal Care by country

	Formal LTC							Informal LTC	
	Public spending in LTC				Number of LTC workers per 100 individuals 65+	LTC beds per 100,000 inhabitants	Share of private NH for profit (%)	Share of population providing informal care (%)	Share of informal carers providing more than 20h care per week (%)
	% of GDP	Institutional care	Home care	Cash benefits					
Denmark	3.5	62.0	38.0	0.0	8.1	750	6.5[2]	15.2	8.1
Netherlands	3.7	51.0	16.4	32.6	8.0	1371	20.0	36.7	3.3
Sweden	3.3	52.6	44.7	2.6	12.4	1388	15.0	22.0	5.4
Belgium	2.2	62.5	26.8	10.7	4.8	1276	33.0*	11.6	15.0
France	1.9	69.6	24.8	5.6	2.3	981	22.0	14.1	10.5
Germany	1.6	35.7	23.5	40.8	5.1	1152	40.0	6.8	15.0
Luxembourg	1.0	63.8	35.6	0.6	7.9	1168	9.6[3]	6.2	17.8
Switzerland	2.4	82.9	17.1	n.a.	8.3	1170	40.0	n.a.	
Austria	1.8	49.1	9.9	41.0	4.1	865	21.0	8.1	19.0
Italy	1.7	28.2	19.5	52.3	1.9	416	22.0	5.8	40.5
Spain	0.7	50.2	25.9	23.9	4.5	830	53.0	11.5	52.9
Czech Rep.	1.5	57.0	15.4	27.5	2.3	687	3.0	4.6	33.3
Estonia	0.4	52.7	42.7	4.6	5.3	871	80.0	13.4	17.3

Note: Figures for the column "Private Nursing Home for profit" come from the European Network of Corporate Observatories (2021). When there is missing data, we use firstly STATISTA information (https://www.statista.com/statistics/1239811/distribution-of-nursing-home-care-beds-by-public-or-private-ownership/), indicated by the symbol "²", this is the case of Denmark. For Luxembourg, information is not available on STATISTA and data then comes from SPC and DG EMPL (2021), indicated by the symbol "³". For the other variables, data come from SPC and DG EMPL (2021) for countries from EU and from OECD (2021) or Office fédéral de la Statistique (https://www.bfs.admin.ch/bfs) for Switzerland. The data correspond to data collected between 2016 and 2019, prior to COVID.

In particular, they show a mix of low average public spending (from 1.6% of GDP in Germany to 2.4% in Switzerland), a low number of LTC workers per 100 individuals (particularly in France) and a large proportion of for-profit nursing homes (from 22% in France to 40% in

Germany or Switzerland). These figures tend to show a lower concern for the elderly, which could be associated with lower quality. On the contrary, countries of the North of Europe (Denmark, the Netherlands and Sweden) devote more resources to long-term care than the other countries. The Netherlands and Sweden have also the highest number of workers per 100 people over 65 years old and the highest number of beds per 100,000 inhabitants. These countries are also characterized by a small proportion of private nursing homes (less than 20% of the available supply). Without concluding as to any causal effect, these countries do not present excess mortality pertaining to being in a nursing home. Also, data on informal care in the Northern countries shows a high proportion of the population providing care but for a rather small number of hours; actually the smallest number of our sample. In these countries, help to the elderly is widespread but is rather a complement to formal care largely provided by public services (Klimaviciute et al., 2017).

In Italy and Austria, public spending (as a share of GDP) dedicated to formal long term care is similar to what we observe in Central Europe but with much more assistance in terms of cash benefits. Also, intensive informal support is widespread. The situation seems to be more heterogeneous in the East with the majority (80%) of nursing homes in Estonia being for profit, this associated with low state intervention (0.4% of GDP). Informal care is more intensive but less frequent in the Czech Republic than in Estonia.

One interesting finding from this exploratory analysis is the association between health outcome and the for profit status of the nursing homes. ENCO (2021) identified 14 private companies in the elderly care sector in Europe and provided an overview, country by country, of the institutional statuses of nursing home beds. Behind the considerable variation from country to country, they observe that the share of the for-profit sector is constantly growing. They show that in France, particularly in the field of nursing homes, the growth and internationalisation of national champions has been very rapid. For Germany, Europe's largest market, they explain that there are powerful groups that are mainly active at the national level and whose profits are exploding (ENCO, 2021). They underline the evils encountered in terms of practices in commercial care facilities: institutional abuse, lack of equipment and personal; exorbitant prices and priorisation of profit.

Future research should address this for profit/not for profit distinction on the impact of well-being or mortality, in line with Comondore et al. (2009) who suggested that not-for-profit facilities delivered higher quality care than did for-profit facilities. Unfortunately, our data from SHARE does not allow to identify for each resident the nature of the nursing home.

7. Conclusion

The current health crisis has highlighted the vulnerability of the society's most elderly people, whose numbers is expected to double by 2050 (OECD, 2019). One important finding from the COVID pandemic is the high number of COVID-related death in nursing homes and in particular the differences observed between countries. During the COVID pandemic, the structural shortcomings of the long-term care sector have become even more visible: care workers are under enormous pressure in often very difficult conditions and with limited support (OECD, 2020). This has had an impact on the management of the epidemic by exposing older people to additional risks (OECD, 2020; Chen *et al.*, 2020). On the basis of these observations

of excess mortality in homes during the pandemic period, we wanted to verify the pre-existence of this impression/trend.

Using the propensity score matching method, we constructed a sample in which treated (being in a nursing home) and untreated individuals staying at home have similar characteristics in terms of age, gender, degree of dependence, state of health, availability of informal help and assets. The goal was to determine whether there is a causal link in being in a nursing home on the probability of death. Our results indicate that overall, residing in nursing homes increases the probability to die earlier than staying at home. This hides important differences across countries with Germany, Switzerland, Belgium and France showing "deadlier" nursing homes than the other countries. One should note that this finding can be interpreted alternatively as indicating that staying home in these countries is a safer option than moving to a nursing home.

These results can be related to country-specific features of the long-term care. It appears that countries in which the mortality in nursing homes is higher are also the countries in which the public spending and the resources devoted to long term care are low. This does not allow to draw a causal conclusion but gives some hints on the mechanisms that would explain the mortality differential. Future research on the specific role of nursing homes should investigate the cross-country differences. It might be the case that some countries give more weight to the possibility of long-term care (and dying) at home surrounded by family. Where this is the case, one may expect that there will be less nursing homes and less dying in nursing homes than where less value is attributed to long-term care and dying at home.

The Covid-19 crisis has shown the extent to which older people staying in institutions were exposed when the virus managed to infect their nursing homes. This would only confirm, on a much larger (and dramatic) scale, the *mortality ratio* already observed previously in several countries between dependent people with similar characteristics being cared for in institutions or staying at home.

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Appendixes

A.1. Gross data and representativeness of nursing homes respondents' samples

		Pooled Obs. of 65+ (#) at time t	NH if 65+ (%) at time t	ADL if NH (%) at time t
North	Denmark	4743	2.5	81.2
	Netherlands	2785	1.5	42.9
	Sweden	6849	1.5	76.7
Central	Austria	6721	1.8	55.3
	Belgium	7550	3.8	70.2
	France	6663	1.7	73.7
	Germany	5413	1.3	73.5
	Luxembourg	1098	4.4	56.2
	Switzerland	4820	1.7	47.5
South	Italy	6824	0.4	74.1
	Spain	8993	1.2	81.7
East	Czech. R.	8009	2.0	44.2
	Estonia	10202	0.6	73.8
All		80670	1.6	66.0

A.2. Propensity score estimations

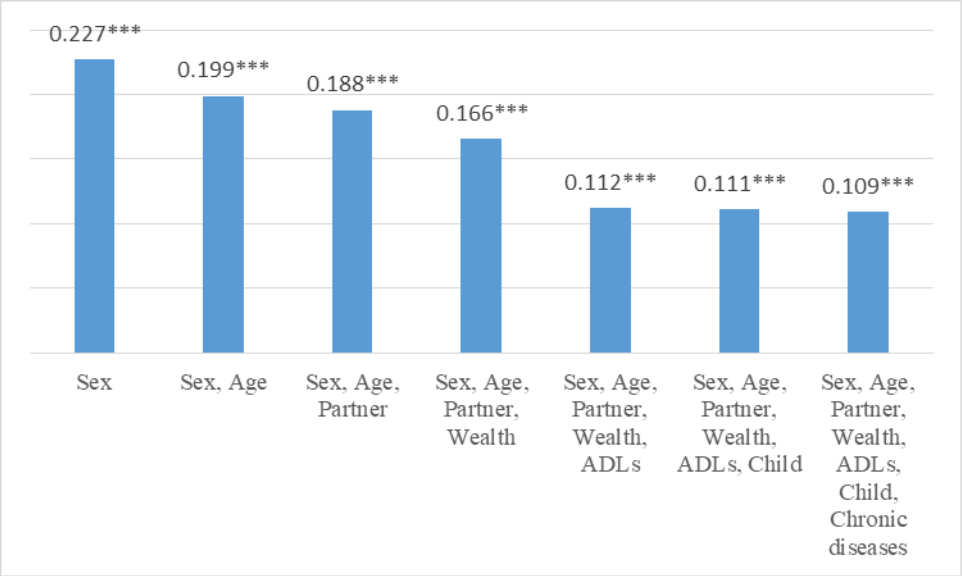
		Female	Age categories	In couple	Wealth terciles	# ADLs	At least one child	At least 2 chronic diseases	Pseudo-R^2
North	Denmark	=	+	-	-	+	=	=	0.29
	Netherlands	-	+	.	=	+	=	=	0.29
	Sweden	-	+	-	-	+	=	=	0.39
Central	Austria	=	+	-	-	+	=	-	0.28
	Belgium	-	+	-	-	+	=	-	0.35
	France	=	+	.	-	+	=	-	0.27
	Germany	-	+	-	=	+	-	=	0.34
	Luxembourg	=	=	.	-	=	=	=	0.09
	Switzerland	=	+	-	-	+	=	=	0.25
South	Italy	=	=	-	-	+	-	-	0.29
	Spain	-	=	-	-	+	-	=	0.32
East	Czech Rep.	=	=	-	-	+	-	=	0.24
	Estonia	=	+	-	.	+	=	=	0.29
All		-	+	-	-	+	-	-	0.28

Notes: The sign "+" or "-" means that the results are significant at the 95% threshold and go in the direction of the symbol. If the symbol is an "=", it means that there is no correlation established between the variable and being in a nursing home.

A.3. Robustness tests of Average Treatment Effects of the Treated with other algorithms

		# treated	# control	ATT	S.E.
ATT estimation with the Stratification method		863	11445	0.085***	0.019
ATT estimation with Radius Matching method		863	11445	0.204***	0.017
ATT estimation with the Nearest Neighbor Matching method		863	4301	0.094***	0.021
ATT estimation with the Nearest Neighbor Matching method by country					
North	Denmark	93	112	0.014	0.088
	Netherlands	17	19	0.225	0.160
	Sweden	77	66	0.126	0.121
Central	Austria	68	141	0.030	0.087
	Belgium	198	316	0.035	0.070
	France	83	137	0.104	0.100
	Germany	50	58	0.232**	0.103
	Luxembourg	27	15	0.185	0.171
	Switzerland	38	46	0.257*	0.134
South	Italy	20	27	-0.150	0.160
	Spain	78	155	-0.006	0.081
East	Czech Rep.	72	153	0.069	0.085
	Estonia	42	204	0.062	0.101

A.4. Addition of covariates and ATTs estimated (Kernell)



A.5. Sensitivity analysis by country: confounder-like

		ATT estimation with Kernell Matching method (bootstrap)								
		Confounder U = distribution woman			Confounder U = distribution one child			Confounder U = distribution chronic dis.		
		ATT	Out. Eff.	Sel. Eff.	ATT	Out. Eff.	Sel. Eff.	ATT	Out. Eff.	Sel. Eff.
All		0.116	0.654	1.577	0.106	0.965	0.401	0.108	0.919	0.674
North	Denmark	0.057	0.941	1.908	0.055	1.081	1.029	0.054	1.051	0.694
	Netherlands	0.182	0.524	0.989	0.195	1.563	1.344	0.182	1.329	1.248
	Sweden	0.066	0.800	1.112	0.064	0.925	0.401	0.069	1.152	0.900
Central	Austria	0.056	0.683	0.475	0.041	0.789	0.475	0.043	0.785	0.475
	Belgium	0.093	0.586	1.674	0.083	0.853	0.734	0.084	0.926	0.807
	France	0.112	0.795	2.445	0.112	1.337	0.516	0.107	0.847	0.823
	Germany	0.205	0.807	1.544	0.201	0.894	0.158	0.213	2.317	1.002
	Luxembourg	0.276	1.171	4.413	0.246	0.383	0.478	0.280	0.530	2.380
	Switzerland	0.282	0.456	4.180	0.240	1.485	0.518	0.240	1.002	1.335
South	Italy	-0.056	0.729	3.682	-0.107	1.059	0.098	-0.061	1.166	0.727
	Spain	0.041	0.577	1.310	0.029	1.109	0.199	0.034	0.799	0.798
East	Czech Rep.	0.134	0.712	1.807	0.125	1.011	0.375	0.129	0.715	1.272
	Estonia	0.134	0.514	2.790	0.110	1.036	0.354	0.103	0.673	0.387