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Population ageing and the public finance burden of dementia: A simulation analysis[1]

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Abstract

This paper uses long-term population projections to study the evolution of dementia in Luxembourg through 2070, as well as its impact on public expenditure through healthcare and long-term care. We extend the Giordana and Pi Alperin (2022) model by adding an algorithm to identify individuals suffering from dementia. This allows us to simulate dementia prevalence among individuals aged 50 and more in several scenarios incorporating alternative hypotheses about risk factors, new treatments and comorbidities (including long-run effects of COVID-19). Public health policies reducing stroke and hypertension risk could lower dementia prevalence by 17% and public expenditure on healthcare for dementia patients by a similar amount. A new treatment extending the mild dementia phase could nearly double prevalence and possibly triple the associated healthcare costs. Finally, past exposure to COVID-19 could raise prevalence by 12% to 24% in the medium term and public expenditure on dementia healthcare by 6% to 12%. Public expenditure on long-term care for dementia patients would increase even more, generally doubling by 2070.

Keywords: Dementia; Dynamic micro-simulation; Healthcare; Health-related public expenditure; Long-term care; Luxembourg; SHARE

JEL classification codes: D3; H30; I10; I12; I13; I18

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1 Introduction

Dementia represents a global health challenge that will continue to grow for decades to come (World Alzheimer Report, 2015). The progressive ageing of the EU population (21% aged over 65 in 2021; Eurostat, 2020) and the increase in life expectancy make dementia, a major contributor to disability among the elderly, one of the most prevailing chronic neurological disorders.

Dementia covers a group of symptoms associated with a progressive decline of brain functions, such as memory, understanding, judgement, orientation, language, comprehension, calculation, and learning capacity. The consistent feature of the dementia syndrome is that patients depend on caregivers as well as health services. Therefore, dementia has a significant impact on public expenditure for healthcare and for long-term care (Ganguli et al., 2005; Xie et al., 2008; Jönsson and Wimo, 2009). Public health policies that could limit the burden of dementia on public healthcare systems would contribute to ensuring the long-term sustainability of public finances.

To evaluate the social and economic burden of dementia for present and future generations, several studies have estimated the cost in different European countries (e.g., Scuvee-Moreau et al., 2002; Rigaud et al., 2003; Francois et al., 2004; Atance Martinez et al., 2004; Lopez-Bastida et al., 2006; Wolstenholme et al., 2002; Livingston et al., 2004). These studies covered the cost of formal care, i.e. resources used in medical settings (hospitals) and non-medical settings (nursing homes), as well as informal care given at home (including housework). Some studies focused on cost drivers in one specific year (e.g. gender, age, and dementia stage). Others concentrated on costs in the long- run. For instance, Meijer et al. (2022) estimated the direct and indirect economic costs attributable to dementia in eleven European countries using SHARE data. Braun et al. (2020) simulated the cost of dementia in Austria over a period of ten years, accounting for the severity and progression of the syndrome. Connolly et al. (2014) estimated the annual cost of dementia in Ireland in 2010 taking into consideration formal and informal care, medication and long stays in hospital and nursing homes. They found that almost half of total costs from dementia patients living within a community is attributable to informal care provided by family and friends. Using German data, Leicht et al. (2013) analysed the predictors of dementia costs, with the principal determinant being the impairments in instrumental and non-instrumental activities of daily life.

While most articles focused on the cost of dementia per patient, to our knowledge, this is the first study estimating the long-term effect of dementia on public expenditure for healthcare or long-term care. Such an effect depends, among other factors, on the evolution of dementia incidence. In the absence of a medical cure for dementia, the main way to reduce its incidence is to address underlying risk and protective factors (e.g., hyper-cholesterol, hypertension, diabetes, education, cardiovascular diseases) (Chen et al. 2009).

In this paper, we used micro-simulations to produce long-term projections for the prevalence of dementia in Luxembourg, as well as projections of total public expenditure on healthcare and long-term care for dementia patients. In Luxembourg, a small and wealthy country in Western Europe, more than 1.25% of the population is affected by dementia, which represents 20.6% of all beneficiaries of long-term care (IGSS, 2020). This share is projected to almost double through 2050 to reach 2.44% of the population, exceeding the average increase in dementia prevalence across European countries (Alzheimer Europe, 2019), while population is projected to grow 23%. To analyse the impact of dementia on public finances, we extended the model that Giordana and Pi Alperin (2022) developed to simulate trends in public expenditure on healthcare and on long-term care, by adding an algorithm to identify individuals suffering from dementia. We designed this algorithm to cover the entire spectrum of dementia severity, including the different stages of the syndrome. We then simulated the evolution of dementia prevalence among individuals aged 50 and more in scenarios reflecting different hypotheses about medical progress, risk factors and comorbidities (including long-run effects of COVID-19). In each scenario, we projected health-related public expenditure on patients suffering from dementia.

The remainder of the paper is organized as follows. Section 2 briefly presents the main characteristics of the dementia syndrome. Section 3 describes the data used in the paper, as well as the empirical model that served to run the simulations. The different scenarios analyzed and results are presented in Section 4. Section 5 provides a discussion and Section 6 concludes.

2 Dementia: characteristics and stages

Dementia is a clinical syndrome, with various causes, progressively leading to diffuse brain dysfunction. Dementia types are classified according to their pathogenic origins, mainly clinical presentation and progression, as well as etiology and age at onset. Among the different types, degenerative dementia due to Alzheimer's disease (AD) is the most common, accounting for around 60% to 70% of all cases (Fratiglioni et al., 2000). Non-degenerative dementias type include those dementias due to traumatic, endocrine, metabolic, nutritional, toxic, infective, and immunological causes such as vascular dementia, dementias due to Lewy bodies, and frontotemporal dementia. Other less frequent causes of non-degenerative dementia include Huntington's disease, Korsakoff syndrome, Creutzfeldt-Jakob disease, multiple sclerosis, motor neuron disease, acquired immunodeficiency syndrome, AIDS (Knopman et al., 2006). Lastly, SARS-CoV-2 infection has been suggested as a potential cause for dementia resulting from neurological damage (Azarpazhooh et al., 2020). Mixed forms often co-exist, e.g. AD and vascular dementia or AD and dementia with Lewy bodies (NICE, 2007).

The progression of dementia is marked by several stages, commonly allocated based on symptomatology. Comprehensive seven-stage descriptions are provided by the Global Deterioration Scale (Reisberg et al., 1982), based on cognitive decline, and by the Functional Assessment Staging Test (Sclan and Reisberg, 1992), based on the level of functioning and autonomy. Most health professionals focus on three phases: *mild dementia*, the early stage, during which individuals are still able to live independently and maintain a social life, sometimes using compensation strategies (e.g. post-it, phone notes). However, memory may start to decline in this phase (difficulty remembering words and names, more frequent misplacement of objects) and complex activities may reveal difficulties with planning, organizing and decision-making. This stage may also feature easy confusion, poor judgement capacity, and instable mood. In the middle stage of *moderate dementia* conditions worsen, with more severe memory loss (e.g. personal address, personal history), more severe confusion and wandering (loss of geographical references), difficulty to communicate and follow a conversation, important mood changes (e.g. agitation, aggressiveness, repetition of actions or words), depression and sleep disorders. This longest stage may require assistance with activities of daily living (shopping, housekeeping, cooking, personal hygiene, and dressing). Movement and coordination disorders increase the risk of falls. The late and more advanced stage of *severe dementia* involves extensive memory loss (family member names, meal beforehand, time period implying sometimes reversion back to childhood), and loss of autonomy (restricted mobility and communication, difficulties with basic body functions e.g. swallowing and bowel/bladder control). This stage requires continuous care and usually ends with the patient permanently confined to bed.[5] These three stages may not always be easily distinct, since the clinical manifestations of dementia evolve continuously over time, moreover the symptoms differ according to both the type of dementia and the individual patient. Mild dementia is estimated to last three years on average, moderate dementia lasts two to ten years and severe dementia can last up to five years.

Two kinds of risk factors have been highlighted for dementia (Livingston et al., 2020): “non-modifiable” ones, such as aging, family history, genetics, and “modifiable risk factors”, including diabetes, hypertension, hypercholesterolemia, obesity, physical inactivity, hearing loss, social isolation, brain injury, lower education level or low cognitive stimulation through life, as well as alcohol consumption.

Due to the multiple origins of the syndrome, research efforts have focused on treatment for dementia-causing diseases. Available pharmacological treatments usually slow the progression of symptoms (e.g. Acetylcholinesterase inhibitors, used in certain subtypes of dementia such as dementia due to AD, Lewy body dementia including dementia due to Parkinson’s disease; Colovic et al., 2013). Non-pharmacological treatments (i.e., cognitive behavioural therapy, memory training, animal assisted therapy) can also be used to slow the progression of symptoms.

However, in practice, it is difficult to effectively single out individual drivers. In fact, social features, living conditions, education, treatments or modulation of risk or protective factors all appear to influence this health condition. Our approach could contribute to disentangle the role of these elements.

[5] See https://www.dementiacarecentral.com/aboutdementia/facts/stages.

3 Data and methodology

In this section, we first briefly present the different data sources used to estimate and calibrate the parameters of the model and the different scenarios simulated. Second, we present the equations of the empirical model used in the simulations. Third, we present the algorithm used to identify individuals with dementia in each period. Finally, we describe how we computed health-related public expenditure.

3.1 Data

The core of this paper uses data from the Survey of Health, Ageing and Retirement in Europe (SHARE), Release 7.0.0 (Börsch-Supan, 2018), waves 5 and 6 collected in Luxembourg in 2013 and 2015. SHARE is a multidisciplinary cross-national panel survey studying the effects of health, social, economic, and environmental policies over the life-course of European citizens aged 50 years and older (Börsch-Supan et al., 2013). SHARE data is particularly well suited for health-related questions (O'Donnell, 2009). In Luxembourg, SHARE is representative of the resident population by gender and by age (Malter and Börsch-Supan, 2015). The sample includes 1563 respondents, of which 54.35% are women. Individual sample weights are applied to represent the whole resident population.

We also use data from the second SHARE Corona Survey conducted between June and August 2021. This survey specifically targets the living situation of Europeans who were 50 years and older during the pandemic (Börsch-Supan, 2022). Information related to SARS-CoV-2 infections and related hospitalizations were drawn from official data released by the Ministry of Health.[6]

To calibrate health-related activities and associated expenditure by gender, age, and disease, including the number of medical visits to general practitioners or specialists as well as the number of nights spent in hospital, we use data from Luxembourg's Ministry of Social Security (IGSS, 2020). Finally, the long-term simulations use demographic

[6] Available at https://data.public.lu/fr/datasets/donnees-covid19/

projections from EUROPOP2019 (Eurostat, 2020) and associated macroeconomic projections from the Central Bank of Luxembourg (Garcia Sanchez et al., 2021).

3.2 The empirical model

Based on a standard theoretical framework (Deaton, 1991), Giordana and Pi Alperin (2022) developed a dynamic model that allows individual economic decisions and health-related behaviour to affect long-term public expenditure on healthcare and on long-term care. This model, adapted to the specificities of the healthcare system in Luxembourg, links health-related public expenditure to individuals' health status. In particular, the model simulates the evolution over time of different health conditions such as diseases (e.g., hypertension, diabetes, Parkinson's, Alzheimer's, cancer, lung disease), limitations in daily activities (e.g., difficulties dressing, eating, taking medication, walking 100 meters), and symptoms (e.g., appetite loss, trouble sleeping, energy loss). These variables in turn, depend on individual health-related behaviour (smoking habit, alcohol drinking, physical exercise, and obesity) as well as individual demographic (age, gender), socio-economic characteristics (educational attainment, income, workforce participation and years of contribution to the pension system) and childhood circumstances (country of birth, parents' longevity, and financial situation during childhood). Model equations were estimated by combining micro data on individuals from SHARE with aggregate data from the Luxembourg Social Security system. Dynamic simulations were designed to match long-term demographic projections published by the European Commission and corresponding macroeconomic projections published by the Central Bank of Luxembourg.

Following Giordana and Pi Alperin (2022), in Equation (1), binary variable $I_{a,g}^{i}$ indicates whether health condition i affects an individual of age a and gender g. The probability that $I_{a,g}^{i} = 1$ depends on the individuals' health-related behaviour (vector $hb_{a,g}$), risk of comorbidities (vector O^{i}), demographic and socio-economic characteristics and childhood circumstances (vector X^{i}), and health status (variable Z^{i}). In total, the empirical model consists of sixty-one equations, one for each disease, limitation in daily activities, and symptom considered in the model. Each equation contains the same set of vectors with the same variables with a few exceptions. For instance, vector O^i varies across equations and incorporates deviance residuals estimated from probit regressions of Equation (1) for each equation in the system. Thus,

$$Pr\left(I_{a,g}^i = 1 \,\middle|\, X_{a,g}, Z_{a,g}, hb_{a,g}, O_{a,g}^i\right) = \tag{1}$$
$$= F_i\left(-u_{a,g}^i < X_{a,g}\beta_X^i + Z_{a,g}\beta_Z^i + O_{a,g}^i\beta_O^i + hb_{a,g}\gamma^i - \zeta^i\right). \quad \forall i \in \Phi$$

We assume that $u_{a,g}^i$ is a normally distributed random variable representing the source of risk with cumulative distribution function F_i and ζ^i a structural parameter (for more details see Giordana and Pi Alperin, 2022).

As an example, Appendix A reports the average marginal effects on the probability of suffering AD or a stroke, two core equations that matter for our simulation exercises. The nature of the data used in estimation means that results presented in the Appendix do not validate or invalidate any causal relationship, but only illustrate correlations existing in the data.

3.3 Identifying individuals with dementia

SHARE does not directly identify individuals suffering from dementia but only those with AD, so we extended the model by Giordana and Pi Alperin (2022) to include an algorithm identifying individuals affected by different types of dementia (degenerative, non-degenerative, and mixed). In particular, our dementia algorithm uses a two-step procedure. First, based on individuals' self-reported health records, the algorithm identifies individuals with different types of dementia. Among these, 76% suffer from degenerative dementia (70% of individuals suffer from AD and 6% are randomly selected among those who declared they suffer from Parkinson's disease for at least ten years) [7], 10% suffer from non-degenerative dementia (individuals who had a stroke or other cardiovascular disease), and 14% suffer from mixed dementia, a condition resulting from the combination of different types of dementia. In all cases, the algorithm randomly selects individuals

[7] These shares match those who declared having these diseases in the SHARE survey in 2015.

conditional on their health status, limitations in daily activities, cognitive results as well as their risk and protective factors.

The algorithm ignores several diseases because SHARE did not collect the necessary information: dementia with Lewy bodies, dementia due to Huntington's disease, HIV, Korsakoff syndrome, multiple sclerosis, Creutzfeldt-Jakob disease, and motor neurone diseases. Drug-induced dementia is not considered, as it is a reversible condition.

Second, based on limitations in daily activities (e.g., moving around the house) and cognitive results, our algorithm classifies each individual with dementia into one of the three severity stages: mild, moderate or severe dementia (see Section 2 and Appendix B). These individuals remain a maximum of three years in the mild dementia stage and a maximum of two years in the moderate dementia stage before moving to the severe dementia stage.

We implemented this algorithm in each simulated period to project the evolution of dementia prevalence and the annual health-related public expenditure for all patients affected by this syndrome.

3.4 Computing health-related public expenditure for patients with dementia

The literature focuses on several categories of health-related costs associated with dementia: direct medical costs (e.g., drugs, technical acts, visits to doctors); direct social care costs (professional home care as well as residential and nursing home care); costs of informal (unpaid) care; the opportunity cost of informal caregivers; and productivity losses associated with premature death or absence from work due to early dementia.

This paper focuses on health-related public expenditure paid by the Luxembourg Social Security System. In particular, direct medical costs paid by the *Health and maternity insurance* and the direct social care costs paid by the *Long-term care insurance* (henceforth, "public expenditure on healthcare" and "public expenditure on long-term care", respectively).

In practice, to compute public expenditure on healthcare, we assign each individual identified with dementia to a standard treatment that includes, depending on the stage of the syndrome, drugs, visits to general and specialist practitioners, and typical technical acts (medical imaging, electrocardiogram, Doppler echocardiography, and psychomotor rehabilitation). Public expenditure on healthcare also includes medical care, care provided by health professionals, treatments in hospital and out-of-hospital settings, laboratory analyses, medical imaging, physiotherapy, drugs, and rehabilitation targeting other health conditions affecting each dementia patient.

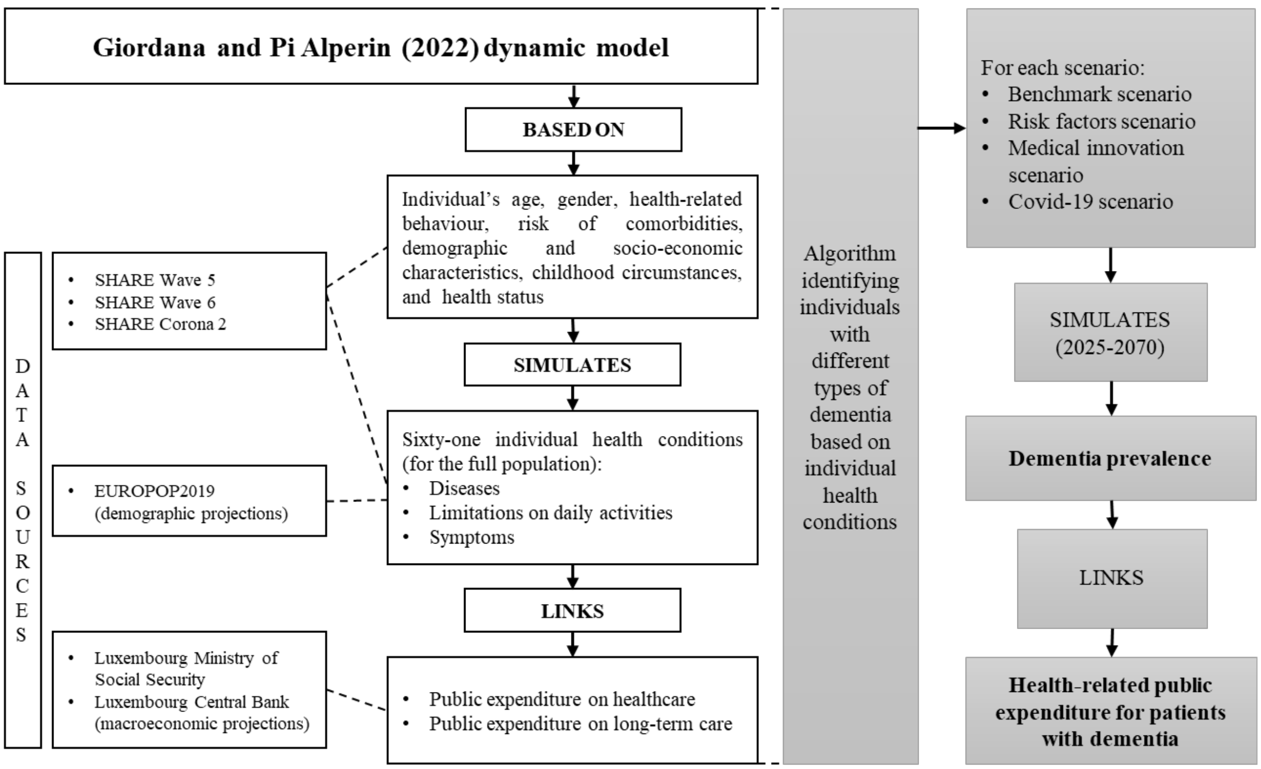


Figure 1. Data and Methodology.

Public expenditure on long-term care includes costs of aid provided by a caregiver to perform essential acts of daily life (personal hygiene, elimination, nutrition, clothing, and mobility). This was calculated using the separate algorithm in Giordana and Pi Alperin (2022), which mimics procedures used by the Luxembourg Social Security System. In addition to aid provided by caregivers at home for individuals with mild or moderate dementia, the algorithm assumes that individuals with severe dementia receive aid in nursing homes or residential homes. The algorithm was calibrated to find that 40% of individuals with dementia were in stage three in 2015, which is in line with official statistics from the Social Security Annual Report (IGSS, 2020).[8]

Figure 1 summarizes the methodology implemented, the different components of the model and the databases used to simulate, up to 2070, the prevalence of dementia and the total health-related public expenditure of individuals affected by this syndrome.

4 Scenarios and simulation results

From 2025 to 2070, we simulate the evolution of dementia prevalence among individuals aged 50 and more in Luxembourg and public expenditure on healthcare and long-term care for patients with dementia in a baseline scenario that focuses on population ageing, and four alternative scenarios.[9] The first of these is based on two main risk factors and comorbidities such as hypertension and stroke. A second alternative scenario simulates a medical innovation that delays the appearance of dementia symptoms. The last two scenarios focus on long-term consequences of the COVID-19 pandemic. These scenarios represent examples of the different factors that could have an impact in one of the two components of the dementia prevalence: the incidence and the average duration of the syndrome.

Following Giordana and Pi Alperin (2022), the benchmark scenario assumes that in every simulated period the prevalence of all the sixty-one simulated health conditions remains constant among those younger than 80, as well as among those who are older. This means that the prevalence of the different health conditions remain at the levels that the SHARE survey observed for these two subpopulations in 2015. The alternative scenarios maintain these assumptions from the benchmark, except the prevalence of AD that is allowed to evolve in line with an estimated version of Equation (1) (see Section 3.2 and Appendix A).

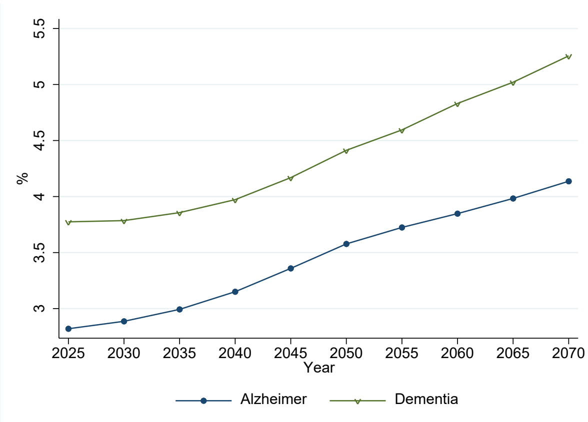
In addition, each scenario assumes that the unit cost of healthcare and long-term care provision increases at the same rate as *per capita* real Gross Domestic Product (GDP).

[8] Costs related to public expenditure on healthcare and long-term care were computed using the official rates in 2021.
[9] Henceforth, unless explicitly indicated, the dementia prevalence is measured relative to the population aged 50 years and more.

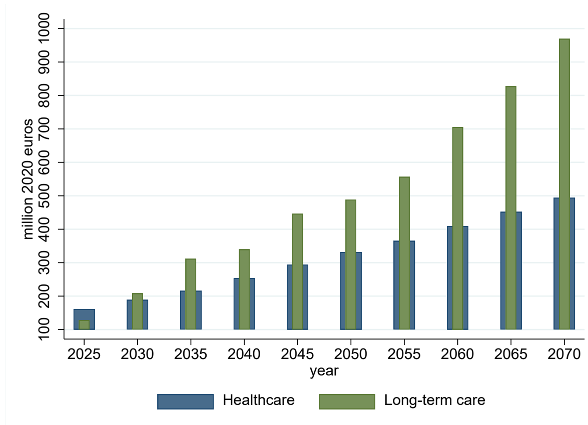
Finally, population growth and age structure match the baseline scenario of the EUROPOP2019 projections (Eurostat, 2020). These assumptions allow us to isolate the effect of demographic ageing on health-related public expenditure, while controlling for the evolution of individual health status and costs of producing health services.

4.1 Benchmark scenario

The benchmark assumes that the prevalence of dementia remains constant at 1.7% for individuals below 80 years old and 11.6% for those above this age. However, among those aged 50 and more, the prevalence of dementia grows from 3.8% in 2025 to 5.3% in 2070, while the prevalence of AD grows from 2.8% to 4.1% (Figure 2a). This only reflects the effect of population aging, as the demographic projection anticipates an increase in the share of the population above 80 years old (Eurostat, 2020).



(a) Prevalence



(b) Public expenditure on dementia patients

Fig. 2. Benchmark scenario: (a) Prevalence of Alzheimer's disease (AD) and dementia, (b) Public expenditure on healthcare and on long-term care for individuals affected by dementia.
Note: The benchmark scenario features the constant prevalence assumption for all the different health conditions simulated. Population growth and ageing explain the growth in prevalence of dementia and in related public expenditure.

Public expenditure on healthcare for individuals affected by dementia reaches 494 million euros by 2070 (0.5% of projected GDP) that is three times its value in 2025 and twice the GDP share in 2021. Public expenditure on long-term care for these patients reaches 969 million euros by 2070 (0.9% of projected GDP)[10], which is almost eight times its value in 2025 and nearly three times the GDP share in 2021 (Figure 2b). Considering

[10] To calculate the shares, we used Garcia Sanchez et al.'s (2021) GDP projections.

all health conditions, Giordana and Pi Alperin (2022) projected that between 2020 and 2070 public expenditure would increase by 1.2% of GDP for health care and by 1.8% for long-term care (3% overall), reaching 9.5% of GDP in 2070.[11]

Our projections of dementia prevalence in 2025 among the population aged 50 and more are aligned with those of Alzheimer Europe (2019). Luxembourg is among the least affected countries in Europe, along with Ireland (3.8%) and well below France (5.1%), Germany (4.9%) and Belgium (4.6%). In 2050, however, our projections of dementia prevalence are 1.2 percentage points below Alzheimer Europe's (2019), which projected Luxembourg at 5.6%. This difference reflects our use of more recent population projections.

4.2 Risk factors scenario: the role of comorbidities

The *risk factors scenario* evaluates the long-term effect of reducing the incidence of a modifiable risk factor such as hypertension and a comorbidity such as stroke.

Motivation

An increasing consensus recognizes the potential to reduce late-life dementia prevalence by addressing well-known risk factors in early life (Kivipelto et al., 2006; Exalto et al., 2014). Hypertension among the elderly is associated with higher occurrence of several forms of dementia (Kannel, 1999). Research conducted since 1960 identified hypertension as one of the major causes of vascular cognitive impairment and dementia (Waldstein, 1991; Gorelick et al., 2011; Elias et al., 2012). There is also increasing evidence that hypertension plays a role in the pathogenesis of AD (in't Veld et al., 2001; Faraco and Iadecola, 2013; Iadecola, 2013).

Cognitive decline can also be due to previous stroke(s) (Pendlebury and Rothwell, 2009). Several studies highlighted the causal role of symptomatic stroke on all-cause dementia. For instance, Savva and Stephan (2010) reported that stroke approximately doubles the risk of dementia in older adults.

[11] Using a different methodology, the AWG (2021) benchmark scenario projects a similar increase in public expenditure by 1.3% of GDP for healthcare and by 1.7% for long-term care (i.e. 3 percentage points of GDP).

Implementation

We simulate the outcomes of two different public health policies with both direct and indirect effects on dementia prevalence. The first policy eliminates the risk of stroke for all individuals over 80 years old, the age when dementia prevalence increases considerably. This policy outcome had a direct effect on the number of non-degenerative dementia cases and an indirect effect on the number of degenerative dementia cases (via its impact on the AD condition risk). The second policy eliminates the risk of hypertension for all individuals over 80 years old. This policy outcome has a direct effect on the number of degenerative dementia cases by affecting AD risk and an indirect effect on the number of non-degenerative dementia cases as hypertension is a risk factor for strokes.[12] Overall, the combined effect is non-linear and therefore, we focus on the total impact.

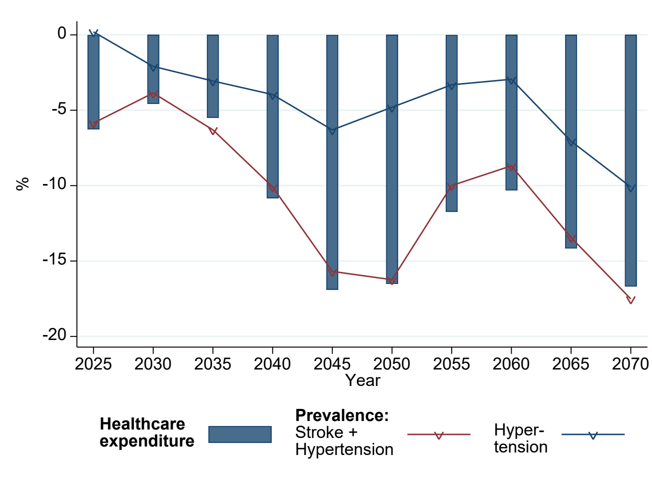


Fig. 3. Risk factors scenario: prevalence and public expenditure on healthcare, percentage changes relative to the benchmark.
Note: Compared with the benchmark, the risk factor scenario allows the prevalence of AD to evolve in line with an estimated version of Equation (1) and a lower risk of being affected by comorbidities for all individuals over 80 years old. Blue bars represent the reduction in annual public expenditure for healthcare of individuals affected by dementia. The lines represent the reduction in dementia prevalence.

Results

Not surprisingly, the prevalence of dementia declines over the simulated period (Figure 3). However, until 2060 at least, eliminating hypertension risk is less effective at reducing the prevalence of dementia than eliminating stroke risk. While the direct and indirect effects

[12] To simulate these policy outcomes, we shift $u_{a,g}^{i}$ to the left for $a \geq 80$ in Equation (1).

of the former lower the prevalence between 0% in 2025 and 10% in 2070, when eliminating both risks prevalence decreases between 6% in 2025 and 17% in 2070.

Public expenditure on healthcare for dementia patients would decline about 5% until 2035. After that date, it would decline more than 15%, representing a saving of 0.08% of GDP in 2070.

4.3 Medical innovation scenario: slowing dementia progression

The *medical innovation scenario* evaluates the long-term effect of an increase in the average duration of mild dementia resulting from an innovative treatment for AD. We assume that the treatment is widely adopted and fully reimbursed by public health insurance.

Motivation

So far, there is no cure for AD. However, in 2019, the U.S. Food and Drug Administration (FDA) granted accelerated approval for Aduhelm, a treatment that reportedly partially and temporarily alleviates some AD symptoms if administered sufficiently early.[13] Aduhelm is an antibody directed against the peptide amyloid beta, which is the main component of plaques found in the brain of individuals with AD. Despite controversy over the balance between benefits and safety, as well as the high cost for a year's treatment (56.000 US dollars or 56.000 euros), this medication represents a promising treatment for AD.[14] Similar medications could be developed in the near future.

Implementation

We introduce a new drug treatment by increasing the duration of the first stage of the disease. We assume the treatment is administered to all individuals the algorithm identifies as having mild stage AD. The treatment does not modify the prevalence of the disease but eliminates some symptoms and increases the duration of its first stage from two to five years, as well as increasing cost of treatment in this stage. Consequently, this scenario

[13] On December 16, 2021, the European Medicines Agency refused marketing authorization for Aduhelm over efficacy and safety concerns (Mahase, 2021).
[14] https://www.fda.gov/drugs/postmarket-drug-safety-information-patients-and-providers/aducanumab-marketed-aduhelm-information

increases life expectancy and changes the distribution of patients across stages of the disease.

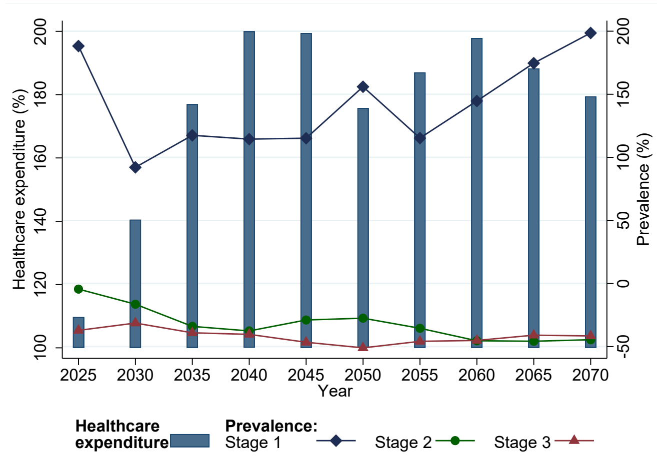


Fig. 4. Medical innovation scenario: prevalence and public expenditure on healthcare, percentage changes relative to the benchmark.
Note: Compared with the benchmark, the medical innovation scenario allows the prevalence of AD to evolve in line with an estimated version of Equation (1), a longer duration of the first stage (mild dementia) of the syndrome (right axis) and fewer symptoms. Blue bars represent the increase in annual public expenditure on healthcare for individuals affected by dementia (left axis) and lines represent the change in prevalence by dementia stage (right axis).

Results

Individuals in stage 1 of dementia would more than double with respect to the benchmark (with peaks close to 200% in 2025 and 2070), while the number of individuals in stages 2 and 3 would be halved (lines in Figure 4). If public health insurance covers the cost of treatment, public expenditure on healthcare for individuals with dementia would nearly triple between 2040 and 2070 (bars in Figure 4) reaching 1.3% of 2070 GDP.

4.4 COVID–19 scenarios: long-term consequences of infection

The *COVID-19 scenarios* assume a SARS-CoV-2 infection is a risk factor for developing dementia.

Motivation

An increasing number of studies have uncovered long-term consequences on individuals' health from a SARS-CoV-2 infection. In particular, Sharma (2021) suggested the pandemic may increase dementia prevalence in coming decades.

Studies have distinguished different potential links between previous SARS-CoV-2 infection and risk of developing dementia. First, Azarpazhooh et al. (2020) studied a link between dementia and SARS-CoV-2 infection based on neurological symptoms observed after infection. Ellul et al. (2020) found that between 2% and 5% of patients hospitalized with COVID-19 disease had a stroke. The resulting neurological damage could increase the risk of neurological disease, including additional stroke episodes and cognitive impairment (Heneka et al., 2020; Miners et al., 2020; Sharma, 2021).

A second link establishes dementia as a strong predictor for COVID-19 mortality (Atkins et al., 2020; Azarpazhooh et al. 2020; Bianchetti et al., 2020; Hwang et al., 2020; Mok et al., 2020). On the one hand, patients with dementia are more vulnerable to COVID-19 because they are unable to appropriately self-quarantine and maintain social distancing, in particular when living in long-term care facilities (Zimmerman et al., 2020). On the other hand, dementia and COVID-19 share several comorbidities and risk factors such as age, gender, hypertension, diabetes, and obesity, making these individuals more susceptible to develop severe COVID-19 symptoms (Miners et al. 2020).

Finally, a more recent study by the Feinstein Institute for Medical Research, based on 1.800 older adults hospitalized with COVID-19, found that patients who were taking psychotropic medication (for conditions like bipolar disorder, anxiety or depression) were almost three times more likely to develop dementia.

Implementation

There are three steps in this scenario based on the first link between dementia and SARS-CoV-2 infection. First, we estimate the number and profile of Luxembourg residents aged 50 and over who recovered from SARS-CoV-2 infection. We use official data on infections and related hospitalizations, covering 79,720 individuals of all ages who were infected between the start of the pandemic and October 14, 2021.

Second, we implement two separate scenarios. In the “mild link” scenario, 15% of those who recovered from infection suffer lasting neurological sequels. In the “moderate link” scenario, this share is 30%. We randomly selected individuals with neurological sequels among infected individuals from the first step who had risk factors such as hypertension, diabetes, cholesterol, and obesity. As the simulation progresses through time, we add younger individuals (as they reached 50) until we include all 79,720 individuals who recovered from infection.

Third, we assume that 30% of those with lasting neurological sequels would develop dementia at the age of 75 (Shively et al., 2012; de Erausquin et al., 2021; Douaud et al., 2022; Taquet et al., 2022).

Results

By 2050, the prevalence of dementia could be 12% higher than in the benchmark in the "mild link" scenario and 24% higher in the "moderate link" scenario (Figure 5). Public expenditure on healthcare for patients with dementia could be 6% higher than in the benchmark in the "mild link" scenario and almost 12% higher in the "moderate link" scenario. Between 2020 and 2070, SARS-CoV-2 infection could raise public expenditure on healthcare for dementia by 0.03 percentage points of GDP relative to the benchmark.

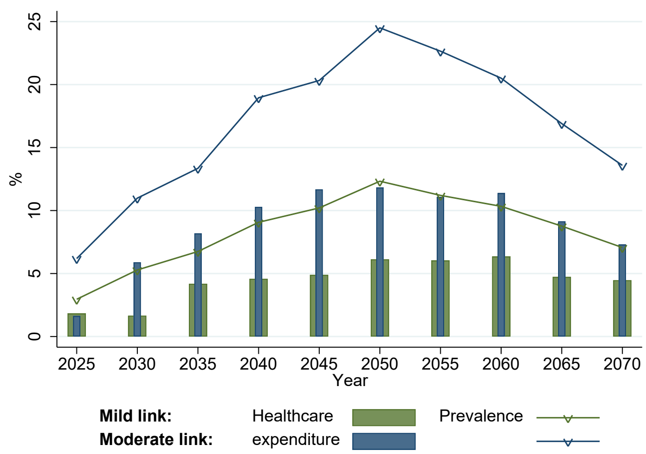


Fig. 5. COVID-19 scenarios: prevalence and public expenditure on healthcare, percentage changes relative to the benchmark.
Note: Compared to the benchmark, the COVID-19 scenarios allows the prevalence of AD to evolve in line with an estimated version of Equation (1) and a higher dementia risk following SARS-CoV-2 infection. The bars represent the increase in annual public expenditure on healthcare for individuals affected by dementia and the lines the increase in dementia prevalence.

4.5 Long-term care: beneficiaries and public expenditure in each scenario

Beneficiaries of long-term care may suffer from several concomitant conditions. However, those suffering from dementia will see their needs increase with the stage of the syndrome.

Our simulations show that the changes in public expenditure on long-term care are much stronger than for healthcare.

Under the risk factor scenario, the number of long-term care beneficiaries suffering from dementia in 2070 could be almost 70% lower than in the benchmark. As a result, total public expenditure on long-term care for individuals with dementia could decrease by almost 80% (Table 1).

Table 1: Long-term care for dementia - Percentage change in number of beneficiaries and in associated public expenditure

Percentage changes	Simulation periods									
	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
	Risk factors scenario									
Beneficiaries	-20.6	-16.6	-18.8	-35.9	-61.4	-66.4	-71.01	-58.7	-62.9	-67.4
Expenditure	-19.3	-27.1	-23.9	-40.1	-57.7	-67.6	-74.4	-69.6	-71.1	-78.7
	Medical innovation scenario									
Beneficiaries	22.3	64.1	86.9	108.2	87.9	72.8	177.2	217.9	155.1	115.3
Expenditure	20.9	62.1	66.8	84.4	67.9	52.7	146.1	197.9	145.1	108.7
	COVID-19 mild link scenario									
Beneficiaries	28.1	65.7	88.0	114.0	92.9	77.3	176.8	234.00	163.5	116.5
Expenditure	27.2	63.0	67.8	94.4	70.4	55.4	146.8	210.9	149.9	111.1
	COVID-19 moderate link scenario									
Beneficiaries	27.2	68.2	93.4	121.1	101.9	85.7	194.4	237.5	163.8	122.5
Expenditure	22.4	69.3	73.4	98.0	80.1	66.1	162.2	222.3	149.8	116.2

Note: The benchmark scenario features the constant prevalence assumption. The alternative scenarios allow the prevalence of AD to evolve in line with an estimated version of Equation (1). The risk factors scenario features a lower risk of being affected by comorbidities. The medical innovation scenario features a longer duration of mild dementia stage. The COVID-19 scenarios feature a higher risk of developing dementia following SARS-CoV-2 infection.

In the medical innovation scenario, the number of long-term care beneficiaries suffering from dementia would increase to a peak in 2060 about 218% above the benchmark (Table 1). Public expenditure on long-term care for patients with dementia would be 198% above the benchmark in the same year. In this scenario, dementia incidence is unchanged but the average duration of the mild stage is extended. However, the combination of longer life expectancy with dementia, demographic ageing and long-term care for other reasons than dementia raises the number of beneficiaries and the associated public expenditure on long-term care.

In the COVID-19 scenarios, the number of long-term care beneficiaries affected by dementia in 2070 would be 116% higher than in the benchmark under the “mild link” scenario and 122% higher in the “moderate link” scenario (Table 1). Public expenditure on long-term care for individuals suffering from dementia in 2070 would increase by 111% in the “mild link” scenario and by 116% in the “moderate link” scenario. The difference peaks in 2060, when the youngest individuals who were infected with SARS-CoV-2 during the first twenty months of the pandemic reach the age to potentially develop dementia.

5 Discussion

Population aging makes dementia one of the most important global public health and societal challenges for present and future generations. Finding solutions that limit the burden of the syndrome on health and social security systems has become a priority. Our results can contribute to identify efficient preventive strategies to reduce the incidence of dementia. In particular, by quantifying potential benefits our simulation results provide a cost maximum for public health policies to help ensure their efficiency.

The *risk factor scenario* highlighted that reducing the incidence of two well-known risk factors for dementia, such as hypertension and stroke, can lead to a substantial reduction of public expenditure on both healthcare and long-term care. From a public health policy perspective, campaigns to raise awareness, reduce smoking and improve diet can reduce the probability of stroke or hypertension, which could be an efficient way to decrease the impact of dementia on public finances. In particular, our simulations indicate that the present value of potential benefits could be as high as 6.67 billion euros in 2022 (11.5% of projected 2022 GDP), from which 778.7 million euros (1.3% of projected 2022 GDP) correspond to the reduction in public expenditure for healthcare.[15]

The *medical innovation scenario* exhibited mixed results. From a patient perspective, a new medication increasing the average duration of mild stage dementia would allow patients to live independently for a longer period, postponing the later stages

[15] To calculate the present value, we assumed: public expenditure on healthcare and long-term care for dementia evolves linearly between the simulated periods (e.g. 2026-2029, 2031-2034); a 2.5% discount rate; and a 2% annual real growth rate for Luxembourg GDP between 2021 and 2022 (BCL, 2022).

when assistance becomes inevitable. However, from a public finance perspective, such a treatment would considerably increase public expenditure on individuals with dementia. On the one hand, public expenditure on healthcare for patients in the first stage of dementia would increase relative to the benchmark, but public expenditure on long-term care would decline, as the number of beneficiaries affected by the more costly stage three dementia would be lower than in the benchmark. On the other hand, the aging process and longer life expectancy of patients with dementia would make long-term care necessary for other reasons frequently associated with age, limiting the gains from such an innovation. Our simulations pointed out a substantial increase of public expenditure on healthcare and on long-term care. Assuming a 2.5% discount rate, the present value of the increase in public expenditure is 23.9 billion euros (41.4% of projected 2022 GDP). Overall, the decision to extend public health insurance to cover this kind of treatment would require a more detailed cost-benefit analysis that accounts, in particular, for the social welfare gains of a longer mild dementia stage.

The *COVID-19 scenarios* warned that the pandemic could have long-term consequences. The number of individuals who have recovered from SARS-CoV-2 infection continues to increase with time. Evidence suggests COVID-19 might have consequences for the dementia prevalence in the future. Our simulation results report significant effects on the number of dementia patients and associated public expenditure, even though we only considered those infected during the first twenty months of the pandemic when collective immunity was probably the lowest. The simulations indicate that the present value of the additional public expenditure on healthcare could vary between 0.6% and 1.1% of projected 2022 GDP. In addition, the present value of additional public expenditure on long-term care could vary between 20% and 137% of projected 2022 GDP. From a public health policy perspective, limiting contaminations and continuing vaccination campaigns would not only reduce COVID-19 hospitalizations and severe cases, but may also reduce the number of future dementia patients.

Since our simulations covered a very long horizon, the traditional caveats apply. We assumed constant preferences and moderate productivity growth to focus on population ageing and its likely impact on average health status. However, supply and demand for healthcare and long-term care services could change substantially over the next fifty years.

For instance, medical innovations could provide cheaper and more effective substitutes for current treatments, as well as new (potentially) expensive treatments for dementia and other diseases included in the model. Income growth and changes in the income distribution could affect the demand for healthcare. New diseases (e.g., COVID-19) may alter health status trajectories over individual lifetimes and, of course, demographic projections are also subject to uncertainty.

6 Conclusion

In this paper, we use a micro-simulation tool to study the prevalence of dementia in Luxembourg between 2025 and 2070 and the evolution of public expenditure on healthcare and on long-term care for individuals affected by dementia. We propose four different scenarios reflecting alternative assumptions on the risk factors, medical treatment and other diseases at the origin of dementia. The paper quantifies the impact on public expenditure from the resulting changes in dementia prevalence.

The first scenario assumes that stroke and hypertension risks are eliminated for all individuals over 80, leading to a decline in the prevalence of dementia relative to the benchmark. Public expenditure on healthcare and on long-term care would diminish accordingly. In the second scenario, a treatment reducing the symptoms of AD, the principal cause of dementia, would alter the distribution of patients across stages of the syndrome, helping them to live longer. If public health insurance covers this treatment, public expenditure on long-term care would increase substantially as well as expenditure on healthcare. Finally, the last two scenarios assume that the COVID-19 pandemic will raise dementia prevalence in the long term. Based on infections in Luxembourg in the first twenty months of the pandemic, the associated public expenditure on healthcare and long-term care could double or even triple relative to the benchmark scenario.

Although the different scenarios do not consider all the risk and protective factors, the analysis can be easily adapted to other scenarios using the model calibrated to Luxembourg. From a public health policy perspective, our results could contribute to design preventive strategies to reduce the incidence of dementia. From an economic perspective, our results could contribute to identifying the priorities to limit the impact of an ageing population on public finances.

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Appendix A: Average marginal effects (AMEs)

Table A.1: AMEs on the probability of suffering a Stroke

Explanatory variables	Average AME	AMEs by age					
		50	60	70	80	90	100
Demographic characteristics							
Age	0.0006***						
Gender (RG♠: F)	0.0404***	0.0176***	0.0387***	0.0520***	0.0478***	0.0301***	0.0117***
Nationality (RG: Luxembourgish)							
Portuguese	-0.0478***	-0.0169***	-0.0403***	-0.0608***	-0.0640***	-0.0471***	-0.0219***
Other	-0.0446***	-0.0158***	-0.0376***	-0.0567***	-0.0597***	-0.0439***	-0.0204***
Health-related behaviour							
Alcohol consumption	0.0037***	0.0013***	0.0032***	0.0048***	0.0050***	0.0037***	0.0017***
No physical exercise	0.0099***	0.0035***	0.0084***	0.0126***	0.0133***	0.0097***	0.0045***
General health status							
Bad health status	0.0315***	0.0112***	0.0266***	0.0401***	0.0422***	0.0310***	0.0144***
Comorbidities							
Hypertension	0.0015***	0.0005***	0.0013***	0.0019***	0.0020***	0.0015***	0.0007***
Diabetes	0.0053***	0.0019***	0.0044***	0.0067***	0.0070***	0.0052***	0.0024***
Socio-economic characteristics							
Education level (ISCED-97) – Reference group Code 0							
code 1	0.0384***	0.0145***	0.0335***	0.0497***	0.0521***	0.0385***	0.0181***
code 2	-0.0011	-0.0003	-0.0009	-0.0014	-0.0015	-0.0010	-0.0004
code 3	0.0071***	0.0024***	0.0060***	0.0094***	0.0098***	0.0069***	0.0029***
code 4	0.0070***	0.0024***	0.0060***	0.0093***	0.0097***	0.0068***	0.0029***
code 5 + 6	0.0065***	0.0022***	0.0055***	0.0086***	0.0090***	0.0063***	0.0027***
Childhood circumstances							
Childhood financial situation (RG: Comfortable)							
Average	0.0092***	0.0032***	0.0077***	0.0117***	0.0123***	0.0090***	0.0041***
Poor	0.0088***	0.0031***	0.0074***	0.0112***	0.0118***	0.0086***	0.0039***
Variable	-0.0002	-0.0001	-0.0002	-0.0003	-0.0003	-0.0002	-0.0001
Parents longevity							
Father	-0.0003***	-0.0001***	-0.0003***	-0.0004***	-0.0004***	-0.0003***	-0.0001***
Mother	0.0001**	0.0000***	0.0001***	0.0002***	0.0002***	0.0001***	0.0001***
Observations	1542						

Notes: * p<0.05, ** p<0.01, *** p<0.001. ♠RG: Reference Group. F: Female; M: Male. The International Standard Classification of Education (ISCED-97) levels are: Level 0: Pre-primary education; Level 1: Primary education or first stage of basic education; Level 2: Lower secondary or second stage of basic education; Level 3: (Upper) secondary education; Level 4: Post-secondary non-tertiary education; Level 5: First stage of tertiary education; and Level 6: Second stage of tertiary education. AME for Having the Belgium, French or German nationality, Smoking, and Obesity could not be estimated because not enough observations in these groups.

Table A.1 lists the variables included in the vectors for Stroke as well as the associated marginal effects (AME) on the probability of having been affected by a stroke (henceforth, “stroke probability”). For instance, one year of aging raises the stroke probability by 0.0006 on average. Compared to women, being a man increases stroke probability in all ages by 0.0404 on average. Education attainment increases stroke probability at all educational levels but decreases on average in upper levels.

Table A.1 also shows that, on average, declining health[16], higher hypertension, diabetes, higher alcohol consumption, and less physical activity increase stroke probability. Compared with individuals with a comfortable financial situation during childhood, having an average and poor financial situation increases the stroke probability by 0.0092 and by 0.0088 on average, respectively.

Table A.2 lists the variables included in the vectors for AD as well as the associated marginal effects on the probability of having been affected by the AD (henceforth, "AD probability"). For instance, one year of aging raises the AD probability by 0.0011 on average. Compared to women, being a man increases AD probability for individuals younger than 80 years old (especially at 60 years old), but decreases it for individuals aged 80 and more. Education attainment beyond pre-primary education reduces AD probability by around 5 percentage points (ppts) on average. This value increases with age and is more important for men than for women at 60 years old and beyond.

Table A.2 also shows that, on average, declining health, higher hypertension, higher alcohol consumption, and less physical activity increase AD probability. Likewise, on average, risks of diabetes, stroke and obesity, reduce AD probability. Looking at the role of age and gender on AMEs, uncovers the effect of aging with the risk of diabetes and stroke increasing AD probability for oldest men and women. Table A.2 further shows that, for instance, a one point increase of the risk of stroke, raises AD probability by up to 12 ppts and 19 ppts respectively for individuals aged 90 and 100 but reduces it for younger.

[16] Individuals' health status was measure using the multidimensional approach of Pi Alperin (2016), which relies on the aggregation of several health conditions reflecting various aspects of mental and physical health into a synthetic health indicator.

Table A.2: AMEs on the probability of suffering from Alzheimer Disease

Explanatory variables	Average AME	Gender	AMEs by age 50	60	70	80	90	100
			Demographic characteristics					
Age	0.0011***							
Gender (RG♠: F)	0.0045***		0.000	0.002**	0.002	-0.017***	-0.036***	-0.051***
Nationality (RG: Luxembourgish)								
Portuguese	0.0027	F	0.001*	0.002*	0.003*	0.006*	0.006*	0.005*
		M	0.000*	0.001*	0.003*	0.007*	0.009*	0.008*
Other	-0.0035*	F	-0.002**	-0.002**	-0.004**	-0.008**	-0.008**	-0.006**
		M	-0.001**	-0.002**	-0.004**	-0.009**	-0.012**	-0.010**
			Health-related behaviour					
Alcohol consumption habits	0.0129***	F	-0.003***	0.001	0.012***	0.043***	0.066***	0.069***
		M	0.005***	0.010***	0.016***	0.013***	-0.010**	-0.032***
Physical exercise (absence of)	0.0156***	F	0.003***	0.008***	0.019***	0.047***	0.060***	0.056***
		M	0.002***	0.006***	0.014***	0.027***	0.035***	0.028***
Smoking habits	-0.0161***	F	0.008***	-0.001	-0.023***	-0.085***	-0.133***	-0.140***
		M	0.006***	0.010***	0.010***	-0.010**	-0.054***	-0.082***
Obesity (BMI>30)	-0.0050***	F	-0.001	-0.003***	-0.007***	-0.017***	-0.022***	-0.021***
		M	0.001***	0.002***	0.000	-0.012***	-0.031***	-0.039***
			General health status					
Bad health status	0.0428***	F	-0.017***	-0.002**	0.037***	0.148***	0.239***	0.254***
		M	0.010***	0.023***	0.042***	0.058***	0.038***	-0.002
			Comorbidities					
Hypertension	0.0013***	F	-0.022***	-0.021***	-0.015***	0.012***	0.057***	0.079***
		M	-0.001***	-0.002***	0.001	0.011***	0.028***	0.036***
Diabetes	-0.0069***	F	0.000	0.002***	0.007***	0.020***	0.027***	0.027***
		M	-0.009***	-0.019***	-0.035***	-0.044***	-0.021***	0.016**
Stroke	-0.0087***	F	-0.027***	-0.027***	-0.025***	-0.001	0.047***	0.075***
		M	-0.016***	-0.029***	-0.034***	0.008***	0.120***	0.196***
			Socio-economic characteristics					
Education level (ISCED-97) – RG: Level 0								
Level 1	-0.0446***	F	-0.026***	-0.033***	-0.057***	-0.087***	-0.076***	-0.056***
		M	-0.007***	-0.021***	-0.059***	-0.128***	-0.170***	-0.145***
Level 2	-0.0493***	F	-0.028***	-0.035***	-0.062***	-0.098***	-0.087***	-0.065***
		M	-0.008***	-0.024***	-0.065***	-0.140***	-0.188***	-0.160***
Level 3	-0.0543***	F	-0.030***	-0.038***	-0.068***	-0.109***	-0.100***	-0.075***
		M	-0.009***	-0.026***	-0.071***	-0.152***	-0.205***	-0.174***
Levels 5 + 6	-0.0573***	F	-0.031***	-0.040***	-0.071***	-0.116***	-0.109***	-0.082***
		M	-0.009***	-0.027***	-0.074***	-0.159***	-0.215***	-0.183***
Current job situation (RG: Retired)								
Employed / Independant	0.007*	F	0.002*	0.004*	0.007*	0.014*	0.015**	0.012**
		M	0.001**	0.003*	0.007*	0.015*	0.021*	0.018*
Disable	0.035***	F	0.016***	0.023***	0.039***	0.067***	0.065***	0.050***
		M	0.005***	0.015***	0.041***	0.088***	0.117***	0.099***
Housekeeper	0.006***	F	0.002***	0.004***	0.007***	0.013***	0.015***	0.012***
		M	0.001***	0.003***	0.007***	0.015***	0.020***	0.017***
Other	0.039***	F	0.019***	0.026***	0.044***	0.075***	0.072***	0.055***
		M	0.006***	0.017***	0.046***	0.100***	0.132***	0.112***
			Childhood circumstances					
Parents longevity								
Father / Mother	0.0003***	F	0.000***	0.000***	0.000***	0.001***	0.001***	0.001***
		M	0.000***	0.000***	0.000***	0.001***	0.001***	0.001***
Observations	1542							

Note: * p<0.05, ** p<0.01, *** p<0.001; ♠RG refers to the Reference Group; F refers to Female; M refers to Male. AME values for Father and Mother longevity are the same; AME for Education Level 4, Having the Belgium, French or German nationality, and Unemployed could not be estimated because not enough observations in these groups.

Appendix B: Stages information in SHARE on individual's mental conditions, orientation, cognitive functioning, and limitations on daily activities

<table>
<tr><td rowspan="5">Stage 1: Mild dementia</td><td rowspan="4">Orientation</td><td rowspan="4">Having difficulties to distinguish</td><td>Which month it is</td></tr>
<tr><td>Which year it is</td></tr>
<tr><td>What day of the week it is</td></tr>
<tr><td>Which day of the month it is</td></tr>
<tr><td colspan="2">Suffering from Depression</td><td>Suffering at least from five symptoms included in the EuroD scale</td></tr>
<tr><td rowspan="9">Stage 2: Moderate dementia</td><td rowspan="4">Orientation</td><td rowspan="4">Having difficulties to distinguish</td><td>Which month it is</td></tr>
<tr><td>Which year it is</td></tr>
<tr><td>What day of the week it is</td></tr>
<tr><td>Which day of the month it is</td></tr>
<tr><td colspan="2">Suffering from Depression</td><td>Suffering at least from five symptoms included in the EuroD scale</td></tr>
<tr><td colspan="2">Suffering from Anxiety</td><td>Doctor told the patient she/he had affective or emotional disorders, including anxiety, nervous or psychiatric problems</td></tr>
<tr><td rowspan="3">Having difficulties with these activities for more than three months</td><td colspan="2">Shopping for groceries</td></tr>
<tr><td colspan="2">Managing money, such as paying bills and keeping track of expenses</td></tr>
<tr><td colspan="2">Dressing, including putting on shoes and socks</td></tr>
<tr><td rowspan="16">Stage 3: Severe dementia</td><td rowspan="4">Orientation</td><td rowspan="4">Having difficulties to distinguish</td><td>Which month it is</td></tr>
<tr><td>Which year it is</td></tr>
<tr><td>What day of the week it is</td></tr>
<tr><td>Which day of the month it is</td></tr>
<tr><td colspan="2">Suffering from Depression</td><td>Suffering at least from five symptoms included in the EuroD scale</td></tr>
<tr><td colspan="2">Suffering from Anxiety</td><td>Doctor told the patient she/he had affective or emotional disorders, including anxiety, nervous or psychiatric problems</td></tr>
<tr><td rowspan="9">Having difficulties with these activities for more than three months</td><td colspan="2">Shopping for groceries</td></tr>
<tr><td colspan="2">Managing money, such as paying bills and keeping track of expenses</td></tr>
<tr><td colspan="2">Dressing, including putting on shoes and socks</td></tr>
<tr><td colspan="2">Using the toilet, including getting up or down</td></tr>
<tr><td colspan="2">Bathing or showering</td></tr>
<tr><td colspan="2">Eating, such as cutting up tour food</td></tr>
<tr><td colspan="2">Walking across a room</td></tr>
<tr><td colspan="2">Doing personal laundry</td></tr>
<tr><td colspan="2">Taking medication</td></tr>
<tr><td colspan="2">Cognitive functioning</td><td>Ten words list learning first trial
Ten words list learning delayed trial</td></tr>
</table>

Source: Information available in SHARE

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