COVER PAGE

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Short summary of current research activity: My academic career has centered on health economics, with a focus on developing and applying economic and econometric methodologies to evaluate health conditions, interventions, and healthcare technologies—especially those related to population aging. My main research lines to date include: i) evaluating the effects of functional decline and frailty (a reversible precursor to disability) on healthcare and non-healthcare resource use and quality of life in older adults; ii) quantifying the impact of prevalent conditions such as diabetes on resource utilization in older populations; iii) analyzing the effects of life shocks—such as widowhood or becoming an informal caregiver—on mental health, well-being, and quality of life in individuals over 50; and iv) studying the healthcare and non-healthcare costs of interventions from both methodological and empirical perspectives, assessing their broader societal impact.

Building on these lines, my emerging and short-term projects include: i) examining how endogenous shocks (e.g., political events) affect mental health, well-being, and resource use—supported by a Ramón Areces Foundation award in Social Sciences; ii) evaluating a Madrid-based public policy aimed at reducing social isolation and loneliness across age groups (younger and older adults), in collaboration with the Regional Department of Social Policies of Madrid (Spain); iii) assessing hospital interventions for older adults, focusing on red blood cell and iron transfusions, as part of a current collaboration with the Center for Health and the Social Sciences (University of Chicago); and iv) expanding the use of causal inference methods (e.g., regression discontinuity, difference-in-differences) in health economics and outcomes research, following up on some of my previously published work.

Description of the distinctive perspective contributed to the Summer Institute's research community: As a health economist trained and based outside of the U.S., currently at Complutense University of Madrid and presently a Fulbright scholar at the University of Chicago, I aim to bring a distinctive international and policy-oriented perspective to the Summer Institute's research community. My work bridges empirical rigor with real-world applications, addressing the pressing challenges of aging populations, health inequalities, and long-term care across different healthcare systems. This dual grounding in European and U.S. research environments has shaped a comparative lens that I believe can enrich ongoing conversations at the Summer Institute, particularly in sessions focused on health economics, economics of aging, public economics, and social determinants of health.

My current and emerging research intersects with themes of mental health, informal caregiving, and the economic impact of social policies, topics that are underrepresented but increasingly relevant in the broader economics literature. I also seek to contribute to methodological discussions through the application of quasi-experimental designs and cost-effectiveness analysis in health outcomes research, drawing on collaborations with both social policy departments in Spain and clinical research centers in the U.S.

What I hope to gain from the experience: By participating in the NBER Summer Institute, I hope to connect with researchers working at the intersection of aging, policy, and applied microeconometrics. I see the Institute as a unique opportunity to refine my research agenda (through any possible discussion on my emerging projects related to social isolation, transfusion practices in older adults, and the mental health effects of political shocks), spark new collaborations, and contribute to a more globally diverse and methodologically inclusive research community.

Summer Institute session(s) most interested in attending: SI 2025 Economics of Health, SI 2025 Workshop on Aging and SI 2025 Public Economics.

Curriculum Vitae

Contact Information

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Professional and work experience

- February 2025 – present: Fulbright scholar at the Center for Health and the Social Sciences, University of Chicago (US)
- September 2021 – present: Assistant professor at Universidad Complutense of Madrid, Madrid (Spain)
- September 2020 – August 2021: Lecturer and Researcher at the University Camilo José Cela, Madrid (Spain)
- August 2018 – August 2020: Researcher at the University of Castilla la Mancha, Spain.
- March 2017: Visiting lecturer at Universidad de Cantabria, Santander (Spain)
- January 2016 - currently: Visiting lecturer at Universidad Carlos III, Madrid (Spain)
- October 2015 – July 2018: Lecturer and Researcher in the University of Groningen, The Netherlands.

Education

July 2018: PhD in Economics, University of Groningen, The Netherlands. PhD title: "The economic approach to diabetes among older adults: A focus on European countries"

January 2015: MSc in Health Economics, University of York, United Kingdom.

July 2013: Degree in Business Administration and Management in Universidad Carlos III, Madrid, Spain.

Publications

Scientific articles in peer-reviewed journals

1. Mora, T., **Rodríguez-Sánchez, B** (2025). Diabetes diagnosis based on glucose control levels and time until diagnosis: a regression discontinuity approach to assess the effect on direct healthcare costs. *Health Economics Review*, 15, 26
2. **Rodríguez-Sánchez, B.**, Aranda-Reneo I, Mora T (2024). Effects of a nutrition education intervention on food-provision managerial decisions in Catalan old age nursing homes. *PLoS ONE* 19(12): e0310856.

3. Mora, T., Roche, D., & **Rodríguez-Sánchez, B.** (2023). Predicting The Onset Of Diabetes-Related Complications After A Diabetes Diagnosis With Machine Learning Algorithms. *Diabetes Research and Clinical Practice*, 110910.
4. Álvarez-Bustos, A., Carnicero, J. A., **Rodríguez-Sánchez, B.**, El-Assar, M., Rueda, R., Pereira, S. L., ... & Rodríguez-Mañas, L. (2023). Association between pulse wave velocity and frailty, disability, and mortality in community-dwelling older adults. *JACC: Advances*, 2(5), 100423.
5. Peña-Longobardo, L. M., **Rodríguez-Sánchez, B.**, & Oliva, J. (2023). Does becoming an informal caregiver make your health worse? A longitudinal analysis across Europe. *Economics & Human Biology*, 101264.
6. **Rodríguez-Sánchez, B.**, Daugbjerg, S., Peña-Longobardo, L. M., Oliva-Moreno, J., Aranda-Reneo, I., Cicchetti, A., & López-Bastida, J. (2023). Does the inclusion of societal costs change the economic evaluations recommendations? A systematic review for multiple sclerosis disease. *The European Journal of Health Economics*, 24(2), 247-277.
7. Álvarez-Bustos, A., **Rodríguez-Sánchez, B.**, Carnicero-Carreño, J. A., Sepúlveda-Loyola, W., Garcia-Garcia, F. J., & Rodríguez-Mañas, L. (2022). Healthcare cost expenditures associated to frailty and sarcopenia. *BMC geriatrics*, 22(1), 1-12.
8. Sanchez-Sanchez, J. L., Carnicero-Carreño, J. A., Garcia-Garcia, F. J., Álvarez-Bustos, A., **Rodríguez-Sánchez, B.**, & Rodríguez-Mañas, L. (2022). Physical performance measures in frailty screening: diagnostic and prognostic accuracy in the Toledo Study of Healthy Ageing. *Maturitas*, 165, 18-25.
9. Prieto, D. C., Pascual, M., & **Rodríguez-Sánchez, B.** (2022). Differences in the use of formal and informal care services among older adults after the implementation of the dependency act in Spain. *Hacienda Publica Espanola*, (240), 61-93.
10. Peña-Longobardo, L. M., Oliva-Moreno, J., & **Rodríguez-Sánchez, B.** (2022). The effects of severe acute respiratory syndrome coronavirus 2 on the reported mental health symptoms of nonprofessional carers: an analysis across Europe. *Value in Health*, 25(5), 736-743.
11. **Rodríguez-Sánchez, B.,** Peña-Longobardo, L. M., & Oliva-Moreno, J. (2022). The employment situation of people living with HIV: a closer look at the effects of the 2008 economic crisis. *The European Journal of Health Economics*, 23(3), 485-497.
12. Peña-Longobardo, L. M., **Rodríguez-Sánchez, B.**, & Oliva-Moreno, J. (2021). The impact of widowhood on wellbeing, health, and care use: A longitudinal analysis across Europe. *Economics & Human Biology*, 43, 101049.
13. Lopez-Bastida, J., Aranda-Reneo, I., **Rodríguez-Sánchez, B.**, Peña-Longobardo, L.M., Ye, X., Laeis, P., Fronk, E.M., Palmerini, E., Leithner, A., & Van de Sande, M.A.J. (2021) Economic burden and health-related quality of life in tenosynovial giant-cell tumour patients in Europe: an observational disease registry. *Orphanet Journal of Rare Diseases*, 16(1): 294.

14. **Rodríguez-Sánchez, B.**, Pascual Sáez, M., & Cantarero-Prieto, D. (2021). Dependent, Poorer, and More Care-Demanding? An Analysis of the Relationship between Being Dependent, Household Income, and Formal and Informal Care Use in Spain. *International journal of environmental research and public health*, 18(8), 4339.
15. **Rodriguez-Sanchez, B.**, Aranda-Reneo, I., Oliva-Moreno, J., & Lopez-Bastida, J. (2021). Assessing the Effect of Including Social Costs in Economic Evaluations of Diabetes-Related Interventions: A Systematic Review. *ClinicoEconomics and Outcomes Research: CEOR*, 13, 307.
16. Aranda-Reneo, I., **Rodríguez-Sánchez, B.**, Peña-Longobardo, L. M., Oliva-Moreno, J., & López-Bastida, J. (2020). Can the Consideration of Societal Costs Change the Recommendation of Economic Evaluations in the Field of Rare Diseases? An Empirical Analysis. *Value in Health*, 24(3): 431-442.
17. Duevel, J. A., Hasemann, L., Peña-Longobardo, L. M., **Rodríguez-Sánchez, B.**, Aranda-Reneo, I., Oliva-Moreno, J., López-Bastida, J. & Greiner, W. (2020). Considering the societal perspective in economic evaluations: a systematic review in the case of depression. *Health economics review*, 10(1), 1-19.
18. Rodríguez-Mañas, L., **Rodríguez-Sánchez, B.**, Carnicero, J. A., Rueda, R., García-Garcia, F. J., Pereira, S. L., & Sulo, S. (2021). Impact of nutritional status according to GLIM criteria on the risk of incident frailty and mortality in community-dwelling older adults. *Clinical Nutrition*, 40(3), 1192-1198.
19. **Rodríguez-Sánchez, B.**, Sulo, S., Carnicero, J. A., Rueda, R., & Rodríguez-Mañas, L. (2020). Malnutrition prevalence and burden on healthcare resource use among Spanish community-living older adults: results of a longitudinal analysis. *Clinicoeconomics and Outcomes Research: CEOR*, 12, 355.
20. Eggleston, K., Chen, B. K., Chen, C. H., Chen, Y. I., Feenstra, T., Iizuka, T., Lan, J.T.K., Leung, G.M., Lu, J.F.R., **Rodríguez-Sánchez, B.**, Struijs, J.N., Quan, J., & Newhouse, J. P. (2020). Are quality-adjusted medical prices declining for chronic disease? Evidence from diabetes care in four health systems. *The European Journal of Health Economics*, 1-14.
21. Mata-Cases, M., **Rodríguez-Sánchez, B.**, Mauricio, D., Real, J., Vlacho, B., Franch-Nadal, J., & Oliva, J. (2020). The association between poor glycemic control and health care costs in people with diabetes: a population-based study. *Diabetes care*, 43(4), 751-758.
22. **Rodríguez-Sánchez, B.**, Peña-Longobardo, L. M., & Sinclair, A. J. (2020). Cost-effectiveness analysis of the Neuropad device as a screening tool for early diabetic peripheral neuropathy. *The European Journal of Health Economics*, 21, 335-349.
23. Peña-Longobardo, L. M., **Rodríguez-Sánchez, B.**, Oliva-Moreno, J., Aranda-Reneo, I., & López-Bastida, J. (2019). How relevant are social costs in economic evaluations? The case of Alzheimer's disease. *The European Journal of Health Economics*, 20(8), 1207-1236.

24. **Rodríguez-Sánchez, B.**, Feenstra, T. L., Bilo, H. J., & Alessie, R. J. (2019). Costs of people with diabetes in relation to average glucose control: an empirical approach controlling for year of onset cohorts. *The European Journal of Health Economics*, 20(7), 989-1000.
25. **Rodríguez-Sánchez, B.**, & Cantarero-Prieto, D. (2019). Socioeconomic differences in the associations between diabetes and hospital admission and mortality among older adults in Europe. *Economics & Human Biology*, 33, 89-100.
26. **Rodriguez-Sanchez, B.**, Alessie, R. J. M., Feenstra, T. L., & Angelini, V. (2018). The relationship between diabetes, diabetes-related complications and productive activities among older Europeans. *The European Journal of Health Economics*, 19(5), 719-734.
27. Peña-Longobardo, L. M., **Rodríguez-Sánchez, B.**, Mata-Cases, M., Rodríguez-Mañas, L., Capel, M., & Oliva-Moreno, J. (2017). Is quality of life different between diabetic and non-diabetic people? The importance of cardiovascular risks. *PloS one*, 12(12), e0189505.
28. **Rodríguez-Sánchez, B.**, & Cantarero-Prieto, D. (2017). Performance of people with diabetes in the labor market: An empirical approach controlling for complications. *Economics & Human Biology*, 27, 102-113.
29. **Rodríguez-Sánchez, B.**, Angelini, V., Feenstra, T., & Alessie, R. J. (2017). Diabetes-associated factors as predictors of nursing home admission and costs in the elderly across Europe. *Journal of the American Medical Directors Association*, 18(1), 74-82.
30. Kasteridis, P., Mason, A., Goddard, M., Jacobs, R., Santos, R., **Rodriguez-Sanchez, B.**, & McGonigal, G. (2016). Risk of care home placement following acute hospital admission: effects of a pay-for-performance scheme for dementia. *PloS one*, 11(5), e0155850.

Book chapters

1. **Rodríguez-Sánchez, B.**, & Sinclair, A. (2022). Health economics of diabetic foot disease: costs of diabetic neuropathy and diabetic foot. In Diabetic Neuropathy (pp. 211-221). Elsevier.
2. **Rodríguez-Sánchez, B.** (2021) Fundamentos económicos: la eficiencia como objetivo. In Fundamentos de la atención sanitaria a la persona mayor. Actualización 2020 (pp. 231 – 254).
3. Oliva-Moreno, J., Peña-Longobardo, L.M., **Rodríguez-Sánchez, B.** (2020). Envejecimiento, enfermedad y cuidados en el anciano: una perspectiva económica. In Tratado de medicina geriátrica. Fundamentos de la atención sanitaria a los adultos mayores, 2nd edition (pp. 176 – 183). Elsevier.

Prizes, awards and grants

November 2024: Fulbright scholarship for postdoctoral research for junior researchers. Research stay at the University of Chicago (01/02/2025 – 31/07/2025)

October 2024: IE Prize for Teaching Excellence for the 2023-24 academic year.

October 2024: Recognition for the excellence in the teaching activity during the 2021-2022, 2022-2023 and 2023-2024 academic years by the Universidad Complutense of Madrid.
April 2024: Recognition for the teaching activity and quality during the period 2015 – 2018 and 2021-2023 by the Universidad Complutense of Madrid.
October 2022: Grant for Research in Social Sciences by the Fundación Ramón Areces within the XXI national call for research grants on social sciences.
July 2021: National recognition for the research activity and quality during the period 2015 – 2020 by the National Assessment Committee of Research Activity.
June 2018: Grant for Research in Health Economics by the Spanish Health Economics Association.
November 2017: Prize to the best work carried out by a young investigator, "Ferenç Bojan" award, for "Socioeconomic inequalities in diabetes outcomes: Some evidence from older Europeans using the SHARE database", Stockholm, Sweden
June 2016: Prize to best oral communication for "How related are diabetes and diabetes-related complications with productive activities in an ageing society? An analysis across Europe in the period 2006 - 2013", Murcia, Spain

Involvement in Research projects

Project: SALUD country level economic model adaptation. PI of the project: Beatriz Rodríguez Sánchez, PhD (Universidad Complutense de Madrid). Funding from Abbott (May 2023 – September 2023)
Project: Health, subjective wellbeing and ideological distance: an international and generational perspective. PI of the project: Beatriz Rodríguez Sánchez, PhD (Universidad Complutense de Madrid). Funding from Fundación Ramón Areces (October 2022 – October 2025)
Project: Relationship between muscle loss / sarcopenia, HMB levels and functional outcomes in older people with T2DM. PI of the project: Leocadio Rodriguez-Mañas, MD. PhD (Hospital Universitario de Getafe) and Beatriz Rodríguez Sánchez. Funding from Abbott (June 2022 – December 2022)
Project: Understanding the role of arterial stiffness, body composition and insulin resistance on the onset or worsening of frailty status, disability and mortality. PI of the project: Leocadio Rodriguez-Mañas, MD. PhD (Hospital Universitario de Getafe). Funding from Abbott (January 2021 – December 2021)
Project: Improved methods and actionable tools for enhancing health technology assessment (Impact-HTA). PI of the project: Julio López Bastida (Universidad de Castilla la Mancha). Funding from European Commission (January 2018 – September 2021)
Project: Does widowhood seriously worsen wellbeing and health status? A longitudinal analysis within the European framework. PI of the project: Beatriz Rodríguez Sánchez, PhD and Luz María Peña Longobardo, PhD (Universidad de Castilla la Mancha). Funding from Química Farmacéutica Bayer, S.A.; Asociación de Economía de la Salud (June 2018 – June 2019)
Project: Economic evaluation and impact of population ageing and functional limitations degree on the expenditures of dependence assisstance: use and redistributive incidence. PI of the project: David

Cantarero-Prieto, PhD and Marta Pascual-Sáez, PhD (Universidad de Cantabria). Funding from Instituto de Estudios Fiscales (December 2017 – December 2018)

Project: Assessing the Impact of Nutritional Deficiencies on Health and Economic Outcomes among Older Adults in Spain: Evidence from The Toledo Study for Healthy Aging. PI of the project: Leocadio Rodriguez-Mañas, MD. PhD (Hospital Universitario de Getafe). Funding from Abbott (September 2017 – 2018)

Project: De novo cost analysis of Neuropad for the National Institute of Health and Care Excellence (NICE). PI of the project: John Simpson (SkyRocket Pharma). Funding from SkyRocket Pharma (2017)

Involvement in Teaching Innovation projects

Project: Online apps and artificial intelligence in the classroom for the experience-based learning: application and responsible use in Economic related subjects. PI of the Project: Beatriz Rodríguez Sánchez, PhD (Universidad Complutense of Madrid) (June 2024 – July 2025)

Project: Flipped classrooms and gamification of Introduction to Economics subjects. PI of the project: Joaquín Artés Caselles, PhD (Universidad Complutense of Madrid) (June 2022 – July 2023)

Courses attendance

June 2024: Masterclass on "The Aging Paradox". The London School of Economics (LSE) and Fundación Ramón Areces. Madrid, Spain.

May 2024: CodeChella Madrid 2024. Mixtape Sessions and CUNEF University, Madrid, Spain.

July 2018: The System for Autonomy and Dependency Support (Sistema para la Autonomía y Ayuda a la Dependencia, SAAD) under crossroads. International University Menendez Pelayo, Santander, Spain

June 2017: Venice International University (VIU) Summer Institute on Ageing, Venice, Italy

July 2015: International Doctoral Course in Inequalities in Health and Health Care, Swiss School of Public Health, Switzerland

July 2011: Master in Negotiation Boot Camp in London School of Economics (LSE), United Kingdom

Other information

IT Skills: STATA, SPSS and Eviews for Statistics and Econometrics user level. Microsoft Office.

Attendance to 16 national and international conferences, resulting in 24 conference presentations.

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Does becoming an informal caregiver make your health worse? A longitudinal analysis across Europe

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ABSTRACT

Objective: To determine whether becoming an informal caregiver in Europe has a significant effect on health status, compared with non-informal caregivers, distinguishing by place of residence (in or outside the home of the care receivers) and country. And to determine whether there is an adaptation effect after the passage of time.
Methods: The Survey of Health, Aging and Retirement in Europe (2004–2017) was used. Propensity score matching was applied to analyse the differences in the health status of people who became informal carers between different periods and those who did not. We considered short-term (2–3 years after the shock) and medium-term effects (4–5 years).
Results: In the short term, the probability of those who became informal caregivers being depressed was 3.7% points (p.p.) higher than among their counterparts, being higher among those who lived in the care recipients' homes (12.8 p.p.) and those providing care outside and at home (12.9 p.p.). Significant differences in the probability of being depressed were also observed by country (Southern and Eastern Europe), and in countries with low expenditure on long-term care (LTC). Those effects remained in the medium term. No significant effects were found in cancer, stroke, heart attack and diabetes.
Conclusions: The results might help to concentrate a major effort of any policy in the field of mental health on the period immediately after the negative shock, especially for those caregivers who live with the care receiver, for those in Southern and Eastern Europe and in countries with low expenditure on LTC.

1. Introduction

Long-term care (LTC) systems are one of the basic pillars of the Welfare State in Europe (European Parliament resolution, 2017). In recent decades, there have been very profound changes in several European countries in the field of LTC (European Commission, 2018; OECD/WHO, 2021), increasing the professional resources dedicated to this matter. The ageing of the population (Robine, 2021; Bonnet et al., 2021), in a context in which it is not clear whether the increase in life expectancy is going to be accompanied by an increase in healthy life years and years free of disability (Robine, 2021), is expected to lead to an even greater increase in the resources invested and has opened deep debates about how LTC systems should be orientated in the demographic scenarios foreseen (European Commission, 2018; Costa-Font et al., 2015; Spasova et al., 2018).

It is important to stress that LTC systems in Europe are not homogeneous (Bolin et al., 2008; Kraus et al., 2010; Mot et al., 2012; Muir, 2017). The demographic, social, and economic challenges and the implications of population ageing adopt different forms, depending on the characteristics of each country and the maturity of its welfare systems. One of the ways in which European countries differ the most is in the role given to the family as a provider of care for people with limited autonomy (Kikuzawa et al., 2008; Leitner, 2014; Verbakel, Jun, 2018). The recent change in LTC systems is aimed at dividing obligations and responsibilities between the State and families. However, due to the structural factors indicated (historical, social, etc.), the changes in care

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policies can lead either to the maintenance of a strong responsibility in families for the provision of care (explicit or implicit "familialism", to use Leitner's terminology), or to a reduction of that responsibility ("de-familialism"), or to favouring the right to care but without implying any obligation ("optional familialism") (Leitner, 2003; Saraceno, 2016). The care of dependent people is thus a "fragmented territory", divided between professional services, financed publicly or by the families themselves, and care provided by people who do not professionally dedicate themselves to it; this is called family or informal care (Triantafillou et al., 2010). In all European countries, family or informal care is crucial in caring for dependent people, although the amount of such care, in both absolute and relative terms, is highly variable (Peña-Longobardo and Oliva-Moreno, 2021).

In this sense, here is a substantial and growing amount of literature on the effect of informal care on caregivers' health and well-being. Although positive aspects related to care have been identified (Andrén and Elmståhl, 2005; Bauer and Sousa-Poza, 2015; Ekwall and Hallberg, 2007; García-Mochón et al., 2019; Kuuppelomäki et al., 2004; Lopez et al., 2005; McKee et al., 2009; Tarlow et al., 2004; Del-Pino-Casado et al., 2018), most of the literature has focused on the potentially negative effects of care provision on the caregivers' job opportunities, on their family and social relationships and on their own mental and physical health (Bolin et al., 2008; Bauer and Sousa-Poza, 2015; Hoffman and Wallace, 2018; Liu et al., 2017; Masuy, 2009; Mudrazija, 2019; Peña-Longobardo et al., 2021c; Pinquart and Sörensen, 2003; Plaisier et al., 2015; Roth et al., 2009; Schulz and Sherwood, 2008; Baji et al., 2019; Ciccarelli et al., 2018; Heitmueller and Michaud, 2006; Kaschowitz and Brandt, 2017; Lilly et al., 2007; Metzelthin et al., 2017; Peña-Longobardo et al., 2021a; Verbakel, 2014; Walsh and Murphy, 2018). Focusing on the effects on health, the identification of these effects, as well as their intensity, differs according to personal and family characteristics, to the intensity of care and to the context itself where the care was provided (Bom et al., 2019a).

It should also be noted that becoming a caregiver can be perceived as an unwanted event (negative shock). In this sense, the consequences for the well-being of the caregiver may differ between the initial moment of care provision and the situation after some time (Grant and Graven, 2018; Hirst, 2005; Ornstein et al., 2014; Pot et al., 1997; Slatyer et al., 2019; Whittingham et al., 2013; Zygouri et al., 2021). In the initial moments, the caregiver will need time to adapt to the new situation, both psychologically and in terms of learning certain tasks related to care. Inclusion of the temporal dimension is therefore very important when considering how becoming an informal caregiver affects a person.

The adaptation to unexpected events in life, such as the loss of the spouse (Infurna and Luthar, 2017; Lucas et al., 2003; Peña-Longobardo et al., 2021b), retirement (Baji and Bíró, 2018), being diagnosed with a certain disease (Baji and Bíró, 2018; Brickman et al., 1978; Cubí-Mollá et al., 2017; Riis et al., 2005) or becoming functionally limited (de Hond et al., 2019; Powdthavee, 2009), has been widely analysed in the field of psychology, and the usual conclusion is that, immediately after the shock experienced, the well-being, quality of life and health status of the person concerned might worsen, this being known as the reaction effect. However, in the medium/long term, some people might recover, partially or completely, the original level of well-being or health before the adverse event occurred. Such a return to the initial degree of well-being/quality of life is called the adaptation effect (Infurna and Luthar, 2017; Siflinger, 2017). Even so, since the provision of informal caregiving is a continuous activity, the possible effect on an informal caregiver's health and well-being could follow an inversed U-shape, with an initial negative shock, followed by a recovery period, and a later worsening. This is a hypothesis to be tested herein. Hence, compared to other studies which explore the association between informal caregiving and mental health (Brenna and Di Novi, 2016), also depending on a North South Europe gradient, we pursue to determine whether becoming an informal caregiver in Europe in different periods can be modelled as a negative shock. Our contribution to the literature is defined by two aspects. Firstly, because we analyse the effect of becoming a caregiver, as a negative shock, compared with those remaining as non-caregiver, which builds over the work by Brenna and Di Novi (2016), as they assessed the effect between those who are informal caregivers (not becoming informal caregivers) and non-informal caregivers. Secondly, we determine whether there is an adaptation effect of such negative shock, additionally testing whether living in or outside the home of the care receivers alters the results.

The main aim of this paper, therefore, is to assess the effects in which new informal caregivers adapt to their new caregiving role and its effect on several health domains (mental health and chronic diseases). Additionally, we study differences between caregivers within and from outside the household, the relevance of the geographical location and the extent of the formal resources dedicated by each country to its LTC system.

2. Data and methods

2.1. Theoretical framework

Hedonic adaptation refers to the notion that after negative (or positive) events and a subsequent deterioration (or improvement) of well-being or health status, people return to a relatively stable, baseline level.

Following the model proposed by Graham and Oswald (2010), (2006) and previously adapted by Peña-Longobardo et al. (2021b), we assume that a human being begins with a given level of psychological coping resources. This stock is hedonic capital. Hedonic resources can produce wellbeing and health today or being invested in hedonic capital to produce greater wellbeing and health tomorrow.

We take into consideration three basic assumptions which underlie our simple model of an individual's psychological structure. First, we consider that individuals have a stock of psychological coping resources, which we call hedonic capital, which has the following properties:

(i) It depreciates at a rate δ.

(ii) Any change on its level is referred to as investment, denoted by i.

(iii) It is affected by exogenous shocks, denoted by ω.

These properties are summarized in a law of motion for hedonic capital as follows:

$$k_{t+1} = (1-\delta)k_t + i_t + \omega_t \tag{1}$$

Second, we assume that hedonic capital produces a flow of psychological resources, *y*. An increasing and concave function (f) captures how hedonic capital is used to produce wellbeing and health, which can be defined by the following equation.

$$y_t = zf(k_t) + xf(k_t) + v_t, f^{'} > 0, f^{''} < 0 \tag{2}$$

Where *z* and x represent individual characteristics and contextual factors, respectively, related to the personal efficiency in the use of the stock of hedonic capital and *v* represent exogenous shocks (in our case, becoming a caregiver) that can affect the hedonic flow.

And, third, the flow of psychological resources can be used either directly to produce health, *h*, in the current period, or as investment to increase the stock of hedonic capital

$$y_t = h_t + i_t \tag{3}$$

A perfect hedonic treadmill results when the adaptation occurs to the point where the experience is rendered neutral in its effect on the observed variable of interest. A relative hedonic treadmill results when a partial adaptation occurs but the experience cannot be totally considered neutral in its effect on the observed variable of interest.

The hypotheses that we propose in our work are:

1) Becoming a caregiver will be associated to a negative impact on health

2) The observed effect will be stronger in the short term. In the long term, the adaptive effects will smooth the effects identified in the short term (partial hedonic treadmill) or will make them completely disappear (complete hedonic treadmill)
3) The effects on the dependent variables considered will vary depending on the context. The country of residence of the people interviewed is the variable chosen to identify the context.
4) The observed effect will be stronger in those countries with lower LTC expenditure and in those located in the Southern and Eastern Europe, as the protection of caregivers is lower in these countries.

2.2. Data

The Survey of Health, Ageing and Retirement in Europe (SHARE) was used. SHARE is a longitudinal survey that includes detailed information about 120,000 people, aged 50 years old or older, in twenty-seven European countries plus Israel. SHARE is divided into twenty different modules in which information is collected about household characteristics, socio-demographic variables, health status, lifestyle factors, cognitive impairment and mental health problems, employment status, financial situation, social support, and the use of healthcare and non-healthcare resources. The period analysed was from 2004 to 2017[4] (Börsch-Supan et al., 2005), and people who were institutionalized were not included in the analysis.

We did not use any data from wave 8 (the most recent so far) as they contain information from 2019 and 2020–21 (the COVID-19 period), and the questions relating to informal caregiving have slightly changed, making the comparison with the other waves quite difficult.

2.2.1. Main independent variable

The question we have considered to define being an informal caregiver is when those individuals responded YES to the following question:

> *"In the last twelve months, have you given any kind of help listed on this card to a family member from outside the household, a friend or neighbour?"*

If the individual responded "yes", we considered that this person was an informal caregiver. Additionally, in order to generate our main variable (that is, becoming an informal caregiver), we generated a variable that took value 1 if the respondent reported being an informal caregiver (at home, outside the home or both) in period t but was not an informal caregiver in the previous period, t-1. On the other hand, the generated variable took value 0 if an individual declared that they were not an informal caregiver in either period, t or t-1.

When defining medium/long-term effects in terms of becoming caregivers, the main variable of interest (becoming a caregiver) took value 1 if the respondent answered to be an informal caregiver in time *t* and *t-1*, but negatively responded in time *t-2*.

Therefore, we defined short term as the period for those who became and remained as no caregiver for, at least, one wave (that is, 2 years), compared to being a non-caregiver in the previous wave, whereas medium/long term effects referred to the same scenario but for, at least, 4 years on average (that is, for, at least, caregivers during two waves).

2.2.2. Outcomes

We focused our analysis on several chronic diseases. For cancer, stroke, heart attack and diabetes mellitus we used information about whether the individual had been informed by a doctor of the diagnosis of one of those diseases during the previous twelve months. For mental health outcomes, we used the European-Depression (EURO-D) scale. This instrument collects information about the state of depression, pessimism, suicidal tendencies, guilt, sleep, loss of interest in life in general, irritability, appetite, fatigue, concentration, lack of enjoyment, and suffering (Prince et al., 1999). The score ranges from 0 (not depressed) to 12 (very depressed). Using the score obtained, we classified individuals as being depressed if the score was equal to or higher than 4 (value of 1 in the generated variable) and non-depressed if the score was equal or below 3 (value of 0 in the new variable).

Due the nature of the mental health variable, we analysed separately each of the twelve dimensions as potential drivers of the aggregated measure. Some of them are defined as follows: pessimism (having no hopes for the future), suicidal tendencies (feeling rather be dead), guilt (blaming him/herself or feeling guilty about something), sleep (having had troubles sleeping recently), loss of appetite (diminution in desire for food), fatigue (having had too little energy to do what the subject wanted to do), lack of enjoyment (not mentioning any enjoyable activity) and tearfulness (having cried in the previous month). All of them took value one in the case of a positive response for any of those feelings, and zero otherwise.

2.3. Methods

The statistical analysis was focused on assessing whether there were statistical differences in the outcomes previously mentioned (probability of being depressed, feeling pessimism, irritability, fatigue, lack of enjoyment, having sleeping problems and suffering from cancer, stroke, heart attack or diabetes) between those individuals who had become informal caregivers in different periods and those who had not, controlling for several covariates such as gender, age, years of education, country, household income, marital status, wave, health status and employment status. A detailed description of the variables included can be found in Table A2, Supplementary material.

The statistical technique used was matching, which displays information about the differences between the health status of people who had become informal caregivers and that of people who had not. This is a statistical technique usually used for addressing selection bias due to confounding; assuming no unobserved confounding, $0 < \Pr(T_i = 1|X_i) < 1$, as well as in the co-variables; and no overlap between groups. The treatment group was defined as those who became informal caregivers in different periods, whereas the control group was defined as those who remained without caregiving, where the difference in average actual outcomes between treatment and control groups is defined as follows: $E(y_i|T = 1) - E(y_i|T = 0)$.

As the treatment assignment (becoming an informal caregiver) was not a random process and the differences between individuals in the treatment and control groups were recorded with observable variables (gender, age, years of education, country, household income, marital status, wave, health status and employment status), a matching method was the most suitable method (Dehejia and Wahba, 2002; Heckman et al., 1998; Rubin, 1973). The idea was that individuals from the control group (not being an informal caregiver) were matched with individuals in the treatment group (becoming an informal caregiver). The key assumption, therefore, was that for each treated individual, an untreated individual could be found.

Propensity score matching (PSM) aims to directly estimate the average treatment effect on the treated (ATET). It does not compare one group with another (at the group or the macro level); instead, it compares a unit in the treatment group with a similar unit in the control group (at the individual or micro level). Thus, ATET is defined as follows: $\text{ATET} \equiv E(y_{1i}|T = 1) - E(y_{0i}|T = 1)$.

The logit model (logistic regression) was used by specifying the probability as:

$$\Pr(T = 1) = \Pr(u < \beta x) = \frac{e^{\beta x}}{1 + e^{\beta x}} \quad (4)$$

The propensity score (ps_i) for the i-th observation is as follows:

[4] Table A1, Supplementary material, shows detailed information on the countries included by wave, as well as their sample sizes.

$$ps_i = \Pr(T_i = 1) = \frac{e^{\hat{\beta}x_i}}{1 + e^{\hat{\beta}x_i}} \quad (5)$$

where $\widehat{\beta}$ is from the estimated logit model in Eq. (4). After that, the propensity score is used for matching a unit in the treatment group with the most similar unit in the control group (which can provide y_{0i}).

Having checked which matching estimator was the most suitable for carrying out our analysis (nearest-neighbour matching or Kernel matching), we opted for the nearest-neighbour matching technique[5] (Deheija and Wahba, 1999) with a logit estimation for obtaining the propensity score.[6] Additionally, the greedy nearest neighbour matching was used without replacement within specified caliper width algorithms, as some previous studies have shown (Peter, 2014) that algorithms which employ greedy neighbour matching within a caliper width may produce less biased estimates of effect when compared with other matching algorithms. This technique is therefore highly recommended in the literature. Basically, it matches an individual in the treatment group with an individual in the control group only if the absolute difference in their propensity scores is within a specific maximal distance (caliper), which is defined as a proportion of the standard deviation of the logit regression of the propensity score (Rosenbaum and Rubin, 1985; Cochran and Rubin, 1973).[7]

In this way, by applying the Propensity score matching (PSM), and the estimation of the ATET, we will compare the changes in health status between people who start as caregivers and those who are not (hypothesis 1). Monitoring their health status over successive waves will allow us to test the second hypothesis formulated in the theoretical framework. To test the third hypothesis, since the differences in health status between informal caregivers and non-informal caregivers might be affected by other important factors such as (i) the type of informal caregivers (that is, whether the carer lived in or outside the home of the person who was cared for); (ii) the geographical location; and (iii) the type of LTC systems in each country, three different sub-analyses were performed according to each of these factors. We assessed whether the differences in health between those who became informal caregivers and those who did not depended on the area considered (considering North, Centre, South and East), and also whether these differences were greater or lesser depending on the geographical area. We also performed the analysis by considering whether the country in which the individuals lived had high, moderate or low public expenditure on LTC, considered as a percentage of its GDP (Health, OECD database, 2021).

3. Results

3.1. Descriptive statistics

As shown in Table A5, Supplementary material, there were 21,006 individuals who became informal caregivers in the past two years and 74,914 who remained as non-informal caregivers. Of those who became informal caregivers, more than 77% provided care outside the home, 18% in the home and 5% both in and outside the home. More information about differences between these two groups may be found in Table A5.

People who became informal caregivers were statistically younger, with a higher educational level, higher household income and household size, and with a higher probability of being depressed.

Regarding the differences between the medium/long term (4–5 years after the event), and previous information about the short term, no significant changes were observed (Table A6, Supplementary material).

3.1.1. Results from the statistical analyses

Table 1 displays the results obtained after applying matching techniques to analyse the differences in the short term (defined as the 2–3 years after becoming an informal caregiver) between the individuals who became non-professional caregivers and those who did not. Being depressed and some chronic diseases (such as a stroke) were statistically significant effects associated with becoming an informal caregiver. Additionally, those who became informal caregivers had a higher probability of being depressed (by 3.7% points (p.p.) than those who did not become caregivers. However, the quantitative effect varies significantly depending on whencluded in the Northern part: Sweden, the Netherlands, Dether the informal caregiver provides those tasks at home, outside the household or both. Then, those who became informal caregivers living in the same home as the person who is cared for had a higher probability, by 12.8 p.p., of being depressed than those who were not informal caregivers (and by 12.9 p.p. in the case of caregivers providing care in and outside the home).

Table 1 also shows the results in several dimensions related to the probability of being depressed. The probability of feeling pessimism and lack of enjoyment was 0.8 and 1 p.p. lower, respectively, among those who became caregivers than among those who did not, although differences were observed between at-home caregivers (3.5 and 2.9 p.p. more likely to report that feeling) than outside-the-home caregivers (−2.1 and −1.5 p.p.). Becoming an informal caregiver was significantly and positively associated with the probability of being sad or depressed (11.6 p.p. more if providing care inside the household, 4.5 p.p. more if outside, and 15.1 p.p. more if both inside and outside), having sleeping problems (12.8 p.p. more in the case of caregivers inside and outside the home), being irritable (10.5 p.p. more likely if caregiving within the household), having too little energy (10.3 p.p. more if providing care inside and outside) and feeling tearfulness (10.2 p.p. more likely if caregiving within the household and 11.7 p.p. more if inside and outside), compared with those who remained as non-caregivers in the short term.

In the medium term (Table 2), the shock seems to remain significant and positive in comparison to people who have never been caregivers. Similarly, the effect observed in the short term remained in the medium term for some of the outcomes (being depressed for those becoming caregivers), whereas it was increased in some of them (for example, the probability of having sleeping problems and feeling tearfulness among those who became caregivers in and outside their homes) and lost its significance in some other cases (probability of stroke).

A significant difference is also observed in the probability of being depressed in the short-term depending on the geographical area (Table 3). Those who became informal caregivers in Southern Europe have a higher probability of being depressed (by 9 p.p.) than those in the same geographical area who did not. Likewise, informal caregivers living in East European countries have a 3.9 p.p. higher probability of being depressed than those who did not become caregivers in those countries. No statistical differences were found in Northern or Central Europe. When assessing differences in depression-related dimensions by geographical area, we observed that becoming an informal caregiver was significantly and positively associated with a higher probability of being sad or depressed, having sleeping problems, being irritable and feeling tearfulness, regardless of the area. Higher coefficients were reported by Southern European countries (10.6, 8.5, 8.9 and 8.6 p.p. more probability of being sad or depressed, having sleeping problems, being

[5] As Caliendo and Kopeinig (2008) pointed out, asymptotically all propensity score matching estimators, regardless of the used algorithm, should lead to the same results, because with growing sample size, as it is our case with SHARE data, they all become closer to comparing only exact matches (Smith, 2000). In small sample sizes, a trade-off between bias and variance might arise due to the choice of the matching algorithm (Caliendo and Kopeinig, 2008), which is not the scenario of the data used in the current analysis.

[6] A higher pseudo-R squared was obtained with logit estimation techniques (0.0472) than with probit (0.0467), as well as a lower log-likelihood (−42,380.188 vs −42,401.945, respectively)

[7] Data on the covariates balance and the quality of the matching performed can be found in Tables A3 and A4 and Figs. A1, A2 and A3, Supplementary material.

Table 1
Differences in health between those who become caregivers in the short-term (2 years ago) and those who have never been caregivers.

		Becoming caregivers[a]		Becoming caregivers at home[a]		Becoming caregivers out of home[a]		Becoming caregivers in and out of home[a]
Outcome	N[b]	ATET (SE)	N	ATET (SE)	N	ATET (SE)	N	ATET (SE
Being depressed	83,740	0.037 (0.004)***	68,230	0.128 (0.011)***	79,574	-0.003 (0.005)	65,920	0.129 (0.020)***
Depression dimensions								
Being sad or depressed	84,536	0.067 (0.006)***	68,921	0.116 (0.013)***	80,311	0.045 (0.006)***	66,560	0.151 (0.023)***
Feeling pessimism	84,403	-0.008 (0.004)*	68,794	0.035 (0.011)**	80,184	-0.021 (0.004)***	66,439	0.010 (0.016)
Feeling rather be dead	84,407	0.011 (0.003)***	68,798	0.039 (0.007)***	80,190	0.003 (0.003)	66,445	0.009 (0.012)
Feeling guilty	84,372	0.015 (0.003)***	68,762	0.018 (0.007)***	80,162	0.015 (0.004)***	66,416	0.035 (0.013)**
Sleeping problems	84,600	0.042 (0.006)***	68,977	0.066 (0.012)***	80,365	0.027 (0.006)***	66,606	0.128 (0.022)***
Feeling loss of interest	84,491	0.003 (0.003)	68,877	0.060 (0.009)***	80,264	-0.014 (0.003)***	66,512	0.041 (0.014)***
Being irritable	84,253	0.044 (0.005)***	68,907	0.105 (0.012)***	80,294	0.024 (0.006)***	66,542	0.086 (0.020)***
Loss of appetite	84,666	0.002 (0.003)	69,039	0.044 (0.008)***	80,425	-0.010 (0.003)***	66,662	0.049 (0.013)***
Having too little energy	84,520	0.021 (0.005)***	68,902	0.087 (0.012)***	80,294	-0.004 (0.006)	66,540	0.103 (0.021)***
Having concentration difficulties	84,363	0.011 (0.004)**	68,772	0.065 (0.011)***	80,141	-0.009 (0.009)*	66,140	0.014 (0.018)
Feeling lack of enjoyment	84,446	-0.010 (0.004)**	68,838	0.029 (0.010)**	80,227	-0.015 (0.004)***	66,483	0.011 (0.014)
Feeling tearfulness	84,531	0.043 (0.005)***	68,197	0.102 (0.011)***	80,308	0.029 (0.005)***	66,556	0.117 (0.020)***
Cancer	87,335	-0.000 (0.002)	71,563	0.010 (0.005)	82,899	-0.000 (0.002)	69,035	0.014 (0.009)
Stroke	87,335	-0.002 (0.002)	71,563	0.023 (0.005)***	82,899	-0.007 (0.002)	69,035	0.003 (0.009)
Heart attack	87,335	0.005 (0.003)	71,563	0.009 (0.009)	82,899	-0.006 (0.003)	69,035	0.027 (0.015)
Diabetes	87,335	-0.004 (0.003)	71,563	0.012 (0.009)	82,899	-0.010 (0.004)	69,035	0.027 (0.014)

***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$. Only observations within the common support.

[a] the variable to be compared is never caregiver, control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-1)).

[b] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

Table 2
Differences in health between those who become caregivers in the long-term (4 years ago) and those who have never been caregivers.

		Becoming caregivers[a]		Becoming caregivers at home[a]		Becoming caregivers out of home[a]		Becoming caregivers in and out of home[a]
Outcome	N[b]	ATET (SE)	N	ATET (SE)	N	ATET (SE)	N	ATET (SE
Being depressed	32,996	0.039 (0.010)***	29,541	0.151 (0.025)***	32,110	0.007 (0.011)	29,135	0.120 (0.039)***
Depression dimensions								
Being sad or depressed	33,290	0.070 (0.012)***	29,822	0.139 (0.028)***	32,394	0.055 (0.013)***	29,408	0.178 (0.045)***
Feeling pessimism	33,255	-0.028 (0.008)***	29,786	0.026 (0.023)	32,358	-0.038 (0.009)***	29,373	0.025 (0.031)
Feeling rather be dead	33,250	0.009 (0.006)	29,784	0.037 (0.017)**	32,353	-0.002 (0.006)	29,369	0.025 (0.025)
Feeling guilty	33,240	0.013 (0.007)**	29,772	0.008 (0.013)	32,343	0.016 (0.007)**	29,359	0.045 (0.024)*
Sleeping problems	33,299	0.043 (0.012)***	29,832	0.120 (0.027)***	32,400	0.020 (0.013)	29,417	0.153 (0.044)***
Feeling loss of interest	33,278	-0.004 (0.007)	29,809	0.015 (0.020)	32,381	-0.011 (0.007)*	29,396	0.025 (0.026)
Being irritable	33,276	0.043 (0.011)***	29,810	0.140 (0.026)***	32,379	0.028 (0.012)*	29,395	0.091 (0.044)*
Loss of appetite	33,330	0.004 (0.007)	29,861	0.035 (0.019)*	32,431	-0.012 (0.007)*	29,446	-0.017 (0.027)
Having too little energy	33,278	0.002 (0.12)	29,811	0.03 (0.028)**	32,381	-0.036 (0.013)**	29,398	-0.012 (0.045)
Having concentration difficulties	33,206	0.002 (0.009)	29,743	0.073 (0.024)	32,311	-0.006 (0.009)	29,330	0.029 (0.034)
Feeling lack of enjoyment	33,264	-0.020 (0.008)**	29,796	0.032 (0.021)	32,365	-0.032 (0.008)***	29,381	0.021 (0.030)
Feeling tearfulness	33,281	0.066 (0.010)***	29,812	0.090 (0.026)***	32,384	0.037 (0.011)***	29,399	0.169 (0.041)***
Cancer	34,549	-0.004 (0.004)	31,065	0.001 (0.011)	33,630	-0.006 (0.005)	30,638	-0.024 (0.020)
Stroke	34,549	-0.006 (0.004)	31,065	0.001 (0.011)	33,630	-0.002 (0.004)	30,638	-0.012 (0.017)
Heart attack	34,549	-0.024 (0.007)	31,065	-0.005 (0.019)	33,630	0.004 (0.007)	30,638	-0.012 (0.027)
Diabetes	34,549	-0.012 (0.007)	31,065	0.032 (0.020)	33,630	-0.011 (0.008)	30,638	-0.016 (0.03)

***: $p < 0.001$; **: $p < 0.01$; *:$p < 0.05$. Only observations within the common support.

[a] The variable to be compared is never caregiver, control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-2)

[b] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

irritable and feeling tearfulness, respectively).

Countries included in the Northern part: Sweden, the Netherlands, Denmark and Finland. Countries included in the Central part: Germany, France, Belgium, Switzerland and Luxembourg. Countries included in the Southern part: Spain, Italy, Greece and Portugal. Countries included in the East: Israel, Czech Republic, Poland, Slovenia, Hungary, Estonia, Croatia, Lithuania, Bulgaria, Cyprus, Latvia, Malta, Rumania and Slovakia.

When analysing the effect in the medium term (Table 4), one observes that the effect in Southern European countries remains, while the effect in East European countries disappears. Moreover, becoming an informal caregiver seems to have an effect in Central European countries, as people who experienced this shock had a 5.1 p.p. higher probability of being depressed than those in the same area who did not. Moreover, the effect of becoming an informal caregiver on medium-term depression-related outcomes particularly remained in Southern European countries.

Finally, taking into account the public expenditure on LTC in each

Table 3
Differences in health between those who become caregivers in the short-term (2 years ago) and those who have never been caregivers, depending on the geographic area.

		Northern Countries		Center Countries		Southern Countries		Eastern Countries
Outcome	N[a]	ATET (SE)	N	ATET (SE)	N	ATET (SE)	N	ATET (SE
Being depressed	11,771	0.016 (0.009)	25,199	0.020 (0.008)	19,989	0.090 (0.012)***	21,142	0.039 (0.010)***
Depression dimensions								
Being sad or depressed	11,909	0.051 (0.013)***	25,393	0.040 (0.010)***	20,164	0.101 (0.014)***	21,565	0.069 (0.012)***
Feeling pessimism	11,887	-0.028 (0.007)***	25,375	-0.009 (0.006)	20,129	0.025 (0.012)*	21,504	-0.014 (0.009)
Feeling rather be dead	11,899	0.003 (0.005)	25,371	-0.001 (0.006)	20,124	0.036 (0.007)***	21,507	0.002 (0.006)
Feeling guilty	11,894	0.014 (0.008)*	25,368	0.015 (0.005)***	20,110	0.016 (0.007)**	21,496	0.018 (0.007)**
Sleeping problems	11,918	0.031 (0.013)*	25,401	0.031 (0.009)**	20,163	0.085 (0.013)***	21,602	0.061 (0.011)***
Feeling loss of interest	11,907	-0.002 (0.007)	25,379	-0.004 (0.005)	20,141	0.038 (0.010)***	21,550	0.003 (0.007)
Being irritable	11,904	0.030 (0.011)**	25,385	0.039 (0.009)***	20,156	0.089 (0.013)***	21,657	0.050 (0.011)***
Loss of appetite	11,924	-0.005 (0.007)	25,410	-0.002 (0.006)	20,180	0.016 (0.009)*	21,630	0.005 (0.006)
Having too little energy	11,898	-0.014 (0.012)	25,390	0.005 (0.009)	20,154	0.083 (0.013)***	21,564	0.021 (0.011)
Having concentration difficulties	11,895	0.006 (0.010)	25,338	-0.017 (0.008)**	20,101	0.048 (0.012)***	21,511	0.010 (0.008)
Feeling lack of enjoyment	11,901	-0.004 (0.008)	25,377	-0.008 (0.006)	20,149	0.007 (0.011)	21,506	-0.011 (0.007)
Feeling tearfulness	11,912	0.026 (0.011)**	25,404	0.036 (0.009)***	20,155	0.086 (0.012)***	21,548	0.049 (0.009)***
Cancer	12,043	0.002 (0.005)	25,770	0.003 (0.003)	21,148	0.001 (0.004)	22,476	-0.004 (0.004)
Stroke	12,043	-0.012 (0.005)	25,770	-0.005 (0.003)	21,148	0.004 (0.005)	22,476	-0.004 (0.004)
Heart attack	12,043	0.012 (0.007)	25,770	-0.001 (0.005)	21,148	0.003 (0.008)	22,476	0.002 (0.007)
Diabetes	12,043	0.003 (0.007)	25,770	0.000 (0.006)	21,148	0.015 (0.009)	22,476	-0.011 (0.008)

Control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-1)
***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$. Only observations within the common support.
[a] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

Table 4
Differences in health between those who become caregivers in the long-term (4 years ago) and those who have never been caregivers, depending on the geographic area.

		Northern Countries		Center Countries		Southern Countries		Eastern Countries
Outcome	N[a]	ATET (SE)	N	ATET (SE)	N	ATET (SE)	N	ATET (SE
Being depressed	4867	-0.033 (0.022)	10,200	0.051 (0.016)***	8689	0.103 (0.027)***	7250	0.017 (0.023)
Depression dimensions								
Being sad or depressed	4869	0.045 (0.025)*	10,302	0.062 (0.019)***	8773	0.165 (0.030)***	7340	0.076 (0.026)***
Feeling pessimism	4865	-0.018 (0.012)	10,297	-0.033 (0.013)*	8759	0.056 (0.024)*	7330	-0.012 (0.019)
Feeling rather be dead	4865	-0.021 (0.011)*	10,293	0.014 (0.011)	8753	0.022 (0.015)	7335	-0.015 (0.014)
Feeling guilty	4863	0.001 (0.016)	10,294	0.014 (0.010)	8750	0.023 (0.015)	7329	0.027 (0.016)*
Sleeping problems	4874	0.002 (0.024)	10,304	0.060 (0.019)***	8767	0.061 (0.029)*	7345	0.030 (0.026)
Feeling loss of interest	4871	-0.010 (0.012)	10,300	0.009 (0.010)	8756	0.050 (0.022)**	7343	-0.029 (0.015)**
Being irritable	4869	0.023 (0.021)	10,297	0.028 (0.018)	8763	0.083 (0.029)**	7341	0.083 (0.024)**
Loss of appetite	4876	-0.010 (0.013)	10,313	0.006 (0.011)	8779	0.036 (0.020)*	7349	-0.007 (0.014)
Having too little energy	4869	-0.034 (0.024)	10,298	-0.013 (0.019)	8766	0.106 (0.029)***	7335	0.010 (0.025)
Having concentration difficulties	4861	-0.002 (0.017)	10,276	0.010 (0.014)	8740	0.076 (0.028)**	7319	-0.017 (0.018)
Feeling lack of enjoyment	4868	-0.016 (0.014)	10,299	-0.023 (0.011)	8761	0.030 (0.024)	7330	-0.020 (0.014)
Feeling tearfulness	4872	0.026 (0.021)	10,297	0.086 (0.017)	8768	0.107 (0.028)***	7340	0.045 (0.022)**
Cancer	4932	0.000 (0.009)	10,486	0.000 (0.007)	9168	0.000 (0.010)	7773	0.002 (0.009)
Stroke	4932	-0.029 (0.011)	10,486	0.003 (0.005)	9168	0.007 (0.008)	7773	-0.009 (0.009)
Heart attack	4932	-0.009 (0.016)	10,486	-0.005 (0.010)	9168	-0.026 (0.019)	7773	0.002 (0.016)
Diabetes	4932	-0.001 (0.014)	10,486	-0.017 (0.011)	9168	-0.017 (0.022)	7773	-0.023 (0.01)

Control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-2)
***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$. Only observations within the common support.
Countries included in the Northern part: Sweden, the Netherlands, Denmark and Finland. Countries included in the Central part: Germany, France, Belgium, Switzerland and Luxembourg. Countries included in the Southern part: Spain, Italy, Greece and Portugal. Countries included in the East: Israel, Czech Republic, Poland, Slovenia, Hungary, Estonia, Croatia, Lithuania, Bulgaria, Cyprus, Latvia, Malta, Rumania and Slovakia.
[a] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

country, it is observed that those individuals who became informal caregivers in countries with low expenditure on LTC have a higher probability of being depressed (by 7.9 p.p.) than those individuals who did not become informal carers in such areas (Table 5). This effect seems to be stable in the medium term (Table 6).

When evaluating differences in depression-related dimensions, we found quantitative differences depending on public expenditure on LTC in each country in the short term (Table 5), although becoming an informal caregiver was always significantly associated with the probability of being sad or depressed, feeling guilty, having sleeping troubles, feeling irritable and feeling tearfulness. In the medium term, most of the significant associations observed in the short term disappeared (Table 6), but for the countries in which expenditure on LTC is low, its coefficient increased.

4. Discussion

The purpose of the article was to assess whether the shock of

Table 5
Differences in health between those who become caregivers in the short-term (2 years ago) and those who have never been caregivers, depending on the LTC expenditure in the country.

		High LTC expenditure		Middle LTC expenditure		Low LTC expenditure
Outcome	N[a]	ATET (SE)	N	ATET (SE)	N	ATET (SE)
Being depressed	34,908	0.013 (0.006)	13,903	0.023 (0.011)	34,929	0.079 (0.009)***
Depression dimensions						
Being sad or depressed	35,032	0.049 (0.008)***	14,078	0.040 (0.013)***	35,426	0.093 (0.010)***
Feeling pessimism	35,004	-0.004 (0.005)**	14,054	-0.020 (0.010)*	35,345	0.013 (0.008)
Feeling rather be dead	35,010	0.004 (0.004)	14,064	-0.001 (0.008)	35,333	0.017 (0.005)***
Feeling guilty	35,004	0.012 (0.004)***	14,062	0.031 (0.007)***	35,306	0.013 (0.006)**
Sleeping problems	35,053	0.023 (0.008)**	14,100	0.046 (0.013)***	35,447	0.079 (0.010)***
Feeling loss of interest	35,033	-0.008 (0.004)**	14,079	-0.013 (0.007)*	35,379	0.026 (0.007)***
Being irritable	35,021	0.023 (0.007)***	14,088	0.027 (0.012)*	35,414	0.071 (0.010)***
Loss of appetite	35,070	-0.004 (0.004)	14,108	-0.016 (0.008)**	35,488	0.018 (0.006)***
Having too little energy	35,026	-0.003 (0.008)	14,087	0.011 (0.013)	35,407	0.052 (0.010)***
Having concentration difficulties	34,997	-0.011 (0.006)*	14,049	-0.008 (0.010)	35,317	0.038 (0.008)***
Feeling lack of enjoyment	35,026	-0.008 (0.005)	14,057	-0.020 (0.007)**	35,363	0.010 (0.007)
Feeling tearfulness	35,045	0.040 (0.007)***	14,082	0.031 (0.011)***	35,404	0.073 (0.009)***
Cancer	35,778	0.006 (0.003)	14,418	-0.001 (0.005)	37,139	0.001 (0.003)
Stroke	35,778	-0.006 (0.002)	14,418	-0.000 (0.005)	37,139	-0.005 (0.003)
Heart attack	35,778	0.007 (0.004)	14,418	0.009 (0.008)	37,139	0.002 (0.006)
Diabetes	35,778	-0.004 (0.004)	14,418	-0.004 (0.009)	37,139	-0.005 (0.007)

Control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-1)
***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$. Only observations within the common support.
[a] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

Table 6
Differences in health between those who become caregivers in the long-term (4 years ago) and those who have never been caregivers, depending on the LTC expenditure in the country.

		High LTC expenditure		Middle LTC expenditure		Low LTC expenditure
Outcome	N[a]	ATET (SE)	N	ATET (SE)	N	ATET (SE)
Being depressed	13,918	0.010 (0.012)	5430	0.012 (0.022)	13,648	0.078 (0.022)***
Depression dimensions						
Being sad or depressed	13,990	0.068 (0.016)***	5502	0.066 (0.026)**	13,798	0.102 (0.023)***
Feeling pessimism	13,984	-0.026 (0.009)**	5493	-0.039 (0.020)*	13,778	-0.005 (0.020)
Feeling rather be dead	13,983	-0.003 (0.008)	5493	0.004 (0.015)	13,774	0.019 (0.011)*
Feeling guilty	13,981	0.017 (0.008)**	5491	0.012 (0.015)	13,768	0.006 (0.014)
Sleeping problems	13,997	0.023 (0.015)	5508	0.000 (0.025)	13,794	0.099 (0.023)***
Feeling loss of interest	13,993	-0.002 (0.008)	5502	0.011 (0.012)	13,783	0.001 (0.016)
Being irritable	13,986	0.038 (0.013)**	5499	0.032 (0.024)	13,791	0.076 (0.023)**
Loss of appetite	14,009	0.001 (0.009)	5511	-0.004 (0.014)	13,810	0.015 (0.015)
Having too little energy	13,990	-0.014 (0.015)	5497	0.017 (0.025)	13,791	0.065 (0.023)**
Having concentration difficulties	13,966	-0.010 (0.011)	5497	-0.004 (0.019)	13,743	0.050 (0.019)***
Feeling lack of enjoyment	13,988	-0.014 (0.009)	5494	-0.042 (0.014)**	13,782	-0.012 (0.018)
Feeling tearfulness	13,988	0.065 (0.014)***	5499	0.033 (0.022)	13,794	0.075 (0.021)***
Cancer	14,334	0.004 (0.006)	5668	-0.011 (0.010)	14,547	0.006 (0.008)
Stroke	14,334	-0.005 (0.005)	5668	-0.005 (0.008)	14,547	-0.004 (0.008)
Heart attack	14,334	-0.008 (0.009)	5668	-0.018 (0.015)	14,547	-0.001 (0.015)
Diabetes	14,334	-0.013 (0.010)	5668	-0.039 (0.017)	14,547	0.004 (0.016)

Control variables: age, gender, education, household income, marital status, labour situation, country, year and self-perceived health status at baseline (before transition occurred (t-2)
***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$. Only observations within the common support.
Countries with low level of LTC expenditure are those with a LTC expenditure lower than 1% of its GDP. Countries with medium level of LTC expenditure are those with a LTC expenditure equivalent to more than 1% and less than 2% of its GDP, and, finally, countries with high LTC expenditure are those with a LTC expenditure higher than 2% of its GDP.
[a] The number of observations refers to the treated individuals (those becoming caregivers) and the controls (those individuals who remained as non-caregivers between waves)

becoming an informal caregiver had an effect on the care provider's health status (by using, as outcome measurements, individual mental health, and also physical health through some chronic conditions, such as diabetes, heart attack, stroke or cancer). The analysis was of a thirteen-year period in a European context, taking into account not only country-specific conditions but also the welfare from the LTC systems. We also considered whether there is an adaptation effect after such an event once time has passed. Even though the literature about the effect of being caregivers on health status has been previously analysed (Bom et al., 2019b; Stöckel and Bom, 2022; De Zwart et al., 2017; Easterlin, 2005a), our study contributes to the existing literature by providing evidence on the effect of becoming (transition situation) an informal caregiver on health status.

Our results have shown that the immediate negative burden of becoming an informal caregiver is especially relevant in terms of mental health, especially among those providing care inside the household, irrespective of whether they additionally provide care outside. The negative effect is even maintained for four to five years after becoming

an informal caregiver at home, even increasing the probability of being depressed by 15% points if care is solely provided in the home, from its original 13 p.p. This maintenance and increase of the quantitative effect in the medium term refutes the adaptation paths that the hedonic treadmill models have suggested previously (Infurna and Luthar, 2017; Easterlin, 2005b), which assume that the intensity of the effect in the initial moments after a shock might steadily lessen or even disappear. Such an adaptative pathway could be confirmed when using the probability of having a stroke as an outcome, since, in the short term, there was a positive and significant effect of becoming an informal caregiver inside the household, but this turned out to be non-significant in the medium term. However, in the case of mental health, especially among informal caregivers at home, the available data point towards an inverse-U shape as hypothesized in the introduction, especially with respect to the presence of sleeping problems and the feeling of irritability as a result of caregiving. A possible explanation of the reason why we do not observe an adaptative effect in the case of caregivers could be that the progression in the health of the people who are cared for does not remain constant over time but can progress, in a high percentage of cases, to stages of more severe dependence. The literature has already suggested that the higher the number of co-morbidities (Metzelthin et al., 2017; Gérain and Zech, 2019) or disability level of the care receiver (Flyckt et al., 2015; Verbakel et al., 2018), the higher the negative burden borne by their informal caregiver. This would mean that the burden of care could increase through various mechanisms: more hours of daily care, activities that require more physical effort, more strenuous activities (nappy changes), accumulation of years of care, amongst others. This is a hypothesis that we hope to be able to check in future studies. In any case, our results would confirm some previous findings about the negative burden associated with the provision of informal care, especially among those who care for someone inside their household (Kaschowitz and Brandt, 2017; Peña-Longobardo et al., 2021a; Brenna and Di Novi, 2016; Bom et al., 2019b; Stöckel and Bom, 2022; De Zwart et al., 2017). However, the results cannot be fully comparable in terms of magnitude due to differences in the methodological approach and in the assessed outcomes (Kaschowitz and Brandt, 2017), or because cross-sectional associations were assessed, in addition to uncertain situations such as the recent health crisis (Peña-Longobardo et al., 2021a).

These results might in some way be confirmed when analysing the effects by geographical location or LTC welfare states. The former showed a significant and positive effect in Central, Eastern and Southern European countries in the short term, the quantitative effect in the medium term increasing in Central and Southern European countries but disappearing in Eastern Europe. It is interesting to note that Kaschowitz and Brandt (2017) concluded that negative effects on the mental health of informal caregivers within the household were present in most European countries, regardless of the type of welfare state. By contrast, in our study, for the "new" informal caregivers, the intensity of the negative effects on health are quantitatively different depending on the geographical area and the effort made by the country in terms of spending dedicated to long-term care. When assessing the impact of becoming an informal caregiver by expenditure on LTC, we found a higher probability of being depressed in every category, although the effect was quantitatively higher in countries with low effort in the LTC systems. It was only in those countries that the effect remained significant in the medium term. These results would contradict those of a previous study, which concluded that negative effects on the mental health of informal caregivers within the household were present in most European countries, regardless of the type of welfare state (Kaschowitz and Brandt, 2017), even concluding that providing such care outside the homes was positive for the mental health of informal caregivers. The difference with respect to the welfare states might be method of classifying the countries, as we used the amounts spent on LTC, whereas the other authors classified each country according to whether they were service- or family-based, as proposed by Haberkern and Szydlik (2008). The international evidence about the use of LTC suggests that differences between countries might be due to their different eligibility criteria for public LTC coverage, which could be reflected by national expenditure on LTC, comprehensiveness of the public LTC system, and household characteristics, among other factors (Brenna and Di Novi, 2016; Bakx et al., 2015; Casanova et al., 2017; Ilinca et al., 2017).

Some limitations also deserve to be mentioned. First of all, we had no information about the health status of the person who was cared for, and as already mentioned, this could lead to a heavier burden borne by the caregiver (Peña-Longobardo and Oliva-Moreno, 2021; Andrén and Elmståhl, 2005; García-Mochón et al., 2019; Del-Pino-Casado et al., 2018; Liu et al., 2017; Peña-Longobardo et al., 2021c). This might be explained by the fact that the worse health status of the dependent person, the higher number of informal caregiving hours provided, and this may lead to a higher burden supported by the caregiver (García-Mochón et al., 2019), and consequently, a worse mental health of the carers, among others type of problems (Peña-Longobardo et al., 2021c). Similarly, the health status of the care receiver could be related to the intensity of care, which was not available in our dataset either. However, we did have information about whether the informal care was given inside the household, outside it, or both, which could be a proxy for the intensity of care and has already been supported to drive significant differences in the mental health burdens of informal caregivers (Kaschowitz and Brandt, 2017). Secondly, we were not able to consider whether the informal caregiver had benefited from any support policy implemented in each country, as there seem to be more conclusions about the protective effect on mental health of non-financial supportive measures, such as respite care services, than about the effect of financial support (Jowsey et al., 2013; Verbakel et al., 2017; Calvó-Perxas et al., 2018). Even so, in order to control for the welfare status of LTC systems, we performed our analysis by considering the extent of national expenditure on LTC. Moreover, measurements of both caregiving and health status were self-reported and crude, so measurement error may have biased the results. Finally, there might be additional differences between carers and non-carers which cannot be observed given the availability of data.

Nevertheless, and despite all the limitations mentioned above, we contribute to the existing literature in several ways. First of all, an immediate effect has been identified on the health status of care providers when they become informal caregivers. This effect does not remit but is maintained and even becomes stronger over time. Therefore, and contrary to what is observed in widowing (Ornstein et al., 2014), the support resources should be maintained over time. Moreover, we take into account country-specific characteristics in terms of regional differences, by grouping countries by geographical location, and in terms of LTC efforts, through the clustered analysis according to the expenditure of each country on LTC as a percentage of its GDP. The information generated could be useful for the implementation of policy measures to support these care tasks, such as the provision of respite care services and psychological care, through a continuum of care, it being helpful to identify the most vulnerable informal caregivers, who would include those providing care at home and those who live in countries where the intensity in terms of expenditure on LTC is low. Additionally, in an uncertain scenario of health crisis such as the pandemic that we have experienced recently (and still are experiencing), these policy measures should be taken into consideration, since, due to the outbreak of COVID-19, it has been proved that informal caregivers in Europe have had a higher probability of reporting mental health symptoms than non-caregivers (Peña-Longobardo et al., 2021a). Besides, as the pandemic has seriously affected the mental health of the population, the results also highlight the importance of health policy measures to support mental disorders not only informal caregivers but also population as a whole.

Declaration of Competing Interest

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Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ehb.2023.101264.

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