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The effect of older population on public health spending: Evidence from Spain

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Abstract

Background: The gradual ageing of the population, and its effect on public spending, constitutes an urgent challenge for advanced economies. Through this study, we analyse the effect of older people, and their health and individual characteristics, on public health spending.

Methods: Using logistic regression methods, we have analysed the use of different health services and health technologies by older people in Spain, controlled for several health, socioeconomic, and other individual factors.

Results: The main factors that explain the consumption of both health services and health technology, above age, are related to the so-called need factors: self-reported health status, presence of chronic diseases, and disability.

Conclusion: Knowing the main factors that imply greater public health spending is a topic of special interest for designing efficient health policies, in a context of growth in public health spending. In this way, preventive attention on the so-called need factors may be an important driver to improve the effectiveness of spending.

KEYWORDS

ageing, health technology, older population, public health spending, Spain, use of health services

1 | INTRODUCTION

1.1 | Background

The gradual ageing of the population in developed countries is a reality that is posing major challenges, unknown to date, related to the sustainability of public finances [1], in areas as varied as pensions [2], savings [3], health spending and long-term care [4], that requires timely decision-making to ensure the viability of public accounts in the future. Within this framework, health economics has analysed for years the effect of population ageing on health systems and their use that is [5–7], where abundant empirical research has been generated. The growing trend over the last few decades in both health expenditure and the number of elderly people has led to search for the relationship between the two.

Abbreviations: CT, computed tomography; ENS, Encuesta Nacional de Salud (National Health Survey); ER, emergency room; GDP, gross domestic product; GP, general practitioner; MRI, magnetic resonance imaging; OR, odds ratio; SRHS, self-reported health status; VIF, variance inflation factor.

As said before, there has been a significant increase in public health expenditure in developed countries in recent years. In Spain, measured in relative terms, public health spending grew by 84.7% between 2002 and 2018.* Measured in *per capita* terms, Spanish public health expenditure in 2018 reached 1523 euros, the highest figure in the last decade, when in 2002 it was 921 euros. In relation to gross domestic product (GDP), public health expenditure in Spain in 2018 was 5.9% of GDP, being 5.1% in 2002.

Developed countries are also undergoing a rapid process of population ageing. The Spanish population over 65 years of age accounted for 19.26% of the total population in 2019†; only 20 years earlier, this proportion was 16.76%. The number of elderly people has risen from 6.7 million to 9 million in that period. The "ageing of ageing" is also a fact: people over 75 years of age accounted for 49.5% of the total elderly population in Spain in 2019 (in 1999 they were 42.2%), with an increase of 1.6 million people in that period. This trend, far from stagnating, looks set to continue to increase in the coming years in developed countries and many developing countries, due to an increase in life expectancy and a decrease in fertility rates, with important macroeconomic implications, including health spending.

These circumstances essentially pose a problem for the sustainability of public health and long-term care systems. In this area of analysis, part of the empirical research has focused its efforts on finding out how the progressive increase in the elderly population affects the increase in healthcare and long-term care expenditure [8–10], since it is to be expected, at least from a theoretical point of view, that an increase in the elderly population, due to gains in longevity and the increase in associated health and dependency problems, such as disability, the presence of chronic diseases and polymorbidity, will generate significant increases in public health spending, which in turn will cause significant strains on public finances.

In this context, the analysis of the effect of the elderly population on the consumption of health resources and health expenditure constitutes an important area of analysis, given the unstoppable demographic trend towards ageing populations in developed countries.

Spain has a public, universal and free Beveridge-type health system, with funding from public budgets. Administratively, Spain is divided into 17 Autonomous Communities, with a high degree of decentralisation, where each is directly responsible for both the expenditure and the management of the health systems in its region. The Ministry of Health establishes a basic portfolio of common services for all the Autonomous Communities; but each of them has the power to set additional services in its portfolio, as well as to choose the organisational model that they consider most appropriate, always within the limits set under the laws of the Spanish state. 99.1% of the Spanish population has free public health coverage. The Spanish healthcare system does not have any type of copayment for acute or chronic healthcare, if presenting a copayment for nonhospital pharmaceutical consumption, which in the case of the elderly is very limited (in 2017, the maximum total monthly copayment for elderly pensioners ranged from 8.23 euros to 18.52 euros depending on income, except for incomes above 100,000 euros per year, rare in Spain, whose limit was 61.75 euros. In addition, there are total exemptions for certain cases, such as dependency cases or the receipt of noncontributory pensions).

This study aims to analyse the effect that aging may have on the use of acute care services. A second objective is to determine whether aging may have an interaction with medical technology growth, which has often identified as the main driver of increased healthcare spending [11–13].

1.2 | Conceptual framework

The analysis of the effect of aged on public health expenditure in this paper is based on the model proposed by Meijer et al. [14] developed from Andersen and Newman [15], which incorporates other determinants of health expenditure, identified as societal determinants, into the original model, focused on the consumption of health resources, so that we move from a model of consumption of health resources to a model of health expenditure.

In this model, the determinants of healthcare services use and health expenditure depend on *individual factors* and *social factors*. Individual factors are further divided into three groups: *predisposing factors*, which are those that reflect the predisposition to use health services, including gender, living and working conditions, health behaviour, coresidence status, socioeconomic status and the main independent variable in this study, age.

The presence of age as a predisposing factor is essential in the analysis, because it indicates that age by itself is not necessarily a determinant in the consumption of health resources and may be relevant to the extent that it is related to the determinants of the second subgroup, the *need factors*, which indicate the reasons why an individual, given all other factors, makes use of health

Source: Spanish Ministry of Health.
†*Source*: Spanish National Statistics Institute.

services. The main ones are health status, disability and mortality. Indeed, there is abundant empirical evidence that the effect of age on healthcare expenditure underlies the presence of chronicity or dependency conditions, as well as poor health status [7, 16–19].

The third subgroup, called *enabling factors*, is the group of resources available to meet the need for health resources consumption. These include the availability of informal care, which is mainly influential in the consumption of long-term services, personal or family income, and the presence of health insurance.

The social factors identified as determinants of increased health spending are national income, technology, health policy and healthcare system, prices and wages. Although national income is shown as a factor strongly related to the increase in health spending, when income is analysed at the individual level, the impact is much more limited [20, 21], an issue that can be explained by the presence of collective health insurance for Bismark-type health systems or, as in Spain, the presence of a Beverdige-type public health system with universal coverage.

As we previously pointed out, medical technology progress is often mentioned as the most important driver of increased healthcare expenditure, mainly in acute care [22, 23], essentially related to a significant increase in use [24]. The evidence further shows that medical technology interacts strongly with age and health, that is, population aging reinforces the influence of medical technology on health expenditure growth and vice versa. The present study delves into the relationship between ageing and health technology use to determine whether there is an interaction between both.

Prices and wages are the other two drivers identified by the model. As healthcare systems are labour-intensive, healthcare labour costs may be influenced by the so-called Baumol's cost disease [25], and there is a large literature on this effect in the healthcare sector [26, 27].

2 | METHODS

2.1 | Sample and variables

The data used in this study have been taken from the adult module (over 15 years) of the 2017 Spanish National Health Survey (ENS 2017). The ENS is a national cross-sectional study. The data used in this study correspond to the survey conducted throughout 2017 in a total of 23,860 households and collects health information regarding the Spanish resident population, with a total of 23,089 individuals.

For the present study, and given that the aim is to analyse the effect of aged on public health expenditure, those individuals who did not have public health insurance at the time of the survey in any of the existing modalities in Spain were excluded, with a total of 204 cases being eliminated (0.88% of the sample) as well as those who, having public health coverage, also had private health insurance (3040 individuals, 1.45% of the sample), so that all the sample units analysed only had public health coverage at the time of the survey, totalling 19,845 individuals. In this way, the presence of the so-called enabling factors that directly affect the aims of the present study is controlled.

2.1.1 | Dependent variables

The dependent variables used in this study, all dichotomous with possible YES/NO responses, divided into two groups, are as follows:

Variables related to healthcare services use:

(a) General practitioner (GP) attendance in the last 4 weeks
(b) Specialist doctors attendance in the last 4 weeks
(c) Nurse attendance in the last 12 months.
(d) Emergency room (ER) attendance in the last 12 months.
(e) Hospital admission in the last 12 months

Variables related to the use of health technologies:

(a) Performance of computed tomography (CT) in the last 12 months
(b) Performance of ultrasound in the last 12 months
(c) Performance of magnetic resonance imaging (MRI) in the last 12 months
(d) X-ray performed in the last 12 months
(e) Blood test performed in the last 12 months.
(f) Consumption of drugs prescribed by doctor in the last 12 months

Through these dependent variables we aim to cover a broad spectrum of the consumption of healthcare services and healthcare resources, in such a way as to provide robustness to the results obtained.

The variables related to the performance of diagnostic tests and the consumption of prescription drugs are used as proxies for health technology use, to assess the effect of aged on health technology consumption.

A descriptive analysis of dependent variables is shown in Table 1.

TABLE 1 Descriptive analysis.

	n	%		*n*	%
GP visits	13,479	67.9	CT	1818	9.2
Specialist visits	2636	13.3	Ultrasound	3055	15.4
Nurse visits	3389	17.1	MRI	1674	8.4
ER visits	6032	30.4	X-ray	5289	26.7
Hospital Admission	1794	9.0	Blood test	14,999	75.6
			Prescription drugs use	12,380	62.4

Note: Dependent variables.

2.1.2 | Independent variables

The main independent variable in this study is age, which has been transformed into a dichotomous categorical variable by dividing the sample into two groups: people aged 65 and over (value 1) and people under 65 (value 0).

The control variables are divided into three groups, following the proposed conceptual framework:

Need factor variables: Self-reported health status (SRHS), presence of chronic diseases, and presence of disability.

SRHS, as a proxy for individuals' health status, consists of a five-item ordinal categorical variable. The variable responds to the question asked to respondents: In the last 12 months, how would you say your health has been? and whose response possibilities include five options: Very poor, Poor, Fair, Good and Excellent. In this study, the variable has been recoded (in the original version, 1 indicates "Excellent health" and 5 indicates "Very poor"), to bring the results in line with standard practice on this scale. The SRHS variable is also important in the present study to capture the effects of one of the predisposing factors of the theoretical model, health behaviour, since there is empirical evidence of the association between both variables [28, 29].

Presence of chronic diseases (in the last 12 months) is a dichotomous categorical variable with possible YES/NO responses, and disability consists of a polytomous categorical variable with three categories: Severe disability, nonsevere disability, and no disability, in the last 6 months.

Predisposing factor variables: Gender, cohabitation status (dichotomous) including married or legal cohabitation (as common-law couple), socioeconomic status (three-category polytomous: lower, middle, and upper class) and educational level (four-category polytomous: no education, primary education, secondary education, higher education).

Enabling factors: The main personal enabling factor for the analysis of the consumption of acute healthcare services is the participants' health insurance. The design of the present study allows us to control for this variable, since, as indicated in the sample definition, only subjects who at the time of the survey only had public health insurance were taken for the analysis. Another of the other important enabling factors in the model, individual incomes, cannot be used because the Spanish ENS2017 lacks this variable, using the socioeconomic status included in the predisposing factors as a proxy for its control.

The design of the present study allows to control the social determinants, since by reducing the study sample to only users of the Spanish public health service, as previously mentioned, the variables health policy, organisation healthcare system, wages and prices are controlled. The other important social variable, medical technology, is considered within the group of dependent variables for its analysis.

A descriptive analysis of independent variables is shown in Table 2.

2.2 | Statistical analysis

First, a univariate logistic regression was performed for each of the 11 dependent variables on the main independent variable age, to evaluate the isolated effect of ageing in each of the dependent variables used. Subsequently, multivariate logistic regressions were performed, with the statistical objective of modelling the probability of the occurrence of a given dichotomous event (the dependent variables) in the presence of a series of factors, described in the previous section.

We also run logistic regressions for each of the 11 dependent variables on the main independent variable age, controlled by pooled factors (need, enabling and predisposing). The purpose of this additional evaluation was to check the robustness of the previous results, analysing the effect of the main independent variable controlled only by the (pooled) variables of each of the three-factor groups described in the theoretical framework.

2.3 | Collinearity

Given the possibility of collinearity, especially between the variables that make up the need factors, we performed three checks:

TABLE 2 Descriptive analysis.

	n	%
Age group		
65 years or above	6492	32.7
15–64 years	13,353	67.3
Gender		
Man	9041	45.6
Woman	10,804	54.4
Chronic diseases		
YES	14,015	70.6
NO	5830	29.4
Disability		
No disability	13,752	69.3
Nonsevere disability	4888	24.6
Severe disability	1205	6.1
Self-reported health status		
Excellent	3287	16.6
Good	9516	48.0
Fair	4995	25.2
Poor	1582	8.0
Very poor	465	2.3
Cohabitation		
YES	10,513	53.0
Educational level		
Higher education	4398	22.2
Secondary education	8520	42.9
Primay education	4234	21.3
No education	2693	12.3
Socioeconomic status		
Upper	2876	14.5
Middle	6272	31.6
Lower	10,697	53.9

Note: Independent variables.

First, the correlation matrix of the estimation of the parameters for the model terms, for each of the different models carried out, was analysed, without finding evidence of high correlations between the need factor variables, except relatively high values for the pair Disability-SRHS.

Additionally, a study of collinearity of the variables in all the multivariate models was carried out through the variance inflation factor (VIF), from which it was concluded that there was no collinearity among the selected variables.

Lastly, the models were run consecutively removing the variables (need factors) on which there was suspicion of collinearity (always keeping the SRHS variable in the models), without appreciating significant changes in the regression coefficients. Therefore, the models used were validated.

The results of each regression are presented as odds ratio (OR), with the aim of facilitating their interpretation.

Three levels of significance were taken: <0.1, <0.05 and <0.01.

3 | RESULTS

When we performed the univariate logistic regressions for each of the 11 dependent variables (Table 3), using being over 65 years old as the independent variable, we obtained a higher likelihood of using health resources and technology in all cases, with statistical significance for 10 of the 11 variables analysed (all except the use of ultrasound). Especially striking is the likelihood of using prescription drugs, with an OR of 10.90 (confidence interval [CI]: 9.94–11.95), followed by blood test (OR: 3.17) and, related with health services use, Hospital Admission (OR: 2.61) and General Practitioner visits (OR: 2.25).

The multivariate logistic regression shows (Tables 4 and 5), for the main independent variable, age, and once controlled for the rest of the independent variables, an increase in the individual likelihood of using general practitioner (OR: 1.34), nursing services (OR: 1.7) and

TABLE 3 Univariate logistic regressions.

Dependent variable	OR	Sig	95% CI
Use of health services			
GP visits	2.25	***	2.12–2.4
Specialist doctor visits	1.25	***	1.15–1.37
Nurse visits	2.2	***	2.04–2.38
Hospital admission	2.61	***	2.36–2.87
E.R. use	1.12	***	1.05–1.19
Use of health technologies			
Blood test	3.17	***	2.91–3.44
X-ray	1.6	***	1.49–1.7
CT	1.85	***	1.68–2.04
Ultrasound	1.06		0.97–1.15
MRI	1.18	***	1.06–1.31
Prescription drug use	10.9	***	9.94–11.95

Note: Independent variable: 65 years or above.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 4 Multivariate logistic regressions.

	GP visits			Specialist visits			Nurse visits			E.R. visits			Hospital admission		
	OR	**Sig**	**95% CI**	**OR**	**Sig**	**95% CI**	**OR**	**Sig**	**95% CI**	**OR**	**Sig**	**95% CI**	**OR**	**Sig**	**95% CI**
65 years or above	1.34	***	1.23-1.45	0.86	***	0.77-0.96	1.7	***	1.55-1.87	0.7	***	0.64-0.76	1.5	***	1.33-1.7
Men	0.84	***	0.79-0.91	0.79	***	0.72-0.86	0.82	***	0.76-0.89	0.89	***	0.83-0.95	1.32	***	1.19-1.47
Chronic diseases	1.92	***	1.76-2.11	1.62	***	1.41-1.85	1.82	***	1.61-2.05	1.17	***	1.07-1.28	1.56	***	1.28-1.9
Disability															
No disability	1			1			1		-	1			1		
Non-severe disability	1.39	***	1.28-1.51	1.76	***	1.573-1.967	1.3	***	1.17-1.44	1.45	***	1.33-1.58	1.77	***	1.55-2.02
Severe disability	1.32	***	1.14-1.53	2.06	***	1.728-2.466	1.7	***	1.44-2.01	1.87	***	1.61-2.17	2.78	***	2.3-3.36
Self reported health status															
Excellent	1			1		-	1		-	1		-	1		-
Good	1.36	***	1.22-1.53	1.43	***	1.21-1.7	1.19	**	1.04-1.37	1.24	***	1.12-1.38	1.63	***	1.25-2.13
Fair	2.36	***	2.08-2.68	2.62	***	2.17-3.17	1.48	***	1.26-1.73	2.23	***	1.98-2.53	3.89	***	2.94-5.15
Poor	3.43	***	2.91-4.04	3.86	***	3.1-4.82	1.7	***	1.4-2.06	3.41	***	2.91-4	6.08	***	4.49-8.24
Very poor	3.68	***	2.9-4.67	4.41	***	3.32-5.85	2.27	***	1.75-2.95	4.16	***	3.29-5.27	8.85	***	6.3-12.5
Cohabitation	1.1	***	1.03-1.17	1.22	***	1.11-1.33	1.13	***	1.05-1.23	0.91	***	0.86-0.97	1		0.9-1.11
Educational level															
Higher education	1			1		-	1		-	1		-	1		-
Secondary Education	0.97		0.88-1.07	0.87	**	0.77-0.99	0.98		0.87-1.1	1.03		0.94-1.13	1.1		0.93-1.3
Primay education	0.98		0.88-1.11	0.66	***	0.57-0.77	0.86	**	0.75-0.0	0.95		0.84-1.06	1.02		0.84-1.24
No education	1.03		0.9-1.18	0.6	***	0.5-0.72	0.75	***	0.64-0.0	1.04		0.91-1.19	0.89		0.72-1.11
Socio-economic status															
Upper	1			1			1		-	1			1		
Middle	0.94		0.88-1.01	1.15	***	1.05-1.27	0.99		0.91-1.08	0.96		0.89-1.03	1.09		0.97-1.23
Lower	0.91	*	0.81-1.01	1.31	***	1.14-1.52	0.94		0.83-1.08	0.93		0.83-1.04	1.14		0.94-1.38

Note: Dependent variables related to healthcare services use.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 5 Multivariate logistic regressions.

	CT			Ultrasound			MRI			X Ray			Blood test			Prescription drug use		
	OR	Sig	95% CI	OR	Sig	95% CI	OR	Sig	95% CI	OR	Sig	95% CI	OR	Sig	95% CI	OR	Sig	95% CI
65 years or above	1.16	**	1.03-1.31	0.81	***	0.73-0.89	0.73	***	0.64-0.84	1		0.92-1.09	2.11	***	1.91-2.34	4.81	***	4.29-5.38
Men	1.28	***	1.62-2.36	0.6	***	0.55-0.65	1.08		0.97-1.2	0.94	*	0.88-1.01	0.93	**	0.87-1	0.74	***	0.68-0.8
Chronic diseases	1.96	***	1.16-1.42	1.46	***	1.3-1.64	2.34	***	1.94-2.82	1.52	***	1.38-1.68	2	***	1.84-2.16	7.27	***	6.66-7.93
Disability																		
No disability	1			1			1			1			1			1		
Non-severe disability	1.52	***	1.33-1.73	1.25	***	1.12-1.39	1.91	***	1.67-2.19	1.74	***	1.6-1.9	1.21	***	1.09-1.35	1.61	***	1.43-1.81
Severe disability	2.21	***	1.83-2.68	1.33	***	1.12-1.59	2.06	***		1.84	***	1.58-2.14	1.22	*	0.98-1.54	2.89	***	2.1-3.98
Self reported health status																		
Excellent	1			1			1			1			1			1		
Good	1.59	***	1.24-2.04	1.26	***	1.09-1.45	1.26	**	1.01-1.57	1.29	***	1.14-1.45	1.31	***	1.2-1.43	1.53	***	1.38-1.7
Fair	4.06	***	3.13-5.27	2.32	***	1.97-2.73	2.18	***	1.72-2.78	2.28	***	1.99-2.6	2.13	***	1.88-2.42	3.66	***	3.18-4.2
Poor	5.79	***	4.34-7.74	3.46	***	2.83-4.22	3.83	***	2.92-5.03	3.42	***	2.89-4.04	3.35	***	2.68-4.19	6.39	***	4.85-8.4
Very poor	7.06	***	5.01-9.95	3.67	***	2.8-4.82	5.11	***	2.67-7.11	3.16	***	2.49-4.01	3.12	***	2.16-4.51	7.43	***	4.31-12.82
Cohabitation	1.15	**	1.03-1.27	1.34	***	1.23-1.45	1.22	***	1.09-1.35	1.05		0.98-1.12	1.32	***	1.23-1.41	1.2	***	1.11-1.3
Educational level																		
Higher education	1			1			1			1			1			1		
Secondary Education	1.02		0.87-1.19	0.76	***	0.68-0.85	0.92		0.79-1.07	1.07		0.97-1.18	0.76	***	0.69-0.84	1.05		0.95-1.16
Primay education	0.87		0.72-1.04	0.66	***	0.57-0.75	0.77	***	0.64-0.93	0.99		0.88-1.12	0.77	***	0.68-0.88	1.39	***	1.21-1.59
No education	0.67		0.54-0.83	0.57	***	0.48-0.67	0.66	***	0.53-0.81	0.88	*	0.76-1.01	0.65	***	0.56-0.76	1.35	***	1.12-1.62
Socio-economic status																		
Upper	1			1			1			1			1			1		
Middle	1.14	**	1.02-1.28	1.14	***	1.06-1.27	1.21	***	1.08-1.53	1.02		0.94-1.1	1.13	***	1.04-1.22	0.97		0.89-1.06
Lower	1.18	*	0.99-1.41	1.5	***	1.19-1.54	1.28	***	1.07-1.53	1.07		0.95-1.2	0.98		0.87-1.09	1.1		0.97-1.24

Note: Dependent variables related to the use of health technologies.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 6 OR in pooled factor logistic regressions.

	GP visits	Specialist visits	Nurse visits	Hospitalitation	ER visits
Crude	2.25***	1.25***	2.20***	2.61***	1.12***
Need adjusted	1.36***	0.72***	1.54***	1.39***	0.70***
Predisposing adjusted	1.89***	1.28***	2.20***	2.27***	0.96
Enabling adjusted	2.22***	1.26***	2.19***	2.58***	1.10***
Full adjusted	1.34***	0.86***	1.67***	1.50***	0.70***

	Blood test	X-ray	CT	Ultrasound	MRI	Prescriptions
Crude	3.17***	1.56***	1.85***	1.060	1.18***	10.90***
Need adjusted	1.93***	0.94	0.98	0.69***	0.62***	5.39***
Predisposing adjusted	3.03***	1.434***	1.79***	1.09*	1.15**	7.84***
Enabling adjusted	3.17***	1.58***	1.84***	1.07*	1.19	10.78***
Full adjusted	2.11***	1.00	1.16**	0.81***	0.73***	4.81***

Note: Main independent variable: 65 years or above.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

hospital admission (OR: 1.5). However, the individual likelihood of the use of ER visits (OR: 0.7) and visits to a specialist doctor (OR: 0.86) decrease for the elderly group (in this last case, this result should be taken with caution, because in the Spanish public health system, access to specialists can only be done under the prescription of a general practitioner, so demand is not free). All results are statistically significant.

In relation to the use of health technologies as a dependent variable, the likelihood of using ultrasound and MRI (OR: 0.73) decreases, with statistical significance, with increasing age, while the likelihood of using blood tests (OR: 2.11), CT (OR: 1.16) and especially the use of drugs prescribed by a doctor (OR: 4.81) increases. The use of X-rays is not statistically significant.

In control variables of the multivariate model, we observe that gender, disability, SRHS, chronicity and cohabitation status have, in general, statistically significant effects on the different dependent variables considered.

Regarding gender, being female increases the likelihood of using health services, except hospital admission. Regarding to the use of health technologies, being female increases the likelihood in four of the five significant ones (all except CT).

Chronicity increases the likelihood of use in all the dependent variables analysed. Regarding to disability, the worse the person's situation, the greater the likelihood of using health services and technologies, with statistical significance in all cases. Self-reported health status is also a good predictor of the use of health services and health technology, increasing the likelihood of use the worse the health condition declared by the individual, with statistical significance in all dependent variables analysed.

Cohabitation increases the probability in a statistically significant way of assistance to the general practitioner, specialist doctor and nurse, reducing the possibility of going to ER. Regarding to health technologies, the likelihood of the use of all of them increases, being statistically significant in the cases analysed except in X-ray.

The variable of academic studies completed by individuals shows disparate results. In relation to the use of health services, it shows statistical significance in visits to specialists and nursing consultations, with a lower likelihood of use a lower level of education. In relation to the use of medical technology, a lower likelihood of use is also observed in people with lower levels of education, except in the use of prescribed drugs.

Social class shows us, with statistical significance, a higher likelihood of visiting specialists and a lower likelihood of visiting general practitioners for the lowest levels, as well as a higher probability of using CT, ultrasound and MRI for the lowest social classes.

Finally, the pooled factor logistic regressions (Table 6), used to see the consistency of the results,

show us that, in general terms, the models that control only the need factors have similar OR figures for age variable than the full model. The five health services use models were statistically significant, with very close values of OR between the two; in the case of the health technologies use models, we found four models with statistical significance and close OR values (all except X-ray and CT dependent variables). For the 11 models adjusted for the predisposing factors and the 11 models adjusted for the enabling factors, the OR values were more disparate (i.e., when only the variables of this group are taken into account, and not those of the other two groups), which suggests the preponderant weight that the need factors have over the full model.

4 | DISCUSSION

The gradual increase of the ageing population is one of the main concerns for the sustainability of public health system in European countries. In this study, we have approximated the effect of the elderly population on public health services utilisation, with the important novelty of analysing up to 11 health services and health technologies in the same study.

Thus, the first important finding of this study is that, in public health systems with free and universal coverage such as the Spanish case, aged, although it has a positive effect on the increase in the probability of its use, is not as important in explaining the use of health services (consultations with professionals, hospital admissions), as are, essentially, the so-called need factors, which include the self-perceived state of health, the presence of chronic diseases and the presence of disability, being the three factors that most influence the likelihood of using health services.

The univariate logistic regression shows a statistically significant increase in the likelihood of using all health services with aged, regardless of the type of service (primary care or specialised care) or the origin of the demand for the service (free demand or demand induced by an optional factor). However, when the model is adjusted for the control variables, we observe that the presence of chronicity, disability and poor self-perception explain an important part of the association between old age and use of health services. This effect is powerful enough for all services analysed. These results are confirmed by the pooled regression models. These results confirm the findings of previous studies in Spain for certain services. Regarding consultations with healthcare professionals [30], the previous evidence shows that higher use of Primary Care services in patients with chronic conditions, more for GP than nursing, increases with clinical needs (worse health status, disability, polypharmacy) and age. Other studies [31] find more utilisation of Emergency Rooms in Spanish Health Services related to chronic conditions in elderly patients, as well as in hospital admissions and GP.

In addition, our study finds a weak statistical significance effect for GP use related to socioeconomic status, with a direct relationship between lower use and low socioeconomic status, as previous studies have previously pointed out in European countries [32].

About the use of health technologies, usually pointed out as the main driver of the increase in health expenditure, we observe that age is positively related to the use of less expensive technologies such as blood tests or CT. However, for more expensive technologies such as MRI, the relationship is inverse, such that the probability of using them decreases in older people. Again, it is the presence of chronicity, poor self-perception of health, and the presence of disability variables (within the need factors) that explain the higher probability of use. The use of prescribed drugs is also partly explained by the presence of need factors, but age has a greater explanatory power, as it has been pointed out in previous studies [33, 34]. This may be due to the fact that prescribed drugs are almost free for retired people in Spain.

This way, this study opens up an area of study on how to integrate the effect of health-related healthcare measures into the theoretical model of analysis. As the empirical evidence shows, age is not always, in itself, a driver of public spending, but rather the situations of poor health, chronicity and dependency that are generated, the so-called need factors. In this way, the health policy measures taken before in this area (such as public health, health education or patient follow-up policies from Primary Care) that improve current health are decisive when analysing their effect on public health spending. The analysis of these health measures and their effect can be decisive for the definition of health policies aimed at containing public health spending in the future, especially in determining the levels of public health spending necessary for certain population groups. Some initiatives have already been launched in this regard [35–37].

Within the limitations, it should be noted that, given the nature of the data used in this study, and based on the proposed conceptual framework, it is not possible to take into account the effect of some of the so-called social determinants in health spending, such as are the national income, prices or wages, although the design of the study itself, by taking only public healthcare system users, minimises its effect. Others, such as health policy, medical technology and organisation of the health care

system, have been implicitly or explicitly taken into account. Furthermore, due to the cross-sectional nature of the data, causality cannot be established.

5 | CONCLUSIONS

The growing increase in public spending in developed countries is an aspect of special relevance for politicians and academics, in the concern to achieve the sustainability of public accounts. Within the aforementioned increase, public health spending occupies a special role, since societies are aging and there is greater chronicity.

Thus, knowing the main factors that imply greater public health spending is a topic of special interest in designing efficient health policies. This study shows the relationship between the so-called need factors, above and beyond the effect of ageing itself.

In this way, preventive attention to the so-called need factors may be an important driver to improve the effectiveness of public spending.

AUTHOR CONTRIBUTIONS

Carlos Navarro-García: Conceptualisation; methodology; software; validation; formal analysis; investigation; writing—original draft preparation; writing—review and editing. **Antonio Sarria-Santamera:** Conceptualisation; formal analysis; writing—original draft preparation.

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Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

ETHICS STATEMENT

Not applicable. The public data used in this study were anonymised before its use.

INFORMED CONSENT

Not applicable.

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