ORIGINAL

RELATIONSHIP BETWEEN RESEARCH FUNDING IN THE SPANISH NATIONAL HEALTH SYSTEM AND THE BURDEN OF DISEASE

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ABSTRACT

Background: The Carlos III Health Institute (Instituto de Salud Carlos III - Spain) allocates funding to health research support in the Spanish National Health System (NHS). This study aimed to analyse the correlation of health research fund allocations in the NHS and the burden of disease in Spanish population.

Methods: Cross-sectional study. Burden of disease measures were calculated: disability-adjusted life-years (DALYs), years of life lost (YLLs) and mortality by cause. A correlation analysis (Spearman´s Rho) was applied to test the association between these measures and 2006/2007 health research funding.

Results: Using disease categories (n=21), the correlation between funding and disease-burden measures is: DALY (r=0.72; p<0.001), mortality (r=0.60; p=0.004) and YLL (r=0.56; p=0.008). By disease-specific subcategories (n=52): DALY (r=0.55; p<0.001), mortality (r=0.54; p<0.001) and YLL (r=0.55; p<0.001). Malignant neoplasms, neuropsychiatric conditions, cardiovascular diseases and infectious and parasitic diseases receive the greater health research funding support. However, the higher funds allocated per DALY lost ratios were for blood and endocrine disorders, infectious and parasitic diseases and congenital anomalies.

Conclusions: Our analysis suggests that NHS research funding is positive moderately high-associated with the burden of disease in Spain, although there exists certain disease's categories that are over or under-funded in relation to their burden generated. In health planning, burden of disease studies contributes with useful information for setting health research priorities.

Key words: Health priorities. Research support as topic. Health services research. Burden of illness. Disability-adjusted life years. DALY. Potential Years of Life Lost. PYLL. Mortality.

RESUMEN

Relación en España entre la investigación sanitaria financiada por el Sistema Nacional de Salud y la carga de enfermedad en la comunidad

Fundamento: El Instituto de Salud Carlos III destina parte de sus presupuestos a la financiación de la investigación sanitaria en el ámbito del Sistema Nacional de Salud (SNS). El objetivo del estudio es analizar el grado de correlación de la financiación de la investigación sanitaria en el SNS con el patrón de carga de enfermedad en la población española.

Métodos: Estudio transversal. Se calculan los años de vida ajustados por discapacidad (AVAD), los años de vida perdidos (AVP) y la mortalidad por causa. Se realiza un análisis de correlación (Rho de Spearman) para examinar la asociación entre estas medidas y los fondos de investigación 2006/2007.

Resultados: Por categorías de enfermedad (n=21), la correlación entre la financiación y las medidas de carga de enfermedad es: AVAD (r=0,72; p<0,001), mortalidad (r=0,60; p=0,004) y AVP (r=0,56; p=0,008). A nivel de subcategorías (n=52): AVAD (r=0,55; p<0,001), mortalidad (r=0,54; p<0,001) y AVP (r=0,55; p<0,001). Los tumores malignos, las enfermedades neuropsiquiátricas, las cardiovasculares y las infecciosas y parasitarias son las causas con mayor partida presupuestaria asignada. Por otro lado, las enfermedades endocrinas y de la sangre, las infecciosas y parasitarias y las anomalías congénitas reciben la mayor financiación por AVAD perdido.

Conclusiones: Se observa la existencia de una asociación positiva moderada/alta de las medidas de carga de enfermedad con la financiación de la investigación, si bien existen categorías de enfermedad sobre o infrafinanciadas en relación con la carga que provocan. En planificación sanitaria, la carga de enfermedad aporta información útil a los debates sobre establecimiento de prioridades en investigación.

Palabras clave: Prioridades en salud. Apoyo a la investigación como asunto. Investigación en servicios de salud. Carga de enfermedad. Años de Vida Ajustados por Discapacidad. AVAD. Años Potenciales de Vida Perdidos. APVP.

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INTRODUCTION

Health research is a key instrument for bettering quality and expectancy of life of the population and therefore has to be promoted throughout the whole health system as one of the fundamental elements for its growth. In this sense, the Carlos III Health Institute (*Instituto de Salud Carlos III* – ISCIII), a national public research institution, has the responsibility of promoting and fostering health research in the Spanish National Health System (NHS)[1] and participates in its setting of priorities and planning. For slightly over 20 years now, ISCIII has allocated much of its funding to health research through different formulae that are currently included in the Spanish National Plans for Scientific Research, Development, and Technological Innovation (R&D&I)[2, 3], instrument of the scientific and technological policy of the Spanish Central State Administration. Such encouragement of health research is done through subsidies and financial aid from public funds that the Health Research Fund (HRF) of ISCIII (*Fondo de Investigación Sanitaria* – FIS) grants annually. These grants are competitively awarded and public and private non-profit entities are eligible.

In research, it is necessary to set priorities, just as in so many other activities in which one does not have enough resources so as to attain all possible objectives. The planning and priorities setting is done in order to try to orientate research efforts towards the health needs of the population as well as to adhere to the existing resources. The difficulties to decide on the allocation of public funds are tackled in the literature although several procedures to guide decision making and to inform debates on priorities are acknowledged[4-6]. Along these lines, since earlier editions, the national plans have been justifying the setting of priorities around health problems that would contemplate from the molecular, genetic and pathophysiologic basis to the clinical phases of diagnosis and treatment as well as aspects of community and health services evaluation, preferably of those groups of entities whose social and health interest would be more relevant considering the studies of burden of disease and of personal equity[2, 3].

The burden of disease, whose indicator is the Disability-Adjusted Life Years (DALY), measures the health losses in the population that represent the fatal and non-fatal consequences of diseases, injuries and risk factors associated to them[7, 8]. The advantage of using this summary measure of population health in health policy and planning is that it offers the possibility of compiling in just an indicator the set of epidemiological data of each disease (mortality, incidence, prevalence, duration, disability, severity), thus being useful to measure and compare the health of populations or social groups, to study the evolution of the health of a population or the magnitude of a health problem throughout time, or to use these results as an additional instrument in the definition of health priorities or even in the impact assessment of certain health interventions through the use of efficiency analysis techniques (e.g. cost-effectiveness or cost-utility analyses)[9, 12].

In some international studies[16-21], the action of several institutions has been assessed in regards to the allocation of public resources to health research. An example of this was the investigation carried out by Gross and colleagues[16], where they determined the extent to which the distribution of the funding allocated to the research of 29 conditions or specific diseases from U.S. National Institutes of Health (NIH) was associated to different measures of burden of disease. Because of the limited budgets for financing the research of diseases with different health, economic and social

burdens, the interest in this kind of analysis has progressively risen in the last decade as a systematic way of generating knowledge to orientate future research agendas[8, 13].

In this context, our goal in this study is to analyse the correlation between health research fund allocations in the NHS and the burden of disease in the Spanish population.

METHODS

We did a cross-sectional study calculating the burden of disease in the Spanish population and determining its correlation with the funds allocated to health research in the NHS ambit for the study of specific diseases.

Calculation of the burden of disease in Spain 2006

Following the criteria set by Murray & Lopez in the Global Burden of Disease study[8] carried out by the World Health Organization (WHO), the World Bank and Harvard University, all diseases and injuries have been grouped in accordance with the Burden of Disease Classification (BDC) into 3 broad cause groups: *a)* communicable, maternal, perinatal and nutrirional conditions; *b)* noncommunicable diseases; *c)* accidents and injuries. Each group of diseases is divided into 21 categories (table 1) which, in turn, can be divided into several subcategories. Ill-defined causes and garbage codes have been redistributed following the algorithms proposed by Murray and Lopez[8].

DALYs attributable to each disease or injury are the result of adding the time of life lost due to premature death - Years of Life Lost (YLLs) – and the functional and well-being losses caused by disability and poor health - Years Lived with Disability (YLDs) – (table 2).

YLLs are calculated by multiplying the deaths in each group of age by the life expectancy at the time of death. The data of mortality by gender, age and cause for the year 2006 were taken from the anonymized microdata file of death records of the Spanish National Institute of Statistics (*Instituto Nacional de Estadística* – INE)[14]. Deaths were redistributed according to the BDC's criteria. The life expectancy limit we used is defined in a standard life table which is widely used in the studies of burden of disease (Princeton West level 26 modified)[15]. YLDs, on their part, are calculated by multiplying the incidence by the mean duration of the disease and by a value that weights the seriousness of the disability – 0 (full health) to 1 (death) scale–.

In this study, as in others with similar characteristics[16-25], we applied an indirect method of YLDs estimates measurement developed in the Global Burden of Disease project[8] that requires the information corresponding to a reference population detailed by gender, age and cause for YLLs and YLDs, and the structure by gender and age of mentioned population, as well as the YLLs of the population whose burden of disease is to be calculated. For this, we took the European subregion with very low mortality (Euro-A) defined by the WHO[26], to which Spain belongs. We used the information corresponding to the last estimation made by the WHO at the time of analysis[28], applying the YLDs/YLLs ratio by cause, gender and age corresponding to the Euro-A subregion to the YLLs calculated directly for the Spanish population. For those causes that have very low mortality but high disability, in which the YLDs/YLLs ratio is very unstable, the followed method suggests to estimate the YLDs applying the YLDs rate of the reference population (Euro-A) to the population under study (Spain).

Table 1

Burden of disease classification (n = 21 categories)

Disease classification	ICD-10 code
10100. Infectious and parasitic diseases	A00–B99, G00, G03–G04, N70–N73
10200. Respiratory infections	J00–J06, J10–J18, J20–J22, H65–H66
10300. Maternal conditions	O00–O99
10400. Perinatal conditions	P00–P96
10500. Nutritional deficiencies	E00–E02, E40–E46, E50, D50–D53, D64.9, E51–E64
20100. Malignant neoplasms	C00–C97
20200. Other neoplasms	D00–D48
20300. Diabetes mellitus	E10–E14
20400. Endocrine and blood disorders	D55–D64 (minus D64.9), D65-D89, E03–E07, E15–E16, E20–E34, E65–E88
20500. Neuropsychiatric conditions	F01–F99, G06–G98
20600. Sense organs disorders	H00–H61, H68–H93
20700. Cardiovascular diseases	I00–I99
20800. Respiratory diseases	J30–J98
20900. Digestive diseases	K20–K92
21000. Diseases of the genitourinary system	N00–N64, N75–N98
21100. Skin diseases	L00–L98
21200. Muskuloskeletal diseases	M00–M99
21300. Congenital anomalies	Q00–Q99
21400. Oral conditions	K00–K14
30100. Unintentional injuries	V01–X59, Y40–Y86, Y88, Y89
30200. Intentional injuries	X60–Y09, Y35–Y36, Y870, Y871

Adapted from Mathers CD at al. (2004).

Table 2

Simplified formula for calculating Disability Adjusted Life Years – DALY –

$$DALY = YLL + YLD$$

$$YLL = \sum_{0}^{L} d_i * e_i$$

$$YLD = \sum_{0}^{L} N_i * I_i * T_i * D$$

YLL, Years of Life Lost; d, number of deaths at each age group; e, standard life espectancy at the mean age of death; YLD, Years Lived with Disability; N, population susceptible at each age group; I, incidence at each age group; T, average duration of disease by age of onset, measured in years; D, disability weight (range 0-1, best health = 0, and death = 1); L, standard life expectancy for each age and sex obtained from Princeton Model Life Table with Level West 26 modified.

The Spanish population we used was the INE estimate as of July 1st, 2006, a total of 44,068,244 people[27]. As in the Global Burden of Disease study[8, 28], we have incorporated into the calculations the following social value choices: discounting at 3% (time preference), which makes a present benefit more valuable than that same benefit obtained in the future, and age-weighting (K=1), attributing a higher weight to the deaths or disabilities in young adults. We used the Gesmor software package[29].

Research projects analysis and distribution of disease-specific funding allocated

The grants given to carry out projects and studies through the Promotion of Biomedical and Health Sciences Research Program in the grant funding opportunities call for proposals of the years 2006 and 2007 within the framework of the Spanish National Plan for R&D&I 2004-2007[30, 31] were object of the study. Specifically, we included: *a)* research projects[32, 33], *b)* research on health services and health technology assessment studies[34, 35], and *c)* non-commercial clinical research projects with drugs intended for human use[36].
We selected the projects that were evaluated

and approved in the last two proposal call announcements for grant funding, having identified them previously in available records (HRF data bases). Later, we did a systematic review so as to classify the projects (and the allocated funds) within each group, category and subcategory of the BDC. Although the revision and classification phase was carried out by epidemiologists, expert clinicians' opinion was needed at times. The projects were classified according to the title/name of the study, paying attention to the main cause of disease. For those projects that could be classified into more than one cause of disease, funding was proportionately distributed among the pathologies they involved. Such a criterion was valid among the several categories and subcategories and has been used in other published studies[16, 19].

Finally, the *research funds allocated* (in euros) *per DALY lost ratio*, was obtained by dividing the total funding allocated to the research of the several disease categories/subcategories by the total DALYs lost corresponding to each of them.

Statistical analysis

We did a bivariate correlation analysis using software SPSS 15.0 with Spearman's non-parametric correlation coefficient (Rho) to test the direction and strength of linear association between quantitative variables in proportional scale (the measures of burden of disease and the funding of health research). The level of statistical significance was established at 0.05 (confidence level of 95%).

RESULTS

The burden of disease in Spain 2006

It is estimated that 5,025,472 DALYs were lost in Spain in 2006, at a rate of 11,404 DALYs per 100 thousand inhabitants. Of them, 57.7% (2,901,871 YLDs) were caused by disability or poor health, and 42.3% (2,123,602 YLLs) were due to premature death. The leading causes in number of DALYs were neuropsychiatric conditions (31.8% of the total) coming before malignant neoplasms (15.9%), cardiovascular diseases (12.3%) or respiratory diseases (7.5%). Notable among the diseases subcategories causes were the DALY's weight of unipolar depressive disorders (8.8%), dementias (7.6%), ischemic heart diseases (4.5%), alcohol use disorders (4.1%), lung cancer (3.4%) or cerebrovascular disease (2.9%) as leading causes of burden of disease (table 3).

Funding of health research 2006/07 allocated to the study of diseases

A total of 1,615 projects were revised, 87.3% (n=1,410) of which were finally included in the analysis. Of them, 3.8% (n=53) shared more than one disease category/subcategory. Two hundred and five (n=205) projects were excluded, because they did not aim to study specific diseases.

According to data provided by the HRF, during the study period, 139.6 million euros (82.3 million in 2007 and 57.3 million in 2006) were allocated as grants to undertake projects and/or studies, 90.0% (125.6 million euros) of which could be included and classified in specific disease categories (n=21) and subcategories (n=52) (table 3). By disease categories, malignant neoplasms, neuropsyquiatric conditions, cardiovascular diseases and infectious and parasitic diseases were the causes to which the largest

Table 3

Burden of disease measures and health research funding by categories (n=21) and selected subcategories* (n=52)

Code	Classification	DALY (thousand)	%	YLL (thousand)	%	Mortality (thousand)	%	Funds (thousand €)	%	Funds (€) per DALY
	Communicable, maternal, perinatal and nutricional	**247.7**	**4.9**	**133.1**	**6.3**	**17.6**	**4.7**	**17,474.9**	**13.9**	**70.6**
10100	Infectious and parasitic diseases	113.7	2.3	66.9	3.1	7.4	2.0	12,344.9	9.8	108.6
	HIV/AIDS	36.9	0.7	28.1	1.3	1.4	0.4	4,026.5	3.2	109.1
	Diarrhoeal diseases	11.5	0.2	1.5	0.1	0.4	0.1	975.4	0.8	84.8
	Hepatitis B and C	10.3	0.2	8.9	0.4	1.0	0.3	974.4	0.8	95.0
	STD	8.9	0.2	0.2	0.0	0.0	0.0	22.6	0.0	2.5
	Meningitis	4.9	0.1	3.0	0.1	0.2	0.1	277.1	0.2	56.2
	Tuberculosis	4.6	0.1	2.9	0.1	0.4	0.1	840.4	0.7	182.0
10200	Respiratory infections	36.6	0.7	31.6	1.5	8.8	2.4	2,215.5	1.8	60.6
	Lower respiratory infect.	32.7	0.7	31.3	1.5	8.8	2.4	1,693.4	1.3	51.7
	Otitis media	3.2	0.1	0.0	0.0	0.0	0.0	36.3	0.0	11.3
	Upper respiratory infect.	0.6	0.0	0.3	0.0	0.1	0.0	6.1	0.0	10.0
10300	Maternal conditions	18.2	0.4	0.4	0.0	0.0	0.0	1,569.5	1.2	86.3
10400	Perinatal conditions	49.2	1.0	33.2	1.6	1.0	0.3	958.5	0.8	19.5
10500	Nutritional deficiencies	30.1	0.6	1.1	0.1	0.3	0.1	386.5	0.3	12.8
	Non communicable	**4,441.0**	**88.4**	**1,748.8**	**82.4**	**337.8**	**90.9**	**107,085.1**	**85.2**	**24.1**
20100	Malignant neoplasms	797.7	15.9	720.2	33.9	101.0	27.2	26,992.3	21.5	33.8
	Lung	171.4	3.4	166.4	7.8	21.1	5.7	1,008.7	0.8	5.9
	Colon and rectum	101.3	2.0	84.0	4.0	14.3	3.8	1,865.1	1.5	18.4
	Breast	70.6	1.4	58.2	2.7	6.6	1.8	3,856.6	3.1	54.6
	Stomach	42.4	0.8	40.6	1.9	6.2	1.7	466.5	0.4	11.0
	Pancreas	37.9	0.8	36.9	1.7	5.3	1.4	464.6	0.4	12.3
	Lymphoma, myeloma	33.7	0.7	31.9	1.5	4.5	1.2	1,508.3	1.2	44.8
	Liver	32.5	0.6	31.9	1.5	4.8	1.3	646.3	0.5	19.9
	Bladder	31.9	0.6	25.2	1.2	4.9	1.3	942.7	0.8	29.5
	Brain	30.7	0.6	29.9	1.4	2.7	0.7	1,133.7	0.9	37.0
	Leukaemia	28.9	0.6	27.6	1.3	3.4	0.9	2,149.6	1.7	74.5
	Prostate	27.5	0.5	21.8	1.0	5.8	1.6	813.5	0.6	29.6
	Mouth, oropharynx	23.9	0.5	22.3	1.1	2.3	0.6	80.3	0.1	3.4
	Ovary	19.1	0.4	16.8	0.8	1.9	0.5	444.6	0.4	23.3
	Corpus uteri	19.1	0.4	9.5	0.4	1.5	0.4	451.4	0.4	23.6
	Oesophagus	16.5	0.3	16.0	0.8	1.9	0.5	7.0	0.1	4.4
	Kidney	15.9	0.3	14.7	0.7	2.1	0.6	233.3	0.2	14.7
	Larynx	14.6	0.3	13.7	0.6	1.7	0.4	93.8	0.1	6.4
	Melanoma	11.9	0.2	11.0	0.5	1.4	0.4	909.7	0.7	76.6
	Cervix uteri	9.5	0.2	7.7	0.4	0.7	0.2	936.0	0.7	98.7
	Bone and cartilage	5.8	0.1	5.5	0.3	0.3	0.1	200.6	0.2	34.7
	Thyroid	2.0	0.0	1.8	0.1	0.3	0.1	73.2	0.1	37.1
20200	Other neoplasms	21.4	0.4	21.4	1.0	3.5	0.9	182.1	0.1	8.5
20300	Diabetes mellitus	84.4	1.7	39.3	1.8	10.0	2.7	2,726.7	2.2	32.3
20400	Endocrine & blood disorders	59.5	1.2	19.4	0.9	2.8	0.8	6,863.9	5.5	115.3
20500	Neuropsychiatric conditions	1,599.5	31.8	110.9	5.2	28.7	7.7	21,248.7	16.9	13.3
	Unipolar depression	444.7	8.8	0.2	0.0	0.1	0.0	1,779.5	1.4	4.0
	Dementias	381.3	7.6	56.0	2.6	21.9	5.9	2,473.8	2.0	6.5
	Alcohol use disorders	208.4	4.1	3.6	0.2	0.3	0.1	31.8	0.0	0.2
	Migraine	79.6	1.6	0.0	0.0	0.0	0.0	222.0	0.2	2.8

Table 3 *(continued)*

Burden of disease measures and health research funding by categories (n=21) and selected subcategories* (n=52)

Code	Classification	DALY (thousand)	%	YLL (thousand)	%	Mortality (thousand)	%	Funds (thousand €)	%	Funds (€) per DALY
20500	Drug use disorders	70.0	1.4	2.3	0.1	0.1	0.0	1,423.6	1.1	20.3
	Bipolar disorders	68.3	1.4	0.1	0.0	0.0	0.0	198.9	0.2	2.9
	Schizophrenia	64.1	1,3	1.0	0.0	0.1	0.0	2,291.3	1.8	35.8
	Parkinson disease	30.2	0.6	8.5	0.4	2.6	0.7	979.4	0.8	32.4
	Obsessive-compulsive disorder	28.7	0.6	0.0	0.0	0.0	0.0	362.5	0.3	12.6
	Epilepsy	13.9	0.3	4.8	0.2	0.4	0.1	290.2	0.2	20.9
	Multiple sclerosis	10.1	0.2	2.3	0.1	0.2	0.0	945.8	0.8	93.2
20600	Sense organ disorders	260.0	5.2	0.0	0.0	0.0	0.0	3,704.8	2.9	14.3
	Glaucoma	11.1	0.2	0.0	0.0	0.0	0.0	269.8	0.2	24.3
20700	Cardiovascular diseases	618.2	12.3	517.9	24.4	124.8	33.6	19,865.8	15.8	32.1
	Ischaemic heart disease	227.0	4.5	194.5	9.2	38.5	10.4	3,651.3	2.9	16.1
	Cerebrovascular disease	145.1	2.9	130.3	6.1	34.0	9.2	2,947.1	2.3	20.3
	Inflammatory heart disease	50.2	1.0	30.4	1.4	6.3	1.7	777.8	0.6	15.5
	Hypertensive disease	26.1	0.5	21.2	1.0	6.9	1.9	658.9	0.5	25.2
20800	Respiratory diseases	377.4	7.5	123.7	5.8	31.7	8.5	5,822.2	4.6	15.4
	COPD	114.4	2.3	56.8	2.7	16.6	4.5	2,418.4	1.9	21.1
	Asthma	67.4	1.3	4.0	0.2	0.8	0.2	1,036.8	0.8	15.4
20900	Digestive diseases	225.9	4.5	120.8	5.7	20.0	5.4	6,475.0	5.2	28.7
	Cirrhosis	61.4	1.2	49.6	2.3	4.9	1.3	2,336.9	1.9	38.0
21000	Genito-urinary diseases	63.8	1.3	33.0	1.6	9.7	2.6	3,819.8	3.0	59.9
	Nephritis, nephrosis	24.3	0.5	23.1	1.1	6.6	1.8	2,270.3	1.8	93.4
21100	Skin diseases	10.4	0.2	3.4	0.2	1.1	0.3	182.0	0.1	17.5
21200	Muskuloskeletal diseases	234.8	4.7	11.4	0.5	3.5	0.9	4.394.1	3.5	18.7
	Osteoarthritis	124.0	2.5	0.2	0.0	0.1	0.0	549.6	0.4	4.4
	Rheumatoid arthritis	41.5	0.8	1.2	0.1	0.2	0.1	1,458.7	1.2	35.1
21300	Congenital anomalies	49.3	1.0	27.2	1.3	1.0	0.3	4,726.5	3.8	95.8
21400	Oral conditions	38.8	0.8	0.1	0.0	0.0	0.0	81.3	0.1	2.1
	Accidents and injuries	**336.8**	**6.7**	**241.6**	**11.4**	**16.1**	**4.3**	**1,066.1**	**0.8**	**3.2**
30100	Unintentional injuries	268.9	5.4	180.7	8.5	12.5	3.4	760.8	0.6	2.8
30200	Intentional injuries	67.8	1.3	60.9	2.9	3.6	1.0	305.4	0.2	4.5
	Total	**5,025.5**	**100**	**2,123.6**	**100**	**371.5**	**100**	**125,626.2**	**100**	**25.0**

* The subcategories shown do not include all of the diseases in each category, and therefore do not add up to 100% of their corresponding category.

DALY, Disability-Adjusted Life Years; YLL, Years of Life Lost; Mortality, as the number of deaths by cause; HIV/AIDS, Human Immunodeficiency Virus – Acquired Immunodeficiency Syndrome; STD, Sexually Transmitted Diseases; COPD, Chronic Obstructive Pulmonary Disease.

Figure 1

Scatter-plot representing Disability Adjusted Life Years and research funding by 21 disease categories

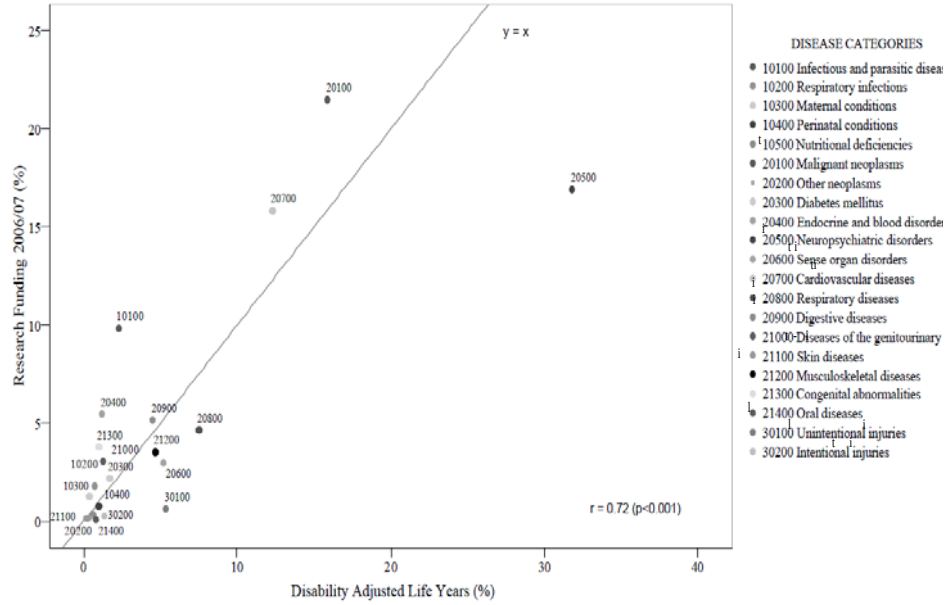
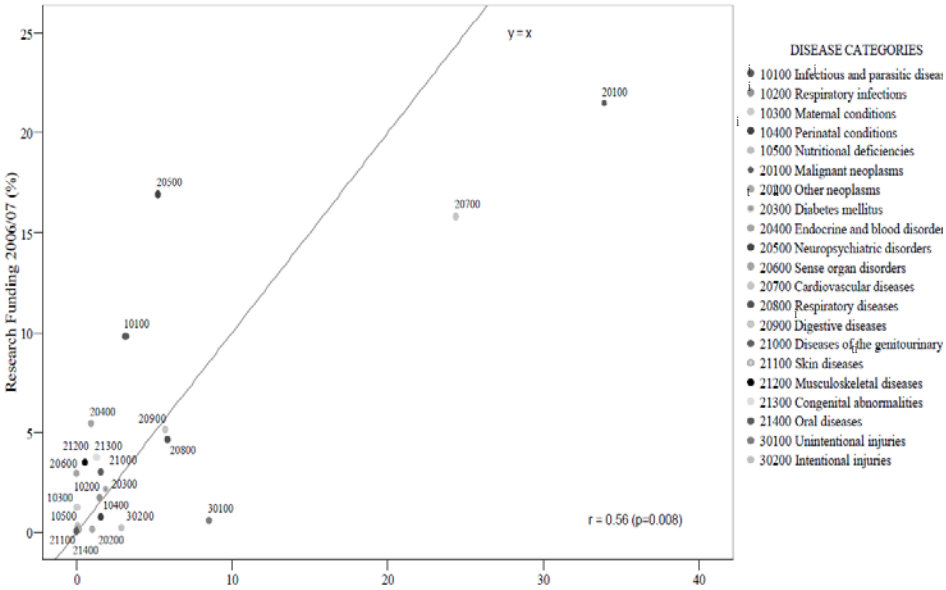


Figure 2

Scatter-plot representing Years of Life Lost and research funding by 21 disease categories



proportion of budget was allocated (64.0% of the total). The subcategories that received more funding were HIV/AIDS (3.2%), breast cancer (3.1%), ischemic heart disease (2.9%) and cerebrovascular disease (2.3%). Among the selected causes for this study, upper respiratory infections, sexually transmitted diseases and alcohol use disorders were the subcategories with less funding in the analyzed period.

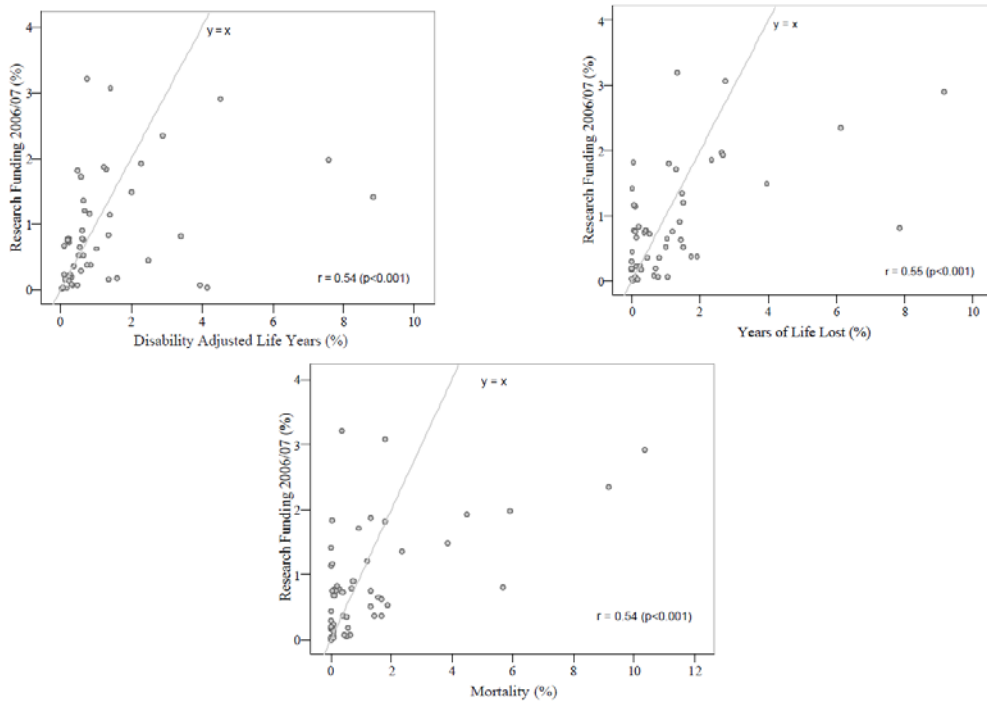
Association between the burden of disease and health research funding

By disease categories, a high correlation was observed between funding and disease burden measures with a positive association at the level of statistical significance applied (figures 1-2). The correlation between the research funds and the DALYs was 0.72 ($p<0.001$), being this the highest correlation we found. Likewise, an association was found for other indicators such as YLLs and proportional mortality, with correlations of 0.56 ($p=0.008$) and 0.60 ($p=0.004$), respectively. The analysis of the main disease subcategories also showed a positive association (figure 3), moderate and statistically significant: 0.54 ($p<0.001$) for proportional mortality, and 0.55 ($p<0.001$) for DALYs and YLLs.

Endocrine and blood disorders, infectious and parasitic diseases and congenital anomalies were the disease categories that most financing received per each DALY lost (see table 3). By subcategories, it is worth mentioning that tuberculosis, HIV/AIDS, cervix uteri cancer, hepatitis B C, nephritis and nephrosis and multiple

Figure 3

Scatter-plots representing disease-burden measures and research funding by 52 disease specific subcategories



sclerosis were the specific causes with most funds allocated per DALY lost.

On the contrary, some neuropsychiatric conditions (e.g. alcohol use disorders, migraine, bipolar affective disorders, unipolar depressive disorders), some specific cancers (e.g. mouth, pharyngoesophageal, lung cancer), unintentional injuries or sexually transmitted diseases, were the causes that had the lowest *research fund allocated per DALY lost ratios*.

DISCUSSION

According to the current Spanish National Plan for R&D&I 2008-2011[3] and to the Quality Plan for the NHS[37], in Spain, the burden of disease should be a criterion for setting priorities in the NHS. This is the first study carried out in the Spanish NHS ambit that evaluates results of the setting of priorities in objective methods of burden of disease assessment, which has permitted observing the existence of a positive moderately high-association between these health outcomes measures and the research funding from the ISCIII. These results would be in keeping with earlier studies done in countries such as the U.S.[16, 17] (National Institutes of Health – NIH, Centers for Disease Control and Prevention – CDC), Canada[18] (Medical Research Council of Canada – MRCC), Australia[19] (National Health and Medical Research Council – NHMRC) or United Kingdom[20, 21] (National Cancer Research Institute – NCRI, UK Clinical Research Collaboration – UKCRC), although the different periods studied and some methodological differences makes difficult a direct comparison between works.

Planning in research is a complex, dynamic and evaluable process in which clinical, epidemiological, socio-economic, political, and other factors meet. So as to set priorities, one can resort mainly to two types of approach[38] : technical assessments through epidemiological or socio-economic data using quantitative methods (e.g. burden of disease studies), and subjective approximations based on implicit evaluations from peer reviewers using qualitative consensus methods or other group techniques, consulting with key agents, etc[39]. Each of the methods suggested in the literature has its pros and cons, but "the transparency and corresponsibility in the process are favoured if the criteria are explicit and the several agents involved: politicians, professionals, researchers, patients and citizens, are committed"[40]. Generally, the actions relating to these processes require the awareness of the population health status. The information from the burden of disease studies make possible that funds are allocated to predetermined goals using a concrete and, in our opinion, solid methodology from a public health point of view.

While the information from these studies can be used as measurement unit of health outcomes in explicit cost-effectiveness (or cost-utility) analyses, the burden of disease on its own does not permit the measurement of the efficiency of the short-medium term allocation of resources to research. Therefore, the fact that the burden of disease is larger for one condition does not necessarily imply larger health benefits allocating more resources, in the same way that the existence of effective health interventions does not guarantee a better use of them in terms of effectiveness, efficiency or equity and accessibility to health services. Therefore, it would be convenient to consider some of these variables as well as the potential gains attributed to research, the use of number of DALYs or other alternative indices being a possibility for doing this[41, 42]. Despite the limitations and difficulties in the

measurement of these results, the explanation of some of these aspects could contribute to a better understanding of the research carried out in the NHS. In economic terms, marginal productivity of the investments in research and innovation could also be an aspect to consider.

In other published analyses, where the range of variation in the data was wide, the variables transformation to logarithmic scales was proposed, and fit tests for normality were used in the variables distribution with the intention of applying a regression analysis that would allow the obtention of projections based on observed values to set future funding needs, assuming the adoption of the burden of disease as the only criterion in the decisions on funding. This last point transcends the goals of this particular study, which limited itself to correlate the relative distributions of both variables, funding and burden of disease, although the methods suggested by other authors[16, 17] will be applied in future analyses to identify needs in specific disease categories or topic areas and to provide with complementary information for the setting of priorities on the allocation and reorientation of research funds.

Some of the limitations of these studies have to do with refer to the parameters used for the calculation of DALYs, such as social preferences to establish the disability weight, the discount rate to be applied and the weighting of years as a function of age. The grounds for the inclusion of these parameters have been widely debated in the scientific literature[43-47]. An uncertainty assessment for these variables was done by means of a sensitivity analysis based on the recommendations given by the WHO in the Global Burden of Disease study[8, 28]. This permitted testing the robustness of the burden of disease model faced with changes in parameters such as the discounting (e.g. without applying discounting) and the age-weighting (e.g. without weighting; K=0).

The analyses of DALYs estimated for the Spanish population along with the funding permits stating that there are groups of categories that receive more funds than burden they generate. Generally speaking, these coincide with the main causes of mortality. Such is the case, for instance, of malignant neoplasms and cardiovascular diseases, which represent 28.2% of burden of disease and 37.7% of funding. A similar situation occurs with infectious and parasitic diseases (2.3% of the total DALYs) or endocrine and blood disorders (1.2% of DALYs), with 9.8% and 5.5% of funding respectively. Quite the opposite occurs with neuropsychiatric conditions, first cause of burden of disease (31.8% of total DALYs), where disability or poor health are much higher than mortality (6.9% YLLs), and to which, despite being the second category in receiving the most funding, only 16.9% of the total funding was allocated.

With reference to research funding in the NHS, excluding research financed by the pharmaceutical and health products industry, funding comes mostly from the ISCIII which works as a funding organization through the HRF. In our opinion, the activities object of this study can be considered representative of the health research promotion measures carried out by the NHS, although it would be interesting to increase the number of call announcements opportunities for these grants in the future, or grants that go to the promotion and strengthening of the stable cooperative research structures and biomedical research network centers, also other budget items that would incorporate actions other than those specifically aimed at the NHS (e.g. fundamental research projects, applied research projects, innovation projects, etc.)

that are included in other programs of the Spanish National Plan for R&D&I[2, 3] as well as the need for analyses of the distribution of funding by topic areas (basic, clinical or in epidemiology and public health research).

There are other types of grant funding opportunities that have not been considered here (e.g. grants given by the Spanish Regional Governments, European programs or other grants coming from public and private non-profit organizations, etc.). This last point leads us to a new consideration. The explicit understanding of how these actions, along with those that are carried out from the private sector, influence the NHS's capacity of attaining its goals, and of how the cross-sector relations or agreements can give rise to several interactions, must be object of reflection, arising the following question: Should public funding adjust itself to the DALYs distribution or should it be the totality of the research in the public and private sectors which does that? Or, indeed: To which extent should public funding cover the research and innovation considered as a social priority but to which the market is not able to allocate funding because it perceives that the potential gains do not justify the opportunity cost of the investment? Such point could be the case of topic areas that are overlooked, poorly developed or present among traditionally disadvantaged population groups (e.g. rare diseases, some infectious and parasitic diseases, the paediatric population, etc.).

The world integration or *globalization* that has been accelerating for the past decades is another aspect worthy of consideration since, logically, it also affects health research. As the integration grows, technological progress accelerates. In fact, the research and development of innovative health interventions carried out by countries with stable scientific and technological policies is allowing other countries' populations to improve their health and welfare.

Finally, in the light of the methodological and practical limitations that can be present in this study, it seems necessary to insist on the convenience of keeping to the initiated line of work, fostering the collaboration and consensus among all agents involved. It is difficult to set priorities on the basis of a single criterion because of the already mentioned complexities. Burden of disease studies let us present the dimension of a population's health problems, provide knowledge about the relative and absolute importance of diseases and, therefore, contribute to the setting of priorities. It is worth recalling that there are other criteria (e.g. quality of the proposals, relevance of the projects, value of transfer to clinical practice, structure and quality of the research team, scientific opportunities, etc.) that also will have to be taken into account by decision-makers, managers and evaluators in their decision making.

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