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Special article

Evolution and Scientific Impact of Research Grants From the Spanish Society of Cardiology and Spanish Heart Foundation (2000-2006)

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A B S T R A C T

Introduction and objectives: The *Sociedad Española de Cardiología* (Spanish Society of Cardiology) every year awards grants to finance research in the field of cardiovascular diseases. The aim of this study is to identify the impact of these investments during the period 2000-2006 from the subsequently published articles in scientific journals.
Methods: Using the identifying data of each project as search terms, all articles that resulted from these grants were located in the Spanish *Índice Médico Español* and *Índice Bibliográfico Español en Ciencias de la Salud* databases, and in Science Citation Index-Expanded and Scopus. Descriptive statistical analysis of these articles included type of grant, number and amount awarded per year, and the recipient's sex and institutional affiliation.
Results: The *Sociedad Española de Cardiología* awarded €3 270 877 to 207 recipients, an average annual total of €467 268, We identified 231 publications that resulted from 123 (59.42%) of these grants. The average number of articles per grant awarded was 1.12, and 1.9 when taking into account only the awards that led to publication.
Conclusions: During the period 2000 to 2006, the *Sociedad Española de Cardiología/ Fundación Española del Corazón* (Spanish Heart Foundation) provided about €500 000 per year to fund research grants, thereby contributing to the fight against cardiovascular diseases. Almost 60% of grants have led to publications, 73% of which were published in international journals, and 91.34% in national or international journals with an impact factor in the Journal Citation Reports.

Evolución y repercusión científica de las becas de investigación de la Sociedad Española de Cardiología y la Fundación Española del Corazón (2000-2006)

Palabras clave:
Becas de investigación
Sociedad Española de Cardiología
Publicaciones derivadas
Producción científica

R E S U M E N

Introducción y objetivos: La Sociedad Española de Cardiología convoca anualmente becas para financiar proyectos de investigación en el campo de las enfermedades cardiovasculares. Nuestro objetivo es identificar la repercusión de estas inversiones durante el periodo 2000-2006 a partir de los artículos derivados de las becas y publicados en revistas científicas.
Métodos: Utilizando los datos de identificación de cada proyecto como términos de búsqueda, se recuperaron todos los artículos derivados de estas becas en las bases de datos del Índice Médico Español, el Índice Bibliográfico Español en Ciencias de la Salud, el *Science Citation Index-Expanded* y *Scopus*. Los artículos se sometieron a un análisis estadístico descriptivo en relación con la tipología de las becas, la evolución anual de su número y de su importe, el sexo y las instituciones de los becados.
Resultados: Se concedieron 207 becas con un importe total de 3.270.877 € y una dotación media anual de 467.268 €. De ellas, 123 (59,42%) aportaron publicaciones derivadas. El promedio de artículos publicados por beca concedida ha sido de 1,12, y de 1,9 si se tiene en cuenta únicamente las becas que dieron lugar a publicaciones.
Conclusiones: Durante el periodo 2000-2006, la Sociedad Española de Cardiología/Fundación Española del Corazón destinó casi 500.000 € anuales a financiar becas de investigación y así contribuir a luchar

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contra las enfermedades cardiovasculares. Casi el 60% de las becas han aportado publicaciones derivadas, 231 artículos. El 73% de los artículos se publicaron en revistas extranjeras y el 91,34%, en revistas españolas o extranjeras con factor de impacto en el *Journal Citation Reports*.

Abbreviation

SEC/FEC: *Sociedad Española de Cardiología* (Spanish Society of Cardiology)/*Fundación Española del Corazón* (Spanish Heart Foundation)

INTRODUCTION

Cardiovascular diseases are the main cause of morbidity and mortality in the European Union, the United States and the most developed countries in the world and they are responsible for about 30% of deaths in the world. According to the World Health Organization (WHO), 17 million people die every year from cardiovascular diseases.[1] The health care costs from cardiovascular diseases are estimated at €296 billion in the United States and €169 billion in the European Union.[2] However, efforts taken to treat and control cardiovascular diseases and the funding allocated to research in this field are not considered to be sufficient today.[2–5]

The official research funding bodies may come from different areas (regional, national or supranational) but these do not always cover research in all the health areas considered important by the scientific associations. The role that these bodies play in the funding of certain diseases is very important as they can help to finance some of the gaps that exist in the research subsidized by public bodies. This is the case of entities such as the British Heart Foundation,[6] the National Heart, Lung, and Blood Institute in the United States,[7] the Netherlands Heart Foundation,[8] the Danish Heart Foundation,[9] and the National Heart Foundation of Australia,[10] among others.

In Spain, the Spanish Society of Cardiology (*Sociedad Española de Cardiología* [SEC]) every year finances experimental and clinical research projects through its yearly call for applications for Grants, Awards, and Financial Assistance. The investment is financed from the overall budget of the *Casa del Corazón* Foundation made up of the SEC and Spanish Heart Foundation (*Fundación Española del Corazón* [FEC]), and also funded by SEC departments and working groups and by contributions from industries, foundations, and businesses that collaborate with the Foundation. A sign of this growing interest is the fact that the number of awards increased from 15 in 2001 to 39 in 2004.

In accordance with current scientific practice, research projects must be published in a medium with a sufficiently large audience.[11] This has become clearly institutionalized and is accomplished through the scientific journals, meaning that an article must appear in a journal with a sufficiently large readership as reflected in databases of the relevant literature for it to be considered valid by the international community.[12] The scientific impact of the investment made by the SEC/FEC in grants for cardiovascular research is unknown, as the resulting publications and their influence on the scientific community (as reflected in citations and impact) has not been analyzed. The aim of this study was to analyze the evolution of the awards made by the SEC/FEC from 2000 to 2006, as well as identifying and describing their impact based on the articles published in scientific journals as a result of these research grants in cardiology.

METHODS

Selecting the Databases

We searched for the articles resulting from the grants and funded projects in 5 Spanish and international databases of scientific literature: *Índice Médico Español* (*IME*) from the *Consejo Superior de Investigaciones Científicas* (Spanish National Research Council), *Índice Bibliográfico Español en Ciencias de la Salud* (*IBECS*) from the *Instituto de Salud Carlos III* (Carlos III Health Institute), Science Citation Index-Expanded (through Thomson Reuters's Web of Science) and Scopus, which includes all of the Medline journals.

The study covered a 7-year period (2000-2006). We decided to use 2006 as the end date to allow time for relevant articles to be published and circulate in the literature databases. The study included all research articles in the strictest sense (original articles, letters to the editor, editorials, and review articles).

Search Strategy to Locate Articles Resulting From the Grants Awarded

We followed a search methodology similar to that employed by other authors.[13–15] The aim was to ensure data accuracy by combining various search criteria: surname(s) of the lead researcher, researcher's institution, and keywords of the project title, including synonyms and acronyms. The identifying information on each project (lead researcher and institution, project title, type of grant, amount, and year of award) was provided by the SEC. A medical doctor specialized in medical documentation and a doctoral researcher specialized in documentation performed the searches.

The first phase consisted of collecting and selecting all the articles found in the searches where the project title and article title matched exactly or almost exactly, as long as these articles had been published in the year of the grant award or later. In case of a partial match, a cardiologist looked at and reviewed each article to determine its relevance to the original project.

The second phase involved sending an e-mail to all those who had received a grant to confirm the results obtained. The message asked them to send any publications that they believed had resulted from their grants. Only 30% of those who participated in the projects replied to this e-mail. Although we do not know why this figure was so low, it is probably due to several reasons: lack of interest; oversight or uncertainty, as the project had been awarded long ago; or lack of publication, interpreted as meaning that it was not necessary to reply. The articles received that were different from those selected during the initial literature search were included in the study after a quick review and selection process to make sure that they actually resulted from grants awarded by the SEC/FEC.

Of the 231 articles recovered, 189 (81.81%) were obtained by searching the databases, while 42 (19.19%) came from the authors' replies. It must be mentioned that these replies identified only 9 new authors for whom the search strategy had not returned a single document. The other replies increased the number of articles from authors that had already been identified.

Exporting to a Relational Database and Data Normalization

Once all the searches had been performed, the final entries were exported to an Access relational database. The data was then normalized to eliminate variations on the same author or institution name, given the lack of standardization that often occurs between the databases that were consulted. The *Catálogo Nacional de Hospitales* (Spanish Catalogue of Hospitals) of the Department of Health and Consumer Affairs was consulted to normalize the names of Spanish hospitals. Hospitals linked to a larger entity were regrouped into a single institution.

Determining the Indicators

Once all the data had been normalized and corrected, we then calculated various bibliometric measurements or indicators: annual distribution of the grants and amount according to the type of grant (SEC/FEC grant, including registry grants; grants from SEC departments and working groups; international travel stay grants from the SEC and departments; industry grants); award distribution by sex; number of years from grant award date to article publication date; number of articles published by grant type; and institutions and autonomous communities that received the grants.

RESULTS

Grants According to Their Type

The SEC/FEC awarded 207 grants over the 7 years studied, with an overall amount of €3 270 877, resulting in a mean yearly allocation of €467 268. The annual amount increased significantly from 2000 to 2005 and then fell slightly in 2006. The number of grants awarded also increased from 15 in 2000 to 36 in 2006. The highest number of grants and largest amount were awarded in 2004 and 2005, respectively (Fig. 1).

The grants are grouped together into 4 large clusters in Table 1. The highest amount corresponded to the "SEC/FEC grants" (which included registry grants), with 98 grants and €1 533 865, followed by the "post-residency grants for stays abroad" (42 grants and €915 806), "industry grants" (47 grants and €594 206), and the grants from departments and working groups (20 grants and €227 000).

We also found that 74.4% of the grants were awarded to male researchers (n = 154) and 25.6% to women (n = 53). The highest percentage of women were seen in post-residency grants for stays abroad (41.86%) and the lowest in industry grants (4.26%) (Table 2).

Grants With Subsequent Publications

Of the 207 grants, 123 (59.42%) out resulted in publications, while the remaining 84 (40.58%) did not result in a publication or we were unable to detect any publication using this study's methodology. The highest percentage of grants with subsequent publications was seen in 2000, when nearly three-fourths of the grants awarded in that year resulted in one or more publications. The lowest percentage was found in 2001, with 46% of grants resulting in publications. Figure 2 shows the annual evolution of the number of grants with and without subsequent publication. The average number of articles published per grant was 1.12 when considering all 207 grants awarded, and 1.9 when only taking into account the 123 grants that resulted in publications.

Of the 123 grants with subsequent publications, 62 contributed one article, 38 contributed two, 9 contributed three, 7 contributed four, and 2 grants produced six and seven articles each (Fig. 3).

Figure 4 shows the distribution of the articles according to the number of years elapsed between the grant being awarded and the subsequent publication. The highest percentage of articles were published 2 years after the grant was awarded (40 articles, 32.52%) and after 3 years (24 articles, 19.5%). Three articles were published 7 years after the grant was awarded and 11 in the same year as the award.

Table 3 shows the annual distribution of the 231 articles resulting from the 123 grants with subsequent publications. The total number of articles refers to the number of articles resulting from the grants awarded in that year and not to the number of articles published in that year, as the articles are normally published a few years after the grants are awarded. The grants that resulted in the highest number of articles were the "basic and clinical research grants in cardiology" (n = 78; 34%), followed by grants for "post-residency training in research" (n = 35; 15%), and

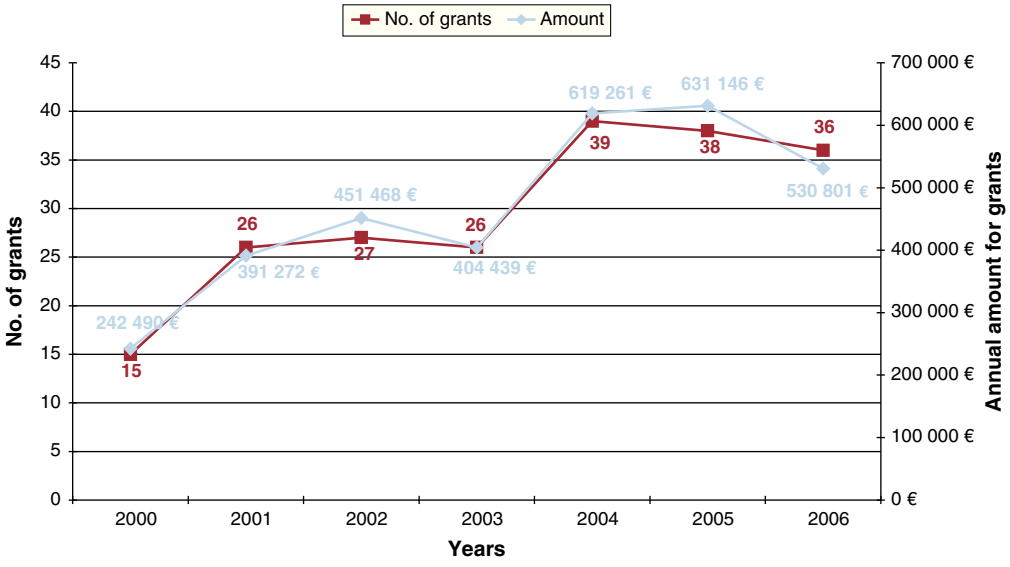

Figure 1. Annual evolution of the number of grants awarded and their amount.

Table 1
Annual Distribution of Grants According to Grant Cluster and the Amount in Euros

Grant cluster	2000		2001		2002		2003		2004		2005		2006		Total grants 2000-2006	% of total grants	Total amount 2000-2006	% of total €
	Grants, no.	Amount (€)	Grants, no.	Amount (€)	Grants, no.	Amount (€)	Grants, no.	Amount (€)	Grants, no.	Amount (€)	Grants, no.	Amount (€)	Grants, no.	Amount (€)				
SEC/FEC grants, including registry grants	8	129 000	15	234 000	14	219 365	13	195 325	17	290 400	16	240 400	15	225 375	98	47.34%	1 533 865	46.89%
Industry grants	5	34 217	7	78 000	6	63 105	7	90 751	8	113 661	7	125 846	7	88 626	47	22.71%	594 206	18.17%
Grants for stays in foreign hospital (from the SEC and its departments)	2	79 273	4	79 272	7	168 998	4	97 363	9	158 200	10	213 900	6	144 800	42	20.29%	915 806	28.79%
Grants from the departments and working groups	—	—	—	—	—	—	2	21 000	5	57 000	5	51 000	8	72 000	20	9.66%	227 000	6.15%
Total	15	242 490	26	391 272	27	451 468	26	404 439	39	619 261	38	631 146	36	530 801	207	100.00%	3 270 877	100.00%

FEC, *Fundación Española del Corazón* (Spanish Heart Foundation); SEC, *Sociedad Española de Cardiología* (Spanish Society of Cardiology).

Table 2
Annual Distribution by Sex of Lead Researcher, According to Grant Cluster

Grant cluster	2000		2001		2002		2003		2004		2005		2006		Total 2000-2006		Total Male and Female	% Total 2000-2006	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		% Male	% Female
SEC/FEC grants, including regisgtry grants	7	1	10	5	7	7	11	2	14	3	11	5	12	3	72	26	98	73.47%	26.53%
Industry grants	5	-	7	—	6	—	6	1	8	—	6	1	7	—	45	2	47	95.74%	4.26%
Grants for stays in foreign hospitals (from the SEC and its departments)	1	1	2	2	3	4	4	—	5	4	6	4	3	3	25	18	43	58.14%	41.86%
Grants from the departments and working groups	—	—	—	—	—	—	1	1	3	2	5	-	4	4	12	7	19	63.16%	36.84%
Total	13	2	19	7	16	11	22	4	30	9	28	10	26	10	154	53	207	74.40%	25.60%

FEC, *Fundación Española del Corazón* (Spanish Heart Foundation); SEC, *Sociedad Española de Cardiología* (Spanish Society of Cardiology).

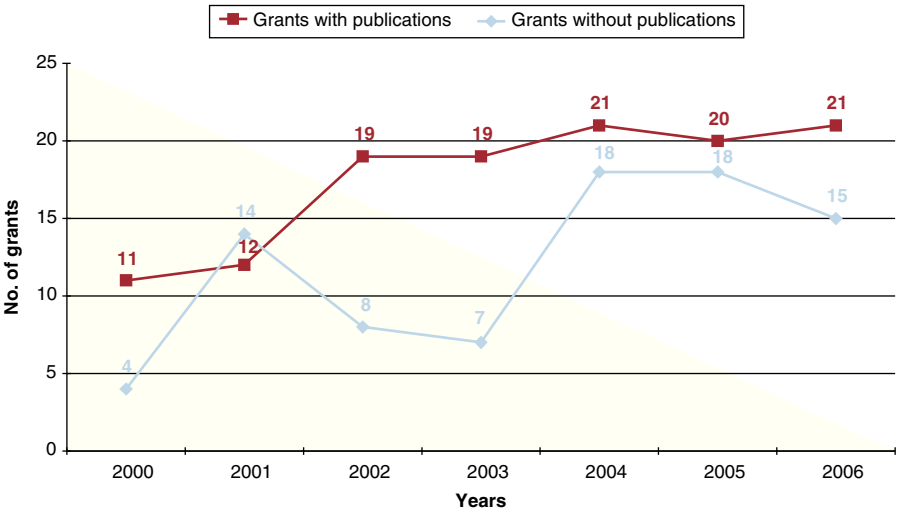

Figure 2. Annual evolution of the number of grants with or without subsequent publication.

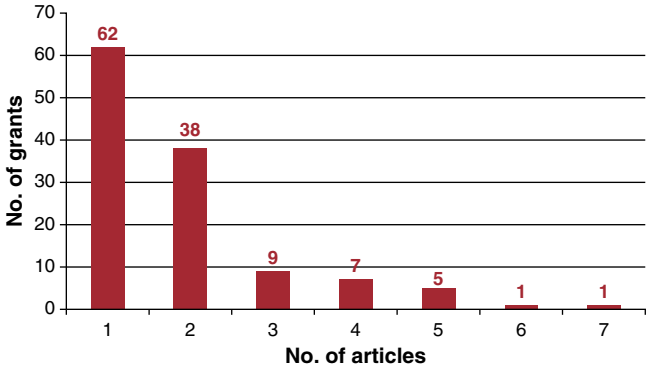

Figure 3. Distribution of the grants according to the number of resulting articles.

the "post-residency grants from the Department of Ischaemic Heart Disease" (n = 20; 8.7%). No articles were published from the following grant categories: "Dr Esteve research grant", "Roche research grant", "FEC clinical research grant", and "Working Group on Pulmonary Circulation grant". However, in relative terms, the highest ratio of "number of articles per grant" was seen in the heart transplant grants from the "Department of Heart Failure, Transplantation and Other Alternative Therapies", as a single grant resulted in 3 articles. This was followed in number by the "post-residency grants from the Department of Ischaemic Heart Disease" (2.86 articles per grant) and the "Pfizer research grants" (2.29 articles per grant). Analyzing the general grouping of grants, we found that 112 articles published were from the "SEC/FEC grants" (48.5%), 55 articles from the "grants for stays in foreign hospitals" (24%), 51 articles from the "industry grants" (22%) and 13 articles from the "department and working group grants"

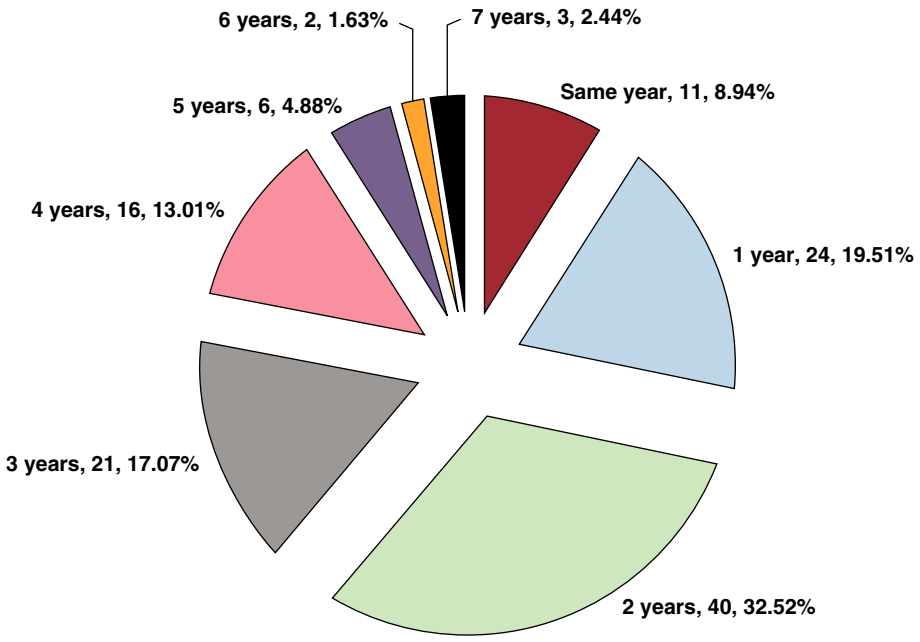

Figure 4. Number of years between the grant being awarded and the article being published.

Table 3
Annual Distribution of the Articles Published By Grant Type and Cluster

Type of grant	2000		2001		2002		2003		2004		2005		2006		Total grants 2000-2006	Total articles 2000-2006	Articles/ grants
	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.			
SEC grant for basic and clinical research in cardiology	7	5	13	8	11	14	11	16	14	22	13	13	—	—	69	78	1.13
FEC grant for basic and clinical research in cardiology	—	—	1	—	—	—	2	3	2	5	3	6	—	—	8	14	1.75
SEC grant for clinical research	—	—	—	—	—	—	—	—	—	—	—	—	7	4	7	4	0.57
SEC grant for basic research	—	—	—	—	—	—	—	—	—	—	—	—	5	6	5	6	1.2
ROCHE grant for basic and clinical research in cardiology	1	—	1	3	1	1	—	—	—	—	—	—	—	—	3	4	1.33
FEC/SEC grants for basic and clinical research in cardiology	—	—	—	—	2	3	—	—	—	—	—	—	—	—	2	3	1.5
FEC grant for clinical research	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2	0	0
SEC grant for a Spanish multicenter trial	—	—	—	—	—	—	—	—	1	2	—	—	—	—	1	2	2
FEC grant for basic research	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
SEC/FEC grant (including registry grants)	8	5	15	11	14	18	13	19	17	29	16	19	15	11	98	112	1.14
SEC grants for post-residency research (grant holders from the SEC)	2	2	4	2	6	6	4	10	7	5	7	4	5	6	35	35	1
Post-residency grants from the department of ischemic cardiopathy	—	—	—	—	1	3	—	—	2	—	3	10	1	7	7	20	2.86
Grants for stays in foreign hospitals (from the SEC and departments)	2	2	4	2	7	9	4	10	9	5	10	14	6	13	42	55	1.31
Pfizer research grant	1	4	1	-	1	3	1	3	1	3	1	1	1	2	7	16	2.29
Bayer research grant	1	1	1	1	1	1	1	1	1	3	1	1	1	1	7	9	1.29
Novartis research grant	1	2	1	2	1	-	1	1	1	—	1	2	1	2	7	9	1.29
3M Foundation research grant	—	—	—	—	1	1	1	2	1	2	1	—	1	2	5	7	1.4
Bristol-Myers Squibb research grant	—	—	1	—	—	—	1	1	1	—	1	—	1	—	5	1	0.2
Schering-Plough grant	1	1	1	—	1	1	1	—	—	—	—	—	—	—	4	2	0.5
Merck Farma y Química research grant	—	—	—	—	1	1	—	—	1	1	—	—	1	—	3	2	0.67
Dr. Esteve research grant	—	—	—	—	—	—	—	—	1	—	1	—	1	—	3	0	0
Uriach-1838 Foundation research grant	—	—	1	—	—	—	—	—	—	—	1	2	—	—	2	2	1
Schering-Plough grant for research into ACS	1	1	1	1	—	—	—	—	—	—	—	—	—	—	2	2	1
Dr. Esteve United States grant	—	—	—	—	—	—	—	—	1	1	—	—	—	—	1	1	1
Roche research grant	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	0	0
Industry grants	5	9	7	4	6	7	7	8	8	10	7	6	7	7	47	51	1.09

Table 3 (*continued*)

Type of grant	2000		2001		2002		2003		2004		2005		2006		Total grants 2000-2006	Total articles 2000-2006	Articles/ grants
	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.	Grants, no.	Articles, no.			
Heart failure grant from the department of heart failure, transplantation and other alternative therapies	—	—	—	—	—	—	1	2	1	—	1	—	1	2	4	4	1
Grant from the department of electrophysiology and arrhythmias	—	—	—	—	—	—	1	—	1	—	1	1	1	—	4	1	0.25
Grant from the department of hemodynamics and interventional cardiology	—	—	—	—	—	—	—	—	1	—	1	—	2	1	4	1	0.25
Grant from the working group of automatic implantable defibrillator	—	—	—	—	—	—	—	—	1	—	1	2	1	1	3	3	1
Grant from the working group of cardiac resynchronization	—	—	—	—	—	—	—	—	1	—	1	—	1	1	3	1	0.33
Heart transplant grant from the department of heart failure, transplantation and other alternative therapies	—	—	—	—	—	—	—	—	—	—	—	—	1	3	1	3	3
Grant from the working group of pulmonary circulation	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	0	0
Grants from departments and working groups	0	0	0	0	0	0	2	2	5	0	5	3	8	8	20	13	0.65
Total	15	16	26	17	27	34	26	39	39	44	38	42	36	39	207	231	1.12

ACS, acute coronary syndrome; FEC, *Fundación Española del Corazón* (Spanish Heart Foundation); SEC, *Sociedad Española de Cardiología* (Spanish Society of Cardiology).

(5.5%). In relative terms, the highest ratio was seen in the "grants for stays in foreign hospitals" (1.31 articles per grant). Our research showed that the 231 articles or studies were published in 73 different journals, 8 of them in Spain and 65 foreign journals. It is important to mention that 211 articles or studies (91.34%) were published by a journal ranked among the 60 journals with impact factor in Journal Citation Reports. We found that 73.2% of the articles were published in foreign journals (n = 169) while 26.8% were published in Spanish journals (n = 62). Figure 5 shows the distribution curves of the articles by year of publication and type of journal.

Institutions That Benefited From the Grants

Table 4 shows the distribution of the institutions to which the 207 funded researchers belong. The number of grants awarded to each hospital is also shown, as well as the number of articles published, the total amount for each institution during the period analyzed, and 2 indicators: the average number of articles published per grant and the amount in Euros for each article published. The 5 institutions, all in Spain, with the highest number of grants were *Hospital Clínic i Provincial* (Barcelona, n = 20), *Hospitals Vall d'Hebrón* (Barcelona, n = 20), *Hospital de la Santa Creu i Sant Pau* (Barcelona, n = 18), *Hospital General Universitario Gregorio Marañón* (Madrid, n = 18), and *Hospital Universitario de San Carlos* (Madrid, n = 13). Consequently, these institutions also had the highest funding totals in Euros.

The 5 most productive institutions in terms of number of absolute articles published were *Hospital Clínic i Provincial* (Barcelona, n = 38), *Hospitals Vall d'Hebrón* (Barcelona, n = 25), *Hospital General Universitario Gregorio Marañón* (Madrid, n = 22), *Fundación Jiménez-Díaz* (Madrid, n = 16) and *Hospital Clínico Universitario de Valencia* (Valencia, Spain; n = 15). The results when the Euros/article indicator was included were: €9943, *Hospital Clínic i Provincial*; €13 075, *Hospitals Vall d'Hebrón*; €14 194, *Hospital General Universitario Gregorio Marañón*; €11 387, *Fundación Jiménez-Díaz;* and €6205, *Hospital Clínico Universitario de Valencia*. In relative terms (number of articles published per grants and Euros per article), the *Complejo Hospitalario Don Benito* (Villanueva de la Serena, Spain) headed the list, followed by the *Hospital Arnau de Vilanova* (Valencia, Spain), *Complejo Hospitalario de Cáceres* (Cáceres, Spain) and the *Complejo Hospitalario de Vigo* (Vigo, Spain).

Table 5 shows the distribution of the grants and articles according to the lead researcher's autonomous communities. The total number of grants in this case is 201 and not 207, as 6 grants were awarded to 5 authors working in foreign hospitals. The Autonomous Community of Cantabria and the Canary Islands each received 1 grant but do not feature in Figure 5 because no articles were published. Although Catalonia and the Autonomous Community of Madrid published the highest number of publications in absolute terms as a result of the grants awarded, the highest number of articles per grant and the lowest cost in Euros per article in relative terms was in Extremadura (with 3 articles per grant and €5006 per article), followed by the Autonomous Community of Valencia (with 2.2 articles per grant and €6100 per article) and the Region of Murcia (also with 2.2 articles per grant and €6282 per article). Similarly, the relative productivity of Extremadura is close to 20 articles for every €100 000 and in the Autonomous Community of Valencia and the Region of Murcia it was around 16 articles, while in Catalonia it was around 7 articles and 6 in the Autonomous Community of Madrid.

Sociedad Española de Cardiología or Fundación Española del Corazón Mentioned as Funding Entities

Given that the grants were funded by the SEC/FEC, it is interesting to note the percentage of these articles that mentioned in their acknowledgements whether they had received help or funding from any source. Figure 6 shows that 50.22% of the published articles stated that they received financial aid from the SEC/FEC, and 23.8% also stated that they received funding from other entities. There were also 40 articles (17.32%) that did not include any acknowledgements or did not mention any entity. It was not possible to access the complete article in 20 cases (8.7%) because of the subscription required to access the journal (in other cases, it was possible to access the articles thanks to the institutional subscription of the *Universidad de Valencia* and the *Consejo Superior de Investigaciones Científicas*).

DISCUSSION

The objective of this study was to find out how many articles were published as a result of the grants and projects awarded by the SEC/FEC. We analyzed the period from 2000 to 2006 to allow at least 4 years for the articles to be published. Kingwell et al.[16] indicated that this is sufficient for research results to be published and to minimize any possible losses. Furthermore, in their study on the publications of researchers who received a 1-year grant that is awarded by the National Institutes for Health (United States), Cohen et al.[17] found that more than 50% of articles were published within 18 months of completing the research year. This result is

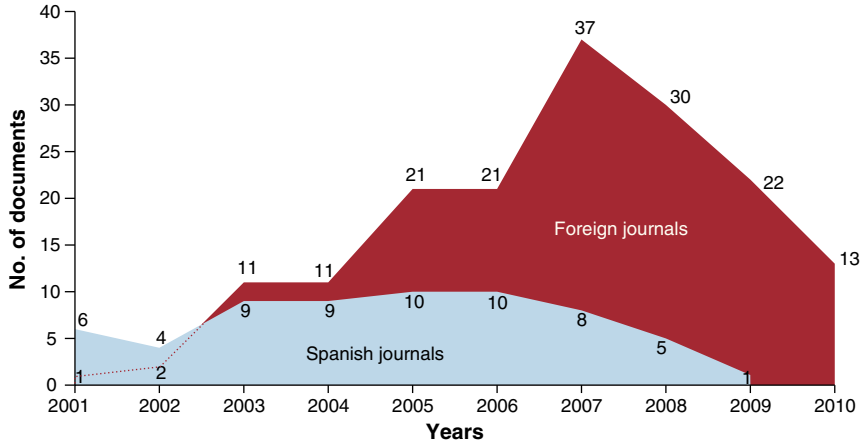

Figure 5. Annual evolution of the articles published in foreign and Spanish journals.

Table 4
Distribution of Grants, Articles, and Amount by Institution

Name of institution	Grants, no.	Authors (unduplicated), no.	Articles, no.	Total € of grants	No. of articles per grant	Amount per article (€)
Centro de Investigación Médica Aplicada	3	2	7	45 050	2.33	6436
Centro Nacional de Investigaciones Cardiovasculares	2	1	3	30 050	1.5	10 017
Clínica Universitaria de Navarra	6	5	4	115 392	0.67	28 848
Complejo Asistencial Universitario de Salamanca	3	2	1	42 050	0.33	42 050
Complejo Hospitalario Don Benito-Villanueva de la Serena	1	1	4	15 025	4	3756
Complejo Hospitalario de Cáceres	2	1	5	30 025	2.5	6005
Complejo Hospitalario de Especialidades Virgen de la Victoria	5	5	6	54 651	1.2	9109
Complejo Hospitalario de Vigo	2	2	5	33 030	2.5	6606
Complejo Hospitalario Dr. Negrín	1	1	–	15 025	–	–
Complejo Hospitalario Regional Carlos Haya	1	1	1	15 025	1	15 025
Complejo Hospitalario Regional Reina Sofía	4	2	3	48 846	0.75	16 282
Complejo Hospitalario Regional Virgen Macarena	3	3	–	57 500	–	–
Complejo Hospitalario Universitario de Santiago	3	2	2	45 075	0.67	22 538
Complejo Hospitalario Universitario Juan Canalejo	4	3	5	51 025	1.25	10 205
Complejo Universitario de San Carlos	13	13	13	241 475	1	18 575
Complejo Universitario La Paz	3	3	–	42 025	–	–
Fundación Jiménez Díaz-UTE	11	7	16	182 195	1.45	11 387
Hospital Arnau de Vilanova	1	1	4	21 636	4	5409
Hospital Central de la Defensa Gómez Ulla	1	1	–	18 000	–	–
Hospital Clínic i Provincial de Barcelona	24	17	38	377 815	1.58	9943
Hospital Clínico Universitario de Valencia	7	4	15	93 075	2.14	6205
Hospital Clínico Universitario de Valladolid	6	3	2	69 035	0.33	34 518
Hospital de la Santa Creu i Sant Pau	18	14	12	283 303	0.67	23 609
Hospital del Mar	1	1	1	8000	1	8000
Hospital General Universitario Gregorio Marañón	18	15	22	312 263	1.22	14 194
Hospital of the University of Pennsylvania	1	1	–	15 000	–	–
Hospital Puerta del Mar	1	1	–	18 000	–	–
Hospital Santa María	1	1	–	15 000	–	–
Hospital Son Llatzer	1	1	–	15 626	–	–
Hospital Universitari de Bellvitge	1	1	1	15 025	1	15 025
Hospital Universitari Dr. Josep Trueta de Girona	1	1	–	12 600	–	–
Hospital Universitari Germans Trias i Pujol de Badalona	2	2	3	43 200	1.5	14 400
Hospital Universitario 12 de Octubre	2	1	–	46 879	–	–
Hospital Universitario Arnau de Vilanova de Lleida	3	3	1	36 040	0.33	36 040
Hospital Universitario Central de Asturias	5	5	6	63 070	1.2	10 512
Hospital Universitario de Getafe	1	1	1	15 025	1	15 025
Hospital Universitario de la Princesa	1	1	2	21 636	2	10 818
Hospital Universitario del Río Hortega	1	1	–	15 025	–	–
Hospital Universitario Dr. Peset	1	1	1	7500	1	7500
Hospital Universitario Marqués de Valdecilla	1	1	–	15 000	–	–
Hospital Universitario Puerta de Hierro	3	3	–	36 025	–	–
Hospital Universitario Virgen de la Arrixaca	5	4	11	69 100	2.2	6282
Hospitals Vall d'Hebrón	20	11	25	326 865	1.25	13 075
Institut de Malalties Cardiovasculars	1	1	1	15 000	1	15 000
Institut Municipal d'Investigació Mèdica (IMIM)	2	1	2	30 025	1	15 013
Instituto de Biomedicina de Valencia *(CSIC)*	1	1	2	12 000	2	6000
Mayo Clinic & Mayo Foundation	1	1	–	12 600	–	–
Mount Sinai School of Medicine	2	1	–	76 000	–	–
Policlínica Miramar	2	1	2	21 020	1	10 510
Texas Heart Institute	1	1	–	26 000	–	–
Universidad Complutense Madrid	2	1	3	30 025	1.5	10 008
University of California, San Diego	1	1	1	15 000	1	15 000
TOTAL	207	159	231	3 270 877	1.12	14 160

Table 5
Grants, Articles and Relative Amount by Autonomous Communities

Autonomous Communities	Grants, no.	Articles, no.	Articles per grant, no.	Amount (€)	Amount per article (€)	Articles/ €100 000, no.
Extremadura	3	9	3	45 050	5005.56	19.98
Autonomous Community of Valencia	10	22	2.2	134 211	6100.50	16.39
Region of Murcia	5	11	2.2	69 100	6281.82	15.92
Asturias	5	6	1.2	63 070	10 511.67	9.51
Galicia	9	12	1.33	129 130	10 760.83	9.29
Catalonia	74	84	1.14	1 162 873	13 843.73	7.22
Navarra	9	11	1.22	160 442	14 585.64	6.86
Autonomous Community of Madrid	57	60	1.05	975 598	16 259.97	6.15
Balearic Islands	3	2	0.67	36 646	18 323.00	5.46
Andalusia	14	10	0.71	194 022	19 402.20	5.15
Castile and Leon	10	3	0.3	126 110	42 036.67	2.38
Cantabria	1	–	–	15 000	–	–
Canary Islands	1	–	–	15 025	–	–
Total	201	230	1.14	3 126 277	13 592.51	7.36

very similar to the publications resulting from the SEC/FEC grants, with nearly 60% of the articles published within 2 years after the grant was awarded.

It is well known that scientific societies and foundations finance cardiovascular research in many countries and in some cases even exceed government funding. For example, this is the case in the Netherlands, where the Netherlands Heart Foundation awards more funding to cardiovascular research than the Netherlands Organisation for Scientific Research, the government agency which funds research.[8] In the United Kingdom, the British Heart Foundation funds 55% of all cardiovascular research, which is equivalent to an investment of £50 million per year, including full salary of 27 researchers and around 600 research projects worth between £100 000 and £250 000 over a 3-year period.[6] The National Heart Foundation of Australia provides around $7.5 million to cardiovascular research every year, and from 2001 to 2005 it increased its investment by 27%, owing to the backing of several sponsors (many of them pharmaceutical companies).[10] In Spain, the government's Health Research Fund *(Fondo de Investigación Sanitaria [FIS]*) from the *Instituto de Salud Carlos III* funded 283 research projects in cardiology during the same period analyzed, with an average of 40 projects per year and an overall total of €22 320 038 and an average of €3 188 577 per year. The amount that is awarded every year has nearly tripled, from €1 575 261 in 2000 to €4 142 671 in 2006, while the number of projects funded has remained constant (42 in 2000 and 41 in 2006). In comparison, the SEC/FEC doubled both the number of grants per year and their amount from 2000 to 2006, as can be seen in our study. However, the average amount awarded to projects by the SEC/FEC (€467 268 per year) is much lower than that awarded by the FIS (€3 188 577 per year). This probably limits the impact of the research developed with SEC/FEC funding, compared to the FIS-funded research.

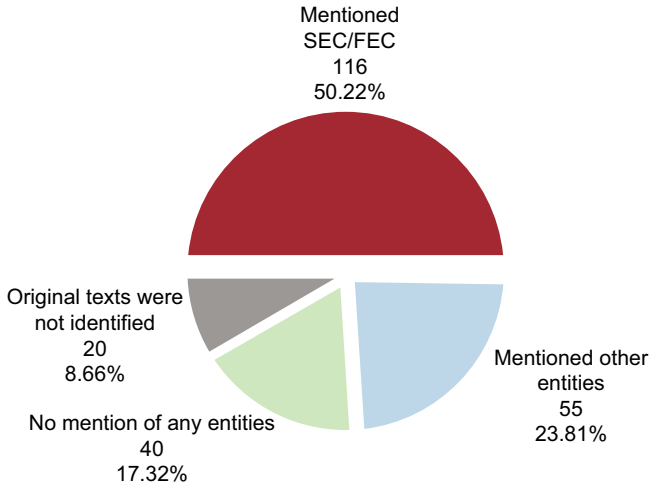

Figure 6. Distribution of the articles that mention funding received. FEC, *Fundación Española del Corazón* (Spanish Heart Foundation); SEC, *Sociedad Española de Cardiología* (Spanish Society of Cardiology).

There is no doubt that funding in cardiovascular research is of great benefit, and this has been well known for a long time.[18] Zerhouni, director of the National Institutes of Health (United States), using research into coronary artery disease as an example, stated that an investment of $3.70 per American citizen per year has meant that a million premature deaths have been avoided in the United States alone[19]. Sipido et al.[20] claim that the average life expectancy of patients with coronary heart disease has increased by 3 years since 1970 owing to research in that field, as well as other factors such as change in lifestyle and disease prevention. Furthermore, the role played by industry in funding cardiovascular investigation is very important, given that it helps improve and speed up existing research and pay for projects that might not fall under government subsidies,[7] as long as there is no conflict of interest or bias.[21,22]

Some of the aspects of research funding in other areas of medicine have already been studied and analyzed, such as genetics,[23] gastroenterology,[24] rehabilitation,[25,26] and stem cell research.[27] However, we did not find many publications that had analyzed the output of articles as a result of investment by scientific associations and foundations in cardiovascular research. Nielsen[9] found that the 139 projects that received grants from the Danish Heart Foundation from 1988 to1990 published 362 articles in 131 different journals. This was equivalent to an average of 2.6 articles per project. However, these results cannot be compared with the average of 1.12 articles as a result of the SEC/FEC grants, as other variables would have to be taken into consideration, such as how much the grants were worth and their length.

The percentage of women receiving SEC/FEC grants (25.6%) is close to that which Gónzalez-Alcaide et al.[28] found in articles published in the *Revista Española de Cardiología*. They found that 27% of the authors who published in this journal from 2002 to 2006 were women, which is higher than the percentage of women members of the *SEC*: 16%, n = 339 (data from 2008). However, this percentage did not increase during the period in terms of

publications as a result of the grants. It is interesting to note that the highest percentage of women was found in the "grants for stays in foreign hospitals" (43% women). This does not seem to follow the supposed family roles that would stop women from moving abroad.[29] Although a progressive fall in the number of women can be seen in all medical disciplines, there is a very strong "male" trend in cardiology. In the academic year 2005-2006 there was a significant difference between the percentage of women finishing their studies in Medicine (69.2%) compared with the percentage of women registered for doctoral courses (62.93%) and the number of women having doctoral theses approved (57.34%). With regard to cardiovascular disease, only 42% of women started training in cardiology in the 2003-2004 residency program[30] and despite the fact that over time the number of women in medicine is increasing, barriers still exist that make it hard for women to access the most important rungs on the academic and scientific ladder. This warning has come from the very field of cardiology.[29] It is therefore essential to tackle the barriers that make it hard for women to access and be completely integrated into clinical practice and research.[31] Factors that may explain the low number of women in the field of cardiovascular diseases are the differences between medical students in their choice of specializations[32] and that women prefer medical practice rather than research.[33] Other influencing variables may be the lack of recognition and lack of medical mentors for women[34] and the effect of motherhood or women taking on a greater role in the family.[35,36]

Some authors believe that research into cardiovascular diseases would increase if the 6th point of the United Nations Millennium Development goals, which focuses on fighting AIDS, malaria, and other diseases, was replaced with a more general statement that also included chronic diseases such as cardiovascular diseases, diabetes mellitus, and cancer.[4,5] Cardiovascular research is becoming more important at a time when the WHO has estimated that longer life expectancy, along with negative trends in certain cardiovascular risk factors such as obesity and type II diabetes, could lead to a doubling in the absolute incidence of cardiovascular disease by 2050.[3,21] Furthermore, the enormous progress made to date is a strong incentive to continue prioritizing the funding of cardiovascular research. As Sipido et al.[20] stated, research should focus more on the early identification of the disease, protection mechanisms, and health promotion.

Methodological Limitations

One of the limitations of this study was that we might have missed articles that did not include any of the words of the funded project title in their title, as well as articles that had very general titles. Furthermore, we may not have been able to find articles published in journals that were not included in the databases consulted. However, the Science Citation Index-Expanded and Scopus databases include worldwide journals that are considered the "main current of scientific research". It is also important to mention that the national journals IME and IBECS include almost all the high-quality peer-reviewed Spanish journals. We tried to overcome both limitations by requesting the list of publications from the grant recipients; 30% of the recipients replied to our request. Another limitation could be that the high number of articles from a single grant may be due to the reprehensible strategy known as salami slicing. This is when some authors break their publication down into "the smallest publishable units" in order to disseminate as many studies as possible. We do not know how much distortion this effect could have on the results of this study, as this analysis this was not included in our objectives. Lastly, it must be taken into account that publications as a result of grants awarded in the last few years, above all in 2006, have hardly had any time to be published. This may have resulted in a lower percentage of subsequent publications.

CONCLUSIONS

The SEC/FEC allocated nearly half a million Euros per year during the period 2000-2006 to fund 207 research grants and contribute to the fight against cardiovascular diseases. Nearly 60% of the grants resulted in publications, with a total of 231 articles and an average of 1.12 articles per grant. The majority of the articles were published in foreign journals and it must be noted that 211 studies (91.34%) were found in 60 journals with impact factor in the Journal Citation Reports. Given that only half of the articles acknowledged receiving financial support from the SEC/FEC, grant recipients should be required to mention their funding source in the resulting publications. The number of articles published as a result of the grants shows that grants from the SEC/FEC, along with other bodies interested in research in the field, help to improve the research and training of new investigators. This may lead to greater improvements in cardiovascular health in Spain and at the international level.

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CONFLICTS OF INTEREST

None declared.

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