

Spanish Scientific Research Output on Tuberculosis Indexed in MEDLINE, 1997–2006

Abstract

Introduction: The objective of the study was to analyze Spanish scientific output on tuberculosis over one decade (1997–2006) and look at it in the context of the framework of the European Union (EU).

Material and methods: A bibliometric study was carried out on the MEDLINE database via PubMed, through a search for “*tuberculosis*” or “*tuberculous*” in any field of the database.

Results: The search returned 35,735 documents dealing with tuberculosis, of which 1,191 (4.1%

of worldwide production) were published by Spanish authors. Spain was the third in the list of EU countries with most documents, with 13.5%. Of these, 51.2% (n = 610) were published in English and 48.8% (n = 581) in Spanish. The number of documents was constant over the years. The most frequent specialty of the principal author was microbiology, with 225 documents (20.6%), followed by internal medicine (n = 154; 14.1%) and pulmonology (n = 117; 10.7%). Journals with the highest number of published documents were *Medicina Clínica* and *Enfermedades Infecciosas y Microbiología Clínica*, with 78 (6.5%) each, *Anales de Medicina Interna* (n = 72), *Revista Clínica Española* (n = 64) and *Archivos de Bronconeumología* (n = 63). The most productive provinces were Madrid and Barcelona, with 272 (22.8%) and 256 (21.5%) documents published, respectively. The most productive institutions were hospitals, with 900 documents (75.6%), followed by universities, with 132 (11.1%).

Conclusions: Research on tuberculosis in Spain has been constant over the last 10 years and has implied an important contribution to that of the EU as a whole. Half of the Spanish publications were in foreign journals and predominantly came from hospitals.

Keywords:

Tuberculosis

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Abstract

Objective: To analyze Spanish scientific research output related to tuberculosis during the 10-year period from 1997 through 2006 and to consider it within the context of European Union (EU) productivity.

Material and methods: The bibliometric study was based on a search of the MEDLINE database, using the PubMed search interface. Search terms were *tuberculosis* or *tuberculous* appearing in any database field.

Results: Of 35,735 titles retrieved, 1191 were by Spanish authors. This represented 4.1% of world output. Spain, accounting for 13.5% of EU scientific output in this area, was the third most productive EU country; 610 (51.2%) of the papers were published in English and 581 (48.8%) in Spanish. The number of papers published remained steady over the 10-year period. The first author's specialty was usually microbiology (225 documents, or 20.6%), followed by internal medicine (154, or 14.1%), and respiratory medicine (117, 10.7%). Journals publishing the largest numbers of papers on tuberculosis were *Medicina Clínica* and *Enfermedades Infecciosas y Microbiología Clínica* with 78 (6.5%) each, *Anales de Medicina Interna* with 72, *Revista Clínica Española* with 64, and *Archivos de Bronconeumología* with 63. The most productive provinces were Madrid and Barcelona, with 272 (22.8%) and 256 (21.5%) papers, respectively. The most productive institutions were hospitals, with 900 titles (75.6%), followed by universities, with 132 (11.1%).

Conclusions: Tuberculosis research in Spain has taken place at a steady rate over the last 10 years and has accounted for a substantial proportion of EU research in this field. Half the papers by Spanish authors were found in international journals published outside Spain. The majority of papers were from authors working in hospitals.

Introduction

Tuberculosis is one of the most prevalent infectious diseases. It constitutes a big worldwide health problem and is the primary infectious cause of death in the adult population. It is estimated that in 2005, there were 8.8 million new cases of tuberculosis in the world. The disease occurs with higher frequency in countries with worse socio-medical conditions, especially in Africa, Asia and South America¹. Spain and Portugal are the countries in western Europe with the highest rates of incidence¹.

The importance of tuberculosis is unquestionable from times past, and there are numerous references to this disease in both scientific and non-scientific literature. Tuberculosis is a multidisciplinary disease, which involves different clinical specialists (pulmonologists, specialists in infectious disease and internalists) laboratory specialists (microbiologists, molecular biologists) and social science specialists (epidemiologists, specialists in preventive medicine). Consequently, it is to be expected that there is a great variety of healthcare disciplines and institutions working and publishing on the subject².

Bibliometrics studies qualitative data proceeding from scientific publications. Numerous bibliometric studies have analysed Spanish scientific output in diverse biomedical journals^{3,4}, disciplines and specialties⁵⁻⁸, and some have focused on specific problems or illnesses⁹⁻¹¹. Scientific output on tuberculosis in Spain, however, has not been analysed in depth. The objective of this study was to analyse, through the MEDLINE database, Spanish scientific production on tuberculosis during the decade 1997–2006.

Materials and methods

A bibliometric search was carried out, on 2 January 2008, of the MEDLINE database. The search used the tool PubMed from the *US National Library of Medicine*. The program Reference Manager, version 11, was employed to recover references from the medical literature in the PubMed database (<http://www.ncbi.nlm.nih.gov>). The search strategy to recover documents was inclusion of the word “*tuberculosis*” or “*tuberculous*” in any of the search fields. The search was limited to the inclusive period of 1997 to 2006. Data recovered for each search return includes authors, title of the article, journal, type of publication, abstract of the article, source institution, abbreviated name of the journal, Medicine’s Medical Subject Headings (MeSH thesaurus) and language of the publication.

In addition to the above data, other fields were added, such as, specialty of the principal author, institutional sector of the center, and autonomous community and province of the principal institution.

Centres were grouped into the following institutional sectors: university, hospital, the Spanish National Research Council (CSIC), primary care and other public or private centres. Documents in which the principal center was both a university hospital and a university were put in the hospital category. The knowledge field of the document was identified on the basis of the structure in the US National Library's MeSH thesaurus.

In accordance with the discipline of the principal author, documents were classified as

basic medicine, clinical medicine and social medicine according to the criteria of Gómez Caridad *et al*¹².

The relative output from each country in the European Union (EU) was studied in terms of economic and demographic parameters and cases of tuberculosis. As economic parameter, we used gross domestic product (GDP) in 2006, obtained from *World Development Indicators* for 2006. As demographic parameter, we used number of inhabitants in 2006, obtained from the same source¹³. The number of cases of tuberculosis

in 2005 was obtained from *Global Tuberculosis Control*, WHO Report 2007¹. The collected data were analyzed statistically with the program SPSS version 12.0 for Windows (SPSS Inc., Illinois, US). The Chi-squared test with Yates's correction was used to compare category variables.

Results

Situation of Spanish scientific output on tuberculosis in the context of world and European Union output

The MEDLINE database search returned 35,735 documents dealing with tuberculosis. The principal language of the documents was English (77.3%), followed by Russian (5.3%),

Japanese (3.6%), French and Spanish (3.3% each). The institutional address of the principal author was localized in 29,323 documents. The biggest producer of documents was the US with 6,150. The EU of 15 countries published 8,095 documents (27.3%), the EU of 25 countries contributed a further 635 and the EU of 27 countries contributed a further 150.

Spain, with 1,191 documents, had the third-highest number of documents of the EU-27, after the United Kingdom and France. Spanish documents represented 13.5% of the EU total. Spain was seventh in the world classification (4.1% of world output), after India,

Japan and China. After adjusting for inhabitants and GDP, Spain was in fourth and third positions respectively, while, on taking into consideration the number of cases of tuberculosis, it descended to fifteenth position (Table 1).

Description of the national output

The number of documents produced in Spain was constant over the years in contrast to the growing annual world production, as shown in Figure 1. The total number of documents varied between 95 in 2002 and 138 in 1997. Of the documents recovered, 51.2%

(n = 610) were published in English and 48.8% (n = 581) were in Spanish. With regard to the type of research published in each document, 305 (25.6%) were case reports, 151 (12.7%) were reviews and 28 (2.4%) clinical trials. In 285 (23.9%), authors received support for their research.

Table 2 presents the contents or the field of knowledge in the documents according to the thesaurus of the MEDLINE MeSH classification. Of the documents, 20.2% (n = 235) were about anti-tuberculosis medicines, 172 (14.8%) were about the human immunodeficiency virus (HIV) and 135 (11.6%) were about AIDS. The principal clinical form of tuberculosis in the retrieved documents was pulmonary (n = 272; 23.3%), followed at a distance by pleural (3.9%) and osteoarticular (3.1%). Of the documents, 29.2% dealt with microbiology, 28.3% with epidemiology and 8.5% prevention and control. Of the documents, 6.8% contained an implication of animals, but only 2.4% concerned veterinary matters.

The specialty of the principal author was available for 1,092 of the 1,191 documents. Figure 2 gives the distribution of the documents by specialty of the principal author. The most frequent specialty was microbiology, with 225 documents (20.6%), followed by internal medicine (n = 154; 14.1%), pulmonology (n = 117; 10.7%), infectious diseases (n = 108; 9.9%) and public health and epidemiology (n = 103; 9.4%). On classifying documents according to discipline of the principal author, 64.6% (n = 706) were in the category of clinical medicine, 275 (25.2%) were in basic medicine and 111 (10.2%) were in social medicine.

Documents were distributed over 280 journals. 2.7% were published in on-line journals and the remainder were published on paper. Table 3 shows national and foreign journals with more than five documents. The first six journals were Spanish. In the first places were *Medicina Clínica* and *Enfermedades Infecciosas y Microbiología Clínica*, each with 78 articles (6.5%), followed by *Anales de Medicina*

Interna (n = 72), *Revista Clínica Española* (n = 64) and *Archivos de Bronconeumología* (n = 63). The two first journals in English were the *International Journal of Tuberculosis and Lung Diseases* (n = 60) and *Journal of Clinical Microbiology* (n = 41).

Provinces with most output were Madrid and Barcelona, with 272 (22.8%) and 256 (21.5%) of the published documents, respectively. Next were A Coruña (n = 64; 5.4%) and

Alicante, Seville and Valencia, with 49 (4.1%) of the documents each. The most productive autonomous communities were Catalonia and Madrid, with 281 (23.6%) and 272 (22.8%) respectively, followed by Andalucía (n = 145; 12.25%), the *Comunidad Valenciana* (n = 106; 8.9%) and Galicia (n = 97; 8.1%) (see Table 4).

The 1,191 documents came from 270 Spanish institutions. The institution-type with highest output was the hospital, with 900 documents (75.6%); in second place was the university, with 132 (11.1%); in third position were *other public institutions*, with 94 (7.9%); and at more distance were health centres, and CSIC, with 20 (1.7%) and 14 (1.2%) documents, respectively. University output represented 18.4% of all documents in foreign journals and 3.4% of those in national journals ($p < 0.001$). Table 5 provides the list of Spanish institutions that published 10 or more documents on tuberculosis; the table separates data for foreign and national journals.

Discussion

There is more and more interest in the analysis of research output by means of so-called bibliometric indicators, which can be grouped in two categories: indicators of output, which evaluate the number of publications, and indicators of impact¹⁴. Indicators of output are limited by the database employed to retrieve information, and there is a possibility of inclusion of duplicate or repeated documents^{14,15}. Despite the limitations and abuses of bibliometric analysis^{14,16}, it provides a vision of the scientific activity of the country studied and enables comparison with other countries¹⁴. In addition, such analysis could be used to measure the results of economic investment in research and thus help in planning of scientific policy¹⁴.

Results of two studies on scientific output - one, by Gagnon *et al.*¹⁵, carried out with MEDLINE and the other, by Camí *et al.*¹⁷, carried out with the databases of the Institute for Scientific Information - concur that Spain occupies eleventh place worldwide and seventh in the EU. In our study, with regard to scientific output on tuberculosis, Spain was situated in seventh position worldwide and third in the EU. When considered in terms of economic and population parameters, the positions are maintained, but when the number of diagnosed cases of tuberculosis is taken into account, Spain descends to fifteenth position.

In view of these results, the absolute position of Spain in relation to other countries in the EU seems to be better in the case of tuberculosis than it is for other medical specialties. Thus, although the study period was not identical, for

publications on the respiratory system, Spain occupied eighth position¹⁸; on surgery¹⁹, gastroenterology²⁰ and public health²¹, seventh position; and on oncology²² and rheumatology²³, sixth position. It should be noted that of all the countries in Western Europe, Spain and Portugal are the two with the highest declared incidence rates of tuberculosis¹.

Spanish scientific output in other biomedical disciplines has increased over the years^{6,7,10,11}. In the study by Camí *et al.*¹⁷, which analyzed Spanish production in biomedicine between 1994 and 2002, Spain is observed to quadruple in number of publications, even though in the case of tuberculosis publications no increment was observed during the years of the study. This could be due to control of the disease in the last few years, which has meant a decrease in the number of cases declared²⁴.

With regard to the subject of tuberculosis publications, it is noteworthy that 20.2% of documents are about anti-tuberculosis medicines and that 20% have a principal author whose specialty is microbiology. 14.8% include HIV in the keywords, and this proportion is higher than that of the number of tuberculosis cases associated with HIV, which was 9% for the years 2005–2006²⁴.

Nearly a third of the documents touched on aspects of microbiology or epidemiology, and somewhat less than 10% covered topics of prevention and control of tuberculosis. The percentage of documents on epidemiological aspects is higher than that of documents signed by epidemiologists and workers in public health, which indicates either that epidemiological topics are also addressed by clinicians and microbiologists, or that epidemiologists feature as collaborators and are not recognized in the database used.

It should be noted that half of the journals in which documents were published are Spanish. *Medicina Clínica* and *Enfermedades Infecciosas y Microbiología Clínica* occupy the first places in terms of number of documents published in the period studied. Following these come *Anales de Medicina Interna*, *Revista Clínica Española*, *Archivos de Bronconeumología* and the *International Journal of Tuberculosis and Lung Diseases*. With the exception of the journal *Anales de Medicina Interna*, all are journals with an impact factor.

Concerning the institutional origin of documents, the majority come from the hospital sector and, to a lesser degree, from universities and other public organisations.

The predominance of the hospital sector indicates that, in our country, clinical research into tuberculosis has greater prominence¹⁷. The lesser contribution by universities would indicate less participation from basic structures in research into tuberculosis in Spain. The greater contribution made by the university sector to foreign journals reflects the greater interest of these institutions in the international repercussions of their publications (impact factor of the document), since there are few Spanish journals with an impact factor.

The main centre of output is the *Hospital Germans Trias i Pujol de Badalona*. This hospital, although it only has 643 beds and covers a health area of 200,000 inhabitants, has, relative to large hospitals, a great concern for research on tuberculosis and has developed a basic research unit for this disease.

The second most productive centre is the *Hospital Ramón y Cajal* in Madrid, which almost always leads lists of hospitals in terms of scientific output^{12,17}. The third centre is the *Complejo Hospitalario de Santiago*, a hospital with over 1,000 beds that is located in a province, A Coruña, and an autonomous community, Galicia, that has the highest rates of incidence of tuberculosis in Spain²⁴. However, it should be noted that to evaluate the results of the ordered list of centres in a correct and prudent manner, it is essential to take into consideration that gross output is generally related to the size of centres' internal systems of research and to the degree that their human resources dedicate themselves to scientific activity¹⁷.

The greatest output on tuberculosis came from Madrid and Barcelona, as occurs with Spanish global output in biomedicine and other disciplines and subject sub-areas^{5-12,17}. This is because most of the best-equipped hospitals and universities in all aspects are located in the provinces of Madrid and Barcelona¹⁷. After these provinces come A Coruña, Alicante, Seville and Valencia. The above order is by absolute numbers.

The current study has the limitation of having retrieved and analysed information from journals included in the MEDLINE database, where journals with and without impact factor are included, which consequently have different international repercussions. In addition, as, in the institutional address of the MEDLINE database, only the institution of the principal author is registered, it was not possible to retrieve any documents created by Spanish authors collaborating with foreign institutions¹⁰. Neither was it possible to study collaboration within and between centres (whether national and international or public and private)^{11,17}.

It is hoped that the results of this study will encourage Spanish specialists who work on tuberculosis to continue actively researching in order to try to achieve greater and greater impact of their publications. In addition, these results should spur the relevant organizations that finance research to continue and to increase funding for national research projects in this field.

Questions:

1. Within the countries of the European Union, in terms of number of articles about tuberculosis, which position does Spain occupy:

1. Second
2. Third
3. Fourth
4. Fifth

2. Which of the following specialties is more a laboratory specialty as opposed to a clinical one?

1. Pulmonology
2. Molecular biology
3. Infectious disease medicine
4. Internal medicine

3. The second most frequent language (for these 1,191 documents) in terms of number of articles was:

1. Spanish
2. French
3. Russian
4. Japanese

4. The main clinical form of tuberculosis in the retrieved documents was:

1. Cerebral
2. Pulmonary
3. Pleural
4. Osteoarticular

5. The English journal that published the most on tuberculosis was

1. Lancet
2. International Journal of Tuberculosis and Lung Diseases
3. Journal of Clinical Microbiology
4. Journal of tuberculosis

6. The principal *bibliometric indicators of output* reflect, above all,

1. the number of publications
2. the immediate impact factor
3. the impact factor at 5 years
4. the H index

7. In contrast, looking at European Union rankings, the following can be said about Spanish output on tuberculosis relative to output in all fields of medicine :

1. The Spanish ranking for tuberculosis is better than that for medicine overall
2. The Spanish ranking for tuberculosis is similar to that for medicine overall
3. The Spanish ranking for tuberculosis is worse than that for medicine overall
4. This was not compared in the article

8. According to this study on the position of Spain in relation to other European Union countries, which of the following specialties has the highest position for Spanish authors?

1. Oncology
2. Public health
3. Tuberculosis
4. Rheumatology

9. If hospitals are compared with universities, it is observed that publications about tuberculosis FROM HOSPITALS:

1. are less abundant and are aimed more at the national rather than the international level
2. are less abundant and are aimed less at the national than the international level
3. are more abundant and are aimed more at the national rather than the international level
4. are more abundant and are aimed less at the national than the international level

30. Within Spain the highest incidence rate of tuberculosis is found in:

1. Madrid
2. Catalonia
3. Andalucía
4. Galicia