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SPECIAL ARTICLE

Bibliometric analysis of scientific literature on intestinal parasites in Argentina during the period 1985–2014



Juan A. Basualdo^{a,*}, María S. Grenóvero^b, Evangelina Bertucci^a, Nora B. Molina^a

^a Centro Universitario de Estudios Microbiológicos y Parasitológicos (CUDEMyP), Facultad de Ciencias Médicas, Universidad Nacional de La Plata, Buenos Aires, Argentina

^b Laboratorio de Bioestadística, Epidemiología y Matemática, Facultad de Bomatología, Universidad Nacional de Entre Ríos, Entre Ríos, Argentina

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Abstract The study of scientific production is a good indicator of the progress in research and knowledge generation. Bibliometrics is a scientific discipline that uses a set of indicators to quantitatively express the bibliographic characteristics of scientific publications. The scientific literature on the epidemiology of intestinal parasites in Argentina is scattered in numerous sources, hindering access and visibility to the scientific community. Our purpose was to perform a quantitative, bibliometric study of the scientific literature on intestinal parasites in humans in Argentina published in the period 1985–2014. This bibliometric analysis showed an increase in the number of articles on intestinal parasites in humans in Argentina published over the past 30 years. Those articles showed a collaboration index similar to that of the literature, with a high index of institutionality for national institutions and a very low one for international collaboration. The original articles were published in scientific journals in the American Continent, Europe and Asia. The use of bibliometric indicators can provide a solid tool for the diagnosis and survey of the research on epidemiology of intestinal parasites and contributes to the dissemination and visibility of information on the scientific production developed in Argentina. © 2016 Asociación Argentina de Microbiología. Published by Elsevier España, S.L.U. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

PALABRAS CLAVE

Bibliometría;
Parásitos intestinales;
Argentina;

Análisis bibliométrico de la literatura científica sobre los parásitos intestinales en Argentina durante el período 1985–2014

Resumen El estudio de las publicaciones científicas constituye un buen indicador del progreso de la investigación y de la generación de conocimiento. La bibliometría es una disciplina que

* Corresponding author at: Centro Universitario de Estudios Microbiológicos y Parasitológicos (CUDEMyP), Facultad de Ciencias Médicas, Universidad Nacional de La Plata, Calle 60 y 120, s/n, La Plata (1900), Buenos Aires, Argentina. Tel.: +54 221 4258987; fax: +54 221 4258987.
E-mail address: jabasua@med.unlp.edu.ar (J.A. Basualdo).

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utiliza un conjunto de indicadores para expresar cuantitativamente las características bibliográficas de las publicaciones. La literatura científica sobre la epidemiología de los parásitos intestinales en la Argentina se encuentra muy dispersa en numerosas fuentes impresas y *online*, con escasa visibilidad para la comunidad científica. Nuestro objetivo fue realizar un estudio bibliométrico cuantitativo de la literatura científica publicada sobre los parásitos intestinales de humanos en Argentina durante el período 1985–2014. Este análisis mostró un incremento en el número de documentos publicados en los últimos 30 años. Dicha publicaciones mostraron un índice de colaboración similar a la literatura, con un alto índice de institucionalidad para las instituciones nacionales y un índice bajo para la colaboración internacional. Los artículos fueron publicados en revistas científicas del continente americano, Europa y Asia. El uso de indicadores bibliométricos proporciona una herramienta sólida para el diagnóstico y estudio de la investigación sobre la epidemiología de los parásitos intestinales y contribuye a la difusión y visibilidad de la información sobre la producción científica desarrollada en Argentina.

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Introduction

The development of science as a system is governed by the production and flow of information until it becomes knowledge. Science journals are traditionally the primary means of communication and preservation of scientific advances through the publication of scientific articles^{21,75}.

Bibliometric indicators are numerical data estimated from the bibliographic characteristics seen in published documents, allowing the analysis of various features of scientific activity, linked both to output and consumption of information^{7,11,21,32,43,89,92}.

Bibliometric laws include several laws for the regulation of matters regarding the distribution of articles in scientific journals, the authors of publications, the exponential growth of scientific knowledge, the obsolescence of the publications and the dispersion of scientific literature^{7,21,75,87}.

The growth of scientific information occurs at a markedly higher rate than other social phenomena. This growth has four stages: precursors, exponential growth phase, linear growth phase and collapse or saturation of information in a subject area. While there are variations in the different areas of knowledge, information is growing exponentially and its growth can be expressed as: $N = N_0 \times e^{b \times t}$, where N is the measured variable related to the size of science; N_0 is the measured variable at time $t=0$; t is time, and b is a constant relating the growth rate^{7,21,75}.

Obsolescence of knowledge is a function of time and can be measured by several indicators. The index of obsolescence represents the relationship between recent references and total references, conveying a sense of obsolescence of the literature and can be expressed as $IO = \text{number of recent citations} / \text{number of total citations} \times 100$ ^{7,21,75,92}.

The dispersion of scientific literature allows to organize the journals by decreasing productivity. This law reveals that most of the documents specialized in a subject area are concentrated on a few journals and are represented by the following formula: $Jp = C \times p - 2$, where Jp is the number of scientific journals, p is the number of publications and C is a constant^{7,21}.

Collaboration in science can be conceptualized as the research effort by research groups that interact in a supplementary and specialized form. This collaboration is a growing phenomenon in most areas of research that can share resources and promote the development of scientific networks to enrich the intellectual and social skills of the researchers. This index is calculated by the weighted average number of authors per paper divided by the number of papers presented at an institution or journal^{20,75,78}.

Infections by intestinal parasites are a world public-health issue due to their high prevalence, wide geographic distribution and effects on the nutritional status and immunity of the population⁶¹. Intestinal parasites add to the burden caused by communicable diseases and cause economic losses all over the world, primarily in developing countries. They affect a third of the world population with varying prevalence in different regions. The higher parasitic infections rates are observed in Latin America, China, South East Asia, and Sub-Saharan Africa^{11,12,15}.

Developed countries record approximately 88% of all scientific and technical literature included in the Journal Citation Report, while Latin America contributes with less than 5% of the total published⁵³. In recent years, Latin America and Asia have increased their scientific productivity in the area of parasitology. In Argentina, scientific research on intestinal parasites has been conducted in humans in spatially limited areas, showing heterogeneity in geographic and population distribution and being subject to a variety of socio-economic, environmental and climatic influences. Scientific publications are scattered among numerous sources of information, both electronic and printed, making their access and visibility to the scientific community harder.

Therefore, the volume, evolution, visibility and structure of scientific research in human parasitology are yet to be determined. Our purpose was to perform a quantitative, bibliometric study of the scientific literature published on intestinal parasites in Argentina in the period 1985–2014.

Number and typology of documents

Analyzing scientific publications is an essential component in the research process. It has become a useful tool to rate the

quality of the knowledge-generating process and its impact on the academic world^{21,43,75,92}.

The number and type of published documents is the simplest indicator to study scientific literature. We found 177 documents associated with human infection of intestinal parasites in Argentina published in the past 30 years.

The scientific publications were categorized as follows: periodical (articles in journals), non-periodical (dissertations and books), and limited circulation (Conference Proceedings or communications). According to documentary typology, we found 46 original articles, 128 communications to scientific meetings, two graduate dissertations, and one book chapter.

Chronological evolution of documents

A basic phenomenon of the production of scientific knowledge is its exponential growth^{21,75}. We found 13 publications in the first decade (1985–1994), 81 publications in the second decade (1995–2004), and 83 publications in the third decade (2005–2014). The two dissertations and the book chapter were included in the last period.

The global evolution of publications on intestinal parasites in Argentina showed a stationary growth in the last twenty years. However, the chronological analysis according to documentary typology indicated that the number of original articles more than doubled, while communications to meetings showed a numerical decrease in the same period (Fig. 1).

A report from the Network on Science and Technology Indicators (RICYT) showed that the amount of articles published by Latin American authors in science journals registered in the Science Citation Index (SCI) doubled in 2002–2011, showing a growth close to 2%⁷⁰. A Global Research Report published by *Web of Science* (WoS) indicates that Brazil, Mexico and Argentina are the Latin American countries having the largest increase in volume of publications over the last 20 years¹.

Similar results were provided by the National University of La Plata (UNLP), which reported a large increase in scientific production in journals indexed in the Web Library of Science, Scopus, SciELO and RedALyC^{85,86}. The growing trend of publications on intestinal parasites is in agreement with the regional increase in scientific output and might

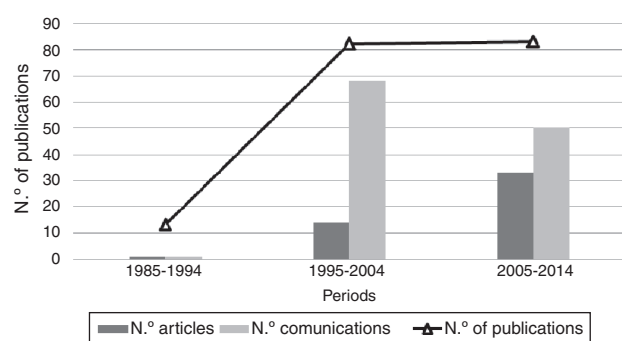


Figure 1 Chronological evolution of the number of total publications, original articles and communications published on intestinal parasites in humans in Argentina over three ten-year periods: 1985–1994, 1995–2004, and 2005–2014.

be attributed to an increase in parasite prevalence in the country, public health research, institutional collaboration and rate of medical science researchers, significant advance in diagnostic methods, improved infrastructure related to biomedical research, introduction of new journals or more funding from international organizations^{12,20,23,91,92}.

Language

Language plays a major role in the readership of scientific and research articles. English is generally considered to be the *lingua franca* of the scientific community and roughly 80% of all the journals indexed in Scopus are published in this language.

Spanish was the language used in 100%, 89%, and 87% of the articles reported in the first, second and third decade, respectively. The remaining articles were written in English and all communications were written in Spanish. Unlike international publication patterns, Spanish was the language of publication of most of the 177 documents. This might be due to the journals chosen for publication of the articles and/or to the geographical scope of scientific meetings (Argentina, Latin America or Spain)^{46,71,84,86,88,92}.

Collaboration between authors and research institutions

The participation of several authors in a research is a consequence of the professionalization of the scientific community. Collaboration in science can be conceptualized as the research effort by research groups that interact in a supplementary and specialized form. This collaboration is a growing phenomenon in most areas of research that can share resources and promote the development of scientific networks to enrich the intellectual and social capacities of the researchers.

The Collaboration Index (CI: number of signatures per publication) shows distinctive values according to the subject field and ranges from 3 to 5 authors, however, for health-related research, the CI per article reached values of 2.7 and 3 in the WHO/PAHO databases and Medline, respectively^{21,32,60}. In this review, the Collaboration Index (CI) reached an average of 5 and was similar between original articles and communications. The total number of authors per publication ranged from 1 to 14, except for one scientific communication that showed a high number of signatures⁶⁸. The CI values found for this bibliometric study were close to those reported in the literature for parasitological studies^{12,32,37,42,43,92}.

The Index of Institutionality (II: number of scientific institutions per publication) measures the collaboration among authors from different institutions. The research institutions to which the authors belong were available in 89.8% of the papers. For original articles, the II reached 76.4% for collaboration and 18.9% for communications. We found that three out of four original articles were written in collaboration with researchers from two or more Argentinean institutions, showing a high interaction among investigators in the field of human parasitology. Only four of the articles had international collaboration (Spain, Italy, United States and Australia)^{2,21,36,41,45,75}.

Table 1 Distribution of original articles in national and international journals publishing articles on intestinal parasites in humans in Argentina during 1985–2014.

Journal	Country	JCR/SCIE ^a
Acta Bioquímica Clínica Latinoamericana ^{b,c}	Argentina	Yes ^{8,25,39,40}
Acta Tropica	Netherlands	Yes ²⁹
American Journal of Human Biology	United States	Yes ⁵⁸
Annals of Tropical Medicine & Parasitology	United Kingdom	Yes ⁵¹
Boletín Chileno de Parasitología	Chile	No ⁶⁷
Bulletin of PAHO	United States	No ⁶
Cadernos de Saúde Pública	Brazil	Yes ⁵⁷
Clinical and Vaccine Immunology	United States	Yes ⁴¹
European Journal of Epidemiology	Netherlands	Yes ^{26,36}
Higiene y Sanidad Ambiental	Argentina	No ⁶⁹
International Journal of Tropical Medicine	Pakistan	No ⁸¹
International Scholarly Research Network Microbiology	United States	No ¹⁷
Journal of Infection in Developing Countries	Italy	Yes ⁵²
Journal of The Selva Andina Research Society	Bolivia	No ³⁰
Medicina (Buenos Aires) ^{b,c}	Argentina	Yes ^{44,48}
Nutrición Clínica y Dietética Hospitalaria	Spain	No ^{31,98}
Pan American Journal of Public Health ^d	United States	Yes ^{4,27,65}
Parasites & Vectors	United Kingdom	Yes ^{2,45}
Parasitología al día	Chile	No ¹³
Parasitología Latinoamericana ^d	Chile	No ^{14,74,83,99}
Polibotánica	Mexico	No ⁵⁶
Prensa Médica Argentina	Argentina	No ³⁸
Revista Argentina de Antropología Biológica ^b	Argentina	No ^{10,59}
Revista Argentina de Microbiología	Argentina	Yes ⁹³
Revista Argentina de Parasitología	Argentina	No ⁹⁷
Revista Argentina de Salud Pública ^b	Argentina	No ⁷³
Revista de Saúde Pública	Brazil	Yes ⁸⁰
Revista do Instituto de Medicina Tropical de Sao Paulo	Brazil	Yes ³
Revista Ibero-Latinoamericana de Parasitología	Chile	No ¹⁶
Revista Latinoamericana de Microbiología	Mexico	No ⁸²
The Korean Journal of Parasitology	Korea	Yes ⁴⁹
World Journal of Gastroenterology	United States	Yes ⁶⁶

^a JCR/SCIE Journal Citation Report and Science Citation Index Expanded.

^b NBR Argentinean journals indexed in the Basic Core of Argentinean Science Journals.

^c Journals of Argentina that concentrate the original articles on epidemiology of intestinal parasites.

^d Journals of America that concentrate the original articles on epidemiology of intestinal parasites.

In Latin America, international collaboration in the health area ranges between 25% and 36% and shows a heterogeneous pattern^{91,92}. Similar rates of collaboration (30–42%) were observed in five public universities in Argentina⁸⁵. However, in epidemiology of human parasites, there was minimal collaboration of Argentinean authors with their peers from foreign institutions.

The II for communications on intestinal parasites was close to 20%, showing less inter-institutional collaboration for scientific meetings. This institutional collaboration profile matches the findings of another bibliometric study, where an II close to 24% was found in the communications presented in several biochemistry conferences in Argentina⁴³.

Bibliometrics of original articles

The global scientific output of public health work is led by North American and Western Europe countries. As from

2005, publications originating in Latin America have thrived widely, reaching about 9% of all documents published. Brazil and Mexico were the two countries contributing with the highest number of publications^{12,32,33,53,62,77,92}.

In Argentina, original articles on intestinal parasites were published in 32 journals in several countries from the American Continent, Europe and Asia (Table 1). The countries with the highest number of publications on this topic were Argentina, United States and Chile. The scattering of scientific information is an issue of great practical significance. Most of the articles are concentrated on a highly reduced core of journals, while the rest of the publications spread over a high number of journals (Bradford's Law of Scattering) (Table 1).

The Web of Science website indexes about 9300 research journals and offers Journal Citation Reports (JCR) and Science Citation Index Expanded (JCR/SCIE) that examine the presence and impact of the journals. The Basic Core of Argentinean Science Journals (NBR) was implemented in

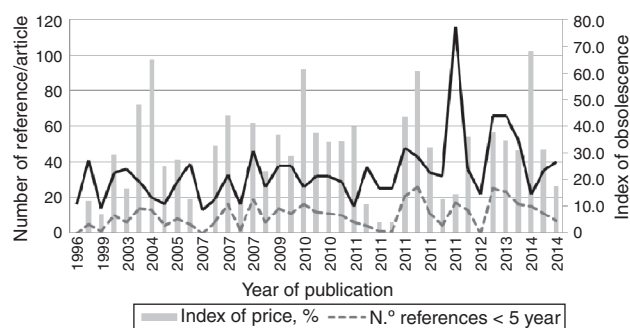


Figure 2 Chronological evolution of the number of recent references per article, number of total references per article and Index of Obsolence (IO) of the original articles published on intestinal parasites in humans in Argentina, over year of publication. The IO of the publication before 1996 could not be access the full text. Bars: Index of Obsolence, full line: number of total references, dashed line: number of recent references (under 5 years old).

Argentina to include periodical science and technology publications in the country subjected to a thorough evaluation using a definite set of quality and significance criteria. We found that 50% of the articles on intestinal parasites in Argentina were published in journals included in the JCR/SCIE and 22% in journals from the NBR. We observed higher numbers than those previously reported for parasitology articles by Latin American authors recorded in journals included in the JCR²³.

References in academic writing may be used as the ultimate authority upon which to base arguments. A number of bibliometric studies have quantified the number of references in publications and most of the papers include almost 15 references per article. Several journals written in Spanish had an average of 20 references per article²⁴. In this review, the number of bibliographic references per article ranged from 4 to 116, showing an increase in time and was higher than what was indicated in other works^{21,32,46,60,62,72,78,90}.

Scientific information loses validity over time. This phenomenon can be measured by several indicators. The Index of Obsolence (IO) represents the relationship between recent references and total references, conveying a sense of the obsolescence of the literature. In scientific disciplines where current literature is more frequent, this index gets close to 50%²⁴, decreasing as historical literature increases.

Several bibliometric studies on medicine and public health have reported this index with values between 20% and 47%^{9,24,54,78,90}. In this work, the number of recent references per article, the number of total references per article, and the average IO were 10, 34, and 28.5%, respectively (Fig. 2). The published articles included in this bibliometric study showed an IO within the rates reported by others authors^{9,24,54,78,90}.

Literature search is an important part of any research and publication activity. Electronic databases of medical literature nowadays come with very versatile tools for searching and retrieving information. Abstracts are usually followed by a list of keywords selected by the author. The instructions for authors will state how many keywords are required. Choosing appropriate keywords is important, because these are used for indexing purposes. Well-chosen keywords

enable your manuscript to be more easily identified and cited. For clinical papers, keywords may need to be chosen from the Medical Subject Headings list. Only 36 original articles included keywords. The authors employed a total of 121 words as descriptors; however, a minimum core of 64 unrepeated words was observed. The most frequent terms were: Argentina, intestinal parasites, enteroparasitosis, intestinal parasitosis, helminths, protozoa, *Giardia*, *Blastocystis*, epidemiology, nutritional status, and children. The names of Argentinean provinces included among the keywords were: Córdoba, Mendoza, Misiones, Entre Ríos, and Salta.

Bibliometrics of scientific communications

Gray, unconventional or informal literature is any kind of document not disseminated through the ordinary publication channels, which include printed documents of limited production, with contents addressed to specialized readers and generally not adhering to standards of bibliographical control. The 128 scientific communications were presented in 33 scientific meetings, with an average of 4 communications per event. The meetings were divided according to their subject field into: *Pediatrics*^{18,22,28,35,64} (Congreso Argentino de Infectología Pediátrica, Congreso Argentino de Pediatría General Ambulatoria, Congreso Nacional de Pediatría, Encuentro Nacional de Investigación Pediátrica); *Biochemistry/Microbiology* (Congreso Argentino de Bioquímica, Congreso Argentino de Microbiología), *Parasitology*^{55,63,76,79,95} (Congreso Argentino de Parasitología, Congreso Argentino de Protozoología, Congreso Latinoamericano de Parasitología, Jornadas Nacionales de Enteroparasitosis), *Zoonosis*^{5,19,50,94} (Congreso Argentino de Zoonosis, Congreso Bonaerense de Zoonosis, Congreso Internacional de Zoonosis, Congreso Latinoamericano de Zoonosis), and *assorted matters*^{34,96} (Jornadas Nacionales de Antropología Biológica, Reunión de Comunicaciones Científicas y Tecnológicas, Congreso Regional de Ciencia y Tecnología, Congreso Argentino de Redes de Laboratorio, Congreso Latinoamericano de Gastroenterología). All communications were published in Conference Proceedings (85; 66%) and two journals included in the NBR (43; 34%). Proceedings have a restricted circulation while journals provide increased availability and visibility of investigation results, intrinsic phenomena of the scientific activity.

Scientific communications on intestinal parasites were presented in numerous scientific meetings, showing a wide scattering of the literature. The CI of communications was similar to that found in original articles, indicating the number of collaborators bore no relation to the documentary typology. However, the II was different in both types of documents revealing that the collaboration between institutions was limited for original articles. We found collaboration between institutions lower than 20% for scientific communications. This situation differs from those published by other authors, who reported a collaborative work in medical topics close to 45%^{43,47}.

Conclusion

Quantitative evaluation of publication and citation data is now used in many countries with a sizeable science

enterprise. Bibliometrics is used in research performance evaluation, especially in university and government labs, and also by policymakers, research directors, information specialists, librarians and researchers⁷⁵.

This study showed an increase in the number of articles published on intestinal parasites in humans in Argentina over the last 30 years. Those articles showed a collaboration index similar to that of the literature, with a high index of institutional collaboration for national institutions and a low one for international collaboration. The Index of Obsolescence showed a lower percentage since recent literature has been published on this subject field. The bibliometric analysis of communications showed a high number of works in scientific meetings, a Collaboration Index similar to that of the original articles and a remarkably lower Index of Institutionalization. Those papers were mostly published in Conference Proceedings, with limited access and availability.

Studying the scientific output in a given subject field continues to be a good marker of research advance and knowledge generation. Both the growth of scientific production in recent decades and its indexation in computerized bibliographic databases have enhanced the use of bibliometrics and the creation of indicators to measure the results of scientific and technological activity. This field of study allows researchers to examine scientific advances in retrospect and to characterize the development, obsolescence and scattering of scientific publications in Argentina.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflict of interest

The authors declare that they have no conflicts of interest.

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