

ORIGINAL ARTICLE

BIBLIOMETRIC ANALYSIS OF ORIGINAL SCIENTIFIC PUBLICATIONS FROM THE INSTITUTO NACIONAL DE SALUD DEL PERU FROM 1998 TO 2018

Franco Romani ^{1,a}¹ Oficina General de Investigación y Transferencia Tecnológica, Instituto Nacional de Salud, Lima, Perú.^a Medical Doctor

ABSTRACT

Objetives: To measure the scientific production of the Instituto Nacional de Salud del Perú (INS) through bibliometric indicators of production, collaboration and impact. **Materials and methods:** Bibliometric study of original publications from journals indexed in Scopus and Scielo Peru in the period between 1998 and 2018. The production indicators were: the number of publications per year and per subperiod (1998-2008 and 2009-2018), by theme, and by journal. The collaboration indicators were: the co-authorship index, the number of institutional signatures, the national and international collaboration rate, the proportion of first-time authorship with INS affiliation. The impact indicators were: the number of citations per year, citation/document index, the proportion of documents ever cited and the citation speed. **Results:** A total of 618 publications had at least one author with INS affiliation. From these, 55.9% (346/618) were published in Peruvian scientific journals and 30 INS authors were major producers. From the publications total, 49.0% (303/618) had a first author with INS affiliation. Regarding the subject of investigation, 132 (21.4%) publications were on vector-borne diseases; 9.7% (60), on tuberculosis; and 9.5% (59), on zoonoses. The international collaboration rate was 38.8%. The ratio of citations/documents was 12.8 for the entire period. The H index of publications with INS participation was 37. **Conclusions:** In the last two decades, the contribution of the INS was focused on infectious diseases. On the other hand, it is required to strengthen the productivity indexes of INS authors, as well as consolidating the new thematic lines that they have developed in the last decade. This effort will allow the INS to improve its function as a public research institute.

Keywords: Bibliometría; Autoría y Coautoría en la Publicación Científica; Institutos de Investigación; Investigación; Indicador de Colaboración; Perú (Source: MeSH NLM).

INTRODUCTION

In recent decades, the scientific production of Peru's research centers has increased in all areas of knowledge ⁽¹⁾, including biomedical and health fields ^(2,3). Bibliometric studies use statistical methods to quantify and describe the characteristics of scientific literature ⁽⁴⁾. Bibliometrics have systematically characterized the scientific publications of Peruvian authors and institutions in defined time periods, by subject ⁽⁵⁻⁷⁾ and for the purpose of description, evaluation or monitoring ^(8,9).

The Peruvian Instituto Nacional de Salud (INS) is a public research institute that is part of the Peruvian Ministry of Health (MINSA). Its mission is to promote and disseminate scientific research in the public health field, to improve population's living conditions. Some studies have quantified the scientific production of the INS. Between 2007 and 2011, the MINSA had 457 publications; however, it is not possible to identify in how many did INS participate ⁽¹⁾. An analysis in the Web of Science (WoS) database for the period 1997-2016 found 196 publications with INS participation ⁽²⁾. Another study of Peruvian scientific production in medicine from journals indexed in WoS found 65 publications with INS affiliation between 2000 and 2009 ⁽³⁾.

Cite as: Romani F. Bibliometric analysis of original scientific publications from the Instituto Nacional de Salud del Perú from 1998 to 2018. Rev Peru Med Exp Salud Publica. 2020;37(3):485-94. doi: <https://doi.org/10.17843/rpmesp.2020.373.5470>

Correspondence to: Franco Romani; Capac Yupanqui 1400, Jesus María, Lima, Perú; fromani@ins.gob.pe

Received: 02/04/2020
Approved: 21/05/2020
Online: 06/07/2020

We did not find specific studies on the INS scientific production, so we lack information about INS publications, such as characteristics, trends over time and the impact of the citations. The two-decades analysis of these bibliometric indicators will allow to properly fill this knowledge gap (2). Due to the foregoing, we conducted a bibliometric study of the original scientific publications with the participation of the INS during 1998-2018.

MATERIALS AND METHODS

Design and information source

A bibliometric study of the INS scientific production was carried out through the analysis of original publications in magazines indexed in Scopus and Scielo Perú during 1998-2018.

The Scopus database was selected because it includes all the journals indexed in Medline⁽⁴⁾ and has an important collection of Latin American journals. It also facilitates the search by institutional affiliation and the identification of the authors' affiliations, which is necessary for the collaboration indicators⁽¹⁰⁾. Scielo Perú allowed the inclusion of publications in Peruvian journals not indexed in Scopus.

The search was conducted in October 2019. In Scopus, the search by affiliation to the "Instituto Nacional de Salud, Lima" was used (affiliation identifier: 60071247). It was filtered for the period 1998-2018; later the database was downloaded in .CSV format, according to the following variables: authors, document title, year, title of the source/journal, authors with affiliations, abstract, and document type.

Journals in the "Health Sciences" category from SciELO Perú were identified. At the time of the search, this base included 12 journals. In order to recover these publications, all the issues of the journals published in Scielo Peru's portal were reviewed. The digitized version of each publication was manually reviewed and those with at least one author with INS affiliation were obtained. This identification was carried out by two analysts with experience in bibliometric studies (DF and MC).

Analysis unit

The unit of analysis was the original publication. The following document types were considered for Scielo Perú's records: original article, short original article and short communication. Regarding Scopus, records were manually reviewed to validate them as publications that reported results of study or research project, following the structure or not (introduction, methods, results and discussion).

KEY MESSAGES

Motivation for the study: The biomedical scientific production in Peru has been quantified, however, the production of the Instituto Nacional de Salud del Peru (INS) has not been evaluated.

Main findings: The INS participated in 618 original publications. Over the years it has increased its production and has more international collaboration and citations, however, its leadership has decreased. The 3 most addressed topics were vector-borne diseases, tuberculosis, and zoonoses.

Implications: Peru needs a strengthened public health research institute with national and international leadership.

Data base elaboration

664 publications were obtained from Scopus, 3 of them eliminated due to repetition, and 12 removed due to the lack of author with INS affiliation. After debugging, 649 records were left. Data from 621 publications was collected by the manual search of Scielo Perú.

On Scopus, the following indexed publications were found: 508 articles, 57 letters to the editor, 34 editorials, 33 reviews, 10 notes, 4 conference papers, 2 misprints and 1 article in press. On Scielo Perú: 266 original articles, 65 letters to the editor, 50 editorials, 45 review articles, 39 short communications, 38 original short articles, 37 special articles, 28 conference papers, 19 photo galleries, 16 case reports, 14 historical/biographical articles, 2 notes, 1 current issue and 1 guidance document.

Databases recovered from Scopus and Scielo Perú were consolidated. Between 1998 and 2018, publications from the *Revista de Gastroenterología del Perú*, the *Revista de Investigaciones Veterinarias del Perú* and the *Revista Peruana de Biología*, as well as the publications between 2009 and 2018 from the *Revista Peruana de Medicina Experimental y Salud Pública (RPMESP)*, produced duplicate records. The Spanish titles were compared, and 302 duplicates were eliminated. The consolidated database comprised 968 records.

A consolidated spreadsheet was created for the original publications. Since the information exported from Scopus presented errors in the document classification, each record was manually verified, by reviewing the structure and information of the abstract or the full article, in order to validate it as an original publication. This process was carried out by two experienced collaborators in bibliometric studies. In case of discrepancies, the identification was made by the author.

The database of the original publications included the following variables: recovery database, name of scientific journal, year of publication, title of publication, abstract, authors, institutional signature, country signature.

The names of the authors were manually normalized due to incomplete data, spelling problems or different names for the same author. For the standardization of the institutional affiliation, the largest institution comprising a laboratory, management, institute, faculty or sub-unit was considered.

For the citation analysis, the number of citations per year for each record with at least one citation was collected in a spreadsheet. The citation count was performed only for the publications retrieved from Scopus through its Metrics tool. The publications retrieved from Scielo Perú were not considered because their citation-counting tool is still going through the development phase and it was confirmed that in many cases it does not provide accurate data.

Variables

The number of original publications per year of publication, scientific journal name and subject matter were the production indicators. The publication years were re-categorized into 2 sub-periods (1998-2008 and 2009-2018). The author assigned the thematic manually, by reviewing the title and abstract of each publication and taking as reference the National Priorities for Health Research in Peru 2019-2023⁽¹¹⁾. The productivity index was defined as the logarithm of the number of original publications per year.

The productivity index for authors with INS affiliation was categorized into small producers (1 publication), medium producers (2-9 publications) and large producers (≥ 10 publications)⁽⁴⁾.

The collaboration indicators were the following: co-authorship (number of authors/number of original publications), number of institutional signatures per document (number of institutional signatures/number of original publications), national collaboration rate (original publications with at least one institutional signature from Peru other than the INS/total number of original publications $\times 100\%$), and international collaboration rate (percentage of original publications with at least one foreign institution signature).

The number of authors was recategorized into single, two to five, six to ten, and more than ten. The number of institutional signatures was recategorized into only INS, two to three, four to five, and six or more. Journals were considered to be national (published in Peru) or foreign, based on their identification. The occurrence of a first author with INS affi-

liation was used as an indicator of capacity for creation and initiative⁽¹²⁾, since it is the position with the greatest intellectual and operational contribution within the study^(13,14).

The following indicators are constructed from the number of citations per year: citations obtained per original publication, citation/original publication index, number of original publications cited at least once, and proportion of documents cited⁽⁴⁾. The speed of citation was defined as the time (in years) from publication to the first citation⁽¹⁰⁾.

Data analysis

Bibliometric indicators will be presented for the entire study period and for the sub-periods 1998-2008 and 2009-2018. The bibliometric indicators of production, collaboration and impact will be presented in frequencies, percentages and central tendency measures. The characteristics associated to original publications with first authorship from the INS were evaluated. Proportions were compared with the Chi-square test, and the ratio of proportions was calculated with a 95% confidence interval. The H index was calculated for the INS production. The statistical analysis was carried out in Microsoft Excel and Epidat 3.1.

RESULTS

Production indicators

During the study period, 618 original publications with at least one author with INS affiliation were recovered from Scopus and Scielo Perú. A second-degree polynomial type growth was observed in the scientific production (Figure 1). 55.9% (346/618) of the articles were published in Peruvian journals. Between 1998 and 2008, 26.6% (62/233) of the articles were published in international journals, and between 2009 and 2018, it was 54.5% (210/385). For the whole period, 136 different journals published articles; 77.8% of the publications were concentrated in 26 journals (Table 1).

During the period between 1998 and 2008 the mean (standard deviation [SD]) productivity index was 1.25 (0.28), and during 2009-2018, 1.78 (0.09). We identified 440 different authors with INS affiliation; according to the productivity index, 231 (52.5%) were small producers; 179 (40.7%), medium producers; and 30 (6.8%), large producers. At the time the data was retrieved, 7 large producers no longer had institutional affiliation with the INS (Figure 2).

First authorship

From the total of publications, 49.0% (303/618) had a first author with INS affiliation. Between the two subperiods,

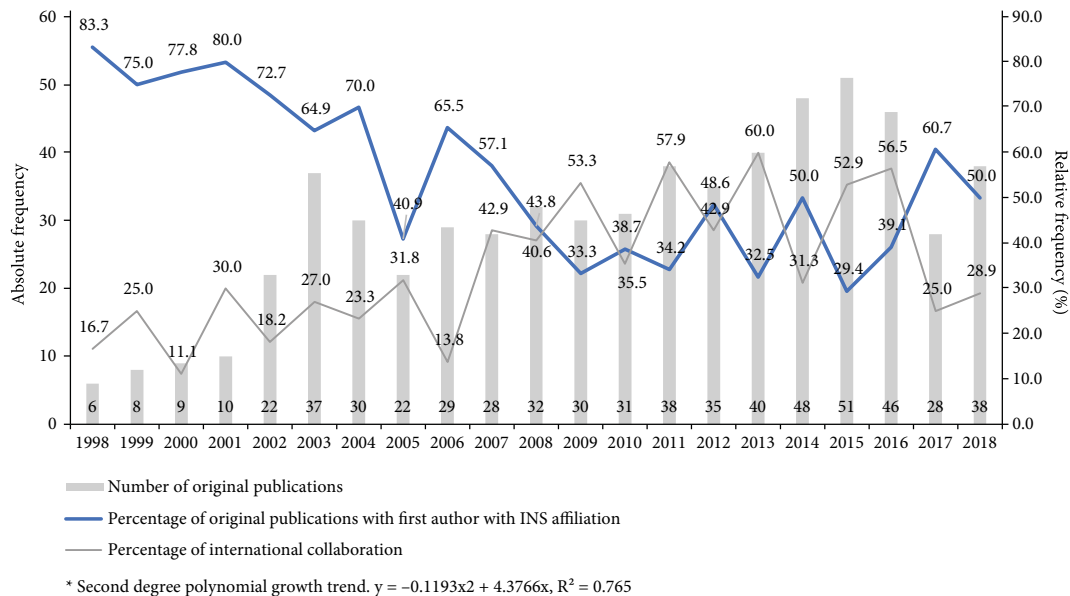


Figure 1. Evolution of original publications*, first authored by the Instituto Nacional de Salud and international collaboration, 1998-2018.

first authorship with INS affiliation decreased from 62.2% to 41.0% (Figure 1). The presence of a first author with INS affiliation is twice as frequent among publications without international collaboration (PR: 2.93; 95%CI: 2.29 to 3.74). As the number of authors and institutional signatures increases, the probability of being an INS-affiliated first author is lower. An INS-affiliated first author is associated with publications in national journals, especially in the RPMESP (PR: 2.33; 95%CI: 1.95 to 2.79) (Appendix 1).

Thematic analysis

132 (21.4%) of the publications were on vector-borne diseases, 60 (9.7%) on tuberculosis and 59 (9.5%) on zoonoses. In 24 of the 29 topics, the production increased in the second subperiod: tuberculosis went from 16 to 44; food and nutrition, from 12 to 30; non-communicable diseases, from one to 24; antivenoms, from 4 to 7; bibliometrics, from 1 to 13; etc. Between 1998 and 2008, vector-borne diseases, tuberculosis, and zoonoses accounted for 51.5% of publications; during 2009-2018, these topics accounted for only 34.0% (Table 2).

Collaboration indicators

We identified 4,099 author signatures. For the entire study period the co-authorship index was 6.63. In addition, 80.3% of the publications had collaborations with authors from

another institution. Between the two subperiods, the rate of international collaboration went from 27.9% to 45.5%, while national collaboration went from 65.2% to 71.2% (Table 3).

Throughout the whole period, INS collaborated with 491 different institutional signatures from 42 countries (including Peru). Among the institutional signatures, 182 were from Peru; 68 from the United States; 30 from Brazil; 25 from Argentina; and 18 from Ecuador. In these institutional interactions, there were 2,679 collaborations with authors affiliated with a Peruvian institution; 806 with authors affiliated with institutions in the United States; 395 with institutions in Brazil; 113 with institutions in Argentina; and 81 with institutions in Ecuador (Appendix 2). The 3 institutions with the greatest interaction with the INS were the Universidad Nacional Mayor de San Marcos (UNMSM), with 319 co-authors, followed by the Universidad Peruana Cayetano Heredia (UPCH), with 307, and the United States Center for Disease Control and Prevention, with 274 (Appendix 3).

Citation analysis

Of 407 original publications recovered from Scopus, 339 (83.3%) were cited at least once. The number of citations was 5,206. The 65 publications during 1998-2008 generated 325 citations, while the 342 publications from the 2009-2018 period generated 4,881. The citation/document index for the entire period was 12.8 (Table 4). Between 2008 and 2015,

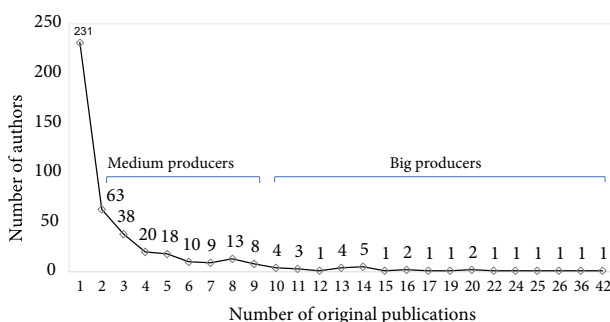
Table 1. Main scientific journals regarding diffusion of original publications with institutional affiliation of the Instituto Nacional de Salud, 1998-2018.

N°	Journal	Country ^a	Subperiod		Total		
			1998-2008	2009-2018	n	%	Accumulated %
1	Revista Peruana de Medicina Experimental y Salud Pública	Perú	158	125	283	45.8	45.8
2	Anales de la Facultad de Medicina	Perú	9	29	38	6.1	51.9
3	American Journal of Tropical Medicine and Hygiene	EE. UU.	12	7	19	3.1	55.0
4	PLoS ONE	EE. UU.	1	12	13	2.1	57.1
5	Emerging Infectious Diseases	EE. UU.	3	9	12	1.9	59.1
6	International Journal of Tuberculosis and Lung Disease	Francia	6	5	11	1.8	60.8
7	Acta Tropica	Holanda	0	9	9	1.5	62.3
8	PLoS Neglected Tropical Diseases	EE. UU.	0	8	8	1.3	63.6
9	Genome Announcements	EE. UU.	0	7	7	1.1	64.7
10	Revista de Salud Pública	Colombia	1	6	7	1.1	65.9
11	Toxicon	Reino Unido	0	7	7	1.1	67.0
12	Malaria Journal	Reino Unido	0	6	6	1.0	68.0
13	Revista de Gastroenterología del Perú	Perú	2	4	6	1.0	68.9
14	Revista Médica Herediana	Perú	0	6	6	1.0	69.9
15	Memorias do Instituto Oswaldo Cruz	Brasil	3	2	5	0.8	70.7
16	BMC Infectious Diseases	Reino Unido	0	4	4	0.6	71.4
17	Clinical Infectious Diseases	Reino Unido	3	1	4	0.6	72.0
18	Horizonte Médico (Lima)	Perú	0	4	4	0.6	72.7
19	International Journal of Infectious Diseases	Holanda	0	4	4	0.6	73.3
20	Journal of Medical Entomology	EE. UU.	0	4	4	0.6	73.9
21	Nutrición Clínica y Dietética Hospitalaria	España	0	4	4	0.6	74.6
22	Revista da Sociedade Brasileira de Medicina Tropical	Brasil	2	2	4	0.6	75.2
23	Revista de Investigaciones Veterinarias del Perú	Perú	0	4	4	0.6	75.9
24	Revista do Instituto de Medicina Tropical de Sao Paulo	Brasil	1	3	4	0.6	76.5
25	Revista Panamericana de Salud Pública	EE. UU.	1	3	4	0.6	77.2
26	Revista Peruana de Biología	Perú	2	2	4	0.6	77.8

^a Country of the publisher according to Scimago Journal & Country Rank.

articles published in each year were cited 400 time or more since their publication (Appendix 4).

Figure 2. Distribution of the production of original publications among authors with affiliation to the Instituto Nacional de Salud, 1998-2018



From the publications with some citations, 106 (31.3%) were cited in the same year of publication; 151 (44.5%), after 1 year; 46 (13.6%), after 2 years; 17 (5.0%), after 3 years; 7 (2.1%), after 4 years; 5 (1.5%), after 5 years; 3 (0.9%), after 6 years; 2 (0.6%), after 7 years; 1 (0.3%), after 8 years; and 1 (0.3%), after 10 years.

Original publications with INS affiliation had an H index of 37. The article with the most citations was published in 2011 and reached 176 citations. In that article, the INS-affiliated author was ranked 12th. Four publications received more than 100 citations. In none of them did the first author have an INS affiliation. Of the 35 most cited publications (≥40 citations), three (8.6%) had a first author with INS affiliation (Appendix 5).

Table 2. Thematic of the scientific production of original publications with participation of the Instituto Nacional de Salud, 1998-2018. periodo 1998-2018

Theme	1998-2008		2009-2018		Total	
	n	% ^a	n	% ^a	n	%
Vector-borne diseases	78	33.5	54	14.0	132 ^b	21.4
Tuberculosis	16	6.9	44	11.4	60	9.7
Zoonoses	26	11.2	33	8.6	59 ^c	9.5
Food and nutrition	12	5.2	30	7.8	42	6.8
Other infectious communicable diseases	20	8.6	13	3.4	33	5.3
Microbiology	16	6.9	16	4.2	32	5.2
Non-communicable diseases	1	0.4	23	6.0	24	3.9
Entomology	6	2.6	15	3.9	21	3.4
Retrovirus infections	10	4.3	8	2.1	18	2.9
Human resources in health	3	1.3	13	3.4	16	2.6
Antivenoms	4	1.7	11	2.9	15	2.4
Child and adolescent health	3	1.3	12	3.1	15	2.4
Bibliometric	1	0.4	13	3.4	14	2.3
Nutritional and metabolic diseases	2	0.9	12	3.1	14	2.3
Others ^d	2	0.9	12	3.1	14	2.3
Viral hepatitis	5	2.1	7	1.8	12	1.9
Mycosis	10	4.3	2	0.5	12	1.9
Health services	2	0.9	10	2.6	12	1.9
Mental health	1	0.4	9	2.3	10	1.6
Pharmaceutical products	3	1.3	6	1.6	9	1.5
Occupational health	2	0.9	7	1.8	9	1.5
Violence	1	0.4	7	1.8	8	1.3
Viral respiratory infections	2	0.9	5	1.3	7	1.1
Medicinal plants	2	0.9	4	1.0	6	1.0
Sexual and reproductive health	0	0.0	6	1.6	6	1.0
Management and research ethics	1	0.4	4	1.0	5	0.8
Heavy metals	0	0.0	5	1.3	5	0.8
Health information systems	2	0.9	3	0.8	5	0.8
Health in indigenous communities	2	0.9	1	0.3	3	0.5

^aPercentage of the number of original publications of the corresponding period. ^bIncludes subtopics: malaria (38), leishmaniasis (26), dengue fever (24), Chagas disease (18), human bartonellosis (10), yellow fever (8), other arboviruses (4), and acute febrile syndrome (4). ^cIncludes subtopics: leptospirosis (14), rickettsiosis (10), echinococcosis (8), rabies (7), hydatidosis (5), plague (4), fascioliasis (3), brucellosis (2), toxocarosis (2), cysticercosis (2), Borrelia infections (1), and ehrlichiosis (1). ^dIncludes gastroesophageal reflux, alternative medicine, climate change, zoology, vaccination, traffic accidents, clinical practice guidelines, genomics, pulmonary embolism, bioinformatics, microbioma.

DISCUSSION

Production of original publications with INS participation has shown an increasing trend from 1998 to 2015, and there was a 65.2% growth in the number of publications in the decade of 2009-2018. INS has contributed 618 original publications, and if we consider all types of publications, the contribution would reach almost a thousand articles. Taking as a denominator the 6,032 biomedical publications with participation of some Peruvian institution found between 1997 and 2016 in the WoS⁽²⁾ base, between 10% and 15% of the biomedical scientific production of Peru had INS parti-

cipation. To understand this estimate, we must consider the analysis of a different database and two additional years.

From 2016 to 2018 the number of publications decreased, there can be several plausible explanations: a) the lower production of new research projects; the INS web portal shows that only 1 out of 44 projects financed for 2018 was approved that year, and 10 in 2017; 5 out of the 31 projects financed for 2019 were approved that year, the others were generated and approved in previous years; b) the emigration of large producers, as of 2019 almost a quarter of these authors were no longer INS-affiliated; and c) the non-completion of research projects, due to administrative and logistical problems in

Table 3. Bibliometric collaboration indicators of the Instituto Nacional de Salud, 1998-2018.

Indicator	Period		Total
	1998-2008	2009-2018	
Number of original publications (a)	233	385	618
Number of author signatures (b)	1370	2729	4099
Number of institutional signatures (c)	618	1426	2044
Co-authorship rate (b/a in %)	5.9	7.1	6.6
Index of number of institutional signatures (c/a in %)	2.7	3,7	3.3
Number of OPs with at least one institution with a foreign country signature (d)	65	175	240
International collaboration rate (d/a in %)	27.9	45.5	38.8
OP number with at least one institution (other than INS) with Peru country signature (e)	152	274	426
National collaboration rate (e/a in %)	65.2	71.2	68.9
OP number with INS affiliation (without collaboration) (f)	58	64	122
Proportion of OP without institutional collaboration (f/a in %)	24.9	16.6	19.7

OP: Original publication

the purchase of goods and services for research activities⁽¹⁷⁾. The fewer studies generated, conducted and concluded, the fewer publications to disseminate their results.

Approaches to INS scientific production were made in studies that measured national production. For example,

between 2000 and 2009, 65 publications were identified in the ISI Web of Knowledge database⁽³⁾, while between 1997 and 2016, 196 publications with INS affiliation were found in WoS⁽²⁾. Both analyses recovered articles of diverse typology. In our study, taking into account only original publications,

Table 4. Citation analysis of original publications of the Instituto Nacional de Salud del Peru, according to Scopus a for the period 1999-2018

Year	Number of OPs (a)	Number of OPs cited at least once (b)	Proportion of OPs cited (b/a in %)	Number of citations received by all OPs in each year (c)	Index of quotations/publication (c/a)
1999	1	1	100.0	0	0.0
2000	2	1	50.0	1	0.5
2001	2	1	50.0	3	1.5
2002	6	5	83.3	1	0.2
2003	9	9	100.0	8	0.9
2004	7	7	100.0	27	3.9
2005	7	7	100.0	41	5.9
2006	6	5	83.3	61	10.2
2007	11	10	90.9	74	6.7
2008	14	13	92.9	109	7.8
2009	30	25	83.3	134	4.5
2010	30	30	100.0	196	6.5
2011	33	30	90.9	301	9.1
2012	30	27	90.0	359	11.9
2013	37	35	94.6	405	10.9
2014	43	40	93.0	527	12.3
2015	46	41	89.1	583	12.7
2016	38	29	76.3	743	19.6
2017	25	16	64.0	856	34.2
2018	30	7	23.3	777	25.9
Total	407	339	83.3	5206	12.8

^aQuotations received as of October 2019; OP: Original publication.

we found four and three times the amounts reported for those periods, by the mentioned studies. This difference could be explained by the database used, WoS has selective criteria for the inclusion of journals. In 2014 the number of journals indexed in WoS was 12,000, while in Scopus it was 21,921, in addition, 11,738 journals were indexed in Scopus but not in WoS⁽¹⁰⁾.

The productivity of INS authors follows Lotka's law. Almost half of them had low productivity, and 30 were the most productive, which means that a significant percentage of researchers worked on a research project and did not re-engage in the research-publication process; therefore, they did not continue the line of research initiated⁽¹⁵⁾. This characteristic does not allow the formation of experts in thematic lines nor does it encourage collaboration in these areas⁽¹⁶⁾. Another explanation would be the lack of an adequate publication culture. Between 2004 and 2008, only 18 of 129 INS research projects became a scientific publication⁽¹⁷⁾. Another study showed that 79 (26.7%) of 296 abstracts submitted to an international congress on tropical diseases culminated in scientific publication within 6 years⁽¹⁸⁾.

When it comes to biomedical research, authorship contribution is usually assigned in descending order: the first author is the one with the greatest contribution to the scientific activities of the study and exercises leadership during the project^(12,19). It was found that first authorship of INS-affiliated authors decreased in the last decade, which could be associated with the increase of the international collaboration ratio and a secondary role of INS authors. In collaborative studies, authors from low- and middle-income countries are often relegated in the order of authorship because their contribution is limited to recruitment of study subjects, data collection, sample referral, and other technical aspects^(20,21).

As is the case for other research institutions^(22,23), the INS international collaboration network expanded in the decade of 2009-2018. Institutional signatures were most frequently from the United States, followed by Brazil and Argentina. This trend has also been observed in similar institutions, such as the Fiocruz Institute in Brazil⁽¹⁶⁾. The frequent collaboration of Peruvian institutions with those from the United States has been reported in medical publications between 2000 and 2009; those that collaborated the most were Johns Hopkins University, the Center for Disease Control and the University of Washington⁽³⁾, the leadership of these U.S. institutions was also evident between 1997 and 2016⁽²⁾.

International collaboration is key to scientific research in Latin America, including the field of public health. Between 1996 and 2011, scientific publications on public health and me-

dicine had a 30% international collaboration rate, decreasing from 35.8% in 1996 to 24.5% in 2011⁽²⁴⁾. In our study, international collaboration was found to be close to 40%, with an increase in the 2009-2018 decade. International collaboration is variable in Peruvian institutions. In the 2006-2011 period, 74.4% of UPCH publications and 56.2% from UNMSM had international collaboration, percentages higher than the values (90%) seen in public research institutes⁽¹⁾.

Articles where first authors are from the INS are published mainly in the *RPMESSP*. This scenario is due to the fact that the INS is the publisher of this journal, it is published in Spanish and is the only Peruvian public health journal indexed in Scopus and Medline. A negative aspect of this preference is that the *RPMESSP* is not indexed in WoS and does not regularly publish in English, which limits the citation possibility of its articles. In fact, the *RPMESSP* achieved only 945 citations in the period 2010-2017⁽⁹⁾.

Infectious diseases were the main topic, which is consistent with the two-thirds of the articles on this subject in publications with Peruvian participation between 1997-2006⁽²⁾. In the field of infectious diseases, the growth of research on tuberculosis stands out, which production tripled in the studied subperiods. The large production in these topics respond to the fact that their authors came from the National Center of Public Health, a division of the INS dedicated to research on communicable diseases, where the greatest number of projects are produced⁽¹⁷⁾.

The INS scientific production covered most of the topics included in the national research priorities⁽²⁵⁾ and in the research agendas approved in 2009 and 2011, respectively. Despite this, there were some neglected topics, for example, maternal mortality did not have any specific research, or mental health which had 10 publications in 20 years, 9 of them in the last decade. The reduced scientific production on such topics is a problem in the country. An analysis of the national scientific production between 2011 and 2014 found maternal mortality and mental health, with 11 and 28 original articles respectively⁽²⁶⁾, as the least studied topics.

As of 2011, there were over 300 citations per year, and 2017 had the highest number of citations for INS articles. This phenomenon could be explained by the indexing of the *RPMESSP* in Scopus and by the increase of international collaboration and publications in international journals⁽²⁷⁾. One third of the publications received at least one citation in the same year of publication, and almost half during the following year, this reflects a high speed of citation; that is, research results tend to be disseminated quickly to the scientific community and used in a short time⁽¹⁰⁾.

This study had some limitations: the citation analysis of all the original publications was not performed, only those

obtained from Scopus, which would not reflect the real use and impact of these publications. This analysis supposes an appropriate attribution of authorship, which could be affected by the changes in the authorship criteria occurred in the two decades covered by this study. INS authors might have not recognized their institutional affiliation, and authors not related to the institution might have stated an INS affiliation⁽²⁸⁾. The analysis of funding sources was not carried out, due to the heterogeneity of the reports, neither the analysis of indicators that evaluate dissemination, industrial production or the impact on health services or systems⁽²⁹⁾. Finally, this analysis may not reflect all of INS's scientific activities, since near 85% of projects it undertakes are not published⁽¹⁷⁾.

The strength of this study is the analysis of original publications, which are the standard format for presenting results of scientific research about technologies, products, new concepts or hypotheses. Citation of these articles brings us closer to the effective impact of an institution's publications on the scientific progress⁽³⁰⁾.

In conclusion, there is an increase of INS participation in original publications during the 2009-2018 decade, despite a drop in production in the last three years of observation. The contribution has been mainly on vector-borne diseases,

tuberculosis and zoonoses. The growing international collaboration has generated more publications in foreign and increasingly cited journals, but it reduced the articles with first authors from the INS. It is recommended to consolidate international collaboration with greater INS leadership; to increase the amount of large producers; to consolidate the new thematic areas in which INS researchers are positioning themselves; and to increase the rate of collaboration at the national level, with equal care as at the international level.

Acknowledgements: To Joselyn Quispe, Diego Flores and Maricela del Carmen Castillo for their work in constructing, cleaning and processing the database. To Paolo Wong Chero for the critical review of the manuscript.

Authors' contributions: FR conceptualized and designed the study, reviewed and validated the database, analyzed the information, wrote the manuscript, approved the final version, and assumes responsibility for its content.

Funding: *The study was funded by the Instituto Nacional de Salud.*

Conflict of Interest: FR serves as executive director of the Office of Technological Transfer and Training of the Instituto Nacional de Salud. He is also scientific editor of the Revista Peruana de Medicina Experimental y Salud Pública

Supplementary material: Available in the electronic version of the RPMESP.

REFERENCES

1. Consejo Nacional de Ciencia, Tecnología e Innovación Tecnológica. Principales indicadores bibliométricos de la actividad científica peruana. 2006-2011 [Internet]. CONCYTEC; 2014 [Cited on December 11, 2019]. Available at: http://repositorio.concytec.gob.pe/bitstream/20.500.12390/93/1/indicadores_bibliometricos_peru_2006_2011.pdf.
2. Belter CW, Garcia PJ, Livinski AA, Leon-Velarde F, Weymouth KH, Glass RI. The catalytic role of a research university and international partnerships in building research capacity in Peru: A bibliometric analysis. Lee BY, editor. PLOS Negl. Trop. Dis. 2019;13(7):e0007483. doi: <https://doi.org/10.1371/journal.pntd.0007483>.
3. Huamani C, Mayta-Tristán P. Producción científica peruana en medicina y redes de colaboración, análisis del Science Citation Index 2000-2009. Rev Peru Med Exp Salud Publica. 2010;27(3):315-25.
4. Jimenez J, Argimon Pallas JM, Martín Zurro A, Vilardell Tarrés M. Capítulo 19: Bibliometría e indicadores de actividad científica. En: *Publicación Científica Biomédica Cómo escribir y publicar un artículo de investigación*. Segunda edición. Barcelona, España: Elsevier España; 2016.
5. Mayta-Tristán P, Huamani C, Montenegro-Idrogo Juan JJ, Samanez-Figari C, González-Alcaide G. Producción científica y redes de colaboración en cáncer en el Perú 2000-2011: un estudio bibliométrico en Scopus y Science Citation Index. Rev Peru Med Exp Salud Publica. 2013; 30(1): 31-36.
6. Caballero P, Gutiérrez C, Rosell G, Yagui M, Alarcón J, Espinoza M, *et al.* Análisis bibliométrico de la producción científica sobre VIH/SIDA en el Perú 1985 - 2010. Rev Peru Med Exp Salud Publica. 2011;28(3):470-6.
7. Yagui-Moscoso M, Oswaldo-Jave H, Curisínche-Rojas M, Gutiérrez C, Romani-Romani F. Análisis bibliométrico de la investigación sobre tuberculosis en el Perú, periodo 1981-2010. An Fac Med. 2013;73(4):299.
8. Romani F, Huamani C, González-Alcaide G. Estudios bibliométricos como línea de investigación en las ciencias biomédicas: una aproximación para el pregrado. CIMEL. 2011;14(1):52-62.
9. Romani F, Cabezas C. Indicadores bibliométricos de las publicaciones científicas de la Revista Peruana de Medicina Experimental y Salud Pública, 2010-2017. Rev Peru Med Exp Salud Publica. 2018;35(4):620. doi: [10.17843/rpmesp.2018.354.3817](https://doi.org/10.17843/rpmesp.2018.354.3817).
10. Todeschini R, Baccinni A. Handbook of bibliometric indicators. Quantitative Tools for Studying and Evaluating Research. Germany: Wiley-VCH; 2016.
11. Ministerio de Salud. Prioridades Nacionales de Investigación en Salud en Perú (2019-2023). Resolución Ministerial N° 658-2019/MINSA [Internet]. [Cited on March 27, 2020]. Available at: https://cdn.www.gob.pe/uploads/document/file/343478/Resoluci%C3%B3n_Ministerial_N_658-2019-MINSA.PDF.
12. Kelaher M, Ng L, Knight K, Rahadi A. Equity in global health research in the new millennium: trends in first-authorship for randomized controlled trials among low- and middle-income country researchers 1990-2013. Int J Epidemiol. 2016;45(6):2174-2183. doi: [10.1093/ije/dyw313](https://doi.org/10.1093/ije/dyw313).
13. Perneger TV, Poncet A, Carpentier M, *et al.* Thinker, Soldier, Scribe: cross-sectional study of researchers' roles and author order in the Annals of Internal Medicine. BMJ Open. 2017;7:e013898. doi: [10.1136/bmjopen-2016-013898](https://doi.org/10.1136/bmjopen-2016-013898).
14. Zbar A, Frank E. Significance of Authorship Position: An Open-Ended International Assessment. Am J Med Sci. 2011;341(2):106-9. doi: [10.1097/MAJ.0b013e3181f683a1](https://doi.org/10.1097/MAJ.0b013e3181f683a1).
15. Fanelli D, Larivière V. Researchers' Individual Publication Rate Has Not Increased in a Century. Dorta-González P, editor. PLoS One. 2016;11(3):e0149504. doi: [10.1371/journal.pone.0149504](https://doi.org/10.1371/journal.pone.0149504).
16. Fonseca BPFE, Silva MVDP, Araújo KM, Sampaio RB, Moraes MO. Network analysis for science and technology management: Evidence from tuberculosis research in Fiocruz, Brazil. Lozano S, editor. PLoS One. 2017;12(8):e0181870. doi: [10.1371/journal.pone.0181870](https://doi.org/10.1371/journal.pone.0181870).

17. Garro G, Mormontoy H, Yagui M. Gestión y financiamiento de las investigaciones por el Instituto Nacional de Salud, Perú 2004-2008. *Rev Peru Med Exp Salud Publica*. 2010;27(3):361-6.
18. Beas R, Anduaga-Beramendi A, Rojas-Ortega A, Cisneros-Montoya A, Pereyra-Eliás R, Mayta-Tristán P. Publication of Abstracts with Peruvian Affiliation Presented to the Annual Meeting of the American Society of Tropical Medicine and Hygiene 2006–2010. *Am J Trop Med Hyg*. 2019; 100(4):1029-1032. doi: 10.4269/ajtmh.18-0168.
19. Baerlocher MO, Newton M, Gautam T, Tomlinson G, Detsky AS. The Meaning of Author Order in Medical Research. *J Investig Med*. 2007;55(4):174-80. doi: 10.2310/6650.2007.06044.
20. Rees CA, Lukolyo H, Keating EM, Dearden KA, Luboga SA, Schutze GE, *et al*. Authorship in paediatric research conducted in low- and middle-income countries: parity or parasitism? *Trop Med Int Health*. 2017;22(11):1362-1370. doi: 10.1111/tmi.12966.
21. Smith E, Hunt M, Master Z. Authorship ethics in global health research partnerships between researchers from low or middle income countries and high income countries. *BMC Med Ethics*. 2014; 15:42. doi: 10.1186/1472-6939-15-42.
22. Parish AJ, Boyack KW, Ioannidis JPA. Dynamics of co-authorship and productivity across different fields of scientific research. *Glanzel W, editor. PLoS One*. 2018;13(1):e0189742. doi: 10.1371/journal.pone.0189742.
23. Patel VM, Panzarasa P, Ashrafian H, Evans TS, Kirresh A, Sevdalis N, *et al*. Collaborative patterns, authorship practices and scientific success in biomedical research: a network analysis. *J R Soc Med*. 2019;112(6):245-257. doi: 10.1177/0141076819851666.
24. Zacca-González G, Chinchilla-Rodríguez Z, Vargas-Quesada B, de Moya-Anegón F. Bibliometric analysis of regional Latin America's scientific output in Public Health through SCImago Journal & Country Rank. *BMC Public Health*. 2014; 14:632. doi: 10.1186/1471-2458-14-632.
25. Yagui Martín, Espinoza Manuel, Caballero Patricia, Castilla Teresa, Garro Gladys, Yamaguchi L Patricia *et al*. Avances y retos en la construcción del sistema nacional de investigación en salud en el Perú. *Rev Peru Med Exp Salud Publica*. 2010; 27(3): 387-397. Available at: http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1726-46342010000300012&lng=es.
26. Romani Romani FR, Roque Henríquez J, Vásquez Loarte T, Mormontoy Calvo H, Vásquez Soplopuco H. Análisis bibliométrico de la producción científica sobre las agendas nacionales de investigación en el Perú 2011-2014. *An Fac Med*. 2016; 77(3):241.
27. Diekhoff T, Schlattmann P, Dewey M. Impact of Article Language in Multi-Language Medical Journals - a Bibliometric Analysis of Self-Citations and Impact Factor. *Bornmann L, editor. PLoS One*. 2013; 8(10):e76816. doi: 10.1371/journal.pone.0076816.
28. Bachelet VC, Uribe FA, Díaz RA, Vergara AF, Bravo-Córdova F, Carrasco VA, *et al*. Author misrepresentation of institutional affiliations: protocol for an exploratory case study. *BMJ Open*. 2019; 9(2):e023983. doi: 10.1136/bmjopen-2018-023983.
29. Thonon F, Boulkedid R, Delory T, Rousseau S, Saghatchian M, van Harten W, *et al*. Measuring the Outcome of Biomedical Research: A Systematic Literature Review. *Fanelli D, editor. PLoS One*. 2015; 10(4):e0122239. doi: 10.1371/journal.pone.0122239.
30. Aroeira RI, A.R.B. Castanho M. Can citation metrics predict the true impact of scientific papers?. *The FEBS journal*. 2020. J. doi: 10.1111/febs.15255.