Original article

Bibliometric study of original articles on anemia in the Peruvian population in Scopus

Estudio bibliométrico de artículos originales en Scopus sobre anemia en la población peruana

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ABSTRACT

Introduction: Anemia constitutes a latent public health problem, mainly caused by iron deficiency. It is important to perform studies in each region that allow describing and formulating interventions to reduce the prevalence of anemia, as well as studies that evaluate the scientific production of anemia to understand the state of the art and propose strategies to direct research towards what the country requires.

Objective: Describe the scientific production of anemia in the Peruvian population in the period 2000- 2019.

Methods: Bibliometric study. A systematic search was carried out in Scopus and the original articles that had anemia among their main variables were selected. Characteristics of each study were manually extracted and descriptively analyzed.

Results: 85 articles were found, of which 18 (21.2 %) were published in the *Revista Peruana de Medicina Experimental y Salud Pública* and 54 (63.5 %) reported receiving funding. In 51 (60.0 %) studies, the corresponding author had Peruvian affiliation and in 76 (89.4 %) articles, at least one author had Peruvian affiliation, mostly from Lima, with the participation of authors from 12 Peruvian regions. Regarding the design, 63 (74.1 %) were observational studies, of which prevalence and associated factors were mainly evaluated, while only 19 (22.3 %) studies evaluated interventions. In respect of the population studied, 55 (64.7 %) were made in the community and 44 articles (51.8 %) studied children up to 2 years of age.

Conclusions: Peruvian scientific production on anemia in Scopus is limited, with the important participation of Peruvian researchers as the correspondent author and with international funding. Most of the studies are observational and there are few intervention studies. Efforts are required to increase this scientific production, decentralize it, and guide it to address interventions in public health.

Keywords: anemia; bibliometrics; Peru; research; support of research.

RESUMEN

Introducción: La anemia constituye un problema de salud pública latente, causado principalmente por la deficiencia de hierro. Es importante realizar estudios en cada región que permitan describir y formular intervenciones para reducir la incidencia de la anemia, así como estudios que evalúen la producción científica de la anemia para conocer el estado del arte y proponer estrategias para orientar la investigación hacia lo que el país requiere.

Objetivo: Describir la producción científica de anemia en la población peruana en el período 2000-2019.

Métodos: Estudio bibliométrico. Se realizó una búsqueda sistemática en Scopus y se seleccionaron los artículos originales que tengan entre sus variables principales a la anemia. Se extrajeron manualmente las características de cada estudio, y se analizaron descriptivamente.

Resultados: Se encontraron 85 artículos, de los cuales 18 (21,2 %) fueron publicados en la *Revista Peruana de Medicina Experimental y de Salud Pública* y 54 (63,5 %) reportaron recibir financiamiento. En 51 (60,0 %) estudios el autor corresponsal tuvo filiación peruana y en 76 (89,4 %) artículos, al menos un autor tuvo filiación peruana, mayormente de Lima, y contaron con la participación de autores de 12 regiones peruanas. Con respecto al diseño, 63 (74,1 %) eran estudios de tipo observacional, que evaluaron mayormente prevalencias y factores asociados, mientras que solo 19 (22,3 %) estudios evaluaban intervenciones. En cuanto a la población estudiada, 55 (64,7 %) fueron hechos en la comunidad y 44 artículos (51,8 %) estudiaron a niños hasta los 2 años.

Conclusiones: La producción científica peruana en anemia en Scopus es limitada, con una participación importante de investigadores peruanos como autor correspondiente y con financiamiento internacional. La mayor parte de los estudios son observacionales y se cuenta con pocos estudios de intervención. Se requieren esfuerzos para aumentar esta producción científica, descentralizarla, y orientarla a la implementación de intervenciones en salud pública.

Palabras clave: anemia; bibliometría; Perú; investigación; fuentes de financiación de investigación.

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Introduction

Anemia constitutes a latent public health problem,[1] mainly caused by iron deficiency.[2] Anemia affects around 1.620 million people worldwide in 2016 according to the World Health Organization (WHO),[3] 43 % children under 5 years old,[1] in whom anemia may have consequences on future development and productivity. Anemia is a priority problem in Peru, where the Ministry of Health (MINSA) reported prevalence of 43.6 % and 40.1 % in 2016 and 2019, respectively.[2, 4]

It is important to perform studies in each region that allow describing and formulating interventions to reduce the prevalence of anemia, as well as studies

that evaluate the scientific production of anemia to understand the state of the art and propose strategies to direct research towards what the country requires. A study in India evaluated the scientific production of anemia between 1993 to 2013, reporting 5085 scientific articles, of which 22.7 % were performed in collaboration with other countries and the most productive institution was All India Institute of Medical Sciences (373 articles).[5]

In Peru, the national research priorities established by the *Instituto Nacional de Salud de Perú* (INS) seek to guide research resources. Anemia is one of these priorities, considered under the term "child malnutrition" for the period from 2010 to 2014, and "malnutrition and anemia" for the period from 2019 to 2023.[6]

Although Peruvian scientific production in health has increased in recent years,[7] it has not yet been aligned with national research priorities.[8] In a Peruvian university, 26.4% of thesis approved during the period 2011 to 2017 addressed health research priorities, and only 4.6% of these studied malnutrition and anemia.[9] Another study found that only 8 % of the publications made between 1954 and 2010 on child malnutrition in Peru corresponded to anemia and micronutrient deficiency.[10]

Due to the importance of anemia as a research priority in Peru,[6] and the lack of studies that have evaluated the state of the art of its scientific production, the present study aimed to describe the scientific production on anemia in Peru, in scopus, during the period 2000 to 2019.

Methods

A bibliometric study was performed of the original articles (in IRMD format: introduction, results methods, discussion) that have addressed anemia among its main variables and that have been performed in the Peruvian population (or in which at least part of the population is Peruvian), published in the Scopus database, during the period 2000 to 2019. Scopus was chosen because it is one of the databases with the largest spectrum of journals, with more than 23,000 peer-reviewed journals;[11] with minimum quality requirements for their journals, and that includes other important biomedical bases such as Medline. Therefore, it is a database commonly used in bibliometric studies.[12]

The search was performed on July 4, 2020. The search strategy used by Scopus was title-abs-key (anemia or anaemia or hemoglobin or haemoglobin) and (affilcountry (Peru) or title-abs-key (Peru or Peruvian)). Variables of interest

extracted from each of the included studies. To do this, three of the authors reviewed the full-text articles, collecting the variables in a data sheet prepared ad-hoc in Microsoft Excel 2016. The data sheets were compared by a fourth author, and if discrepancies were found, these were they were resolved by consensus.

The variables collected: name of the journal, quartile according to SCImago, year of publication, language, funding, foreign co-authors, number of authors, affiliations, type of anemia studied, region where the study was performed, characteristics of the population, and ages of the study participants.

In addition, the type of study was assessed (observational, non-randomized intervention, randomized clinical trial, qualitative). The original quantitative articles evaluated whether anemia was the main objective of the study, classifying it in preclinical, prevalence, associated factors, prevention, diagnosis, and interventions. Likewise, the study evaluated whether it came from a secondary database or was a primary study.

The statistical analysis used was the Stata v15.0 statistical program, relative and absolute frequencies of the categorical variables, and measures of central tendency and dispersion of the numerical variables were reported. For collaborative analyzes, the VOSviewer version 1.6.16 program was used.

Results

675 articles were found when searching Scopus between 2000 and 2019. 223 articles were excluded for not studying anemia as a main variable, 220 articles for not being original, and 147 for not including the Peruvian population in the analysis. Finally, 85 studies were selected that assessed anemia in the Peruvian population. Since 2011, an increase in annual publications has been observed, however, in the last six years (2014 to 2019) there have been oscillations and there does not seem to be an increase in the number of articles published (fig. 1).

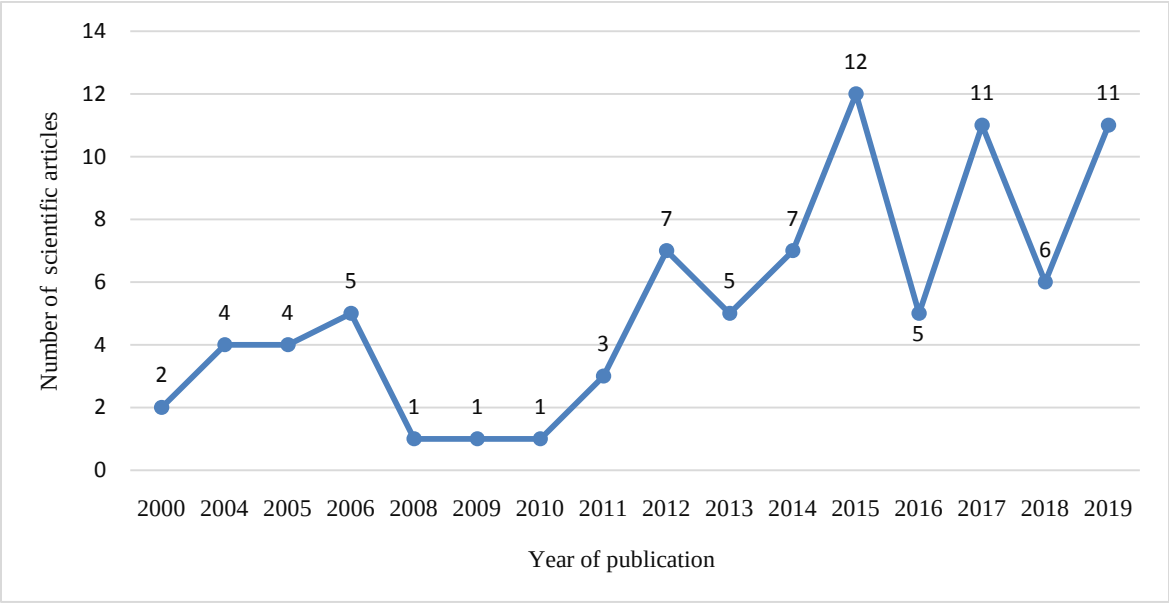

Fig. 1 - Annual trend of scientific publications on anemia in Peru.

More than a fifth of the articles were published in the *Revista Peruana de Medicina Experimental y Salud Pública* (21.2 %), followed mainly by other English-language journals on nutrition and tropical medicine. Regarding financing, 28.2 % of the studies do not report what their financing was and 8.2 % report self-financed. Out of 54 studies funded, 10 were by Peruvian institutions, 37 by foreign institutions, and 7 received joint funding from Peruvian and foreign institutions. In total, 60 institutions participated in financing the studies. The entities that funded the most studies were the National Institutes of Health in the United States (which funded 8 studies, 9.4 %), and the Canadian Institutes of Health Research in Canada (7 studies, 8.2 %) and the *Instituto Nacional de Salud de Perú* (7 studies, 8.2 %).) (table 1).

Table 1 - Editorial characteristics of articles on anemia in Peru (n = 85)

Characteristics	**n (%)**
Main scientific journals (Total: 48 scientific journals)	n **(%)**
Revista Peruana de Medicina Experimental y Salud Pública	18 (21.2)
American Journal of Clinical Nutrition	5 (5.9)
American Journal of Tropical Medicine and Hygiene	5 (5.9)
Food and Nutrition Bulletin	5 (5.9)
Journal of Nutrition	3 (3.5)
Quartile (SJR index)	n (%)

Q1	40 (47.1)
Q2	10 (11.8)
Q3	25 (29.4)
Q4	10 (11.8)
Language	**n (%)**
English	54 (63.5)
Spanish	30 (35.3)
English and Spanish	1 (1.2)
Main sources of funding (Total: 60 funding institutions)	**n (%)**
Not reported	24 (28.2)
National Institutes of Health (INH)	8 (9.4)
Self-funding	7 (8.2)
Canadian Institutes of Health Research	7 (8.2)
Instituto Nacional de Salud de Perú (INS)	7 (8.2)
Bill & Melinda Gates Foundation	4 (4.7)
United Nations International Children's Emergency Fund (UNICEF)	4 (4.7)
World Health Organization (WHO)	4 (4.7)

The publications included authors with affiliation from 37 countries. 89.4% of the publications have at least one author with Peruvian affiliation, followed by authors from the United States (28, 32.9 %), Canada (10, 11.8 %) and Germany (5, 5.9 %). Thus, the main collaborations are with the countries mentioned (fig. 2).

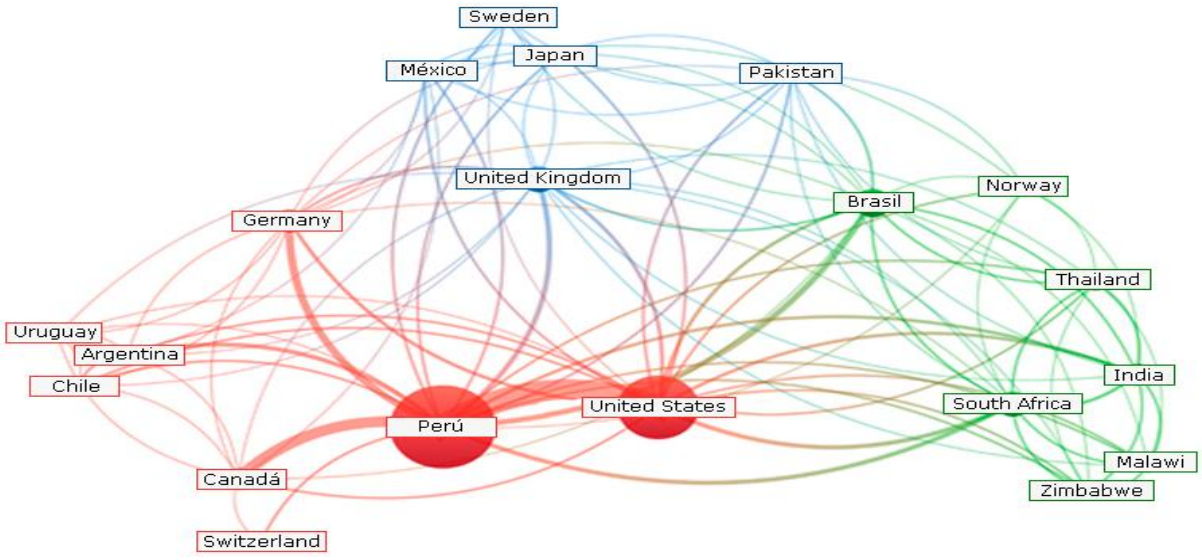

Fig. 2 - Analysis of co-authorship between countries (minimum 2 scientific articles per country).

Among the 76 articles with at least one author with Peruvian affiliation, 90.8 % included authors from Lima/Callao, 11.8 % from Iquitos (Loreto), 5.3 % from Junin, 2.6 % from Ancash. The main Peruvian affiliations were the University Peruana Cayetano Heredia (UPCH) (24.7 %), the INS (16.5 %) and the Institute for Nutritional Research (14.1 %). Regarding the correspondent author, he had an affiliation of Peru in 60.0%, the United States in 21.2 %, and Canada in 10.6 % (table 2).

Table 2 - Characteristics of authors of articles on anemia in Peru (n = 85)

Characteristics	**n (%)**
Country of institutional affiliation of at least one author per article (37 countries)	**n (%)**
Peru	76 (89.4)
United States	28 (32.9)
Canada	10 (11.8)
Germany	5 (5.9)
Argentina	4 (4.7)
Brazil	4 (4.7)
India	4 (4.7)
Peruvian region of institutional affiliation (n = 76 articles with a peruvian author)	**n (%)**
Lima/Callao	69 (90.8)
Loreto	9 (11.8)
Junin	4 (5.3)
Ancash	2 (2.6)
Institutional affiliation of Peruvian authors (51 institutions) (n = 76 articles with a peruvian author)	**n (%)**
Universidad Peruana Cayetano Heredia	21 (27.6)
Instituto Nacional de Salud	14 (18.4)
Instituto de Investigación Nutricional	12 (15.8)
Universidad Nacional Mayor de San Marcos	9 (11.8)
Asociación Civil Selva Amazónica	7 (9.2)
Universidad Nacional Agraria La Molina	5 (6.6)
Universidad Peruana de Ciencias Aplicadas	5 (6.6)
Universidad San Ignacio de Loyola	4 (5.3)
Agencia Internacional de Seguridad Alimentaria	3 (3.9)
Universidad de San Martín de Porres	3 (3.9)

Country of the corresponding author (10 countries)	n (%)
Peru	51 (60.0)
United States	18 (21.2)
Canada	9 (10.6)
Peruvian region of the institutional affiliation (n = 51 articles with peruvian corresponding author)	**n (%)**
Lima	49 (96.1)
Junin	2 (3.9)
Institutional affiliation of corresponding authors (49 institutions)	**n (%)**
Instituto Nacional de Salud	10 (11.8)
Universidad Peruana Cayetano Heredia	10 (11.8)
McGill University	6 (7.1)
Universidad Nacional Agraria La Molina	4 (4.7)
Agencia Internacional de Seguridad Alimentaria	3 (3.5)
Instituto de Investigación Nutricional	3 (3.5)
Universidad San Ignacio de Loyola	3 (3.5)
University of California	3 (3.5)

74.1 % of the scientific publications were of an observational type, which mostly sought to evaluate the prevalence and factors associated with anemia (65.9 %). Most of the studies addressed iron deficiency anemia (95.3 %). 30.6 % of the studies included a population sample at the national level of the country, followed by 23.5 % of the studies that included a specific population of Lima, and 14.1% that included a specific population of Loreto. Most of the studies addressed a general community population (64.7 %), which included children younger than 2 years (51.8 %), 2 to 5 years (37.7 %), and 18 to 59 years (22.4 %). 28.2 % of the studies analyzed a secondary database, being the main databases of the Nutritional Status Information System (37.5 %) and the Encuesta Demográfica y de Salud Familiar (ENDES) (33.3 %) (table 3). Finally, the individual articles with the highest citation in the Scopus database (table 4).

Table 3 - Characteristics of articles on anemia in Peru (n = 85)

Characteristics	n (%)
Type of study	n (%)
Observational	63 (74.1)
Non-randomized intervention	11 (12.9)
Randomized clinical trial	8 (9.4)

Qualitative	3 (3.5)
The purpose of the study (n = 82, not counting qualitative studies)	n (%)
Prevalence or associated factors	54 (65.9)
Interventions	12 (14.6)
Prevention	8 (9.8)
Diagnosis	5 (6.1)
Preclinical	3 (3.7)
Place of execution in Peru (21 places)	n (%)
National	26 (30.6)
Lima	20 (23.5)
Loreto	12 (14.1)
Lambayeque	5 (5.9)
Junin	4 (4.7)
Ica	3 (3.5)
Madre de Dios	3 (3.5)
Ancash	3 (3.5)
Andahuaylas	3 (3.5)
Cusco	3 (3.5)
Type of population included	n (%)
Of the community	55 (64.7)
With some disease	13 (15.3)
Pregnant woman	12 (14.1)
Others	5 (5.9)
Age of the population included (years)*	n (%)
< 2	44 (51.8)
2-5	32 (37.7)
6-11	12 (14.1)
12-17	17 (20.0)
18-59	19 (22.4)
≥ 60	8 (9.4)
Pregnant woman	14 (16.5)
All ages	4 (5.9)
Secondary databases used (n = 24 studies using secondary databases) (17 databases)	n (%)
Sistema de Información del Estado Nutricional	9 (37.5)
Encuesta Demográfica y de Salud Familiar	8 (33.3)
Perinatal Information System in Peru	3 (12.5)
Vitamin and Mineral Nutrition Information	2 (8.3)

Legend: Each analyzed article can contain more than one age category.

Table 4 - Top 10 articles on anemia in Peru with the most cited

Author, year	Title	Journal	Citations	Peruvian author institutions	Peruvian region studied
Kassebaum NJ, 2016	The Global Burden of Anemia	Hematology/Oncology Clinics of North America	125	None	National (database: Vitamin and Mineral Nutrition Information System)
Blom DE, 2005	Anemia and childhood mortality: Latitudinal patterning along the coast of pre-Columbian Peru	American Journal of Physical Anthropology	74	None	Lambayeque, Ancash, Lima, and Ica
Smuts CM, 2005	Efficacy of a foodlet-based multiple micronutrient supplement for preventing growth faltering, anemia, and micronutrient deficiency of infants: The four country IRIS trial pooled data analysis	Journal of Nutrition	74	Universidad Nacional Agraria La Molina	Lambayeque, Ancash, Lima, and Ica
Arnold BF, 2013	Optimal recall period for caregiver-reported illness in risk factor and intervention studies: A multicountry study	American Journal of Epidemiology	59	None	National (database: Water and Sanitation Program)
Zavaleta N, 2000	Changes in iron status during pregnancy in Peruvian women receiving prenatal iron and folic acid supplements with or without zinc	American Journal of Clinical Nutrition	56	Instituto de Investigación Nutricional	Lima
Larocque R, 2005	Relationship between intensity of soil-transmitted helminth infections and anemia during pregnancy	American Journal of Tropical Medicine and Hygiene	52	Universidad Peruana Cayetano Heredia y Asociación Civil Selva Amazónica	Loreto
Zavaleta N, 2011	Efficacy of an mfgm-enriched complementary food in diarrhea, anemia, and micronutrient status in infants	Journal of Pediatric Gastroenterology and Nutrition	48	Instituto de Investigación Nutricional	Lima
López de Romana G, 2005	Efficacy of multiple micronutrient supplementation for improving anemia, micronutrient status, growth, and morbidity of Peruvian infants	Journal of Nutrition	47	Universidad Nacional Agraria La Molina	Lambayeque, Ancash, Lima, and Ica
Casapía M, 2006	Parasite risk factors for stunting in grade 5 students in a	International	46	Asociación Civil Selva	Loreto

	community of extreme poverty in Peru	Journal for Parasitology		Amazónica	
Alarcón K, 2004	Effects of separate delivery of zinc or zinc and vitamin A on hemoglobin response, growth, and diarrhea in young Peruvian children receiving iron therapy for anemia	American Journal of Clinical Nutrition	45	Universidad Peruana Cayetano Heredia	Lima

Discussion

Anemia in Peru is a priority public health problem. However, the scientific production does not reflect the research priority on anemia, since 85 articles during the period from 2000 to 2019 (average of 4.25 articles/year) were found. Similarly, Yagui et al.[10] reported that 8 % of the publications made between 1954 and 2010 on child malnutrition in Peru corresponded to anemia and micronutrient deficiencies. This is less than the production found in India (3799 original articles between 1993-2003).[5]

Another aspect to highlight is the higher frequency of studies on prevalence or factors associated with anemia, a finding similar to that found in scientific production on HIV/AIDS in Peru.[13] Likewise, our study showed that Peruvian scientific research in relation to anemia has focused on observational studies and, to a lesser extent, on research that seeks to develop interventions or technologies that help prevent or control anemia, similar to that previously reported in research of HIV/AIDS, tuberculosis[14] and diabetes[15] in Peru. This could be due to intervention and technological innovation studies tend to be more complex and require greater technical skills and financial resources.[16]

Regarding the place of the study execution, a marked centralism was observed in Lima, highlighting the lack of research in other regions of the country. This contradicts the behavior of the disease in the country, since according to the National Institute of Statistics and Informatics of Peru (INEI) in 2019, the regions of Puno (69.9 %), Cusco (57.4 %), Huancavelica (54.2 %), Ucayali (53.7 %) and Loreto (53.0 %), register the highest number of cases of anemia in Peru, compared to Cajamarca (28.7 %) and Lima (29.8 %) which are regions with the lowest prevalence.[17] This centralism could hinder clinical and public health decision-making due to the limited local evidence available. This is important, because the approach to deficiency anemia depends on the interaction of

different factors,[18] so that the results in one context may not be replicated in another, either due to cultural, demographic, or even geographical reasons (such as diagnosis of anemia in high altitude populations).

A strategy to achieve the necessary technology transfer to decentralize anemia research is to foster research networks between the institutions with the greatest scientific production, such as the UPCH, and those institutions that are beginning to carry out research in this area, especially those that are outside Lima as has been suggested in Peruvian bibliometric studies on other topics.[19] Furthermore, this institutional collaboration can generate publications with greater impact, compared to those produced by non-collaborative entities.[20]

Most of the scientific publications on anemia were published in the Peruvian Journal of Experimental Medicine and Public Health. This result was similar to that reported on the Peruvian scientific production of HIV/AIDS[13] and diabetes. This journal has a guideline aimed at the main public health problems in the country, and it is one of the two Peruvian biomedical scientific journals indexed in Scopus. In addition, a considerable percentage of Peruvian scientific production on anemia is published in the American Journal of Clinical Nutrition and the American Journal of Tropical Medicine, which is related to two of the main causes of anemia in the country: deficiency and that associated with infectious diseases.[21]

We found that just over a quarter of the studies did not mention the source of funding. However, among those who mentioned it, the majority came from state entities, such as the National Institutes of Health of the United States of North America (NIHs), which financed 9.4% of the studies, followed by the INS in Peru, with 8.2%. This indicates that while anemia is a national research priority, the Peruvian state is funding few studies. It is important that the Peruvian state establish funding for the issues selected as priorities for the country, instead of continuing to depend on the agenda of international funders, who will not necessarily have the same priorities.[22]

More than half of the anemia publications focused on children under 5 years of age were found. These results would be related to the national plans for the reduction of anemia and chronic childhood malnutrition, where the research is within the lines of action and strategies to reduce the prevalence of anemia.[2,23] Furthermore, the research priorities implemented over the years focused on anemia, child malnutrition or malnutrition could have influenced the increase in research in this age group.[10] On the other hand, fewer studies were observed in older adults, although it is frequent in this age group and is associated with higher morbidity and mortality.[23]

A limitation would be the non-inclusion of indexed articles in Scopus. However, this base was prioritized due to the large number of journals it includes and the quality criteria it requires of its journals. Another possible limitation is the inclusion of only information reported in the articles, which may be incorrect or imprecise (for example, when the financing of an article is not mentioned, or the institutional affiliations of the author are not included).

Conclusions

Peruvian scientific production on anemia in Scopus is limited, with an important participation of Peruvian researchers as correspondent author and with international funding. Most of the studies are observational and there are few intervention studies. Efforts are required to increase this scientific production, decentralize it, and guide it towards addressing public health interventions.

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Conflict of interests

The authors declare that there is no conflict of interest.

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