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A Bibliometric Analysis of Anemia Research in Children or Adolescents in the Last 10 Years: Advances, Challenges, and Perspectives

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Abstract:

INTRODUCTION: Both nationally and internationally, anemia is one of the greatest public health challenges. It mainly affects children, adolescents, and women of reproductive age and manifests itself in different etiological forms. To examine the worldwide scientific production on anemia in children and adolescents focusing on the Scopus database, in a period between 2011 and 2020, the present bibliometric study is proposed.

METHODOLOGY: The Scopus database was used as the main data source to collect relevant manuscripts on anemia in children and adolescents from 2011 to 2020. The CSV data were exported to SciVal for analysis of most published topics, collaborations, most published institutions, productivity by journal category, most published journals, most published medical specialties, and most published authors.

RESULTS: Of the 1784 manuscripts reported, it was shown that the year 2020 had the highest number of publications with 33, 19, 13, and 15 articles in the Q1 (top 25%), Q2 (top 26%–50%), Q3 (top 51%–75%), and Q4 quartiles (76%–100%), respectively. The University of Pennsylvania (USA), Johns Hopkins University (USA), and Baylor College of Medicine (USA) were the top three institutions with the highest article production. The top three places were for Pediatric Blood and Cancer, Public Health Nutrition, and Journal of Pediatric Hematology/Oncology with 20, 12, and 11 publications, respectively.

CONCLUSIONS: In recent years, there has been evidence of an increase in the number of publications referring to anemia in children and adolescents, experiencing a notorious increase from 2015. In terms of scientific production, the United States, Egypt, and Canada are positioned as the leading countries in this field.

Keywords:

Adolescent, anemia, bibliometrics, children

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Introduction

Currently, anemia remains a major public health problem both globally and nationally. It mostly affects children, adolescents, and women of reproductive age, making them susceptible to various health problems in the short and long term.[1-3] The World Health Organization has reported that anemia affects a significant proportion of children under the age of 5 years.

The World Health Organization has reported that anemia affects a significant proportion of children under 5 years of age and pregnant women worldwide, with an estimated 42% and 40%, respectively.[1] Anemia is characterized by a reduction in the concentration of hemoglobin in

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the blood, which leads to an insufficient capacity to transport oxygen to vital organs and can generate various symptoms, such as asthenia, alterations in growth, and vertigo, among others.[2] Iron deficiency continues to be the main cause of anemia in the world.

Iron deficiency is still the main cause of anemia, caused by a low nutritional intake of this micronutrient or also by physiological blood loss in the case of young women of childbearing age, causing growth disturbances and vertigo, among others.[2] Anemia is associated with factors such as low socioeconomic status, lack of education, limited access to drinking water, precarious living conditions, and other factors such as the environment, i.e. exposure to natural disasters and altitude above sea level.[3]

On the other hand, bibliometrics is known as a branch of scientometrics and is characterized by analyzing quantitative values in relation to the function of both scientific and technological study.[4] This science studies the written connections that are incorporated from the realization to its application to make predictions that can be employed in different scientific procedures, the products are obtained through mathematical processes, counting methods, and statistical studies.[5] Bibliometrics modifies intangible information, such as the quality of scientific information, into an entirely manipulable mathematical instrument since bibliometric techniques are exclusively quantitative but are studied for the estimation of qualitative features.[6] Therefore, the aim of this article is to present the results of the bibliometric techniques in the field of bibliometrics.

Therefore, the aim of this study was to perform a bibliometric analysis of the global scientific production related to anemia in the child and adolescent population, using the Scopus database as the only source of information, during the period 2011–2020.

Methodology

The current literature review was descriptive, observational, and retrospective. In addition, this study was comprehensive of secondary data obtained from Scopus. Metadata from trials on anemia in the infant and childhood population published in the Scopus database during the period from 2011 to 2020 were used.

Inclusion criteria

- Metadata of articles on pediatric anemia published in Scopus that match the previously established search criteria
- Metadata for language restrictions
- Metadata published from 2011 to 2020.

Exclusion criteria

- Letters to the editor, systematic reviews, and/or books
- Articles from PubMed, Embase, or Web of Science databases.

Databases

The articles chosen for the research were acquired through the online database Scopus, which provides access to data on research published in more than 10,500 institutions and 230 regions, which contributed to the diversity and breadth of the sample considered. To analyze the metadata, SciVal, a tool that measures scientific productivity and uses various indicators from around 900 research institutions in 230 countries, was used. It is important to note that both programs are developed by the same publisher, Elsevier, and work together.

Search strategy

For this study, an advanced search strategy was created using keywords for the MeSH thesaurus and Emtree Term of Embase, represented as follows: ("anemia" OR "anemia" OR "neonatal anemia" OR "anemia infancy' OR "premature anemia" OR "aplastic anemia" OR "blackfan Diamond anemia" OR "hemolytic anemia" OR "iron-deficiency anemia" OR "macrocytic anemia" OR "microcytic anemia" OR "myelophthisic anemia" OR "myelophthisic anemia" OR "newborn anemia" OR "normochromic normocytic anemia" OR "refractory anemia" OR "sideroblastic anemia" AND "child" OR "newborn" OR "children" OR "infant" OR "boy" OR "preschool child" OR "school child" OR "baby" AND "adolescent*" OR "adolescence" OR "youth" OR "teen" OR "teenager" OR "juvenile").

An asterisk was used as a truncator for all word variations with the same root, these words were chosen based on the literature related to anemia in children and adolescents.

Data analysis

In this research, the impact of publications was analyzed through the application of different bibliometric criteria as data analysis tools to obtain the results according to the established measures. Various measures and statistical tools, such as frequency and percentage, were used in the research. Frequency refers to the number of times a variable appears in a statistical sample, while the percentage is defined as the proportion of each of the parts that make up a whole, represented by the symbol %.[7] In addition, the impact indicator called source-normalized impact per paper (SNIP), developed by the University of Leiden,[8] was used, which enables direct comparison of articles in different research areas. This indicator is

obtained by dividing the number of citations obtained in the current year and in the previous 3 years by the total number of publications in the last 3 years.[9,10] This study will also use SNIP.

In this study, we will be utilizing the CiteScore metric, developed by Elsevier, to measure the ratio of citations received by studies published in Scopus. This statistical indicator considers all citations received by publications within the previous 3 years, providing a more accurate estimation of a journal's impact.[10,11] Utilizing the CiteScore will provide a more dependable estimate of the impact of the journal. Furthermore, we will also be utilizing another metric, the H-index, developed by Professor J. Hirsch in 2005. This metric is aimed at measuring both the productivity and citation impact of studies published by an author with respect to their quality.[12] To determine this metric, scientific works are ordered from the highest to the lowest number of citations obtained, with the H-index being the number, in which both the order number and the number of citations received by the publication coincide.[13,14] Another relevant indicator is the SCImago Journal Rank (SJR) metric, which, through citation counting, establishes the quality of scientific publications. This calculation is made by counting the number of citations received and calculating the importance or prestige of the journals from which these citations originate.[15-17]

Finally, the Field-Weighted Citation Impact will be used, a globally standardized tool that compares the number of citations received per publication by a researcher with the average number of citations received by the total number of publications of a similar topic published in the Scopus database. If the score equals 1, it means that the published studies meet expectations compared to the overall average of similar publications. For example, a score of 1.35 indicates that publications have been cited 35% more than expected. Values <1 would indicate that publications have been cited below the global average.[18-20]

Results

Top 10 topics by scholarly output

The top 10 topics by scholarly output in the period from 2011 to 2020 were the following: in the first place, the topics, iron-deficiency anemias; transferrin receptors; erythrocyte indices with 41 scholarly outputs; and a field-weighted citation impact of 0.83, followed by the topics adolescent girls; stunting; malnutrition with 34 scholarly outputs, and a Field-Weighted Citation Impact of 0.29, in general, we can see that 6 of the top 10 positions have a Field-Weighted Citation Impact lower than 1 which indicates that they have not been cited as expected, while 4 positions of the top 10 have a Field-Weighted Citation Impact higher than 1 which indicates that they were cited in a higher percentage than expected, being the topics sickle cell anemia; acute chest syndrome; hydroxyurea the most cited with a score of 4.87 [Table 1].

Collaboration

In terms of collaborations, the highest percentage of manuscripts had institutional collaboration (37.1%), followed by national collaboration (36.6%) and international collaboration (19.9%), however, in terms of impact, both international collaboration (2899 citations; 20.9 citations/publication; and 1.97 Field-Weighted Citation Impact) and national collaboration (3557 citations; 13.9 citations/publication; and 1.01 Field-Weighted Citation Impact) outperform institutional collaboration (2262 citations; 8.7 citations/publication; and 0.54 Field-Weighted Citation Impact). The remaining articles belong to the single authorship or noncollaborative category (6.4%) [Table 2].

Top 10 institutions

The top ten most productive institutions are shown in Table 3. The University of Pennsylvania (United States), Johns Hopkins University (United States), and Baylor College of Medicine (United States) were the top three institutions with the highest article production. However, Harvard University (United States) has caused a greater impact as it has 1483 citations; 87.2 citations/publication; and 6.02 Field-Weighted Citation Impact.

Table 1: Top 10 topics by scholarly output

Topic	Scholarly output	Field-Weighted Citation Impact
Iron-deficiency anemias; transferrin receptors; erythrocyte indices	41	0.83
Adolescent girls; stunting; malnutrition	34	0.29
Pregnancy in adolescence; adolescent mothers; maternal age	31	0.51
Iron-deficiency anemias; iron saccharate; prenatal care	28	0.86
Acute chest syndrome; sickle cell anemia; hemoglobin S	18	0.71
Sickle cell anemia; acute chest syndrome; hydroxyurea	12	4.87
Ferric carboxymaltose; iron-deficiency anemias; iron saccharate	12	1.69
Sickle cell anemia; hemoglobinopathies; acute chest syndrome	12	0.47
Celiac disease; gluten-free diet; transglutaminase 2	11	1.28
Aplastic anemia; thymocyte antibody; eltrombopag	10	1.67

Source: Scopus/SciVal database

Table 2: Collaboration

Metric	Scholarly output	Citations	Citations per publication	Field-Weighted Citation Impact	Percentage
International collaboration	139	2899	20.9	1.97	19.9
Only national collaboration	256	3557	13.9	1.01	36.6
Only institutional collaboration	260	2262	8.7	0.54	37.1
Single authorship (no collaboration)	45	495	11	0.65	6.4

Source: Scopus/SciVal database

Table 3: Top 10 institutions

Institution	Country/ region	Scholarly output	Citations	Authors	Citation per publication	Field-Weighted Citation Impact
University of Pennsylvania		21	672	26	32	2.22
Johns Hopkins University		18	1405	36	78.1	5.96
Baylor College of Medicine		17	271	33	15.9	1.36
Harvard University		17	1483	35	87.2	6.02
University of Michigan, Ann Arbor		15	269	23	17.9	1.41
Ain Shams University		12	55	36	4.6	0.22
University of Toronto		12	627	28	52.3	4.37
University College London		11	428	25	38.9	5.44
Cornell University		11	461	25	41.9	3.67
Universidad de Chile		11	52	17	4.7	0.96

Source: Scopus/SciVal database

Publications by CiteScore quartile

According to the publications by CiteScore quartile, the percentage of all institutions globally, 2020 saw the highest number of publications with 33, 19, 13, and 15 articles in Q1 (top 25%), Q2 (top 26%–50%), Q3 (top 51%–75%), and Q4 quartiles (top 76%–100%), respectively, giving a total of 80 articles [Table 4].

Top 10 publications by Scopus source

Table 5 presents the 10 journals with the highest number of publications related to anemia in children and adolescents. The top three places were for Pediatric Blood and Cancer, Public Health Nutrition, and Journal of Pediatric Hematology/Oncology with 20, 12, and 11 publications, respectively. However, JAMA Pediatrics despite having few publications (6 articles) have a higher impact since it has 860 citations, 373 authors, and 143 citations/publication in addition to a SNIP of 4.8, which indicates that citations have a higher value in the field studied, a CiteScore of 20.8 which determines a higher impact per citation, and finally, an SJR of 4.004 which confirms the quality and reputation of the journal.

Top 10 publications by subject area

The most common subject areas were pediatrics, perinatology, and child health, followed by general medicine and hematology with 222, 123, and 116

publications, respectively. However, only three areas have a Field-weighted Citation Impact >1 which indicates that they received more citations than expected being pediatrics, perinatology and child health, general medicine, and obstetrics and gynecology with 1.16, 1.35, and 1.57, respectively [Table 6].

Top 10 authors, by scholarly output

Table 7 shows the authors who have produced the most publications on anemia in children and adolescents. Buchanan, George R.; Powers, Jacquelyn M. and Lozoff, Betsy M. top the list with first, second, and third place, respectively. However, Bhutta, Zulfiqar A. is the author with the highest impact since he has an H-index of 140 which indicates that he is an author with a consolidated professional career in addition to having a Field-Weighted Citation Impact of 7.67, i.e., he is cited in a higher percentage than expected.

Figure 1 shows co-authorship by country. This includes 180 countries contributing a minimum of three manuscripts. Using this criterion, several nodes are identified by color. The largest, represented by the colors light green, dark green, and orange, include the United States, Brazil, and India as the largest contributors. They are followed by countries such as Germany, the United Kingdom, and France.

Figure 2 shows the citations by country. Here, 180 countries were included with a minimum of three manuscripts per country. Using these characteristics, it was found that the United States, represented by the green color, has the highest number of citations. This was followed by countries such as India, Germany, and the United Kingdom, represented by the colors: yellow, violet, and red, respectively.

Table 4: Publications by CiteScore quartile

CiteScore quartile	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Q1	16	11	13	17	22	21	21	22	24	33	200
Q2	13	7	13	16	22	19	12	15	19	19	155
Q3	19	11	10	13	23	10	10	21	15	13	145
Q4	20	18	14	19	18	9	14	17	16	15	160
Total	68	47	50	65	85	59	57	75	74	80	660

Source: Scopus/SciVal database

Table 5: Top 10 publications by Scopus source

Scopus source	Publications	Authors	Citations per publication	SNIP	CiteScore 2020	SJR
Pediatric Blood and Cancer	20	137	12.9	1.174	4.3	1.116
Public Health Nutrition	12	50	3.8	1.368	5.4	1.166
Journal of Pediatric Hematology/Oncology	11	79	5.5	0.559	1.8	0.388
Indian Journal of Community Health	11	48	0.9	0.335	0.3	0.149
Pediatric Hematology and Oncology	10	51	6.6	0.67	1.9	0.499
Indian Journal of Public Health Research and development	10	26	0.1	0.241	-	-
Journal of Pediatrics	8	60	21.6	1.545	4.8	1.227
Archives de pediatrie	6	32	3.8	0.475	1.2	0.286
BMJ case reports	6	26	2.5	0.416	0.8	0.231
JAMA pediatrics	6	373	143.3	4.853	20.8	4.004

Source: Scopus/SciVal database. SNIP=Source-normalized impact per paper, SJR=SCImago Journal Rank, JAMA: Journal archives of pediatrics and adolescent medicine, BMJ=British Medical Journal

Table 6: Publications by subject area

Subcategory	Scholarly output	Citations	Authors	Citations per publication	Field-Weighted Citation Impact
Pediatrics, perinatology, and child health	222	2948	1453	13.3	1.16
General medicine	123	1747	615	14.2	1.35
Hematology	116	1712	848	14.8	0.82
Public health, environmental and occupational health	93	657	447	7.1	0.6
Oncology	61	624	416	10.2	0.76
Medicine (miscellaneous)	46	539	212	11.7	0.83
Obstetrics and gynecology	33	626	215	19	1.57
Infectious diseases	29	259	211	8.9	0.51
Endocrinology, diabetes, and metabolism	25	287	143	11.5	0.59
Gastroenterology	22	361	154	16.4	0.89

Source: Scopus/SciVal database

Table 7: Top 10 authors, by scholarly output

Name	Scholarly output	Most recent publication	H-index	Citations per publication	Field-Weighted Citation Impact
Buchanan, George R	9	2019	58	102.8	6.34
Powers, Jacquelyn M	7	2019	9	14.4	1.91
Lozoff, Betsy M	7	2020	41	7.6	1.49
Ikefuna, Anthony Nnaemeka	6	2020	11	1.7	0.17
Nouraie, Mehdi	5	2020	45	34.4	1.69
Emodi, Ifeoma Josephine	5	2020	11	1.4	0.13
Gahagan, Sheila A	5	2020	24	8.4	1.85
Kapil, Umesh S	5	2019	24	2.2	0.51
Bhutta, Zulfiqar A	4	2020	140	91.8	7.67
McCavit, Timothy L	4	2017	18	21.5	2.42

Source: Scopus/SciVal database

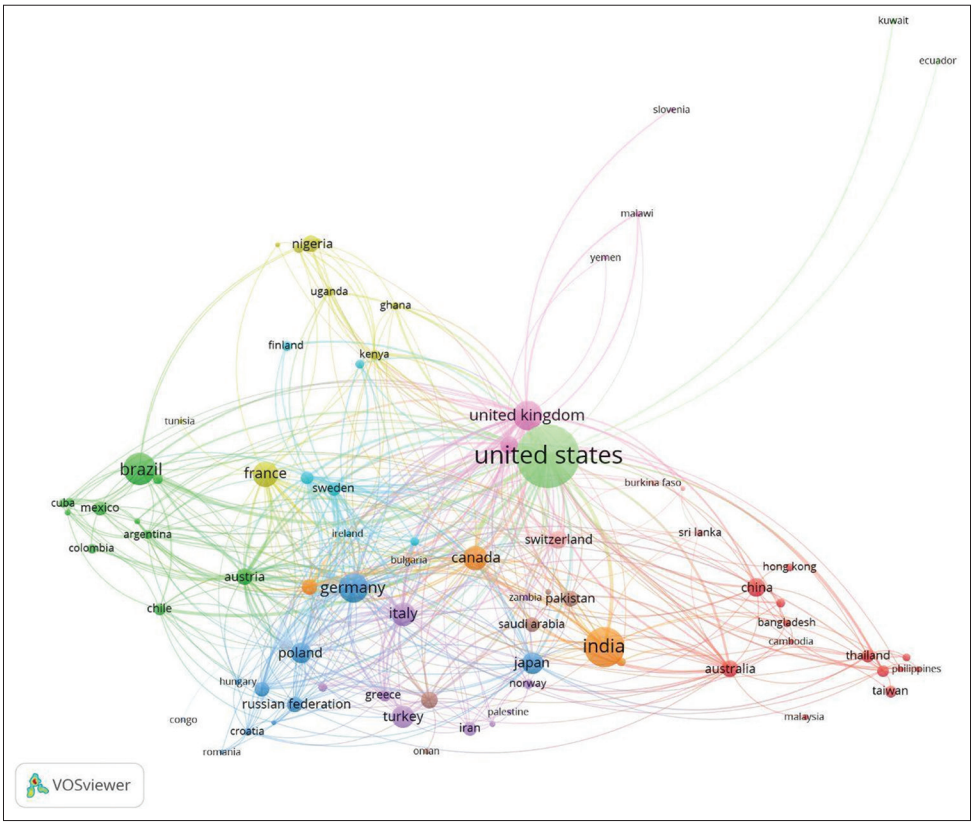


Figure 1: Co-authorship by country

Figure 3 shows the number of citations per journal. A total of 965 journals with a minimum of three manuscripts were included in the study. It was shown that the journals Journal of Pediatric Hematology-Oncology, Pediatric Blood and Cancer, and Public Health Nutrition represented by the colors light green, light blue, and brown, respectively, have the highest number of citations. These are followed by other journals such as Food and Nutrition Bulletin and Plos One.

The graphical representation of the co-occurrence of indexed keywords is shown in Figure 4. A total of 8506 keywords were considered and appeared in a minimum of 7 manuscripts. Wherein, the most frequently used terms were "adolescent" which appeared 1105 times, "child" which appeared 967 times, "anemia" which appeared 663 times, "preschool child" which appeared 395 times, and "hemoglobin" which appeared 337 times. In addition, it can be said that the terms or words associated with anemia in the pediatric population were divided into five groups, represented by the colors: red, yellow, green, blue, and violet.

Discussion

There is no doubt that childhood anemia remains a worldwide public health problem, especially due to its

neurological implications that may last into adulthood,[21] as well as its potential consequences on work capacity and personal and social spheres.[22] Therefore, the aim of this research is to evaluate the global scientific output and compare trends in research on anemia in children and adolescents using data obtained from the Scopus database during the period 2011–2020. Which can provide an idea of the scientific activity in this field.

Thanks to bibliometrics, scientific information can be objectified by converting the data into tangible processes that will help with the implementation of health policies, all this is thanks to the fact that this scientometric uses statistics and informatics in addition to databases and software that work together to synthesize all the information and subsequently be able to be analyzed.[6] Likewise, bibliometric methods are very useful for assessing research trends over time, in addition to providing information on research on specific topics.[23] The results obtained show that the greatest research production in the field of anemia in children and adolescents was obtained from the SCOPUS database in 2011–2020.

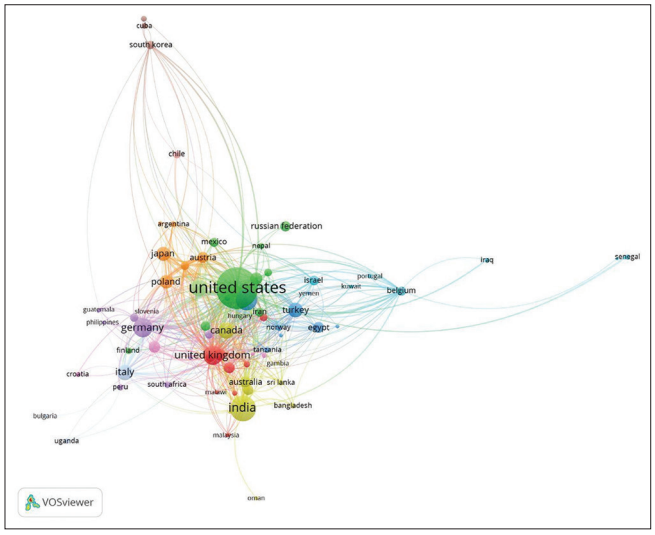


Figure 2: Citation by country

The results obtained show that the highest scientific production is by institutions in the United States, followed by Egypt and Canada, with results such as other iron-deficiency research where India, China, and the United Kingdom could also enter. Likewise, the most productive journal on anemia in children and adolescents was Pediatric Blood and Cancer; however, the journal Archives of Pediatrics and Adolescent Medicine (JAMA Pediatrics) caused more impact and it can be said that the journal provides quality information on the subject, on the other hand, research on anemia deficit positioned Journal of Nutrition in the first place as the most productive, followed by PloS One and World Journal of Gastroenterology based on the number of publications per journal and the Impact Factor, a bibliometric indicator used to compare scientific publications and assess the relative importance within the same field of study.[23]

Regarding the number of publications over the years, we can state that scientific production was highest in the years 2015 and 2020 with 85 and 80 studies, respectively, and that the lowest number of publications occurred in 2012 with a total of 47 studies, of which in the last decade thanks to a similar study we can state that approximately 15% of global publications were contributed by Brazil, Russia, India, China, and South

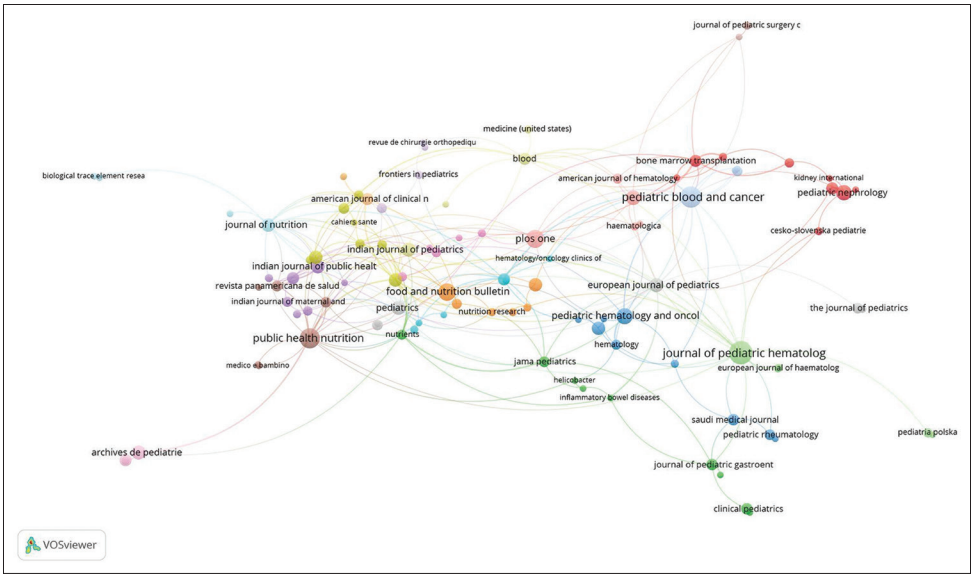


Figure 3: Citation by journal

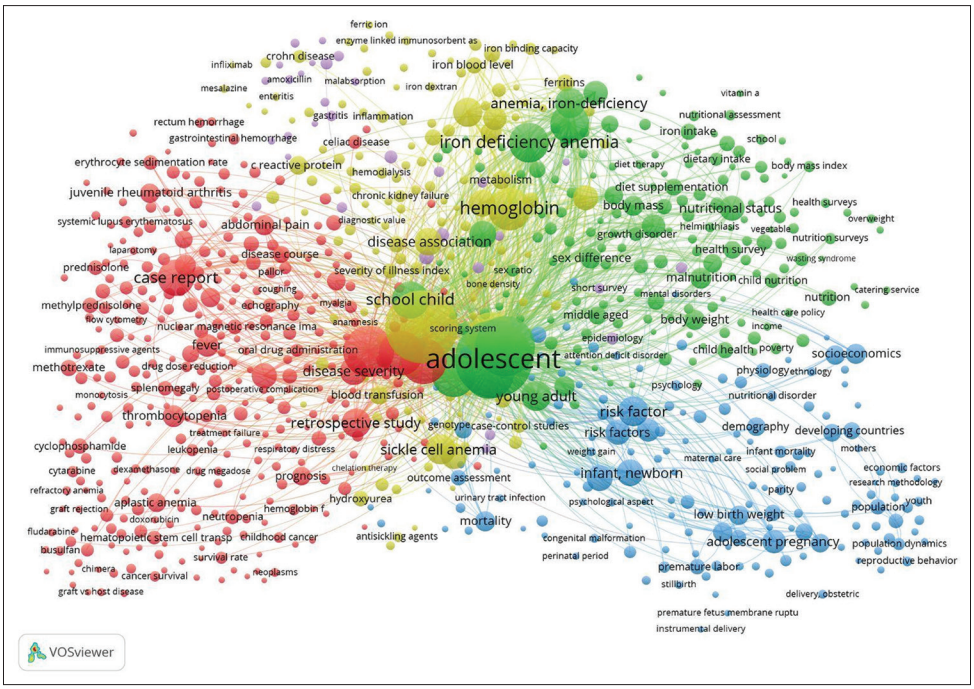


Figure 4: Co-occurrence by indexed key words

Africa countries and that the results of that study coincide in observing a general increase in publications in the last few years.[24]

On the other hand, the study also addressed anemia research in children and adolescents in the form of graphs created in VOSviewer software based on co-authorships by country, co-occurrence of indexed keywords, citations by journal, and citations by country. In which we can observe in the first place regarding co-authorship by country with a minimum filter of three manuscripts the formation of 12 groups with 527 links led in the concentration of collaborations by the United States, followed by India, United Kingdom, Germany, Brazil, and Canada, this contributes significantly to the knowledge and also a better understanding of anemia at a global level since we see an active exchange of information during the last decade.

Regarding the co-occurrence of indexed keywords after applying the respective filters for the topic of anemia in children and adolescents and with a threshold limit of 7 articles, we could observe a distribution of words grouped in five areas differentiated by colors (red, green, blue, yellow, and violet) and it shows that during the last decade, the research was mainly focused on these five groups which are: (1) Risk factors (blue); (2) nutritional aspects (green); (3) biochemical aspects (yellow); (4) causes of anemia (violet); and (5) clinical evaluation/symptomatology (red) with an emphasis on the following terms: Adolescent, schoolchild, hemoglobin, iron deficiency and anemia, risk factors, and sickle cell anemia.

The study had some notable limitations, including the specialized search strategy that was established, although it is recognized that this strategy can always be improved over time. In addition, only studies published in the last 9 years, from 2011 to 2020, were considered, so only the most recent publications were included. In addition, the search formula was adjusted to a limited number of publications to avoid errors when processing the data. It should be emphasized that only the Scopus database was used, which means that studies reviewed in other databases were not included, which could have resulted in an incomplete selection of research on the topic.

Nevertheless, the main strength of this research despite the scarcity of bibliometric studies on anemia in children and adolescents is to get to further study the scientific activity of anemia in the pediatric population. Likewise, research on this topic can contribute to scientific communities or institutions to lead to a better understanding of anemia and thus provide more information for those areas of research that require additional contributions.

Conclusions

After analyzing the databases and the results, we can conclude that there was a general increase in publications during the last decade with peaks of scientific production during the years 2015 and 2020, this scientific production was led by institutions from the United States, Egypt, and Canada. Pediatric Blood

and Cancer was the most productive journal on anemia in children and adolescents, however, Archives of Pediatrics and Adolescent Medicine (JAMA Pediatrics) was the journal with the highest impact, also thanks to VOSviewer software we can also conclude that the last decade research on anemia in children and adolescents focused on risk factors, nutritional aspects, biochemical aspects, causes of anemia, and clinical assessment/ symptomatology according to the co-occurrence of indexed keywords.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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