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Scientific Productions Development in Higher Education: The case of Peru

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ABSTRACT

The following work presents a scientometric study of the growth of scientific production in Peru compiled from the core collection Web of Science (WoS) database, the most representative database of scientific research producing disciplines for foreign and Peruvian researchers. The main objective of the research is to show the evolution of scientific production in higher education by universities and research institutions in Peru. The descriptive methodology of scientometrics allows to understand the development of literary productions and to identify their existence and evolution for their evaluation. The bibliometric study showed nine universities displayed more than 100 publications in 2020. Until February 1st, 2021, the Peruvian institutions' total production was 31,259 documents. The relevance of the research demonstrates the value of enforcing University Law 30220, which has led to a substantial increase in the scientific output of Peruvian universities and has helped the authorities in charge of these institutions to make better decisions on the implementation of policies leading to an increase in scientific output. This is the first study covering all the scientific productions indexed in Peru in WoS in all its disciplines and serves as a starting point for future research in other countries.

Keywords
Scientific production; Higher education; Bibliometric; Scientometric

Introduction

In recent decades, competition for academic work has become increasingly international, with many university programs made up of national and international students and researchers from all over the world (Kim, 2017; Tanyildiz, 2015). Higher education has been influenced by the internationalization of economies and societies and the growing importance of knowledge. These variations take different forms and dimensions in the other regions and countries, and Peru is not far behind. It seeks that its institutions and programs obtain high-quality levels to be at a global competitiveness level. Consequently, no university model is universally suitable to everyone, such that each nation and organization is independent in administering its institutional policies to enhance the growth and enhancement of its academic output levels.

Scientometric studies have frequently been used to study and measure the progress and research efforts on a specific scientific subject by governments, research institutes, universities, colleges, publishers, scientific journals, and researchers (Kim, 2017; Konur, 2012). The scientometric approach offers an analysis of science theory by recognizing the general course taken within a specified time by discoveries in a particular field. This is commonly achieved by using mathematical calculations to interpret the analysis findings (Olawumi & Chan, 2018; Ahmad & Thaheem, 2017). In recent years, the amount of research studies in diverse science fields has risen dramatically, showing the value of disclosing information developments.

This study focuses on developing scientific productions made by Peruvian institutions present in the WoS database. Universities are becoming internationally competitive, so specialized scholars (doctoral and postdoctoral), as well as postgraduate students, must be recruited by individual academics from different universities to form part of their research teams, graduate programs, and specialized research laboratories (Ackers, 2008; Bozeman & Youtie, 2018; Cantwell, 2011;).

Because universities belong to the educational sector, which is in constant evolution and development for optimization in its processes and operations, they have some international dimensions, either in universal knowledge and research or in the student and academic movement by the university family. Altbach and Knight (2007) identify the university as the only institution that has always been global. However, higher education has undergone drastic changes over the centuries in forms, dimensions, and approaches that we can see today.

Today's Higher Education in Peru

In recent decades, the national and international systems of higher education have undertaken a series of changes. These higher education regulatory systems have undergone a series of changes in Peru, from the government to government, which have failed to achieve progressive results due to the government's constant changes. However, there has been a significant shift where a paradigm of state regulation has been shifted to one of supervision, where a regulatory system has been designed to achieve educational policy objectives as a whole, between institutions and the state, to develop institutional missions and visions with a higher degree of independence, and to be able to follow and achieve educational policy objectives as a whole (Benavides et al., 2018). Therefore, the differences that may exist in higher education systems between one nation and another are due to the form of assessment they adopt and the outcome of political and ideological variables that follow sustainable visions and education strategies. Over the years, the institutional framework in Peru has undergone several changes to facilitate the creation of private universities. These functions were not effectively exercised by the bodies created to monitor and ensure the quality of universities (Bernedo, 2018), such as CONAFU (Consejo Nacional para la Autorización del Funcionamiento de Universidades) and SINEACE (Sistema Nacional de Evaluación, Acreditación y Certificación de la Calidad Educativa). The reform in higher

education in Peru implemented in recent years has generated a space for debate on the part of the state powers, which in turn has allowed the articulation of experiences and knowledge of the different sectors (public and private), both from academic specialists as experts in education areas and facilitate the generation of evidence-based on empirical tests, rigorous scientific approaches for decision-making by the authorities in charge of implementing said public policies and state policies. However, this education reform is still in its early stages, as the introduction of University Law 30220, approved by the Congress of the Republic on 9 July 2014, can be seen as the first step in the reform of higher education for sustainable development by SUNEDU (Superintendencia Nacional de Educación Superior Universitaria), an agency ensures and guarantees the standard of education. The overcrowding of the higher education offer was affected as a result of this introduction by the inability to comply with the minimum quality standards for higher education, as many universities have been affected by the revocation of their licenses, meaning that they will not be able to continue to function as provided for by law.

Peruvian Universities

The beginning of Peruvian universities dates back to 1551, when the Universidad Nacional Mayor de San Marcos was founded to provide higher education. Subsequently, to date, universities have gradually expanded to 51 public universities, 92 private universities (40 association universities: private non-profit and 52 corporate universities: private for-profit), of which to date, the last update registered (04/01/2021), only 92 universities and two graduate schools (63.45 %) have been able to receive a license from SUNEDU, the public institution in charge of the program.

In Peru, the Pontificia Universidad Católica del Perú (PUCP), the Universidad Peruana Cayetano Heredia (UPCH), and the Universidad Nacional Mayor de San Marcos (UNMSM) are the leading universities that have a structure and dynamics installed that allows them to train student researchers and that coincidentally appear in international rankings of scientific dissemination. After reviewing the websites of their Vice Rectorates for Research, it is noted that these universities have different activities to promote the so-called 'research hotbeds,' which seek to train undergraduate students to do research, with financially recognized activities such as monograph and thesis competitions, competitive funds to finance thesis preparation, or research work.

Research hotbeds are a strategy with a constructivist basis and active methods that allow real participation of its participants, students, and teachers, prioritizing freedom and innovation to develop learning more effectively than productive classroom work, allowing groups and research lines to be formed and developed, as well as the link between teaching and research, in either of these two situations, both teachers and students: teachers who decide to advise and guide the study of their students or, failing to research with young researchers' support will develop a series of skills that will help them become better professionals. However, it should be clarified that this strategy requires generous institutional support. As we have seen with the aforementioned, three universities require economic resources, hour allocation, infrastructure, and other aspects (Villalba & Gonzáles, 2017).

Other universities, such as the Universidad de San Martin de Porres, the Universidad San Ignacio de Loyola, the Universidad Nacional de Ingenieria, the Universidad Católica de Santa Maria, the Universidad de Ciencias Aplicadas, to mention those that have become more visible in this regard, with the most recent Vice-Rectorships for research, are also promoting research hotbeds in some of their forms.

Research questions

The study was guided by the following research questions (RQs):

RQ_1: How has scientific productivity evolved in Peru?

RQ_2: What universities, journals, and authors contribute the most to Peru's scientific productions?

RQ_3: What significant findings show the evolution of scientific productions in Peru in WoS?

Method

For the following analysis, the source Journal Citation Report (JCR) from the private collection of Web of Science was used, which includes: Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (AHCI) and Emerging Sources Citation Index (ESCI). For research in the field of scientific productions developed in Peru, the search strategy of several components were used: a) word searches, b) searches by institutional addresses, and c) search limited to the entire period available in WoS. For the search involving specific words, the term CU = Peru was initially used in WoS. CU means the search country to obtain information on scientific productions. For the search of Peruvian universities and scientific institutions, manual scrutiny was carried out to see the productions that reached the search ranges., OG = Universidad Peruana Cayetano Heredia; Univ Nacl Mayor San Marcos; Pontifical Catholic University of Peru; University of San Martín de Porres; Univ Peruana Applied Sciences; Univ Cient Sur; Univ Nacl Agr la Molina, Univ. San Ignacio de Loyola, and Universidad Nacional de San Agustin de Arequipa (OG means Organization-Consolidated) were used, the list was longer, but the manual scrutiny showed that only these universities met the minimum search requirement.

For the search of scientific productions, manual scrutiny was carried out to obtain relevant information for the present investigation, separating them by year, authors, journals, among others. The full flowchart of the research for this study is shown in Figure 1. The review protocol understood could help answer the research questions.

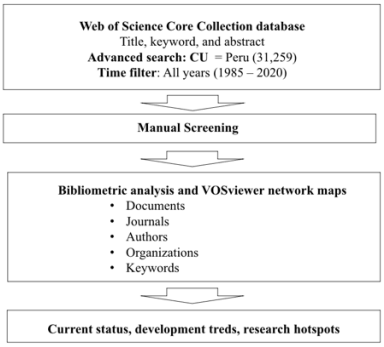

Figure 1. Bibliometric analysis flowchart for the evolution of scientific production

Bibliometric analysis

Bibliometry is a branch of science focused on quantitatively analyzing bibliographic information on a subject (Broadus, 1987; Choudhri et al., 2015; Gil et al., 2020), such as general scientific production, country-by-country scientific production, language, number of citations, affiliations of authors, impact factor of journals, areas of research, keywords, among others. Several authors consider bibliometrics a statistical method for assessing and quantifying a specific subject's output number and growth trend (Mao et al., 2018; Soosaraei et al., 2018). In this study, the bibliometric analysis free access software VOSviewer (Van Eck & Waltman, 2010; Van Nunen, 2018) was adopted to analyze and graphically visualize the distribution, geographical distribution, authorship, citations, and keywords of Peru's scientific, academic production studies found in the WoS database. The references cited in the publications highlight an impact factor by the JCR 2019 that evaluates the journal's influence (Mao et al., 2018).

Results

In Figure 2, scientific productions' evolution by collaborating universities and institutions in Peruvian literary output presented in the WoS database's history is illustrated. It can be seen that there has been an exponential increase between 2014 and 2015, with an increase of almost 1,000 scientific productions, which could have been linked to the creation of SUNEDU in 2014 and other global tendencies.

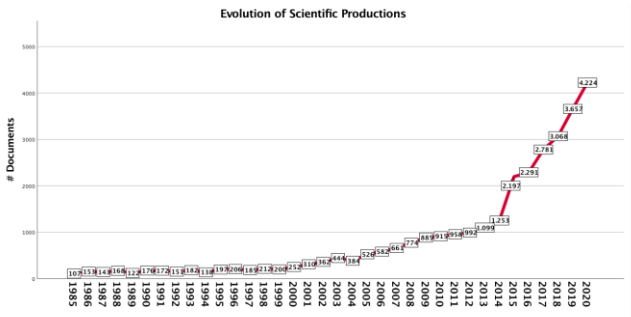

Figure 2. Evolution of scientific productions in the WoS database

The descriptive statistic shows that the minimum production in all timespan in the WoS was 107 documents in 1985 and the maximum of 4,224 in 2020, having a mean of 864.64 and a 1076,308-standard deviation (σ). On the other hand, Table 1 shows the growth of the last ten years' scientific displays in WoS universities with more than 100 scientific productions in 2020.

Table 1. Peruvian universities with more than 100 academic productions in the WoS database in 2020

It is important to note that the Universidad Cientifica del Sur and the Universidad San Ignacio de Loyola had the mayor increases from 2019 to 2020 (76.12% and 60.00%), making then the institutions with the highest growth among the variation of its scientific productions in the last two years, and it is also important to mention that the Universidad Peruana de Ciencias Aplicadas was the university with a higher negative sign in its scientific productions (-25.17%), this decrease may occur due to the impact of COVID-19, among other causes. The first three universities in the ranking, however still retain a higher number than the remainder. It can also be seen that in 2015, a large number of universities began increasing their output.

The total number of scientific productions by nine universities and the total number of authors involved in these productions are shown in Table 2. The ratio of authors (A) and documents (D) produced could indicate that approximately six authors are involved in preparing each academic document. Still, this figure is only the average since a single document's production could involve a much higher number. A large number of records might also be made by one or two authors, which could be explained according to the authors' h-index.

TABLE 2

Table 3 shows the most cited article as “A global reference for human genetic variation” with a total of 5,154 citations, a document produced in 2015 by Altshuler et al., while “Empagliflozin, Cardiovascular Outcomes, and Mortality in Type 2 Diabetes ”and“ Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013 ”each with 4,288 and 3,993 citations respectively, both produced in 2015. It can be seen that all the productions present in the top rank are dedicated to the area of medical sciences. Most of the literary productions are linked because several institutions have intervened in said productions.

TABLE 3

In Figure 3, the display graph is shown by the overlay, where the relationship between weight per citation and scores per year of publication can be observed. Of the total number of documents, with a minimum number of 100 citations per document, 878 references of scientific articles met the threshold. However, some references in the network were not connected, so the most extensive set of connected elements consisted of 95.

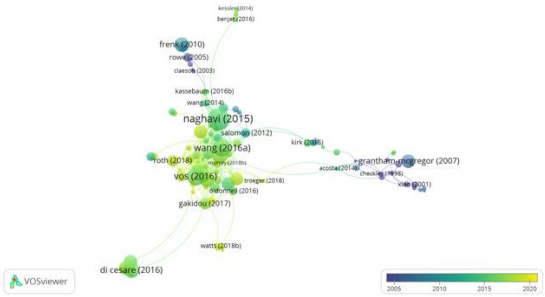

Figure 3. VOSviewer Map of Citations / Document based on citations / year of publication

Journals

Web of Science indexed the 31,259 literary productions in 5,870 journals. With a minimum number of 10 documents per journal and 15 citations per journal, this reached the search threshold of 519. It calculated the total link strength of the citations with other sources. The journals with the highest document production were selected. However, some of the elements of the network were not connected, and the most extensive set of connected components consisted of 494. Those elements were divided into 21 clusters, as shown in Figure 4.

Figure 4. VOSviewer Map of Citations / Source based on the number of publications

It is mentioned that the journal American Journal of Tropical Medicine and Hygiene is the one that has presented the most massive academic productions with 1,213 documents. However, it only shows a total of 9,853 citations and a total link strength of 2,587, while journals such as Lancet (187; 59,877), New England Journal of Medicine (62; 28,694), Science (50; 13,374) and Nature (43; 11,487) have fewer publications but higher citations. Table 4 shows the ten top journals with the highest number of scientific productions in which Peru has collaborated and the number of citations of the total publications found in the WoS database.

TABLE 4

Authors

The number of science productions of the top 10 authors registered in WoS is shown in Table 5. Some authors, however, demonstrated double registration. Therefore, 91,178 were the total number of authors who developed 31,259 literary productions. Seven hundred ninety-seven reached the threshold with a minimum of 15 papers by an author and 15 citations by an author to create the VOSviewer map.

Table 5. Top 10 authors with the most publications that contribute to Peru in WoS (updated 01/02/2021)

Rank	Author	Documents
1	Gilman, Robert H.	841
2	Garcia, Hector H.	422
3	Gotuzzo, E.	408
4	Gupta, R.	406
5	Kim, S.	370
6	Gupta, A.	365
7	Singh, R.	353
8	Costa, F.	350
9	Vargas, A.	349
10	Zhang, X.	344

The total strength of the citation connections with other authors was calculated. It selected the authors with the highest full link strength. As shown, the elements were divided into 20 clusters (some of the 797 network features were not linked, so the most extensive set of connected components consisted of 761). Figure 5 shows the registration of all the information uploaded to create the VOSviewer network map

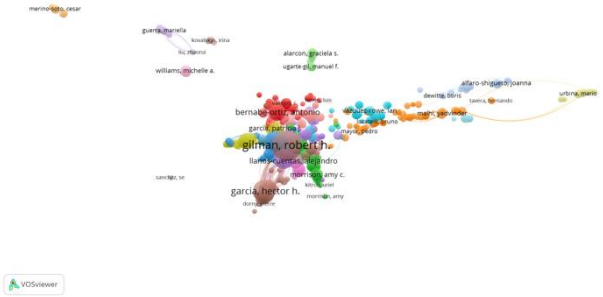

Figure 5. VOSviewer Map of Citations / Authors based on the number of publications

It is worth mentioning that authors such as Black, RE (52; 4,592), Lama, Javier R. (104; 3,390), Tsang, VCW (43; 3,224), among others with higher citations and total link strength, did not appear in Table 5 because the ranking was based on the number of documents and not by the number of citations or link strength.

Organizations

The top 10 organizations that produce the most documents are shown in Table 6; however, it did not take as the primary objective the number of citations or the total link strength. The total number of organizations involved in executing the 31,259 scientific productions was 23,602, which in most cases, more than one organization (dyads or groups) contributed to the total productions.

TABLE 6
Seven hundred fifty-four met the threshold, with a minimum of 20 documents per organization and at least 20 citations. The overall strength of dating connections with other institutions was measured. The institutions with the highest total link strength were selected and, as shown in Figure 6, the elements were split into nine groups.

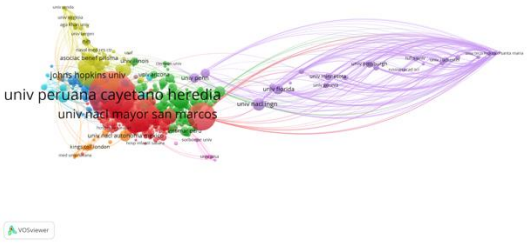

Figure 6. VOSviewer Map of Citations / Institutions based on the number of publications

Of the top 10, three Peruvian universities are in the ranking. They have collaborations between themselves and other organizations that produce scientific productions for Peru, being the Universidad Peruana Cayetano Heredia the one with the highest scientific displays (5,550) and the highest number of citations (126,128), followed by Universidad Nacional Mayor de San Marco (3,735) and the Pontificia Universidad Católica del Perú (2,944) with 41,544 and 41,565 citations respectively. However, the University of California System and the Johns Hopkins University are the two foreign institutions with highest number of citations in their scientific work for Peru (122,123 and, 100,322). An h-index is attributed to the total number of their production by each institution, which is the implication of a certain period when at least h times are cited by publications of an author, nation, journal, institution, etc. (Mao et al., 2018; Yin et al., 2018). A significant database that must be observed to understand scientific growth is provided by the references cited in the publications (Bornmann & Mutz, 2015).

Visualization of keyword clusters

Keywords (author keywords and Keyword Plus) represent the core content of publications; keyword analysis aims to identify important research topics in Peruvian institutions' studies. Larger circles represent the keywords that appear more frequently (Vosner et al., 2016) relative to the other words represented by smaller circles. The strength of their correlation is reflected by the lines between the keywords (Danvila-del-Valle et al., 2019). Although changing patterns can be observed in similar studies from year to year, we found five groups of keywords extracted from the titles, abstracts, and keywords of the authors, as can be seen in Figure 7. Of all the keywords, the words with the most remarkable link strength, and the relationships between terms of different sets used in many scientific productions.

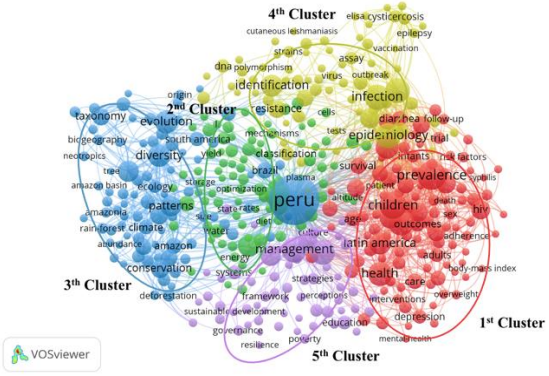

Figure 7. VOSviewer Network map of co-word analysis for keywords (1985–2020). Threshold=50 for the minimum number of occurrences of a keyword

Most conceptual studies that are the subject of analysis in this study use different forms of research, such as logistic regression, multilevel modeling, multiple linear regression, among others (Dewitz, Woolsey & Walsh, 2009; Dey & Astin, 1993; Murtaugh, Burns & Schuster, 1999; Soria, Fransen & Nackerud, 2014).
Within the total sample of documents (n = 31,259). It is found characteristics and variables related not only within the same group but between them; however, they showed a greater bond strength between the same colors. In table 7, we find words that postulate persistent themes of studies by the scientific community.

Table 7. Clusters of keywords in Peruvian scientific production (1985–2020)

Cluster	Colour	Keywords
1		children, prevalence, Latin America, HIV, health, risk…
2		model, system, yield, water, pollution, mechanisms…
3		taxonomy, diversity, andes, evolution, amazon, climate …
4		infection, transmission, identification, epidemiology, vaccination, cysticercosis…
5		management, consumption, reliability, sustainability…

Discussions

The visual representations of bibliometric analyses have the potential to make it less complicated to understand research carried out by universities and scientific institutions on literary productions in higher education; however, the use of visual representations enables decision-makers to understand better how the relevant problems have been addressed or what critical points have helped to manage the research It is essential to add that this is a personalized conceptual approach and that the type of visual representation depends on the search strategy used when exploring the subject. Therefore, the bibliometric technique generates customized graphics that avoid ambiguity and turn on the context suggested by decision-makers. Shang and

Wang (2018), who identified key problems in emerging areas, are consistent with this approach.

It is clear from the present investigation that Peruvian universities are increasing their scientific productions in the last six years. The heads of Peruvian universities strengthen and improve their literary productions through policies following the agencies' requirements to ensure educational quality (SUNEDU). These universities are eager to attain the same status as their elite counterparts, such as the Universidad Peruano Cayetano Heredia, the Universidad Nacional Mayor de San Marco, and the Pontificia Universidad Católica del Perú, putting similar pressure on their faculty to research the same prestige, at least at the same rate.

Growth universities recruit scholars with scientific productions to expect these individuals to promote academic output in the global higher education panorama to their institutions' academic status (Li & Lowe, 2016; Ortiga et al., 2018). However, without the many advantages their peers working in educational centers have in hiring a qualified, educated workforce, these academics must find ways to do so. In the end, academics who are unable to meet universities' requirements aimed at the rapid rise in educational productions are at risk of losing their job, which would mean the loss of job visas in some countries (Ortiga, Chou & Wang, 2020).

In this research, it is shown that there are relatively new institutions compared to others that have more than 100 years in their teaching processes, which implies that these institutions can experience processes and operations that increase their literary productions in the medium or long term, compared to other institutions. It should be noted that environmental changes, such as university law 30220, contributed to a considerable increase in universities' scientific publications to remain in the market, having incorporated processes for improving educational quality, as required by the requirements of a discharge.

Conclusion

The licensing process in Peruvian universities could generate a more generous impulse to research in them, so it is necessary to identify and systematize highly productive universities' acceptable practices. Likewise, collaborative work is essential, generating networks with foreign universities and institutions and within the country and in the same cities. They can add their installed capacities and enhance the national ability to produce quality research.

One of the main objectives of this research is to be able to share the evolution of scientific productions by Peruvian universities in the last years and focus on those that produced more than 100 productions indexed in the WoS database in 2020, as well as the total number of presentations scientific and the number of authors who participated in the exhibitions of the total of said scientific productions. It is shown that only nine Peruvian universities fulfilled the requirement, being the Universidad Cientifica del Sur the one that obtained a more significant increase in its production between 2019 and 2020 (76.12%), while the one with the highest negative index was the Universidad Peruana de Ciencias Aplicadas with -25.17%. The document A global reference for human genetic variation, by Altshuler et al. (2015), was the one that presented the highest number of citations 5,154 and Dr Gilman, Robert Henry is the author with the most massive collaborating scientific productions in Peru (841 documents). However, he is not a Peruvian author. Still, he has Peruvian affiliation with some institution and his main enrolled in WoS is with Johns Hopkins Bloomberg School of Public Health in Baltimore (USA). Mentioning scientific journals where the largest number of scientific productions for Peru are published, the American Journal of Tropical Medicine and Hygiene and PLOS ONE, with 1,213 and 464 productions respectively, while the Revista de Investigaciones Veterinarias del Peru (331) and the Revista del Cuerpo Medico del Hospital Nacional Almanzor Aguinaga Asenjo (312) are the Peruvian journals that index the largest number of scientific productions. The Pontificia Universidad Católica del Perú (PUCP), the Universidad Peruana Cayetano Heredia (UPCH), and the Universidad Nacional Mayor de San Marcos (UNMSM) are the leading universities which produce the most significant number of documents. The visualization of keywords is an essential point in the development of research with bibliometric methodology since it enables the present scope and trends of studies to be given by words and correlations between those words, starting in this case from a macro aspect, and highly recommended at the beginning of studies where the topic is specific to guide researchers from a clearer perspective.

Limitations and Future Studies

Two main limitations require explicit discussion. First, this review relied solely on the WoS database across all of its disciplines. Therefore, the findings cannot be generalized to other databases such as Scopus or Google Scholar. However, this limitation is consistent with the review's objective that sought to map the scientific panorama related to scientific productions by Peruvian institutions that contribute to academia. A second limitation lies in the quantitative method used to analyze the evolution of scientific displays. This review did not assess the quality of the individual studies or their findings. Therefore, the bibliometric analysis results should be interpreted as complementary to other studies obtained from previous efforts (Moquillaza, 2019; Purizaca, Cardoza & Herrera, 2016). Future research may delve into the evolution of scientific productions in the Peruvian context, using other databases, for which other researchers may search for patterns and trends in their research variables and could be replicated in other contexts. It's important to mention that the different databases are updated periodically, so performing a bibliometric analysis of scientific productions may be affected when the databases update their data by incorporating new journals or expelling others. This study is complementary to others can occur on different dates.

Acknowledgement

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Availability of Data and Materials

The datasets used and analyzed during this study are available from the corresponding author on request.

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TABLE LIST

Table 1. Peruvian universities with more than 100 academic productions in the WoS database in 2020

Rank	University	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	% Var
1	Universidad Peruana Cayetano Heredia	219	238	244	249	402	352	509	424	496	**488**	-1.61%
2	Universidad Nacional Mayor de San Marcos	100	107	121	105	245	211	339	400	435	**568**	30.57%
3	Pontificia Universidad Católica del Perú	94	103	104	119	246	292	292	336	419	**409**	-2.39%
4	Universidad Científica del Sur Científica	-	2	16	20	53	72	49	100	134	**236**	76.12%
5	University Nacional Agraria La Molina	37	37	30	37	45	49	86	113	140	**184**	31.43%
6	Universidad San Ignacio De Loyola	1	-	1	6	11	18	43	58	95	**152**	60.00%
7	Universidad Nac. San Agustín de Arequipa	9	12	5	14	15	28	35	59	108	**149**	37.96%
8	Universidad de San Martin de Porres	8	11	17	25	70	91	82	126	113	**127**	12.39%
9	Universidad Peruana de Ciencias Aplicadas	15	18	19	35	109	111	87	138	147	**110**	-25.17%

Table 2. Total scientific productions and authors with more than 100 academic productions in the WoS database (updated to 01/02/2021)

Rank	Universities	Documents	Authors	Ratio A/D
1	Universidad Peruana Cayetano Heredia	5,552	22,975	4.14
2	Universidad Nacional Mayor de San Marco	3,740	26,427	7.07
3	Pontificia Universidad Católica del Perú	2,944	17,168	5.83
4	Universidad Nacional Agraria La Molina	995	8,192	8.23
5	Universidad Peruana de Ciencias Aplicadas	810	6,162	7.60
6	Universidad de San Martín de Porres	713	7,507	10.53
7	Universidad Científica del Sur	693	2,563	3.70
8	Universidad Nac. de San Agustin de Arequipa	499	2,498	5.01
9	Universidad San Ignacio De Loyola	388	1,348	3.47

Table 3. Top 10 of the most cited articles of scientific productions where Peru has participated in WoS (updated to 01/02/2021)

Rank	Document	Author & year	Citations
1	A global reference for human genetic variation	Altshuler et al. (2015)	5,154
2	Empagliflozin, Cardiovascular Outcomes, and Mortality in Type 2 Diabetes	Zinman et al. (2015)	4,288
3	Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013	Naghavi et al. (2015)	3,993
4	Preexposure Chemoprophylaxis for HIV Prevention in Men Who Have Sex with Men	Grant et al. (2010)	2,888
5	Global, regional, and national incidence, prevalence, and years lived with disability for 130 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015	Vos et al. (2016)	2,708
6	Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015	Wang et al. (2016)	2,586
7	Edoxaban versus Warfarin in Patients with Atrial Fibrillation	Giugliano et al. (2013)	2,469
8	Saxagliptin and Cardiovascular Outcomes in Patients with Type 2 Diabetes Mellitus	Scirica et al. (2013)	2,123
9	Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants	Di Cesare et al. (2016)	1,934
10	Global, Regional, and National Cancer Incidence, Mortality, Years of Life Lost, Years Lived with Disability, and Disability-Adjusted Life-years for 32 Cancer Groups, 1990 to 2015 A Systematic Analysis for the Global Burden of Disease Study	Fitzmaurice et al. (2017)	1,841

Table 4. Top 10 journals with the highest scientific productions where Peru publishes in WoS (updated 01/02/2021)

Rank	Journal	Document	Citation	Total link strength
1	American Journal of Tropical Medicine and Hygiene	**1,213**	9,853	2,587
2	PLOS ONE	**464**	8,754	2,145
3	Revista de Investigaciones Veterinarias del Perú	**331**	91	191
4	Revista del Cuerpo Medico del Hospital Nacional Almanzor Aguinaga Asenjo	**312**	43	43
5	Revista Peruana de Ginecología y Obstetricia	**236**	68	26
7	Scientia Agropecuaria	**235**	243	144
6	Revista de Investigaciones Altoandinas	**227**	62	124

8	Journal of Clinical Oncology	**227**	6,151	45
9	Faseb Journal	**191**	110	13
10	PLOS Neglected Tropical Diseases	**188**	5,076	1,322

Table 5. Top 10 authors with the most publications that contribute to Peru in WoS (updated 01/02/2021)

Rank	Author	Documents
1	Gilman, Robert H.	841
2	Garcia, Hector H.	422
3	Gotuzzo, E.	408
4	Gupta, R.	406
5	Kim, S.	370
6	Gupta, A.	365
7	Singh, R.	353
8	Costa, F.	350
9	Vargas, A.	349
10	Zhang, X.	344

Table 6. Top 10 organizations that contribute the most to scientific productions in Peru in WoS (updated 01/02/2021)

Rank	Organization	Documents	Citations	h-index
1	Universidad Peruana Cayetano Heredia	5,550	126,128	133
2	Universidad Nacional Mayor de San Marcos	3,735	41,544	82
3	Pontificia Universidad Católica del Perú	2,944	41,565	92
4	University of California System	1,866	122,123	146
5	Johns Hopkins University	1,681	100,322	126
6	Universidad Sao Paulo	1,334	92,373	125
7	CGIAR	1,291	51,469	91
8	Centre National de la Recherche Scientifique CNRS	1,168	46,045	103
9	International Potato Center CIP	1,086	27,586	75
10	University of Texas System	1,073	67,291	109

Table 7. Clusters of keywords in Peruvian scientific production (1985–2020)

Cluster	Colour	Keywords
1		children, prevalence, Latin America, HIV, health, risk…
2		model, system, yield, water, pollution, mechanisms…
3		taxonomy, diversity, andes, evolution, amazon, climate …
4		infection, transmission, identification, epidemiology, vaccination, cysticercosis…
5		management, consumption, reliability, sustainability…