Scientific production of Ecuadorian Universities

Producción científica de las Universidades Ecuatorianas

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Abstract

Scientific production is a topic of vital importance in Ecuadorian Universities, year after year the evaluation standards and rankings of publications of Higher Education Institutions take these indicators as a reference to determine the quality of each one of them. Therefore, it is essential to analyze the reality of the country in this area and the increase in the dissemination of knowledge in recent years. The objective of this research was to determine the state of development of scientific production in Ecuadorian universities, in the period from 2015 to 2019, with an analysis of its global, national, and local context. The following were used as data collection instruments: scientific databases, national control, accreditation agencies, and digital repository websites. The results showed that in Ecuador, universities in category A are more productive in terms of high-impact publications; however, there is evidence of great progress in type B universities in the factors referring to research and dissemination of results in scientific databases. In conclusion, Ecuadorian universities have made progress in research compared to previous years.

Keywords: Research, publishing, higher education, scientific production, Scopus.

Resumen

La producción científica un tema de vital importancia en las Universidades ecuatorianas, año a año los estándares de evaluación y los rankings de publicaciones de instituciones de Educación Superior, toman estos indicadores como referencia para determinar la calidad de cada una de éstas. En tal virtud, resulta fundamental analizar la realidad del país en este ámbito y el aumento que ha tenido la difusión del conocimiento en estos últimos años. El objetivo de esta investigación fue determinar el estado de desarrollo de la producción científica en las universidades ecuatorianas, en el periodo comprendido entre los años 2015 a 2019, con un análisis de su contexto mundial, nacional y local. Se utilizaron como instrumentos de recolección de información: bases de datos científicas, organismos de control y acreditación nacionales y páginas web de repositorios digitales. Los resultados arrojaron que, en el Ecuador, las universidades que se encuentran en categoría A, son más productivas, en referencia a publicaciones de alto impacto, sin embargo, se evidencia un gran avance en las universidades de tipo B, en los factores referentes a investigación y difusión de resultados, en bases de datos científicos. En conclusión, las universidades ecuatorianas han avanzado en el ámbito de la investigación en referencia a los años anteriores.

Palabras clave: Investigación, publicación, educación superior, producción científica, Scopus.

Introduction

Currently, the evident diversification of challenges faced by higher education in response to the regulatory standards of state agencies and a volatile, uncertain, changing, and ambiguous society (VICA), lead it to restructure its knowledge management as a strategy of permanence in the future, considering the production and dissemination of the results of its research as a relevant and unique value in its organizational structure[1].

In the Ecuadorian context, the Organic Law of Higher Education, LOES, in its Article 8, determines that scientific production, transfer, and technological innovations that contribute to the development of universal thought, are one of the purposes of the academy[2], for which it endorses the dissemination of the scientific production of its professors and research professors through the budget allocation to publish in indexed journals, as a strategy to meet the indicators of academic-scientific production (books, book chapters, and articles)[3].

In this sense, and according to the substantial changes facing higher education, it is necessary for Ecuador to constantly monitor the available scientific and human resources, prioritizing possible collaboration, to work in national and international networks, and to incentive their research from the state and academia, to promote a research culture visible nationally and internationally. Thus, at present, research, linkage with society, and teaching are fundamental pillars (substantive functions or missionary processes) for higher education, recognizing publications as necessary among the scientific activities aimed at contributing to science, improving its institutional quality, and contributing to solving the problems of social reality[5]. Therefore, the objective of this manuscript is to determine the state of development of scientific production in the Ecuadorian university by studying the dissemination of global, regional, and national knowledge, during the period 2015-2019.

On the other hand, and as a historical basis, the scientific production of the Ecuadorian university in the period 2003-2012, visualized in Scopus, maintained an annual average of 10.8% and in ISI Web of Knowledge of 9.4%[6], showing a low production in comparison with the average level of Latin America, occupying the ninth place, below Chile, Colombia, Venezuela, Cuba, Puerto Rico, Peru, Uruguay, and Costa Rica, with a production of 3651 articles in Scopus and 3935 in ISI Web of Knowledge; furthermore, considering that the Scopus database would be, at least quantitatively, the most representative of the production of the Region before SciELO and RedALyC[7], the number of scientific academic journals from Ecuador in the Latin American and Caribbean region in the period 2005-2009 was Scielo=0, Redalyc=3; Scopus=2.

Now, in Ecuador, the number of publications in scientific journals with affiliation to Scimago Journal and Country Rank was 10350, with 9784 citable documents with SJR-linked publications and 149 manuscripts with H-index for the period (2016-2019)[8]. Considering 114 journals in catalog 2.0, 645 journals in the directory, and 196 online journals indexed in regional production as far as Latindex is concerned[9].

From the above, it is evident that research is a fundamental instrument for professional improvement. In this regard[10] states: "Research is a tool that contributes to training teachers who are alert to their personal and professional improvement, and who show commitment to a quality educational offer and sensitivity to their students, to the institution and society" (p. 5). The current dynamism in the research processes obliges professional professors, higher education institutions, and the State itself to make a Copernican turn in the face of outdated research practices. In the words of Bondarenko[11]: It is necessary, first of all, to transform the culture of training institutions, for which the following is recommended to universities and training institutes: 1) Allocate time, space, and resources for research training, 2) Modernize the curriculum and update training programs, incorporating the research component in a transversal manner as part of academic training, 3) Promote close relations with the schools, as well as with the business and productive sectors of the country, providing support to raise the levels of research.

At the same time, it builds a teaching practice congruent with its position in the world. According to Perez[12] "One explains what he knows or thinks he knows, but he guides his students' learning with what he is" (p. 4). If the teacher-researcher is inquisitive and committed to his students and society, he will form professionals along these lines. In addition, the true purpose of the researcher within the social conglomerate must be considered. In this sense Hernández[13] says: The teacher, as a person, citizen, and professional, in his role as researcher and trainer, is competent to guide the real knowledge of the context, the community, the region, the country, the world, science, and technology, with the scientific, technical and human capacity to incite his students to find the answers to multiple questions; for this, the teacher uses logical and systematic processes that allow the construction of research projects aimed at solving problems in different fields.

Methodology

A descriptive, retrospective, ~~retrospective~~, non-experimental documentary review research was carried out. The inclusion criteria were the scientific evidence reported in the Scimago Journal and Country Rank, the number of published papers, the number of citations, and the number of publications in quartile Q1 and H-index were considered.

In addition, the basic information was analyzed through digital tools and web page contents to fulfill the proposed objective and determine, within the study period, the state of development of scientific production in Ecuador, with a deductive methodology, starting from a global analysis to reach the knowledge of the local reality. Under the following structure: a) literature review and state of the art, b) information gathering, through web pages, digital repositories, and scientific databases, c) analysis of the results, in their global, regional, and national contexts through bibliometric statistics and presentation of the results, through the discussion and conclu-

sions of the research. For the statistical analysis of the information, a descriptive analysis was performed using absolute and relative frequencies (qualitative variables) and measures of central tendency for quantitative variables. The Jamovi and Stata statistical programs were used for the analyses.

Results

In this context, comparing the reality of the scientific production of the Ecuadorian university with the world is essential to position itself in the scenario of global improvement. According to data from Scimago Journal & Country Rank[8], the world is made up of 229 countries, among the five continents that publish in scientific journals; thus, the real distance between the best-ranked countries at the world level and Latin America will be observe[4].

According to Table 1, Ecuadorian scientific production was considered compared at the world level, that is, covering the five continents with 240 countries, between sovereign states and dependent states, whose data corresponds to the period (2015-2019), according to www.scimagojr.com/; thus, the difference between the best-ranked countries and Ecuador, is notoriously lower by up to 2 digits in the number of published manuscripts. Table 1 shows the first 14 countries in the world and Ecuador in 68th place, referring to the items of published documents, citable, and H-index. For the analysis, the H-index proposed by Jorge Hirsch -which measures the quality and quantity of scientific articles- was taken as a reference; as a result, the total H-index at a global level is 50249, which represents 100%, and in the Ecuadorian case the contribution of citations is 166, which represents 0.3%, approximately.

Table 1. World Ranking 2015 -2019.

N°	Name of country	# Documents published	# Citable documents	# H-índex
1	United States	3428027	2928522	2386
2	China	2786576	2718550	884
3	United Kingdom	1057075	878736	1487
4	Germany	909251	814743	1298
5	India	820472	752914	624
6	Japan	661631	610761	1036
7	France	614263	554672	1180
8	Italy	597677	527016	1030
9	Canada	553429	485709	1193
10	Australia	518174	450762	1001
11	Spain	477465	432566	904
12	Russia	456958	443056	580
13	South Korea	425799	407251	687
68	Ecuador	17116	16310	166

From the data shown, the United States of America continues to be the leading country in the world with emphasis on H-índex publications. In general, the top ten of the world ranking is the same, except for the irruption of China, a country that in the period (2009-2014), was not among the top 10; in addition, it is observed how Brazil, the only South American country entered the top 15 countries; while Ecuador, marks an improved trend in the 68th position, compared to the previous study that placed it in the 82nd position.

On the other hand, it is necessary to make a balance between Ecuadorian and Latin American production, considering the dependent states, both Spanish-speaking and those of other languages; therefore, a total of 48 countries are included. Consequently, it should be thought that there are influential factors for scientific production, namely: first, endogenous factors such as scientific culture, research structure, and higher education policies, among others; and second, exogenous factors established, fundamentally in technological innovation and scientific knowledge.

For the analysis, information was extracted from the same characteristics (published documents, citable, and H-índex) of the same period (2015-2019), observing the hegemony of Brazil, since this is in the first position at the regional level and within the first 15 at the world level. Data is reflected in Table 2.

Tabla 2. Ranking latinoamericano 2015 -2019.

N°	Name of country	# Documents published	# Citable documents	# H-índex
1	Brazil	393705	368056	578
2	Mexico	123201	113256	454
3	Argentina	71694	65719	431
4	Chile	69211	64629	384
5	Colombia	58782	55062	290
6	Ecuador	17116	16310	166
7	Peru	15363	13813	238
8	Cuba	10342	9535	177
9	Uruguay	8317	7622	193
10	Venezuela	8038	7415	221
11	Costa Rica	5491	5066	188
12	Puerto Rico	4614	4203	220
13	Panama	3152	2881	208
14	Trinidad and Tobago	2116	1808	102
15	Jamaica	2085	1675	106

From Table 2, it is also possible to observe the scientific production trend of the top 5 countries, consolidated as powers in regional scientific knowledge, which is precisely analogous to the period (2009-2014); however, Ecuador climbed to sixth place, surpassing 7 countries in the general ranking. This is due to the fact that its documents with an H-index improved, with 166 citations with an approximate contribution of 2%, in relation to 5,705, which represents the total of the 48 countries under study.

Within the national context, it can be said that Ecuador has more than 55 Higher Education Study Centers, including Universities and Polytechnic Schools, categorized as A and B, according to the National Secretariat for Higher Education, Science and Technology (SENESCYT). Therefore, there is a difference in the scientific production of the Ecuadorian university between the two categories, which reflect specific aspects for research development such as: economic influ-

ence, appropriate infrastructure, international links with the knowledge society, visibility of indexed journals, hourly time investment to research for teachers, among the main ones. In Table 3, information was collected with different characteristics from the previous tables, such as the number of publications in Scopus, the percentage of international collaboration and the percentage of publications in quartile 1 (Q1), applied only to the period (2017-2019), due to that there are no data for the years between 2015 and 2016 in the Scimago Journal & Country Rank platform. In this way, it was projected to estimate the current location and trend of the scientific productivity of the Ecuadorian university, considering the first 13 universities and another two with geographical reference to the Ecuadorian Austro, as shown in Table 3.

Figure 1 also shows the comparison of the number of publications between the world ranking and the Latin American ranking, in which the United States and China undoubtedly predominate in the number of publications of high-impact scientific articles.

Thus, it is observed that universities with category A are the most productive, in terms of high-impact publications, with the support of foreign researchers. The positions of the top ten universities have varied, although they are, for the most part, the same educational cloisters for the period under study compared to the period (2009-2014). On the other hand, the universities classified as B, also have changes in their positions, considering the technological and academic advances of universities such as the Catholic University of Cuenca.

Figure 1. Comparison of high-impact papers published worldwide and in Latin America.

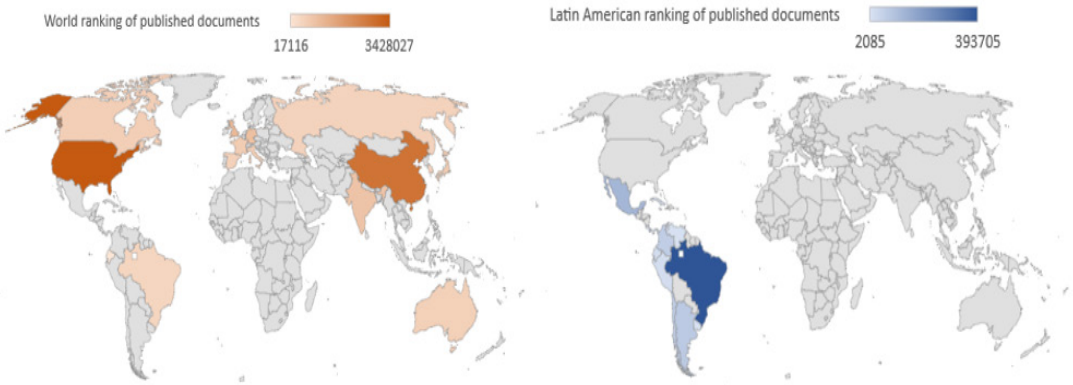
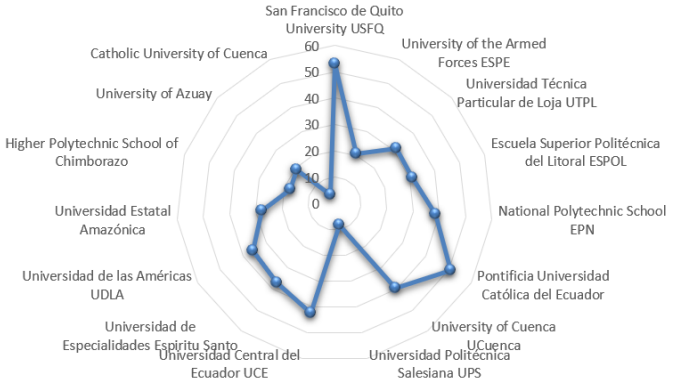


Table 3. Ranking of Universities in Ecuador 2017 -2019.

N°	Name of Institution	# Scopus Scientific Publications	% Publications International Collaboration	% Publications in Q1
1	San Francisco de Quito University USFQ	1940	86.20	53.12
2	University of the Armed Forces ESPE	1633	64.86	20.50
3	Universidad Técnica Particular de Loja UTPL	1592	71.05	31.48
4	Escuela Superior Politécnica del Litoral ESPOL	1479	74.95	31.05
5	National Polytechnic School EPN	1404	81.17	38.59
6	Pontificia Universidad Católica del Ecuador	1378	80.22	51.02
7	University of Cuenca UCuenca	1095	80.71	39.61
8	Universidad Politécnica Salesiana UPS	949	66.55	8.18
9	Universidad Central del Ecuador UCE	767	77.91	42.46
10	Universidad de Especialidades Espiritu Santo	471	67.36	37.35
11	Universidad de las Américas UDLA	452	61.10	35.87
12	Universidad Estatal Amazónica	420	87.03	27.60
13	Higher Polytechnic School of Chimborazo	405	69.53	17.65
26	University of Azuay	162	68.89	19.19
34	Catholic University of Cuenca	89	61.19	3,49

Figure 2. Percentage of Q1 quartile Scopus publications in Ecuadorian universities (2017-2019).



According to the Ibero-American Ranking of Higher Education Institutions 2018 to 2021 given the SCImago Institutions Rankings, in the Ecuadorian universities that has higher publications in Scopus in 2017 and 2018 was the Universidad San Francisco de Quito, and the Q1 Quartile publications were higher than 50%. On the other hand, in 2019 and 2020 the Universidad de las Fuerzas Armadas presented higher publications, but the Universidad San Francisco de Quito obtained a higher percentage of publications in Quartile Q1 (56.22%). Finally, in 2021 the National Polytechnic School surpassed all Ecuadorian universities in publications (n=1501).

As for the percentage of publications in quartile Q1, the Universidad San Francisco de Quito occupies the first place, it was the one that showed in all years from 2017 to 2021 a percentage higher than 50%.

Table 4. Scopus publications and percentage of Q1 quartile in Universities in Ecuador in 2017.

2017			
Rank	**Country**	**SCOPUS**	**%Q1**
1	San Francisco University of Quito	500	51.00
2	Pontifical Catholic University of Ecuador	371	54.72
3	Universidad Técnica Particular de Loja	326	34.66
4	Superior Polytechnic School of Litoral	285	31.58
5	National Polytechnic School	271	44.65
6	University of the Armed Forces	254	25.20
7	University of Cuenca	231	44.16
8	Central University of Ecuador	174	41.38
9	Salesian Polytechnic University	165	8.48
10	Catholic University of Santiago of Guayaquil	107	34.58
11	University of Espiritu Santo Specialties	102	37.25
12	Superior Polytechnic School of Chimborazo	93	16.13
13	Amazon State University	88	25.00
14	University of the Americas	83	31.33
15	Indoamerica Technological University	79	39.24
16	National University of Chimborazo	63	28.57
17	University of Guayaquil	58	20.69
18	State Technical University of Quevedo	47	21.28
19	Eloy Alfaro Laica University of Manabi	40	37.50
20	National University of Loja	38	42.11
21	Simon Bolivar Andean University	34	23.53
22	Technical University of Ambato	34	26.47
23	University of Azuay	32	25.00
24	Technical University of Machala	32	40.63
25	Equinoccial Technological University	31	61.29
26	Peninsula de Santa Elena State University	24	29.17
27	Institute of Higher National Studies	19	36.84
28	Research University of Experimental Technology Yachay	16	18.75
29	Northern Technical University	14	42.86
30	Higher Polytechnic School of Agriculture and Livestock of Manabi Manuel Felix	12	8.33
31	SEK International University Ecuador	10	0.00
32	Technical University of Manabi	10	40.00
37	Catholic University of Cuenca	3	0.00

Table 5. Scopus publications and percentage of Q1 quartile in Universities in Ecuador in 2018.

2018			
Rank	**Country**	**SCOPUS**	**%Q1**
1	San Francisco de Quito University	604	52,15
2	Universidad Técnica Particular de Loja	534	31.65
3	University of the Armed Forces	495	20.81
4	Superior Polytechnic School of Litoral	464	32.54
5	National Polytechnic School	442	37.10
6	Pontifical Catholic University of Ecuador	436	52.29
7	University of Cuenca	361	38.50
8	Salesian Polytechnic University	311	7.40
9	Central University of Ecuador	245	44.90
10	University of Espiritu Santo Specialties	147	37.41
11	Amazon State University	139	28.78
12	Superior Polytechnic School of Chimborazo	129	15.50
13	University of the Americas, Ecuador	124	37.90
14	Universidad Catolica de Santiago de Guayaquil, Ecuador	116	38.79
15	Latin American Faculty of Social Sciences, Ecuador	111	28.83
16	Technical University of Ambato	106	16.98
17	National University of Chimborazo	105	23.81
18	Indoamerica Technological University	99	45.45
19	University of Guayaquil	90	14.44
20	State Technical University of Quevedo	89	15.73
21	National University of Loja	71	35.21
22	Eloy Alfaro Laic University of Manabi	68	35.29
23	Universidad de Investigacion de Tecnologia Experimental Yachay	62	43.55
24	Equinoccial Technological University	60	58.33
25	Technical University of Machala	58	31.03
26	Peninsula de Santa Elena State University	43	41.86
27	University of Azuay	42	16.67
28	Universidad Tecnica del Norte	36	27.78
29	International University of Ecuador	33	30.30
30	Ikram Amazon Regional University	32	46.88
31	Simon Bolivar Andean University. Ecuador	32	28.13
32	Institute of Higher National Studies	30	40.00
33	Catholic University of Cuenca	27	3.70

Table 6. Scopus publications and percentage of Q1 quartile in Universities in Ecuador in 2019.

2019

Rank	Country	SCOPUS	%Q1
1	University of the Armed Forces	884	15.50
2	San Francisco de Quito University	836	56.22
3	Universidad Técnica Particular de Loja	732	28.14
4	Superior Polytechnic School of Litoral	730	29.04
5	National Polytechnic School	691	34.01
6	Pontifical Catholic University of Ecuador	571	46.06
7	University of Cuenca	503	36.18
8	Salesian Polytechnic University	473	8.67
9	Central University of Ecuador	348	41.09
10	University of the Americas	245	38.37
11	University of Espiritu Santo Specialties	222	37.39
12	University of Guayaquil	211	8.53
13	Technical University of Ambato	207	13.53
14	Research University of Experimental Technology Yachay	196	58.16
15	Amazon State University	193	29.02
16	Superior Polytechnic School of Chimborazo	183	21.31
17	National University of Chimborazo	179	19.55
18	Latin American Faculty of Social Sciences	161	27.33
19	Equinoccial Technological University	147	38.10
20	Catholic University of Santiago de Guayaquil	137	32.85
21	Technical University of Machala	136	19.12
22	State Technical University of Quevedo	130	13.08
23	Eloy Alfaro Laic University of Manabí	113	30.97
24	Indoamerica Technological University	110	39.09
25	National University of Loja	102	35.29
26	Technical University of the North	101	24.75
27	University of Azuay	88	15.91
28	Peninsula de Santa Elena State University	73	32.88
29	Ikiam Regional Amazonian University	62	41.94
30	Technical University of Manabi	60	23.33
31	Catholic University of Cuenca	59	6.78

Table 7. Scopus publications and percentage of Q1 quartile in universities in Ecuador in 2020.

2020

Rank	Country	SCOPUS	%Q1
1	University of the Armed Forces	1210	13.72
2	San Francisco de Quito University	1140	59.74
3	National Polytechnic School	1079	33.73
4	Superior Polytechnic School of Litoral	1035	27.25
5	Universidad Técnica Particular de Loja	946	25.69
6	Pontifical Catholic University of Ecuador	750	39.20
7	Salesian Polytechnic University	713	10.66
8	University of Cuenca	684	34.21
9	Central University of Ecuador	464	39.01
10	University of Guayaquil	420	7.62
11	Technical University of Ambato	391	12.28
12	University of Las Américas. Ecuador	376	34.31
13	University of Espiritu Santo Specialties	317	30.28
14	Superior Polytechnic School of Chimborazo	293	19.80
15	Research University of Experimental Technology Yachay	293	55.63
16	Equinoccial Technological University	261	32.95
17	National University of Chimborazo	259	16.99
18	Amazon State University	237	28.69
19	Catholic University of Santiago de Guayaquil	206	26.70
20	Latin American Faculty of Social Sciences	188	25.00
21	Technical University of Machala	184	18.48
22	State Technical University of Quevedo	167	12.57
23	Eloy Alfaro Laic University of Manabi	163	29.45
24	Universidad Tecnica del Norte	158	18.35
25	University of Azuay	146	20.55
26	National University of Loja	142	31.39
27	Indoamérica Technological University	142	35.92
28	Peninsula de Santa Elena State University	133	24.06
29	International University of Ecuador	120	24.17
30	Catholic University of Cuenca	110	6.36

Table 8. Scopus publications and percentage of Q1 quartile in universities in Ecuador in 2021.

2021			
Rank	**Country**	**SCOPUS**	**%Q1**
1	National Polytechnic School	1501	33.90
2	University of the Armed Forces	1494	13.30
3	San Francisco de Quito University	1488	56.40
4	Superior Polytechnic School of Litoral	1346	25.90
5	Universidad Tecnica Particular de Loja	1096	22.50
6	Pontifical Catholic University of Ecuador	982	35.50
7	Salesian Polytechnic University	949	12.30
8	University of Cuenca	850	30.40
9	University of Guayaquil	651	7.37
10	Central University of Ecuador	616	35.40
11	University of the Americas	576	34.00
12	Technical University of Ambato	564	10.60
13	Universidad de Investigación de Tecnología Experimental Yachay	530	50.00
14	University of Espiritu Santo Specialties	438	28.50
15	Superior Polytechnic School of Chimborazo	390	17.40
16	Equinoccial Technological University	355	34.70
17	National University of Chimborazo	345	17.40
18	Catholic University of Santiago de Guayaquil	303	23.10
19	Northern Technical University	275	14.60
20	Amazon State University	256	27.70
21	Technical University of Machala	247	14.60
22	Catholic University of Cuenca	222	4.95
26	University of Azuay	210	8.57

Discussion

The university teacher depends, to a great extent, on the creation of culture, the formation of thought, the production of knowledge, the development of science through research, and, above all, the formation of competent people, citizens, and professionals[13].

For this fundamental reason, university teaching should periodically generate publication processes, both nationally. Regionally, and globally since the teacher has direct contact with all the actors of education. The German professor Jaspers states that the teacher-researcher is the one who puts in direct contact with the process of knowledge itself and is the contact with which science is originally contemplated[13].

Under this framework, it is necessary to focus from a comparative perspective how is the reality of the Ecuadorian university versus the publications at the world and regional level; consequently, it will be possible to obtain the answers to the shortcomings in the field of scientific production and the processes of knowledge generation. Only in this way will it be possible to contribute to the progress of the country, through plans and projects in the different areas of knowledge, with a real contribution to the community.

Now, the degree of impact of indexed journals should be taken into account, since they are generally framed according to editorial guidelines such as presentation, management, and content that guarantee scientific rigor. Their visibility will represent a greater reach both in their dissemination and in their repercussion in the knowledge society, through citation[14].

In conclusion, scientific production is one of the fundamental axes for the development of universities in the global context and fulfills the purpose of being generators of knowledge through the promotion and improvement of basic scientific, applied, and formative research projects. Ecuadorian universities have advanced in the field of research compared to previous years. However, the support of the state has not been adequate to give greater emphasis to the generation of scientific knowledge that allows compliance with one of the axes that the National Development Plan "Toda una Vida" contemplates.

Ecuadorian universities should have as a fundamental principle the development of the substantive functions of teaching, research, and outreach, which will provide comprehensive training to students while raising the quality of education. The investment for the improvement of the scientific production of Ecuadorian universities is one of the key points to improve the level of scientific and technological knowledge, as well as its dissemination and divulgation, which allows promoting the development and innovation of the country contributing to solving the latent problems of society, establishing as a priority the implementation of a research culture that impacts on academic and scientific production, whose purpose is to generate knowledge and contribute to the development of the productive matrix, through the academy.

It is recommended as future research to carry out a greater review of the publications in Scopus that have a quartile (Q1 to Q4) that are in different areas of knowledge such as medicine[15,16], nursing[17-19], education[20], psychology[21-24], law, economics, biopharmacy.

Conflict of interest

There is no conflict of interest between the authors.

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