Revista **U.D.C.A** Actualidad & Divulgación Científica
July-December 2023-Volumen 26 No. 2:e2478
ISSN: 2619-2551 en línea
ISSN: 0123-4226 impreso

Reflection Article
http://doi.org/10.31910/rudca.v26.n2.2023.2478

University scientific production: The case of the Universidad de Ciencias Aplicadas y Ambientales (Bogotá, Colombia)

Producción científica universitaria: el caso de la Universidad de Ciencias Aplicadas y Ambientales (Bogotá, Colombia)

Luz Piedad Romero-Duque[1]*; Germán Anzola Montero[2]

[1]Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, Formación Avanzada. Bogotá, Colombia; e-mail: luz.romero@udca.edu.co
[2]Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, Rectoría. Bogotá, Colombia
*corresponding author: luz.romero@udca.edu.co

How to cite: Romero-Duque, L.P.; Anzola Montero, G. 2023. University scientific production: The case of the Universidad de Ciencias Aplicadas y Ambientales (Bogotá, Colombia). Rev. U.D.C.A Act. & Div. Cient. 26(2):e2478. http://doi.org/10.31910/rudca.v26.n2.2023.2478

Official publication of the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, University, Accredited as a High-Quality Institution by the Colombian Ministry of Education.

Received: June 18, 2023 **Accepted:** October 5, 2023 **Edited by:** Helber Adrián Arévalo Maldonado

ABSTRACT

The research and scientific production of Universidad de Ciencias Aplicadas y Ambientales U.D.C.A was analyzed based on the intellectual capital approach, global academic rankings, research, and scientific production in the last 40 years. The Scimago Graphica tool and the VOSviewer software were used for the bibliometric and content analysis of the scientific publications available in the Scopus database. The bibliometric analysis showed that there are 534 scientific documents in the Scopus database, with at least one author affiliated with U.D.C.A. Of these, 84 % can be found in SciELO and 56 % on Publindex. Most documents (70 %) are in English, and 27 % are in Spanish. The citations of 7 articles account for 64.4 % (37,147) of the total citations. Authors with affiliation U.D.C.A have collaborated with researchers from 72 countries. Based on intellectual capital and scientific production, U.D.C.A is currently in model 2.0 and is transitioning towards model 3.0, drawn by three areas: Medicine, Environmental Sciences, and Veterinary. These areas have focused on inter-institutional cooperation, internationalization, regionalization, and globalization. However, they must incorporate business development, digital technologies, virtual learning, knowledge capitalization, and entrepreneurship. The other areas of knowledge need to reconsider the type and scope of research they develop to be relevant to the academic community and society.

Keywords: Academic ranking; Intellectual capital; Scientific impact; Scientometrics; University model.

RESUMEN

Se analizó la Universidad de Ciencias Aplicadas y Ambientales U.D.C.A con base en el enfoque de capital intelectual, rankings académicos globales, investigación y producción científica de los últimos 40 años. Para el análisis bibliométrico y de contenido de las publicaciones científicas disponibles en la base de datos Scopus, se utilizó la herramienta Scimago Graphica y el software VOSviewer. El análisis bibliométrico arrojó que existen 534 documentos científicos en la base de datos Scopus con, al menos, un autor afiliado a la U.D.C.A. De ellos, el 84 % se encuentra en SciELO y el 56 % en Publindex. La mayoría de los documentos (70 %) están en inglés y el 27 %, en español. Las citas de 7 artículos suponen el 64,4 % (37.147) del total de citas. Autores con afiliación U.D.C.A han colaborado con investigadores de 72 países. Con base en capital intelectual y producción científica, la U.D.C.A se encuentra actualmente en el modelo 2.0 y transita hacia el modelo 3.0, dibujado por tres áreas: Medicina, Ciencias Ambientales y Veterinaria. Estas áreas se han centrado en la cooperación interinstitucional, la internacionalización, la regionalización y la globalización; sin embargo, deben incorporar el desarrollo empresarial, las tecnologías digitales, el aprendizaje virtual, la capitalización del conocimiento y el emprendimiento. Las otras áreas del conocimiento necesitan reconsiderar el tipo y el alcance de la investigación que desarrollan, para que sea relevante para la comunidad académica y la sociedad.

Palabras clave: Capital intelectual; Cienciometría; Clasificación académica; Impacto científico; Modelo Universitario.

INTRODUCTION

In the current economic landscape, creating value in organizations and generating financial wealth heavily relies on knowledge-based resources. Academic institutions are no exception to this trend, where intellectual capital is critical. Intellectual Capital (IC) determines an institution's value and "allows an organization to transform a bundle of material, financial, and human resources in a system capable of creating stakeholder value" (European Commission, 2004). IC serves as the input and output of the complete production process and is primarily intangible (de Frutos-Belizón *et al*. 2020). Intellectual capital comprises three distinct dimensions (Quintero-Quintero *et al*. 2021). The first dimension pertains to human capital, which encompasses the skills and expertise of an organization's employees. The second dimension is structural capital, which comprises the internal components and systems that enable an organization to function effectively. Lastly, the third dimension relates to relational capital, which encompasses the external parts of the organization, such as its relationships with customers, suppliers, and other stakeholders.

According to de Frutos-Belizón *et al*. (2020), within the academic sphere, human capital comprises three key components: firstly, the theoretical and methodological knowledge, skills, competencies, and abilities gained through formal scientific education and research; secondly, the social structure of the researcher's network, which complements their skills and enables knowledge-sharing among team members; and finally, the knowledge stored in databases, team practices and procedures, and shared values and ethics among team members. All these factors, whether directly or indirectly, impact scientific production. Evaluating researchers' scientific production at an institutional level indicates academic performance and the institution's reputation (Shehatta & Mahmood, 2016). Moreover, it provides essential information about the university's ongoing activities and whether they are meeting the goals of doing world-class research, participating in regional development, or having a social impact, among others (Tanveer *et al*. 2019).

Many antecedents analyze universities' scientific production. For instance, Quintero-Quintero & Quintana-Arevalo (2022) conducted a worldwide systematic review of scientific output in higher educational institutions by utilizing various sources and databases. Similarly, analyses have been carried out on the scientific production of universities in Iran (Aminpour & Heydari, 2009; HajiHashemi *et al.* 2016; Nouri & Danesh, 2010; Okhovati *et al.* 2018; Rahmati-Roodsari & Sohrabi, 2013; Rasolabadi *et al.* 2015; Siamian *et al.* 2013), Romania (Repanovici, 2011), Spain and Portugal (Costa & Rodríguez-Bravo, 2016; Rubio, 1992), Mexico (Delgado-Carreón *et al*. 2021; Tarango *et al*. 2015), and Peru (Estrada Araoz *et al*. 2022; Millones-Gómez *et al*. 2021; Rivera-Lozada *et al*. 2022; Roman-Gonzalez & Vargas-Cuentas, 2018; Roque *et al*. 2022). In the case of Colombia, studies have been carried out on intellectual capital and scientific production in public universities (Quintero-Quintero *et al*. 2021), the impact of the scientific output of top universities (Orbegozo *et al*. 2022), the efficiency of the scientific production in universities (Bayona-Rodríguez *et al*. 2018), and the growth of the scientific output in universities (Bucheli *et al*. 2012).

Since intellectual capital (a concept developed in the enterprise and industry sector) has been introduced in the university sector as a mechanism of self-evaluation of the university's quality and performance, and scientific production, as a result of human capital, is one of the indicators of university's quality, the aim of this paper is to reflect on the research and scientific production of the Universidad de Ciencias Aplicadas y Ambientales (U.D.C.A) in its 40 years of existence. The reflection begins with comprehending U.D.C.A's university model, which centers around an approach to intellectual capital. Additionally, this reflection evaluates international academic rankings and U.D.C.A's advancements in this realm. This was achieved by delineating and scrutinizing its scientific output, both broadly and by specialized fields of study.

MATERIALS AND METHODS

For the development of this reflection, scientific publications were considered as evidence of the research work by professors, students, and graduates of any academic level (college and postgraduate). A search was made in the Scopus database for the list of documents with at least one author affiliated with the U.D.C.A, regardless of the publication date. Based on these documents, a bibliometric, content, and scope analysis of the research developed in the U.D.C.A was performed.

The bibliometric analysis was performed in two ways. The first bibliometric analysis determined the number of documents based on the year, document type, language, Latin-American database indexed, open access type, and factor index type (JCR, H Index, and Scopus-Quartile). This analysis was made with Scimago Graphica (Hassan-Montero *et al.* 2022), a no-code tool that creates complex visualizations for simple interactions of drag and drop. The second bibliometric analysis was of the content analysis. It was performed using VOSviewer software developed by Leiden University Library (Netherlands) and is available as a free download for Windows, Mac, and Linux (van Eck & Waltman, 2010). This study used VOSviewer version 1.6.19 (VOSviewer, 2023) to analyze bibliometric data and identify patterns and trends. A keyword co-occurrence analysis was performed, which involved creating a network with nodes representing words and edges representing the co-occurrence of the words within the documents. The objective of keyword co-occurrence analysis is to extract frequency data in multiple documents to form a network of relationships among the keywords to identify and highlight the primary trend of research in the domain. In this study, the analysis was performed based on the U.D.C.A's knowledge areas: Health (medicine, nursing, and sports), Management and Commerce, Basic Sciences (Chemistry and Pharmaceutical Chemistry, and Data Science), Management and Commerce, Education, Agricultural Sciences (agronomy, veterinary, and zootechnics), and Environmental Sciences. The journals were classified into these six knowledge areas, and additional analysis was performed for all journals classified as multidisciplinary. The overlay visualization feature weighted by

citations was used to compare and combine the data differently to display multiple layers on the same map. Overall, these analyses allowed people to gain insights into the relationships and patterns within the data.

RESULTS AND DISCUSSION

There is growing discourse on the need to transform global university models beyond their traditional functions, resulting in significant changes in work, organization, and management methods. Therefore, university models have evolved from the initial University 1.0 to the modern-day University 3.0 (Boehm, 2022). As per Lukovics & Zuti (2015), University 1.0 focused on creating professionals, University 2.0 on creating professionals and scientists, and University 3.0 on creating professionals, scientists, and entrepreneurs simultaneously. Lukovics & Zuti (2015) also introduced University 4.0, where universities serve as both the catalyst and engine of the economy. These changes aim to modify the role of universities in society and the economy (Shtykhno *et al*. 2022), imposing a significant challenge.

The U.D.C.A has earned high recognition of quality from the Ministerio de Educación Nacional of Colombia. The university has approximately 5,000 students and 149 professors, 31 with Ph.D. and 84 with a master's degree. The institution is committed to investing 2,3 % of its tuition towards research initiatives. Notably, the university has already developed software and is in the process of securing its first patent. Furthermore, they are actively engaged in several innovation projects. Additionally, it recently launched two doctoral programs in Sustainability Sciences and Animal Science, representing important knowledge areas of growth for the university. Based on Lukovics & Zuti (2015) university models, U.D.C.A falls under model 2.0 and is moving towards model 3.0.

Another significant challenge imposed on universities is to be in some academic rankings, like Times World University Rankings, QS World University Rankings, Academic Ranking of World Universities (ARWU), and Webometrics Ranking. These rankings have been used to compare university quality using different metrics, datasets, methods, and indicators (Hudec, 2017).

However, while being ranked highly in university rankings could be seen as a prestigious achievement, the validity of these rankings has been the subject of much debate. Universities' rankings often need more transparency regarding information sources and data reliability, as they heavily rely on universities' information, which may not always be objective or comprehensive (Anowar *et al*. 2015). Hudec (2017) indicate that factors such as the university's type, size, model, and context are often not considered, which can significantly impact its overall ranking. The U.D.C.A is not ranked in the top systems, including Scimago Institutions Rankings, which only consider universities that publish over 100 yearly documents. However, the results show progress in the U.D.C.A's scientific production.

Based on the bibliometric analysis, 534 scientific documents authored by authors affiliated with U.D.C.A were found in the SCOPUS database (Figure 1). The oldest record is from 1999 with the paper "Lack of beneficial effects of bethanechol, imipramine or furosemide on the seminal plasma of three stallions with urospermia", published in the journal Reproduction in Domestic Animals (Hoyos Sepúlveda *et al*. 1999). Since then, the number of papers published by authors affiliated with U.D.C.A has significantly increased since 2015, with a range of growth from 77 to 139 % between years (Figure 1). A study by Arias-Pérez *et al*. (2019) analyzed the relationship between intellectual capital management and research group performance in public and private universities in Colombia. The research indicated that individuals with advanced levels of human capital produced the most significant scientific output. Furthermore, according to Quintero-Quintero *et al*. (2022), public universities in Colombia with more authors or researchers tended to publish more scientific articles in Scopus. The increase in publication rates may be attributed to U.D.C.A's efforts to strengthen its team by hiring top-notch researchers across various disciplines since 2015 (Figure 1).

From the 534 scientific documents authored by individuals affiliated with U.D.C.A found in the Scopus database, a significant majority (88 %) are original articles, while reviews account for 6.2 %, and book chapters, case studies, or editorials make up 1.7 %. The remaining documents comprise editorials, letters, errata, conference papers, data papers, and notes (Figure 1). This result agrees with Bayona-Rodríguez *et al*. (2018), who found that articles are the most produced scientific products by universities in Colombia. The study showed a significant increase in new knowledge-generation products between 2009 and 2015, which included articles (60 %), book chapters (220 %), books (58 %), and other products (194 %).

On the other hand, 70 % of the papers were published in English and 27 % in Spanish (Figure 1). These results are consistent with Salatino (2023), who found that of 62.446.772 papers reported in Scopus in 2022, only 0.9 % (542,959) were published in Spanish. Additionally, 23 Latin American countries accounted for 2,502,340 papers, 4 % of the papers published in Scopus. Colombians wrote 5.9 % of these 4 % scientific papers. Colombia is one of Latin America's peripheral centers, along with Argentina, Brazil, Chile, and Mexico. According to Salatino (2023) most Latin Americans (82 %) have published their work in English in journals indexed in Scopus; of them, a smaller percentage (9 %) have published in Portuguese, and even fewer (8.8 %) have published in Spanish. Even the OLIVA Project, the Latin American Observatory of Research Evaluation Indicators, recorded that 23.9 % of papers in journals indexed by Redalyc and SciELO were published in English; in comparison, 43.7 % were published in Spanish, 32.9 % in Portuguese, and only 0.2 % in French (Gallardo, 2022). This is relevant because English is not the official language in Latin American countries with the most research and internationalization capacities (Salatino, 2023) However, although the global science system and the dominance of the English language promote disparities globally regarding knowledge production (Chankseliani, 2023), all these findings are unsurprising because the English language controls science, and authors like Horn (2017) suggest

that publishing in English is necessary for researchers to gain visibility. It appears that this is what authors affiliated with UDCA are targeting.

On the other hand, according to Salatino (2023), the number of Latin American journals included in mainstream indexing bases (Scopus, WoS Core Collection) is negligible concerning the total number of journals published in the region. However, Scientific communities in Latin America have been strengthening since the mid-20th century by creating and organizing bibliographic indexes such as LA-LILACS, DOCPAL, REPIDISCA, AGRINTER-SIDALC, Clase, Periódica, Latindex, and BIBLAT. More recently, initiatives such as SciELO have emerged to promote the dissemination of local and regional scientific knowledge (Beigel *et al.* 2024). Nevertheless, the most important thing is their commitment to developing open science (Packer, 2020).

Of the 534 papers authored by authors affiliated with U.D.C.A found in the Scopus database, 165 were published in 75 Latin American journals (84.4 % are listed in SciELO, 56 % in Publindex, Figure 2), and 110 were published in 34 Colombian journals. Among these, 30 journals are open-access "Gold" (Immediate Open Access publication by the journal or book publisher), "Green" (A version of the publication is archived online), and 30 are open-access "Green." This result is significant because the public cannot access two-thirds of the scholarly literature published, as it is locked behind a paywall (Pourret, 2020). In this sense, it is essential to define the type and scope of the scientific production of the U.D.C.A, and the proportion that it should be oriented to the regional and local public, especially considering that the regional and local journals often have a low JCR index or are not included in the Journal Citation Reports (JCR) (Figure 3).

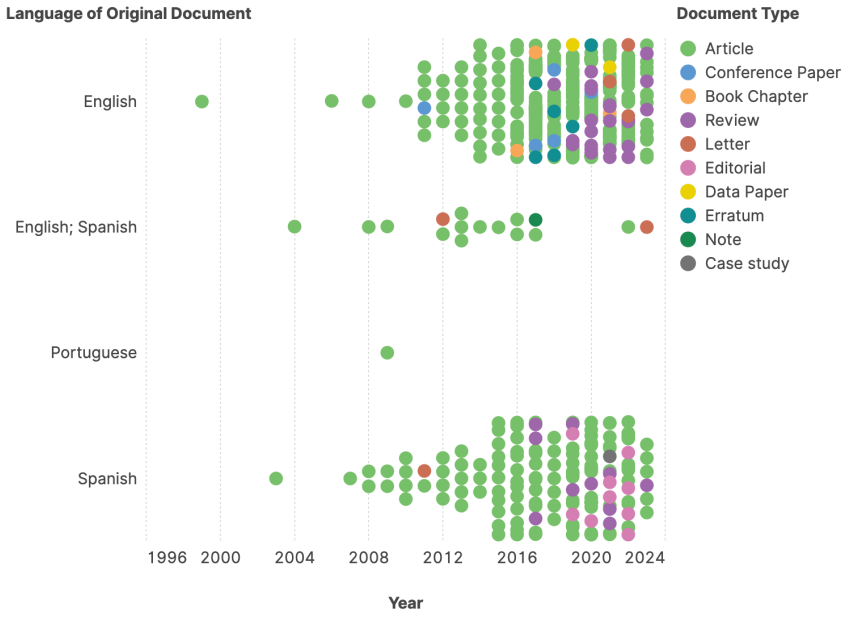

Figure 1. Articles published in the Scopus database by authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, by document type, and the document's language.

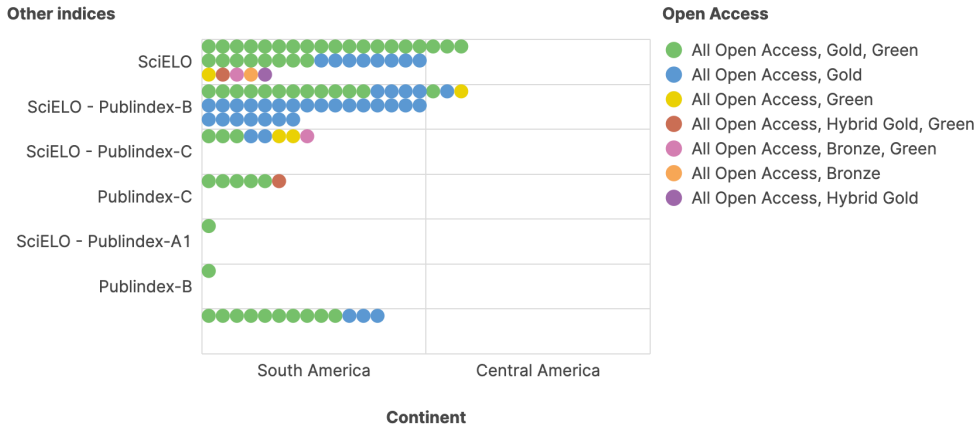

Figure 2. Journals indexed in SciELO and Publindex, and the open access status, in which authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A published in the last 40 years.

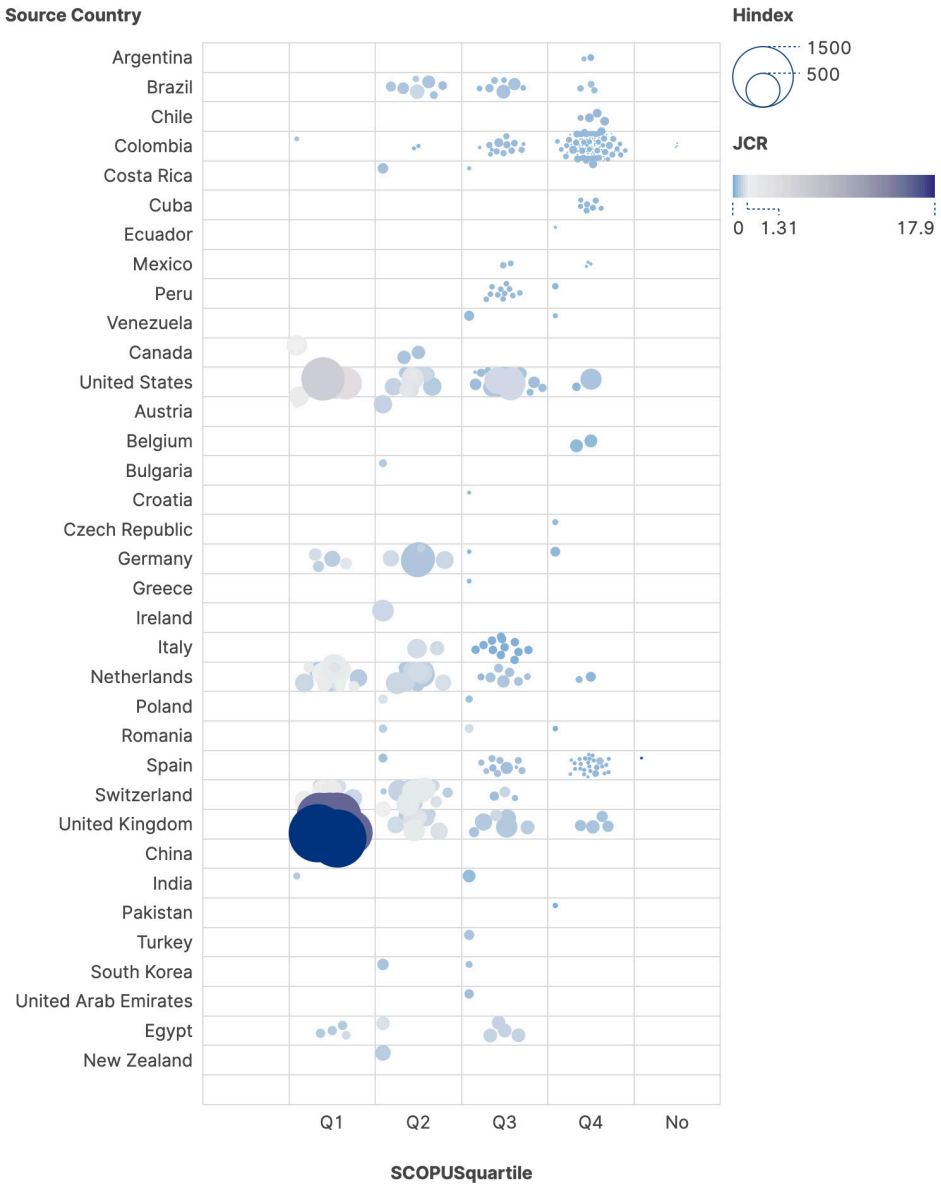

Figure 3. Impact measurement metrics of journals where authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A publish. JCR, HIndex, Scopus-Quartile.

The JCR is a tool within the Web of Science (WoS) that evaluation agencies widely use to assess the quality of scientific production. It calculates a Journal's Impact Factor by dividing the citations it received in the JCR year by the total number of articles published two years prior. An Impact Factor of 1.0 means that, on average, the articles published one or two years ago have been cited once. Authors affiliated with U.D.C.A have published in journals whose JCR ratings range from not being included in the JCR to a maximum of 17.9 (Figure 3). The journals with the highest JCR were Nature (17.9), The Lancet (15.65), and The Lancet Respiratory Medicine (11.12); all of them are from the United Kingdom. In these journals, 22 papers were published by consortia of authors (100 or more, including at least one author affiliated with U.D.C.A). The papers published by authors affiliated with U.D.C.A have been cited 37,147 times. However, only seven papers account for 64.4 % of those citations, as the data indicates (Figure 3). These six papers corresponded to meta-analysis studies conducted by author consortia. In this type of paper, the authors and institutions are not easily identified, but they are essential for scientific research rankings due to the high citation index.

Authors from U.D.C.A. have collaborated with authors from 72 countries, divided into three clusters (Figure 4). The first cluster consists of countries from America (shown in blue), the second cluster includes countries from Europe and Asia, and the third cluster is a mix of countries from Africa, Oceania, and Australia, with the addition of the Russian Federation (shown in red). Although some authors affiliated with U.D.C.A strong collaboration with international authors, this result might be overestimated since many of these relationships may not exist. They could be the result of the meta-analysis studies, in which each author shares their original data to be analyzed by the principal authors of the research

to establish worldwide or regional patterns. It is improbable that the authors of these meta-analyses will collaborate again. The above does not apply to established and consolidated consortia authors like the GBD Collaborator Network, a scientific effort of the Institute for Health Metrics and Evaluation (IHME) at the University of Washington. GDB measures the impact of diseases, injuries, and risk factors on health by age, gender, and location. They also quantify the comparative magnitude of health loss due to conditions, injuries, and risk factors by age, sex, and geographies for specific points in time. At least one author affiliated with U.D.C.A is part of this collaboration network. These authors must remain connected with the U.D.C.A.

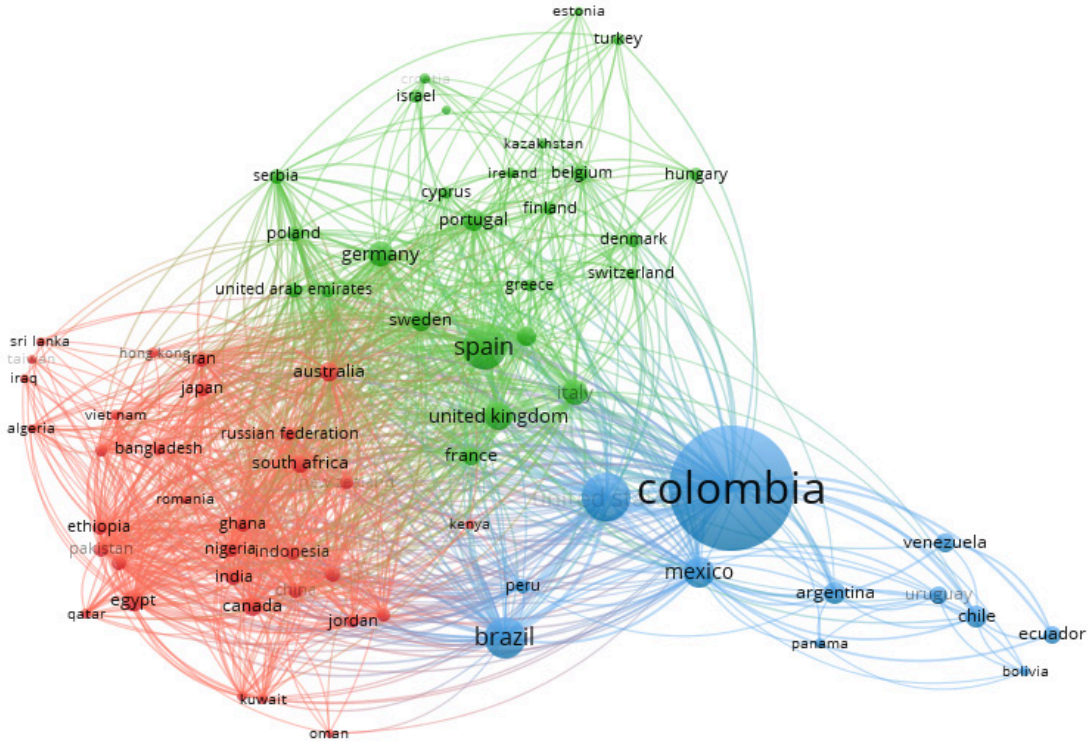

Figure 4. International collaboration network of authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A in publications indexed in the Scopus database. The network corresponds to circles representing authors by country's co-occurrence. The size of the circle represents the number of documents published (the larger the circle, the more documents it covers). The distance between two nodes represents the strength of their connection (a lesser distance shows a more robust bond).

Meta-analysis often relies on data papers, which are articles that describe data resources and the methods used to obtain them (Cao, 2022). These articles are easily accessible, comprehensible, and usable to ensure open access to data (Jie *et al.* 2020). Data papers are essential for conducting meta-analysis, a quantitative method that identifies patterns of underlying relationships and causality, leading to the development of general principles and cumulative knowledge (Guzzo *et al.* 1987). Despite the importance of data papers, only two publications in this category have been recorded from authors affiliated with U.D.C.A. These publications are "Trees and shrubs of the Tropical Dry Forest of the Magdalena River upper watershed (Colombia)," published in Biodiversity Data Journal (Romero-Duque *et al.* 2019), and "Missing data estimation in extreme rainfall indices for the Metropolitan Area of Cali - Colombia: An approach based on artificial neural networks," published in Data in Brief (Ocampo-Marulanda *et al.* 2021).

Based on the areas of knowledge listed in Scopus, authors affiliated with U.D.C.A have published documents in 102 different fields. The most popular knowledge areas were Multidisciplinary (13 %), Medicine (miscellaneous) (11.4 %), and Veterinary (miscellaneous) (11 %). All other knowledge areas accounted for less than 5 % of the papers (Figure 5). The Scopus database contains 2,102 keywords for documents from 88 knowledge areas, but 87 % have only been used once. Analyzing these keywords can help identify the research topics that authors affiliated with U.D.C.A.

According to U.D.C.A's knowledge areas, the Health field has the highest number of publications (176) and citations (35,043) compared to other fields. It includes three subareas, namely Medicine, Nursing, and Sports. The Medicine subarea has 102 keywords classified into five clusters (Figure 6a). Immunology, vaccines, parasites, malaria, and Plasmodium shown in the first cluster (yellow-green) are the primary focus of recent research in this field. The second cluster (purple) includes keywords related to genetics, clinical studies or trials, and topics related to body performance. In contrast, the Nursing subarea has 317 keywords in 25 papers, but only 12 meet the requirement of having at least three co-occurrences. Unfortunately, there are no impactful keywords in this area. The Sports subarea contains 68 keywords in 11 papers, but

none meet the requirement of having at least three co-occurrences. Mean propulsive velocity, muscle strength, and physical fitness had two co-occurrences.

There is only one keyword cluster in the Management and Commerce knowledge area, which can be attributed to the limited number of published papers (4 papers; Figure 6b). Additionally, only one of these papers has received at least a single citation. The primary keywords in this knowledge area are complex systems, models and modeling, decision-making, and well-being. A similar situation was observed in the Education knowledge area, which also has only one cluster, and the primary keywords are related to higher education, pedagogical styles, education for sustainable development, and professional development. Therefore, it is crucial to enhance the scientific output in the Nursing and Sports subareas and the Management, Commerce, and Education knowledge areas at U.D.C.A.

Basic Sciences knowledge shows 1,467 keywords in 5 clusters (Figure 6c). The publications classified in this area are similar, or even the same, as those classified under Medicine. This can be attributed to the research focus of the GIBGA research group, which is mainly centered around cancer, genotoxicity, *Helicobacter pylori*, human physiology, and anatomy. Recent research in this field has been focused on various topics such as molecular diagnosis, nucleic acid amplification, genetics, detection limits, sensitivity and specificity, isolation and purification, histocompatibility, immunology, protein binding, and synthetic peptides. With the recent addition of chemical and data analysis researchers, the scientific productivity of this area is expected to diversify and have a more significant impact, especially in the context of using materials for various environmental processes and applying Big Data tools.

In this work, it was presented the results of the agronomy and veterinary subareas separately. Although it can be challenging to determine the boundary between these two areas of agricultural sciences, it is necessary to make a clear distinction. The Agronomy subarea exhibits 88 keywords distributed among 12 clusters (Figure 6d). Recent publications by authors affiliated with U.D.C.A reveal that the primary trend in this domain is agroforestry and cultivation/harvest. However, cultivation and harvest are the most cited topics, while agroforestry is the least cited. Due to the high citation index of these topics, researchers at U.D.C.A should focus on developing subjects such as soil, ancient crops, production technology, pests and diseases, biomass, carbon sequestration, climate change, and genotype.

On the other hand, the Veterinary knowledge subarea comprises 204 keywords distributed among six clusters (Figure 6e). The central clusters and the cluster at the bottom right (injury, cats, acetabulum fracture) are the most frequently published topics. Based on the average citation score, the research cluster at the bottom right, which covers injury, cats, and acetabulum fracture, is the primary trend in this field. However, scattered keywords (marked in yellow and light green) should also be considered as part of the primary trend, such as bacteria, Hexapoda, cryptosporidiosis, and nucleotide sequence. Researchers in this knowledge area should focus on the progress of these topics to direct their research accordingly.

The Environmental Sciences knowledge area is divided into 7 clusters containing 633 keywords (Figure 6f). Recent publications by authors affiliated with U.D.C.A suggest that the primary research focus in this field is climate change and related topics. The second trend is toward sustainability, sustainable development, education for sustainable development, urban planning, ecosystem services, and geography. The most frequently cited topics in this field are urban planning, ecosystem services, ecology, biodiversity, land use, and land-use change. Although this knowledge area has gained significant recognition, expanding research efforts toward environmental technologies, modeling, and Big Data analysis is essential to further advance in this field of study.

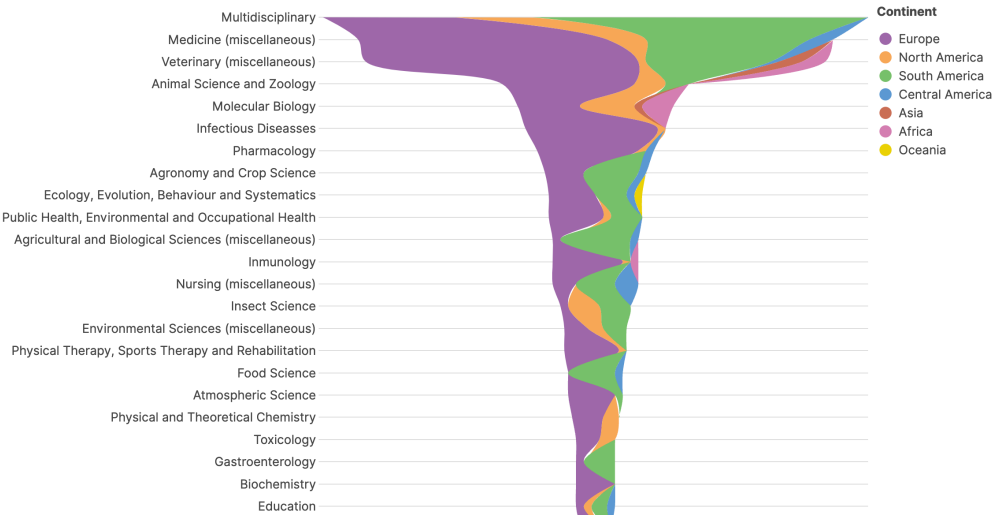

Figure 5. Knowledge areas, with most papers published by authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A in journals organized by subcontinent or continent.

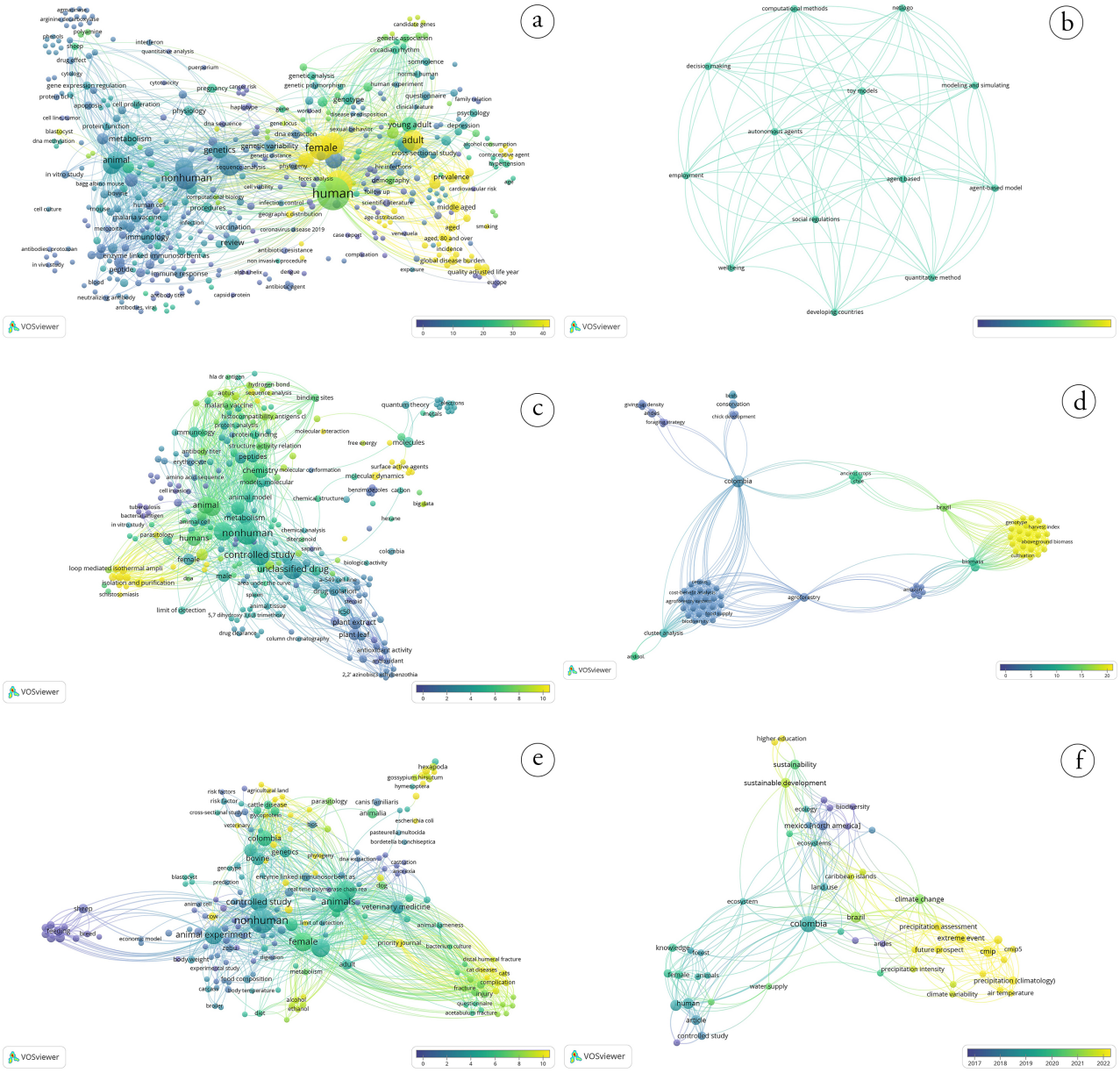

Figure 6. Index keywords co-occurrence network of publications indexed in the Scopus database by authors affiliated with the Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, by knowledge area. a) Health; b) Management and Commerce; c) Basic Sciences; d) Agronomy; e) Veterinary and f) Environmental Sciences.
The size of the circles represents the average citation of documents published (the larger the circle, the more citations it has). The distance between two nodes represents the strength of their connection (a lesser distance shows a more robust bond).

The Scopus database classifies publications as Multidisciplinary, and based on this classification, 621 keywords were identified and grouped into 7 clusters. However, out of these 621 keywords, only 31 have been found to have at least three co-occurrences. These keywords are related to genetics, metabolism, and the study of human subjects, including males, females, and young and adolescent individuals. Due to the diversity of study objects, it is impossible to identify any research trend. Furthermore, many of these keywords overlap with those already identified for different areas of knowledge. Therefore, this category doesn't contribute to the field of research.

This study assesses the scientific output of the U.D.C.A across various fields, analyzing documents authored by authors affiliated with U.D.C.A. The study also examines the impact of the U.D.C.A's scientific production on the global scientific community, evaluates its progress in international academic rankings, and offers recommendations for future research and scientific output that can aid the institution in transitioning toward the University 3.0 model with greater ease.

The scientific research conducted by the U.D.C.A has started to make a significant global impact, especially in Medicine, Environmental Sciences, and Veterinary knowledge areas. Some of their researchers have made noteworthy contributions to meta-analysis in these fields, as evidenced by the high citation rate of their documents. The impact of their scientific research on the academic community worldwide is undeniable. These three areas of the U.D.C.A have begun to focus on increasing inter-institutional cooperation, internationalization, regionalization, and globalization. However, developing business, digital technologies, virtual learning, knowledge capitalization, and entrepreneurship for the academic community in these areas still requires attention.

This situation results from the permanent effort made during the 40 years of existence of the U.D.C.A to strengthen its substantive mission of research. Effort results have seen almost exponential growth since 2015 (Figure 1) and coincide with the opening of postgraduate programs since 2011, the consolidation of research groups, and the strengthening of institutional policies on the matter, actions that have led to an increase in infrastructure and technical and economic capacities assigned to research. For this reason, recently, results have been obtained related to the development of technological products, software methodologies, pedagogical innovation, and the application for a patent, which are also part of scientific production, not reported in Scopus (Estupiñan *et al*. 2023).

The suggested research aims to establish the U.D.C.A. as a benchmark for exceptional scientific production in the country and the region. The U.D.C.A. needs to increase its scientific output in several knowledge areas, promote inter-institutional collaboration, and generate commercially viable innovations. It is worth noting that while this document proposes research suggestions for all knowledge areas at the U.D.C.A., further studies are necessary to evaluate the impact of research on the country and the region. Additionally, research plans should consider indices that measure social impact, such as patent citations, policy documents, and scholary articles, and Web-based metrics "altmetrics" that analyze mentions on social media platforms (Bornmann, 2017).

Finally, as a knowledge producer, it is crucial to establish the extent to which U.D.C.A aims to provide scope to their scientific research. UDCA should analyze their contribution to regional scientific knowledge because the number of papers published in non-Latin American journals in English, or another language is higher than those published in Latin American journals in Spanish. Directing essential scientific research with an open-access vision for resolving regional problems would be an excellent contribution from the U.D.C.A.

Acknowledgments: The authors would like to thank Luis Hernando Estupiñan and Henny Santiago for providing valuable feedback on the manuscript and the two reviewers for their valuable contributions. Conflict of interest: The authors acknowledge that no conflict of interest may compromise the validity of the results and reflections presented as they have prepared and reviewed the manuscript. Author's contribution: Luz Piedad Romero-Duque: conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing-original draft, writing-review & editing. Germán Anzola Montero: conceptualization, writing-original draft, writing-review & editing.

REFERENCES

1. AMINPOUR, F.; HEYDARI, M. 2009. Scientific production of Isfahan University of Medical Sciences. Health Information Management. 6(1):35-42.

2. ANOWAR, F.; HELAL, M.A.; AFROJ, S.; SULTANA, S.; SARKER, F.; MAMUN, K.A. 2015. A critical review on world university ranking in terms of top four ranking systems. En: Elleithy, K.; Sobh, T. (eds) New trends in networking, computing, e-learning, systems sciences, and engineering. Lecture Notes in Electrical Engineering. volumen 312. Springer. p.559–566 https://doi.org/10.1007/978-3-319-06764-3_72

3. ARIAS-PÉREZ, J.; LOZADA, N.; HENAO-GARCÍA, E. 2019. Gestión del capital intelectual y desempeño de grupos de investigación universitarios en un país emergente. El caso de Colombia. Información Tecnológica. 30(4):181-188. https://doi.org/10.4067/s0718-07642019000400181

4. BAYONA-RODRÍGUEZ, H.; BEDOYA, J.; SÁNCHEZ TORRES, F. 2018. Eficiencia en la producción científica de las universidades colombianas. Serie de Documentos Cede. 36. https://doi.org/10.2139/ssrn.3215466

5. BEIGEL, F.; PACKER, A.L.; GALLARDO, O.; SALATINO, M. 2024. OLIVA: La producción científica indexada en América Latina. Diversidad Disciplinar, Colaboración Institucional y Multilingüismo en SciELO y Redalyc (1995-2018). Dados. 67(1):e20210174. https://doi.org/10.1590/dados.2024.67.1.307

6. BOEHM, C. 2022. University 3.0: A conceptual framework for revisiting university futures. En: Arts and Academia (Great Debates in Higher Education), Emerald Publishing Limited, Bingley. p.61-86. https://doi.org/10.1108/978-1-83867-727-520221004

7. BORNMANN, L. 2017. Measuring impact in research evaluations: a thorough discussion of methods for, effects of and problems with impact measurements. Higher Education. 73:775-787. https://doi.org/10.1007/s10734-016-9995-x

8. BUCHELI, V.; DÍAZ, A.; CALDERÓN, J.P.; LEMOINE, P.; VALDIVIA, J.A.; VILLAVECES, J.L.; ZARAMA, R. 2012. Growth of scientific production in Colombian universities: An intellectual capital-based approach. Scientometrics. 91(2):369-382. https://doi.org/10.1007/s11192-012-0627-7

9. CAO, X. 2022. Data papers: An important type of academic articles. Resources Data Journal. 1:10-16. https://doi.org/10.50908/rdj.1.0_10

10. CHANKSELIANI, M. 2023. Who funds the production of globally visible research in the Global South? Scientometrics. 128(1):783-801 https://doi.org/10.1007/S11192-022-04583-4/TABLES/3

11. COSTA, T.; RODRÍGUEZ-BRAVO, B. 2016. Scientific production of the Portuguese and Spanish universities: a comparative analysis. Qualitative and Quantitative Methods in Libraries (QQML). 5:347-354.

12. DE FRUTOS-BELIZÓN, J.; MARTÍN-ALCÁZAR, F.; SÁNCHEZ-GARDEY, G. 2020. An intellectual capital approach to explaining the determinants of scientific productivity in the field of management. European Management Review. 17(4):943-959. https://doi.org/10.1111/emre.12406

13. DELGADO-CARREÓN, C.C.; MACHIN-MASTROMATTEO, J.D.; ROMO-GONZÁLEZ, J.R.; PACHECO-MENDOZA, J. 2021. Creativity-related traits and the scientific production of professors from the Autonomous University of Chihuahua. Digital Library Perspectives. 37(2):119-132. https://doi.org/10.1108/DLP-08-2020-0077

14. ESTRADA ARAOZ, E.G.; GIERSCH, L.V.; VALENCIA MARTÍNEZ, J.C.; LATORRE, M.F.; CONDORI, W.G.L.; PARICAHUA PERALTA, J.N. 2022. Scientific production in the Scopus database of a public university in the peruvian Amazon. Archivos Venezolanos de Farmacologia y Terapeutica. 41(6):437-442.

15. ESTUPIÑAN, L.H.; SANTIAGO, H.M.; PINZÓN, A.D. 2023 El camino de la Investigación en los 40 años de la U.D.C.A. Periódico de La U.D.C.A. p.10-11. Disponible desde Internet en: https://www.udca.edu.co/wp-content/uploads/periodico/2023/index.html

16. EUROPEAN COMMISSION. 2004. Improving institutions for the transfer of technology from science to enterprises: conclusions and recommendations. European Commission, Directorate-General for Enterprise and Industry.

17. GALLARDO, O. 2022. La evolución de la producción científica en revistas indexadas en Iberoamérica. Principales tendencias y diferencias del circuito mainstream. Número 23. Observatorio Iberoamericano de la Ciencia, La Tecnología y la Sociedad de la Organización de Estados Iberoamericanos para la Educación, la Ciencia y la Cultura. 41p.

18. GUZZO, R.A.; JACKSON, S.E.; KATZELL, R.A. 1987. Meta-analysis analysis. Research in Organizational Behavior. 9(1):407-442.

19. HAJIHASHEMI, Z.; MALIH, N.; VAFAEE, R.; SOHRABI, M.R. 2016. Scientific production of Shahid Beheshti University of Medical Sciences in Scopus between 2011-2014. Social Determinants of Health. 2(4):155-161. https://doi.org/10.22037/sdh.v2i4.17599

20. HASSAN-MONTERO, Y.; DE-MOYA-ANEGÓN, F.; GUERRERO-BOTE, V.P. 2022. SCImago Graphica: a new tool for exploring and visually communicating data. Profesional de La Informacion. 31(5) https://doi.org/10.3145/epi.2022.sep.02

21. HORN, S.A. 2017. Non-english nativeness as stigma in academic settings. Academy of Management Learning and Education. 16(4) https://doi.org/10.5465/amle.2015.0194

22. HOYOS SEPÚLVEDA, M.L.; QUIROZ ROCHA, G.F.; BRUMBAUGH, G.W.; MONTIEL, Q.J.; RODRÍGUEZ, M.S.; CANDANOSA DE MORALES, E. 1999. Lack of beneficial effects of bethanechol, imipramine or furosemide on seminal plasma of three stallions with urospermia. Reproduction in Domestic Animals. 34(6):489-493. https://doi.org/10.1111/j.1439-0531.1999.tb01408.x

23. HUDEC, O. 2017. A ranking-free evaluation of universities: An intellectual capital approach. ICETA 2017 - 15th IEEE International Conference on Emerging ELearning Technologies and Applications, Proceedings. https://doi.org/10.1109/ICETA.2017.8102487

24. JIE, X.U.; WENHUI, T.A.N.G.; XINYUE, X.I.A. 2020. Analysis of the status quo and corresponding countermeasures of data publishing based on its practices. Chinese Journal of Scientific and Technical Periodicals. 31(11):1331. https://doi.org/10.11946/cjstp.202005200515

25. LUKOVICS, M.; ZUTI, B. 2015. New functions of universities in century XXI towards "fourth generation" universities. Transition Studies Review. 22(2) https://doi.org/10.14665/1614-4007-22-2-003

26. MILLONES-GÓMEZ, P.A.; YANGALI-VICENTE, J.S.; ARISPE-ALBURQUEQUE, C.M.; RIVERA-LOZADA, O.; CALLA-VÁSQUEZ, K.M.; CALLA-POMA, R.D.; REQUENA-MENDIZÁBAL, M.F.; MINCHÓN-MEDINA, C.A. 2021. Research policies and scientific production: A study of 94 Peruvian universities. PLoS ONE. 16(5):e0252410. https://doi.org/10.1371/journal.pone.0252410

27. NOURI, R.; DANESH, F. 2010. Scientific production of academic members in web of science during 2000-2005 and effective factors: A case study in Isfahan University of Medical Sciences. Irandoc Scientific Communication Monthly Journal. 17(2):2-10.

28. OCAMPO-MARULANDA, C.; CERÓN, W.L.; AVILA-DIAZ, A.; CANCHALA, T.; ALFONSO-MORALES, W.; KAYANO, M.T.; TORRES, R. R. 2021. Missing data estimation in extreme rainfall indices for the Metropolitan area of Cali - Colombia: An approach based on artificial neural networks. Data in Brief. 39 https://doi.org/10.1016/j.dib.2021.107592

29. OKHOVATI, M.; BAZRAFSHAN, A.; ZARE, M.; ABDOLAHI, L.; BAZRAFSHAN, M.S.; ZARE, F. 2018. Qualitative and quantitative assessment of the scientific production of Kerman University of Medical Sciences academic members in Scopus database. Health and Development Journal. 6(4):268-278.

30. ORBEGOZO, J.M.G.; GONZÁLEZ-MENDOZA, J.A.; ARAUJO, V.L.G. 2022. Impact of the scientific production of the Top 15 universities in Colombia. Journal of Positive Psychology and Wellbeing. 6(2):800-805.

31. PACKER, A. L. 2020. The pasts, presents, and futures of SciELO. En: Eve, M. P.; Gray, J. (eds.), Reassembling scholarly communications: Histories, infrastructures, and global politics of open access. MIT Press. p.297-316.

32. POURRET, O. 2020. Global flow of scholarly publishing and open access. Elements. 16(1):6-7. https://doi.org/10.2138/GSELEMENTS.16.1.6

33. QUINTERO-QUINTERO, W.; BLANCO-ARIZA, A.B.; GARZÓN-CASTRILLÓN, M.A. 2021. Intellectual capital: A review and bibliometric analysis. In Publications 9:4. https://doi.org/10.3390/publications9040046

34. QUINTERO-QUINTERO, W.; BLANCO-ARIZA, A.B.; GARZÓN-CASTRILLÓN, M.A. 2022. Investigation related to intellectual capital and scientific production in Colombia public universities: A review from Scopus. In Education Research International. 2022:9039109. https://doi.org/10.1155/2022/9039109

35. QUINTERO-QUINTERO, W.; QUINTANA-AREVALO, S. 2022. Scientific production in higher institutions: A systematic review. PalArch's Journal of Archaeology of Egypt / Egyptology. 19(4).

36. RAHMATI-ROODSARI, M.; SOHRABI, M. 2013. Scientific production of nutrition school of Shahid Beheshti University of Medical Sciences in Scopus and ISI in 2009-mid2012. Iranian Journal of Nutrition Sciences & Food Technology. 7(5):79-86.

37. RASOLABADI, M.; KHALEDI, S.; KHAYATI, F.; KALHOR, M.M.; PENJVINI, S.; GHARIB, A. 2015. Scientific production of Medical Universities in the West of Iran: A scientometric analysis. Acta Informatica Medica. 23(4) https://doi.org/10.5455/aim.2015.23.206-209

38. REPANOVICI, A. 2011. Measuring the visibility of the university's scientific production through scientometric methods: An exploratory study at the Transilvania University of Brasov, Romania. Performance Measurement and Metrics. 12(2):106-117. https://doi.org/10.1108/14678041111149345

39. RIVERA-LOZADA, O.; RIVERA-LOZADA, I.C.; BONILLA-ASALDE, C.A. 2022. Factors associated with scientific production of professors working at a private university in Peru: An analytical cross-sectional study. F1000Research. 11:1219. https://doi.org/10.12688/f1000research.126143.1

40. ROMAN-GONZALEZ, A.; VARGAS-CUENTAS, N.I. 2018. Scientific production in the 50 first universities licensed by SUNEDU. Proceedings of the 2018 IEEE Sciences and Humanities International Research Conference, SHIRCON 2018. https://doi.org/10.1109/SHIRCON.2018.8593133

41. ROMERO-DUQUE, L.P.; ROSERO-TORO, J.H.; FERNÁNDEZ-LUCERO, M.; SIMBAQUEBA-GUTIERREZ, A.; PÉREZ, C. 2019. Trees and shrubs of the tropical dry forest of the Magdalena River upper watershed (Colombia). Biodiversity Data Journal. 7:36191. https://doi.org/10.3897/BDJ.7.e36191

42. ROQUE, R.H.O.; MACAVILCA, M.C.A.; CRUZ, H.J.P.; MARTÍNEZ, A.P.E.; VÉLIZ, M.Z.E.; VÉLIZ, K.L.E. 2022. Management of research and scientific production in private universities of metropolitan Lima. Journal of Positive School Psychology. 6(4):6559-6569.

43. RUBIO, A.V. 1992. Scientific production of Spanish universities in the fields of Social Sciences and Language. Scientometrics. 24(1):3-19. https://doi.org/10.1007/BF02026470

44. SALATINO, M. 2023. Los circuitos lingüísticos de la publicación científica latinoamericana. Tempo Social. 34:253-273. https://doi.org/10.11606/0103-2070.ts.2022.201928

45. SHEHATTA, I.; MAHMOOD, K. 2016. Research Collaboration in Saudi Arabia 1980-2014: Bibliometric Patterns and National Policy to Foster Research Quantity and Quality. In Libri. 66(1):13-29. https://doi.org/10.1515/libri-2015-0095

46. SHTYKHNO, D.A.; KONSTANTINOVA, L.V.; GAGIEV, N.N.; SMIRNOVA, E.A.; NIKONOVA, O.D. 2022. Transformation of university models: Analysis of the development strategies of universities in the world. Vysshee Obrazovanie v Rossii. 31(6):27-47. https://doi.org/10.31992/0869-3617-2022-31-6-27-47

47. SIAMIAN, H.; FIROOZ, M.Y.; VAHEDI, M.; ALIGOLBANDI, K. 2013. Scientific production of medical sciences universities in north of Iran. Acta Informática Medica. 21(2). https://doi.org/10.5455/aim.2013.21.113-115

48. TANVEER, M.; KARIM, A.M.D.; MAHBUB, A. 2019. The use of performance measurement in universities of Pakistan. Library Philosophy and Practice (e-Journal). 3010:1-28.

49. TARANGO, J.; HERNÁNDEZ-GUTIÉRREZ, P.Z.; VÁZQUEZ-GUZMÁN, D. 2015. Evaluation of scientific production in Mexican state public universities (2007-2011) using principal component analysis. Profesional de La Información. 24(5):567-576. https://doi.org/10.3145/epi.2015.sep.06

50. VAN ECK, N.J.; WALTMAN, L. 2010. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 84(2):523-538. https://doi.org/10.1007/s11192-009-0146-3

51. VOSVIEWER. 2023. VOSviewer - Visualizing scientific landscapes. VOSviewer. Disponible desde Internet en: https://www.vosviewer.com/