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The Delphi method is a technique used to reach consensus among specialists in an area who will be able to predict demands or analyze conjunctures about strategic themes. Within this context, the present work consisted of a bibliometric evaluation performed in the Scopus database with the aid of VOSviewer software, prioritizing journals with an affiliation of Brazilian institutions and that made use of the Delphi method for the development of their research. Data collection went through validation stages, and the results obtained showed that this tool was used in several areas of knowledge, with great emphasis on health, more specifically in Medicine, Nursing, and Public health. Together, these three areas accounted for more than 60% of publications made available.

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Abstract

The Delphi method is a technique used to reach consensus among specialists in an area who will be able to predict demands or analyze conjunctures about strategic themes. Within this context, the present work consisted of a bibliometric evaluation performed in the Scopus database with the aid of VOSviewer software, prioritizing journals with an affiliation of Brazilian institutions and that made use of the Delphi method for the development of their research. Data collection went through validation stages, and the results obtained showed that this tool was used in several areas of knowledge, with great emphasis on health, more specifically in Medicine, Nursing, and Public health. Together, these three areas accounted for more than 60% of publications made available.

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1. Introduction

Named in reference to the Delphic Oracle and developed by RAND Corporation, the Delphi method is used to seek consensus among ideas from experts who anonymously voice their opinions through questionnaires, from which several rounds are interspersed with feedback based on the researchers' answers, which configures one of the central characteristics in the technique [DALKEY e HELMER, 1963; DALKEY, 1969].

The Delphi method has a qualitative and quantitative nature since the data obtained can be collected by qualitative and/or quantitative techniques [JOHN-MATTHEWS et al., 2017]. For Melander [2018], Delphi can be combined with other known techniques for safer and more efficient data acquisition, besides adding higher value to the final result. According to the literature, this is one of the most effective existing methods; however, some variables, such as researcher and expert fatigue, as well as the rigor of study and consensus,

make the method relatively time-consuming in terms of completion. Another relevant point is the lack of a definition about the exact number of specialists who should participate, usually being defined underfunding and logistics criteria, as well as strict inclusion and exclusion criteria [DEVANEY; HENCHION, 2018]. On the other hand, bibliometrics is a tool that uses statistical and quantitative analysis techniques to describe information, such as terms, countries, and authors, which are present in documents, identifying, for example, those emerging countries and the existence of a relationship among them. This way, it's possible to use the acquired data to map the surveyed area [WANG et al., 2014]. Nevertheless, the indicators generated do not replace the knowledge of experts in the field under study, and, for practical reasons, these indicators can be combined with other types. The current demand for bibliometric indicators underscores the importance of these data to assist in decision-making and may also serve as a basis for scientific actions [OKUBO, 1997]. In the studied literature there is a diversity of articles that use bibliometric techniques to analyze scientific productions, without being restricted to a specific area, according to the works developed by Kozak, Bornman, and Leydesdorff [2014], which dealt with how research was affected by the demise of the Soviet Union; Romanelli et al. [2018], who presented analyzes on ecological restoration; and Sweileh [2018], who dealt with the use of drugs related to HIV (human immunodeficiency virus).

Bibliometric techniques are known to be used to analyze scientific branches, but these analyzes are not considered infallible [WANG et al., 2014; KHALIL; GOTWAY CRAWFORD, 2015]. The lack of perception by databases in the case of the same words and acronyms, that is, the same words with only different spellings, is one of the limitations of bibliometrics that must be circumvented by careful analysis of the data collected in search of synonyms. Another problem linked to the indicators used in bibliometric studies refers to the fact that the analysis of these indicators is quantitative, so they do not provide a qualitative analysis of the contributions of each work to the literature [KHALIL; GOTWAY CRAWFORD, 2015; OKUBO, 1997].

In this context, the objective of the present study was to evaluate the use of the Delphi method in scientific articles with authors with affiliations in Brazilian institutions. For this, bibliometric methods and VOSviewer software were used for the quantitative analysis and better visualization of the data used, since it was through this software that there was the generation of clustering maps (citations and terms) enabling the perception of emerging terms and interconnections. Therefore, the data were treated independently of their quantity.

The selection of focus on researchers with affiliation with Brazil is related to the economic importance of the country and its position in the research ranking. More specifically, Brazil is one of the emerging powers that make up the BRICS, having growth in its protagonism in the globalized world [PETRONE, 2019]. Besides that, Brazil has relevant positions in search ranking, with 31 institutions ranked according to the World University Rankings [2018], while in the Academic Ranking of World Universities [2018], Brazil presented six institutions in its top 500 and 17 institutions in the rest of the ranking. Regarding Latin American countries, the Nature Index database [2018] reported that Brazil is in the best position among the others, occupying the twenty-third general position.

2. Methodology

The material analyzed was collected from the Scopus database, in which scientific publications were searched through Boolean operators using terms such as “Delphi method”, “Delphi technical” and “Delphi analysis”, in the search field restricted to abstracts, titles or keywords, also having restrictions for only scientific articles, as well as articles that contain at least one researcher with Brazilian affiliation, but in this case, without restrictions about language. Data were collected in February 2019 and contained all articles published up to 2018. After the search procedure, all articles made available by the database were carefully analyzed throughout their scientific text, and the data obtained exported from the Scopus database in the “csv” format for use in VOSviewer software.

For the development of this work, the indicators chosen for the bibliometric analyses were: publications per year, areas of publications, keywords, authors, journals, and institutions. These analyses were performed based on data initially obtained from Scopus, which were subsequently processed using Microsoft Excel software and presented with the results of VOSviewer. In the latter, it was also used a thesaurus file, which refers to a dictionary used to join synonyms, an essential technique in the bibliometric analysis as presented in the literature by other authors [VAN ECK; WALTMAN, 2010; VAN ECK; WALTMAN, 2017].

3. Results and Discussion

3.1 Distribution of articles by year

Regarding the evolution of publications within the limitations presented in the objective of this paper, the first publication in Scopus occurred in 2000, presenting at the end of 2018 a total of 285 publications and thus demonstrating that the presence of works related to the application of the Delphi method in scientific articles authored in Brazilian institutions began to emerge only in the current century (Figure 1).

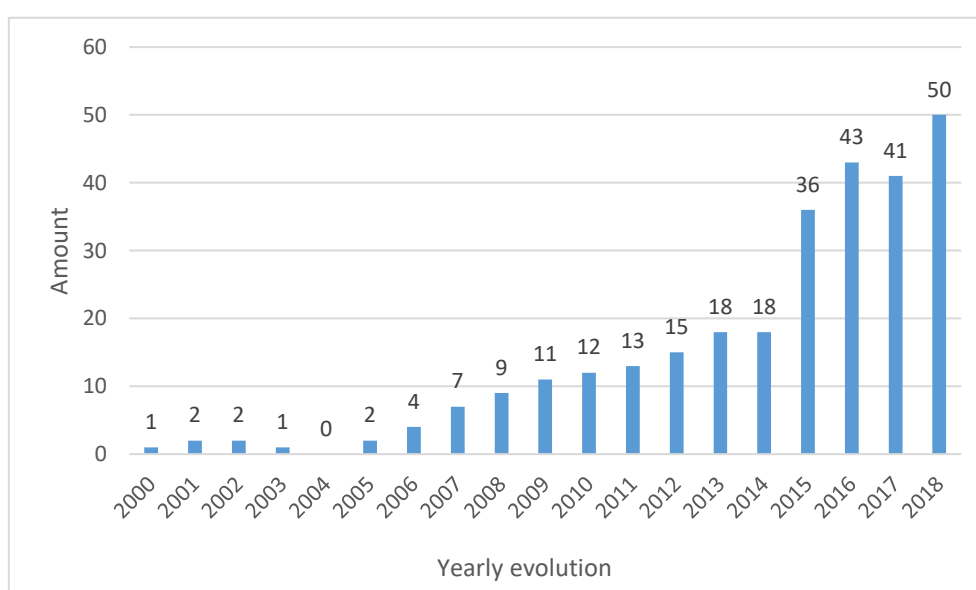


Figure 1. Distribution of scientific articles present in Scopus Base related to the application of the Delphi method with Brazilian affiliations.

It was also possible to observe in Figure 1 a continuous growth in the publications found from 2005 to 2013, with a second higher jump period between 2015 and 2018, representing an approximate total of 60% of the publications in the last four years within the study range. This result indicates an intensified and current interest of researchers in the Delphi method with the expectation of even higher growth over the coming years, because of the constant advancement and development of scientific research in Brazil, as already indicated by several organizations, such as the Nature Index [2018], Academic Ranking of World Universities [2018], and The World University Rankings [2018].

3.2 Research Areas

In the collected articles, 39 different areas of knowledge with Brazilian affiliations were observed. It is important to highlight that these areas were defined by the authors of this work, whose classification was defined after a careful analysis of each of the selected articles, which involved a complete reading of the same. Based on the identified areas, it was observed that several of them widely used the Delphi method, with research found in the health, social, and exact areas.

According to the results shown in Figure 2, the areas of health that stood out in terms of the number of publications were Medicine, with 36% of the total percentage, Nursing, with 19%, and Collective Health, with 6%. Together, these three areas represent about 60% of the publications available. When summing up the publication percentages of all ten areas related to Health Sciences, it was found that 70% of the articles that used the Delphi method are centered in these areas, indicating that such a tool is quite widespread. In contrast, areas such as Engineering represent approximately 14% of publications that fit the criteria defined in the search methodology.

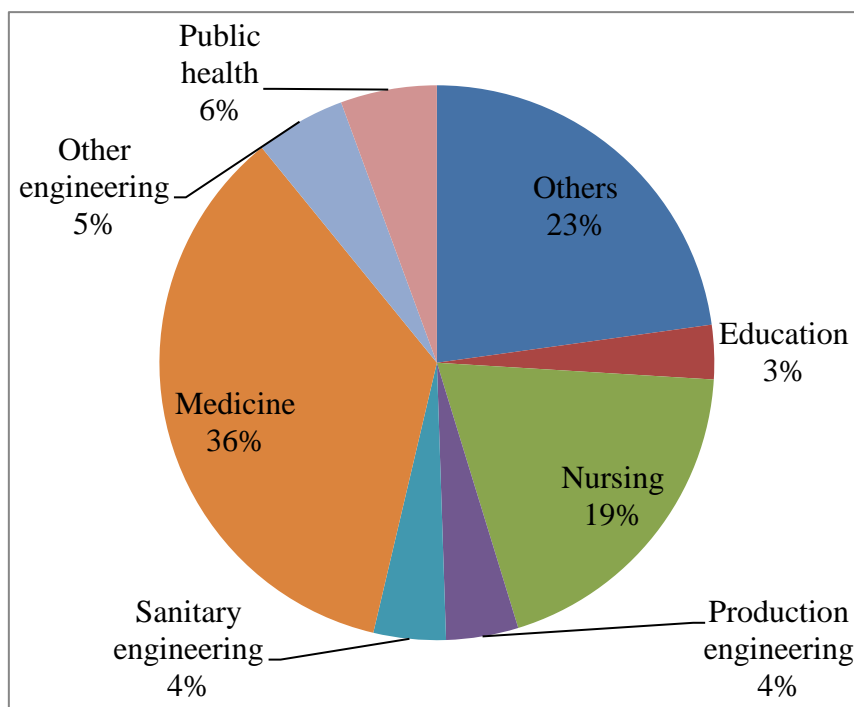


Figure 2. Distribution of areas of knowledge in scientific articles related to the application of the Delphi method with Brazilian affiliations in the Scopus Base.

3.2.1 Applications of the Delphi Method among Knowledge Areas

In areas of knowledge such as education, the Delphi method has been found in articles that address topics regarding the evaluation of performance indicators of postgraduate courses [PAIXÃO et al., 2014]; and evaluation of education program applied in universities [FONSÊCA; JUNQUEIRA, 2014].

Among Engineering, Production Engineering and Sanitary Engineering stood out with the most significant number of publications, both representing approximately 4% of total publications (Figure 2). When considering other engineering studies, the data obtained showed a lower number of publications for the same period analyzed in this work, with a maximum value of only three publications. Among the topics addressed in this group, there was the development of a waste management system [SCHAMNE; NAGALLI, 2018], the improvement of a quality tool [BATTIROLA FILHO et al., 2017], the analysis of perspectives on the use of microalgae as raw material for biofuels [RIBEIRO; DA SILVA, 2015], and the evaluation of policies to promote smart grids [DANTAS et al., 2018].

The various areas of Health Sciences that together accounted for 70% of the total publications that made use of the Delphi method denote the widespread dissemination of the tool between topics ranging from the search for trends to the study and validation of clinical indicators and the development of diverse skills. More specifically, the following works stand out: search for health sector trends in Brazil [PIOLA; OLIVEIRA; MACHADO, 2002], study of indicators for a patient classification instrument [MARTINS; FORCELLA, 2006], skills development professionals [GOUVEIA; BRAGA; HERÁCLIO, 2016], development and evaluation of care protocols [PEDROSA; OLIVEIRA; MACHADO, 2018], identification of trends in health unit management [ANDRÉ; CIAMPONE; SANTELLE, 2013], and competence identification of individual professionals in the Brazilian health system [RODRIGUES; WITT, 2013].

3.3 Countries authoring the articles that applied the Delphi Method

Among the scientific publications related to the application of the Delphi method with at least one affiliation belonging to Brazil among the authors, 78 countries were found within these parameters, as illustrated in Figure 3.

Based on the similarity calculated by VOSviewer, clusters of the keywords were generated in the country co-authoring map (Figure 3). Thus, the cluster that stood out concerning the number of countries was the one that obtained 24 grouped countries, identified in Figure 3 by the reddish color. This result indicated the variety of international collaboration within the grouping, consisting mainly of European countries, with France and Germany presenting respectively 31 and 29 documents each and thus corresponding to the two countries with the most present affiliations in the documents. In the Brazil cluster, formed by Brazil and 11 other nations spread across the continents of Europe, America, Asia, Africa, and Oceania, the United States and Canada were the countries that were closest to Brazil, indicating greater collaboration between researchers from these countries.

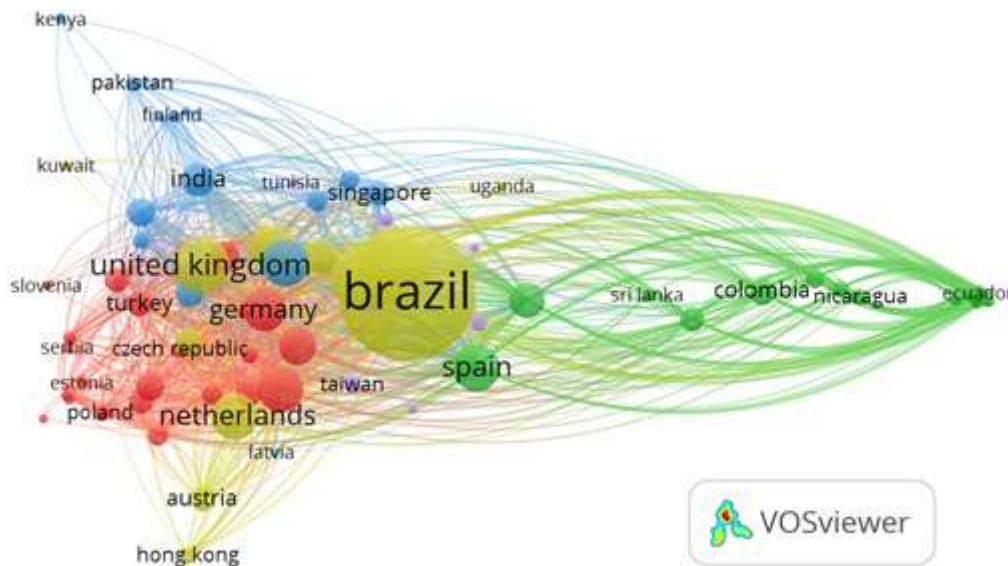


Figure 3. Cluster of countries with scientific publications related to the application of the Delphi method with Brazilian affiliations among the authors in Base Scopus.

Except for Brazil, which was affiliated with all the authors of the research, 76 documents were identified in the United States, followed by Canada and the United Kingdom, with 55 and 50 documents, in this order. The sum of these countries represents more than 60% of the total number of documents, demonstrating the great synergy of these countries in scientific research. Adding to the fact that there are 78 countries in this network, it is possible to notice that in published scientific research there was a collaboration between researchers from different countries, indicating a strong interaction characteristic of these researchers with Brazilian affiliation and other international authors when it comes to the use of the Delphi method.

3.4 Organizations and authors

Among the institutions with scientific publications related to the application of the Delphi method with Brazilian affiliations, the University of São Paulo (USP) is the institution with the most significant number of publications, totaling 77 publications, followed by the Federal University of São Paulo (UNIFESP), with 28 publications, and by the Federal University of Rio Grande do Sul (UFRGS), present in 20 publications. It is noteworthy that among the ten most recurrent institutions are those located in Canada and Australia. All these institutions, shown in Table 1 are found in almost 70% of the documents, showing the concentration of their participation in research on the topic under study.

Table 2 listed the authors with the most significant number of publications about the Delphi method, whose publication had, among the authors, at least one Brazilian affiliation in Scopus. These authors are Health Sciences researchers from eight different nationalities, which reinforces the statement established in previous items that the tool in question is widespread in discussions and studies raised in the health area.

Table 1. Institutions that stood out in scientific publications related to the application of the Delphi method with Brazilian affiliations among the authors in Base Scopus.

Position	Institution	Country	Number of Publications
1	University of Sao Paulo	Brazil	77
2	Federal University of Sao Paulo	Brazil	28
3	Federal University of Rio Grande do Sul	Brazil	20
4	The University of British Columbia	Canada	16
5	Oswaldo Cruz Foundation	Brazil	15
6	Federal University of Rio de Janeiro	Brazil	14
7	Federal University of Rio Grande do Norte	Brazil	14
8	Paulista State University	Brazil	13
9	University of Toronto	Canada	12
10	The University of Sydney	Australia	12

Table 2. Authors with scientific publications related to the application of the Delphi method with Brazilian affiliations among the authors in Base Scopus.

Position	Author	Number of Publications	Country
1	R.R. Witt	7	Brazil
2	M. Boers	4	Netherlands
3	L. Brosseau	4	Canada
4	R. Buchbinder	4	Australia
5	E. A. Burdman.	4	Brazil
6	A. Ravelli	4	Italy
7	J. P. Regnaud	4	France
8	A. Aburub	3	Jordan
9	L. Agulto	3	United States
10	K. L. Bennell	3	Australia

3.5 Keywords used in published articles

With the help of VOSviewer, the keywords present in the selected scientific articles were identified and, then, co-occurrence maps of the authors' keywords and also indexed were generated, constituting, respectively, terms defined by the authors themselves and proposed terms by the database regarding the theme of each article. Thus, these maps were used to analyze the most recurrent terms in research involving the Delphi method with researchers with Brazilian affiliation. The generated network maps aim to discover the themes most used by researchers within these researches.

We found 626 terms in the co-occurrence network of keywords presented by the authors themselves,

grouped in a total of 48 clusters, as shown in Figure 4. The parameter used for the generation of this map was the presence of at least one occurrence per term. The clusters that have the most significant number of terms are red, green, and blue clusters, with 31, 29, and 25 terms, respectively. These three clusters have in common the fact that they are all dominated by Health Sciences terms, such as "children", "treatment", "drug prescriptions", and "morbidity".

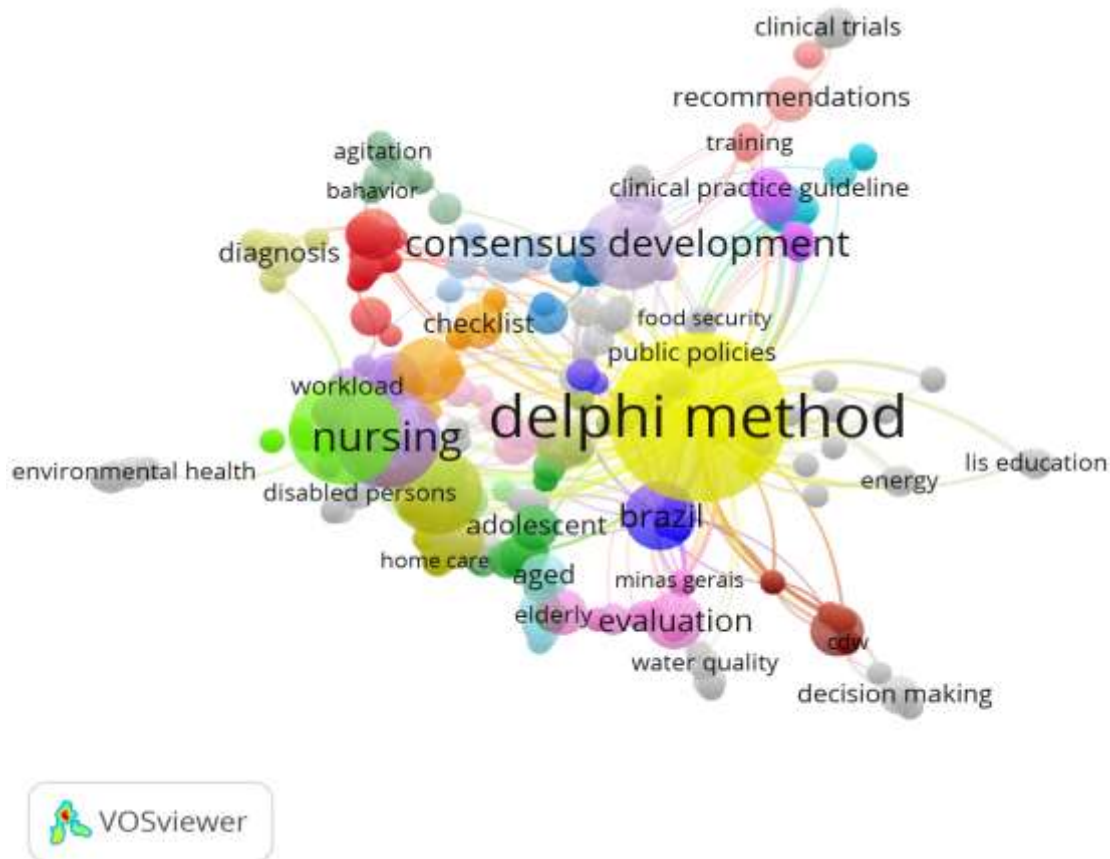


Figure 4. Keywords cluster presented in scientific publications about Delphi method with at least one Brazilian affiliation among authors in Base Scopus.

The Table 3 ranked the ten most frequently occurring keywords identified by VOSviewer. Among these terms were those associated with the object of study, such as “Delphi method”, “Brazil”, and “consensus development”, with half of them having direct interaction with health areas, such as “nursing” and “primary health care”.

Table 3. Most recurring keywords in scientific articles about the Delphi method with at least one researcher with Brazilian affiliation in the Scopus Base.

Position	Keywords	Occurrence
1	Delphi method	54
2	Validation study	21
3	Nursing	19
4	Consensus development	15
5	Primary health care	14
6	Brazil	9
7	Professional competency	8
8	Patient safety	8
9	Evaluation	6
10	Analytical hierarchy process (ahp)	5

When analyzing the indexed keywords, that is, those provided by the database about the respective selected articles, 2019 of them were found in the co-occurrence network, composing a total of 35 clusters, illustrated in Figure 5. The parameter used to generate the map was that of at least one occurrence per term, with clusters of red, green, and blue with 102, 100, and 93 terms, respectively.

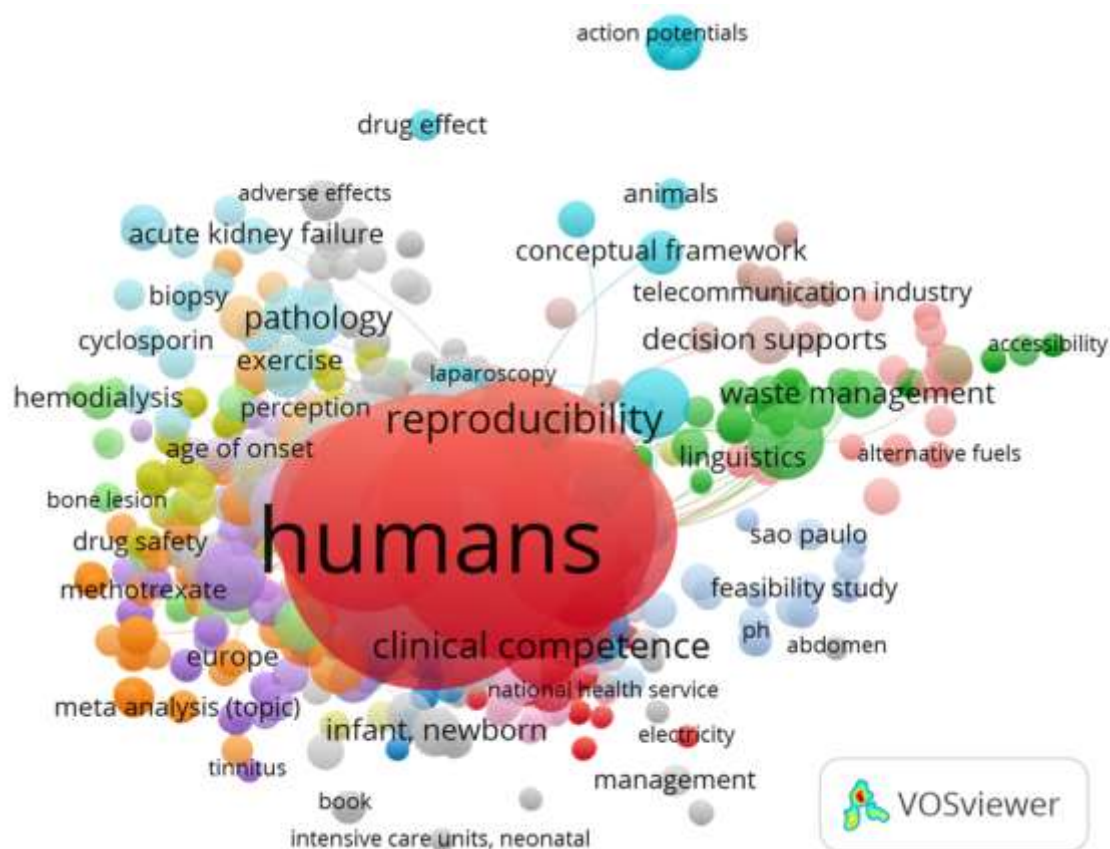


Figure 5. Keywords clustering indexed in scientific publications in Scopus database about Delphi method with at least one Brazilian affiliation among authors.

The analysis of Figure 5 denotes that the red cluster has several noticeable areas related to engineering, urban planning, chemistry, and health. Some of the most recurring terms are present in this cluster, which, by having terms common to all (“Delphi method”, for example), resulted in a diversity of terms from different areas in the same cluster. The green cluster, as far as it is concerned, is strongly linked to environmental issues with keywords such as “waste energy”, “environmental”, and “clean production”, as well as some other health-related keywords. However, the terms present in the blue cluster are predominantly related to the Health Sciences area. Table 4 describes the ten terms related to the most frequently indexed keywords identified by VOSviewer. Among the terms in question, some were seen as “humans”, “female”, and “adult”, which, when associated with health areas, once again reinforce the diffusion of the Delphi method.

Table 4. Most recurring terms in the co-occurrence map of keywords indexed to scientific articles about the Delphi method with at least one researcher with Brazilian affiliation in Base Scopus.

Position	Terms	Occurrence
1	Humans	176
2	Delphi method	156
3	Consensus development	76
4	Brazil	69
5	Female	66
6	Standards	66
7	Male	59
8	Questionnaire	53
9	Priority journal	48
10	Adult	45

4. Conclusion

Based on the quantitative and qualitative analyses performed on data extracted from the Scopus database and involving only scientific articles on the Delphi method application considering the presence of at least one researcher with some kind of affiliation in a Brazilian institution, it was possible to notice a growth in the number of publications over the years, mainly between 2015 and 2018, in almost forty different areas, with a concentration of studies in health. Researchers from the United States, Canada, and the United Kingdom presented a higher number of interactions with Brazilian institutions. Among the ten institutions with the most significant number of publications, the public institutions’ policies have gained prominence in strategic areas such as health, indicating the importance of a more consolidated discussion for strengthening research. Therefore, through the bibliometric analysis presented, it was possible to verify that the application of the Delphi method in research is a widely used and widespread tool in the health field, especially for the discussion of cases involving, above all, decision making, development of indicators and professional skills.

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