

Mapping the Scientific Outputs in the Field of Physiotherapy: A Co-Word Analysis

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Abstract

Introduction: Evaluation and analysis of scientific outputs and between-keywords relationship could provide the investigators with useful information. The aim of this study was mapping of scientific outputs in the field of physiotherapy, with applying the co-word analysis in the ISI Web of Science database. **Methods and Materials:** This study was a scientometric approach using the co-word and network analyses in the field of physiotherapy. Published papers from 2000 to 2018 were reviewed and the results were analyzed by Excel, UCINET, Netdraw and VOSviewer. **Results:** Results showed an increasing trend of scientific outputs in the field of physiotherapy. United States of America (USA) achieved the first rank (7400 documents) followed by England and Australia. Among the Middle East countries, Turkish with 981 documents achieved the first rank while Iran with 235 documents owned the third rank. Regarding the frequently used subjects, the most scientific outputs in the field of physiotherapy were shared with Physical medicine and Rehabilitation, Orthopedic, Neuroscience, Sport medicine, Internal medicine, Surgery, Rheumatology, Health medicine, Pediatrics, and Pulmonology. Results revealed rehabilitation, physiotherapy, exercise, physical therapy, and management based on degree centrality and disability, therapy, physiotherapy, outcome based on both of the betweenness and closeness centrality had the most impact on the network. **Conclusion:** Regarding the trend of scientific outputs, physiotherapy is most related to orthopedic, neuroscience, and pediatric. Moreover, scientific interaction to increase scientific outputs in Iran and other Middle East countries seems to be essential. Additionally, mapping of co-word analyses could provide the policy makers with information regarding the research, key words, and the relationship between key words in the field of physiotherapy. Therefore, they can plan essential and appropriate programs to improve both the quality and quantity of the scientific outputs in this field.

Keywords: Co-word analysis, Network, Physiotherapy, Scientific output

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Introduction

Examination of scientific outputs and its impact on various topics, researchers, and countries has an important goal in scientometric studies. The study of scientific outputs in different fields determines the status and position of that field of science. Therefore, it has an important and effective role in decision making and policy making of that field (1, 2).

The quantity and quality of scientific outputs are examined in scientometric studies. Among these, the number of scientific outputs is considered as an indicator of quantity and the number of citations received is considered as an indicator of quality. The measurement of scientific outputs is based on documents indexed in databases such as ISI Web of Science and Scopus which are the most important citation databases (3, 4).

Nowadays, experts in science assessment studies use different methods and techniques, such as analyses of Co-citation, co-word,

and co-authorship, conduct studies on the structure of knowledge in different fields. The differences and similarities in these techniques leads to achieving new and different information on the studied fields (5).

One method is co-word analysis, in which the most important words or keywords of documents are used to study the conceptual structure of a research field. The co-occurrence of keywords indicates a cognitive relevance between a set of documents. Based on the co-word analysis method, scientific topics can be extracted and the relationship between them can be discovered directly from the thematic content (6). Discovering the conceptual relationships between scientific outputs and topics is a complex scientific field which requires deeper and more studies in that subject area. Subject area analysis has many challenges in every aspect, but conducting studies helps to further strengthen and understand that subject area (7).

The importance of scientometric studies and scientific networks has caused different fields of science to pay attention to it from

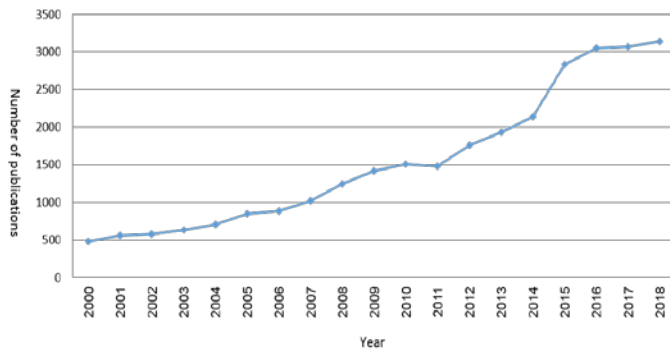


Figure 1. The growth trend of scientific outputs in the field of physiotherapy during the years 2000 to 2018

different aspects. Various researches on co-word analysis and social network analysis have been conducted in different fields including Emami *et al.* on medical and laboratory equipment (7), Mehdizadeh *et al.* on massage therapy (8), Makizadeh and Hazery on addiction (9), Xie on anti-cancer (10), Wu *et al.* on psychiatry (11), Hou *et al.* on life cycle evaluation (12), An and Wu on stem cells (13), and Danel in the field integrative and complementary medicine (14). BaIa and Gupta (15) in the field of neuroscience, Sanz-Casado *et al.* (16) in the field of prion diseases, and Vitzthum *et al.* (17) in the field of scoliosis (density-equalizing) have addressed mapping and reviewing scientific productions.

Given that the focus of most research conducted in Iran and other countries has been on articles published in citation indexes, the present study, on the one hand, evaluated scientific outputs, countries, and subject areas on the ISI Web of Science database, and on the other hand, analyzed co-word analysis and network analysis techniques in the field of physiotherapy.

Today, physiotherapy has a special place in the medical community that can play a significant role in the improvement of the disease along with the medical staff (18). For example, when a patient undergoes surgery, physiotherapy before and after the operation can help accelerate the treatment process (19-21). Moreover, in patients affected by burn events, physiotherapy not only accelerates the recovery of the disease (22), but also it prevents deformation and functional limitations of the affected limbs (23). This indicates that physiotherapy is able to provide significant assistance to the medical staff and therapist for faster treatment of the patient.

Due to the importance of this field and its relationship with other diseases in the scientific development of Iran, conducting this research to evaluate scientific outputs, compare it with the Middle East and Iran, as well as measure various aspects of physiotherapy research of co-word analysis type can be effective in future research and planning for the development of the field of physiotherapy and the optimal allocation of budget and facilities. Finally, the

quantitative and qualitative promotion of physiotherapy products can be achieved. Providing a scientific map of the status of research and knowledge of how to grow and develop in this area is one of the important goals of the present research.

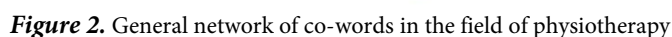
Materials and Methods

The present study was a practical scientometric approach using co-occurrence analysis of words and network analysis technique. The study population was all scientific outputs in the field of physiotherapy in the ISI Web of Science database from 2000 to 2018. The following search strategy was used in this context: TS=(physiotherapy OR "physical therapy" OR "Physical Therapy Modalities")

The keywords were searched in the Topic. Finally, 29,280 documents were saved as plain text. ISI Web of Science database was used to analyze the results for descriptive analysis. The plain text were then converted to readable files by USINET software. USINET and Excel software were used to analyze the centrality indicators and NetDraw and VOSviewer software were used to draw the scientific map.

Centrality analysis is one of the important indicators in social network analysis. Centrality shows the types and number of relationships in a network. Centrality has a broad meaning used to identify and determine the most important and effective people or keywords in a network utilized for analyses such as co-authorship co-occurrence of word.

The types of centers are: 1: Degree centrality: it is the simplest type of center where the value of each node is obtained by the number of adjacent nodes. The number of adjacent nodes is obtained based on the relationships connected to that node. The higher the degree of centrality, the more communication and networks there is, with the more effective that network (24, 25). 2: Betweenness centrality: this index shows the importance of the place of node in the network and transfer of information. This index indicates the frequencies that a node is placed in the shortest path between the other two nodes in the network (24, 25). The high centrality of betweenness indicates the high impact of the node in scientific maps. For example, if a node only establishes a connection between two unrelated clusters, this node will have a very high value of the betweenness of the centrality. In the other word, if a node in the network plays a mediating role between the nodes to transmit information, it will have a high betweenness, and if this node is removed, the flow of information in the network may be stopped (26). 3: Closeness Centrality: A node represents the average length of the shortest paths between that node and other nodes. Nodes with high closeness index have more effective power in the network and play a more central role in the network associated with more accessibility with other nodes (24, 25).



In this research, 25204 keywords were included among which 130 keywords with the highest frequency were evaluated for analysis. Figure 2 shows the co-occurrence analysis of words of the field of physiotherapy in the period 2000 to 2018. This network

Table 3 and Figure 4 show the co-occurrence of words based on the closeness index and the keywords that had the most centrality of closeness. According to the keywords, disability, treatment and physiotherapy had the highest centrality index. According to Figure 4, nodes, which were more central, are

Table 1. The most productive subject areas in the field of physiotherapy

Subject areas	Number of Publications	% of publications
Rehabilitation	8951	30.57
Orthopedics	5169	17.65
Neurosciences Neurology	3543	12.10
Sport Sciences	3401	11.61
General Internal Medicine	3051	10.42
Surgery	2007	6.85
Rheumatology	1361	4.64
Health Care Sciences Services	1294	4.42
Pediatrics	1144	3.90
Respiratory System	1137	3.88

Table 2. Top countries in scientific outputs in the field of physiotherapy in the world and the Middle East from 2000 to 2018

Country	Number of publications	Total (%)	Middle-east countries	Number of publications	Total (%)
United States of America	7400	25	Turkey	981	3.3
England	2870	9.8	Israel	281	0.9
Australia	2800	9.5	Iran	235	0.8
Germany	2043	6.9	Saudi Arabia	179	0.6
Canada	1870	6.3	Egypt	166	0.5
Brazil	1828	6.2	Qatar	45	0.1
Netherlands	1286	4.3	Cyprus	24	0.08
Italy	1048	3.5	Jordan	20	0.06
Spain	1033	3.4	Lebanon	19	0.06
Turkey	981	3.3	Kuwait	18	0.06
France	719	2.4	United Arab Emirates	17	0.05

Table 3. Ranking of topics (keywords) based on the degree, betweenness and closeness centrality

Key word	Degree centrality	Key word	Betweenness centrality	Key word	Closeness centrality
Rehabilitation	5846	Disability	2.98	Disability	100
Physiotherapy	5310	Therapy	2.98	Therapy	100
Exercise	4266	Physiotherapy	2.98	Physiotherapy	100
Physical therapy	3636	Outcomes	2.98	Outcomes	100
Management	3349	Children	2.98	Children	100
Pain	2554	Pain	2.98	Pain	100
Quality-of-life	2253	Exercise	2.98	Exercise	100
Low-back-pain	2104	Physical therapy	2.98	Physical therapy	100
Therapy	2049	Prevalence	2.98	Prevalence	100
Disability	1959	Rehabilitation	2.98	Rehabilitation	100
Outcomes	1762	Low-back-pain	2.98	Low-back-pain	100
Stroke	1746	Management	2.98	Management	100

represented as larger circles. Closeness centrality measures the proximity of a keyword to other words on the network. Nodes with high proximity index had the most effective power in the network. The closer one topic was to other topics, the more important that topic was in that area. Ten closest keywords were: disability, treatment, physiotherapy, treatment outcome, children, pain, exercise, physical therapy, disease prevalence, rehabilitation, low back pain, and treatment management, respectively. These topics and studies have the greatest impact on the network.

Table 3 and Figure 5 show the map of co-occurrence of words based on the betweenness index. The betweenness centrality indicates the importance of the node in terms of the location of that map in the network. In this network, the diameter of the circles indicates the betweenness centrality, which the larger size of the circles, the higher the centrality they

are. Circles of the same color show the similarity of betweenness centrality. Topics and keywords which had the highest betweenness centrality were included: disability, treatment, physiotherapy, treatment outcome, children, pain, exercise, physical therapy, prevalence, and rehabilitation. These subjects act as intermediaries between a large numbers of other nodes. These nodes have the power to increase communication between networks.

Discussion

The present study aimed at providing a comprehensive picture of the status of scientific outputs between 2000 and 2018 using the co-words and network analysis. The continuation of this trend depended on various factors such as the interaction of Iranian

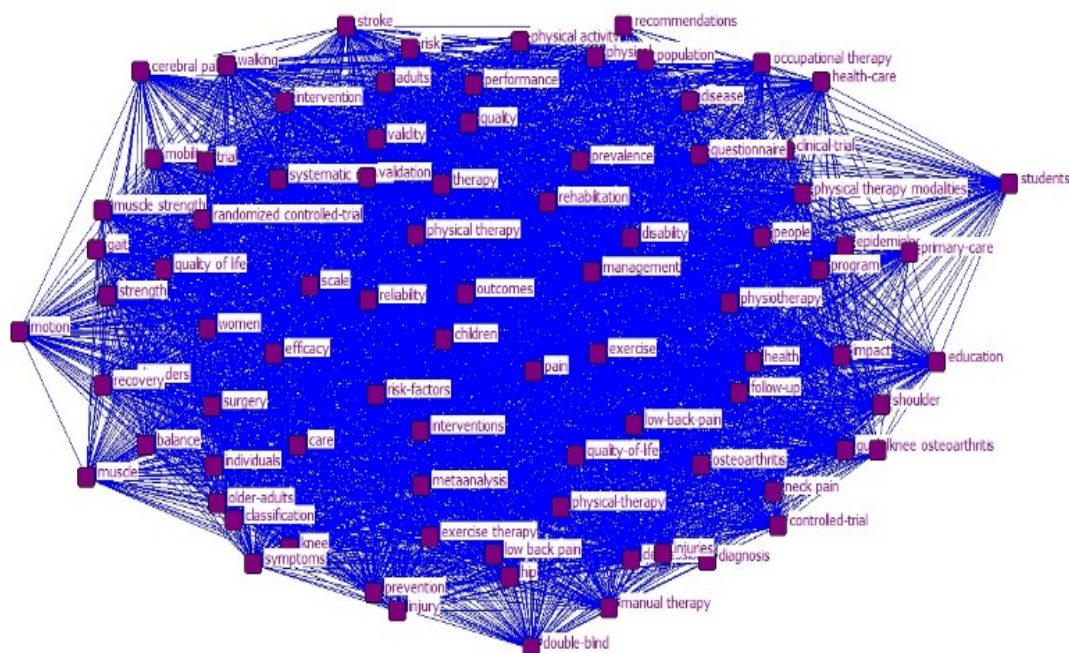


Figure 3. Co-word analysis network of physiotherapy based on degree of centrality

researchers with each other and with researchers from other countries. Data analysis showed that the growth of scientific productions in the field of physiotherapy has been increasing, especially in recent years, so that the number of articles in the last 5 years (2014-2018) has grown more. In general, it can be said that the production of science in the field of medical sciences and related fields is sharply increasing the research budget in the fields of research, holding the way of writing articles, increasing familiarity with databases and English language.

The results of the present study showed that the United States and the England accounted for 25% and 9.8% of the total scientific outputs in the field of physiotherapy. Erfanmanesh in a research examined the regional and global position of the Islamic Republic of Iran in the production of epidemiological science. They concluded that the United States was placed as the first rank and the England as the second rank (27). The results of that study regarding the countries of the world are in line with the present study. Among the Middle Eastern countries, Turkey was in the first rank with 3.3% of the total scientific outputs of this field and Iran was in the third rank. Shirshahi *et al.* (28) in the field of surgery and Emami *et al.* (29) in the field of adrenal showed that Iran was placed as the third rank in scientific outputs, which is in line with the present study but not in consistent with the studies of Erfanmanesh in the field of epidemiology (27) and Emami in the field of diabetes and thyroid disease (30, 31) regarding the output of Middle Eastern countries.

Various studies in the field of physiotherapy have been performed with a scientometric approach. Among them, in a scientometric study based on evidence-based, rehabilitation physical factors were studied among breast cancer patients. 748 studies from 1980 to 2018 were analyzed. 261643 patients used the physical medical factors in rehabilitation. The results showed that physical factors were related to the actual proven effect, physical exercise, water-based physical exercise, and compression therapy (32). In another study, through the investigation of evidence-based scientometrics, the field of physiotherapy and rehabilitation of patients with coronary heart disease was examined. The results showed that clinical effects and potential mechanisms in the performance of physical therapy were used in the patients' treatment with coronary heart disease. Attention to research based on evidence related to doses of physical exercise, health- promoting gymnastics, and other methods of physiotherapy was effective in treating patients with various forms of coronary heart disease (33). Cruz *et al.* also analyzed Brazilian physiotherapists based on scientometric studies. The results showed that 9 institutions in Brazil were active in the field of physiotherapy. There were several programs for PhD physiotherapists in Brazil. Most programs were concentrated in the southeast and there were heterogeneous characteristics related to the duration of the programs, the nature of the institution, or the affiliation of the professors.(34). That type of study is based on scientometric approach, which is in line with the present study in terms of subject matter. However, according to the analyses conducted, it contradicts with the present study.

with high degree of centrality have an effective and important role in network expansion (35). According to betweenness centrality index, disability, treatment, treatment outcome, physiotherapy in children, pain, exercise, physical therapy, disease prevalence, and rehabilitation were in higher ranks. The betweenness centrality of a node indicates the frequency that a node is located in the shortest pathway between the other two nodes in the network. Meanwhile, these topics and keywords act as mediators in the scientific interactions. The mediator nodes make the network more cohesively and connect the nodes and clusters (35).

In terms of closeness index, disability, treatment, treatment outcome, physiotherapy in children, pain, exercise, physical therapy, prevalence, rehabilitation, low back pain, and disease control had higher priorities. Closeness index is measures in terms of length of path. Nodes, which connect to the other nodes with a shorter path, are in a higher position and have generally more effectiveness in the network. These topics and keywords are as a bridge in scientific interactions (35). The present study evaluated the micro-indicators of the network, the degree centrality, betweenness and closeness indicators. In general, the co-word analysis showed that the keywords of rehabilitation, physiotherapy, exercise, physical therapy, disability, disease control and management, pain, back pain, treatment outcome, and physiotherapy in children were important topics in the field of physiotherapy as well as the most effective keywords in increasing and improving the growth trend of scientific outputs in this field. One of the most important treatments in physiotherapy is exercise and massage therapy. Mehdizadeh *et al.* (8) examined the science of massage therapy considering co-occurrence of words. The results showed that the science of massage therapy map consists of 11 main topics, which are: 1. general and important topics (such as complementary and alternative medicine, traditional medicine, cancer, depression and anxiety, music therapy, diets, *etc.*), 2. cardiovascular, 3. herbal medicines and extracts, 4. body, muscles, connective tissues, and joints, 5. infants, baby and pregnant women, 6. skin, eyes, and mouth, 7. prostate, 8. digestion, 9. facial and nerves, 10. pelvis, and 11. lymph. The results of this study in terms of important therapies in physiotherapy, such as massage therapy, are in consistent with the present study, where treatment and treatment outcomes were one of the important issues in the analysis of centrality indicators (8).

It is suggested that policy makers and planners in this field should interact with other specialized disciplines including orthopedics, neuroscience and neurology, sports, internal medicine, surgery, rheumatology, health services, children, and respiratory system which have the main thematic relationship with physiotherapy. The results based on the analysis of centrality indicators and superior keywords showed that researchers should consider conducting joint projects, holding international seminars

and conferences with other disciplines related to the field of physiotherapy to help increase the scientific outputs of this field. In addition, scientific outputs in the field of physiotherapy indexed in other citation databases such as Scopus or Cochrane using other bibliographic analyzes including citation analysis or co-authorship analysis should be conducted.

Conclusion

The findings showed that the growth trend of scientific outputs in the field of physiotherapy is increasing which is one of the advantages of this study. However, in terms of ranking of Iran in the third place, Iran needs to increase its scientific outputs and publish articles in international journals in order to improve its ranking in this field. International cooperation with top countries, interaction with related specialized disciplines, holding international congresses, and access to the latest important achievements in the field of physiotherapy are of particular importance.

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Conflict of interest:

None

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Authors' contributions:

All authors made substantial contributions to the conception, design, analysis, and interpretation of data.

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