

Semantic Network Analysis of Physiotherapy Research: Based on Studies Published in the Journal of IAPTR

Background: Physical therapy has been widely studied in various fields, however, the academic trends and characteristics has not been systematically analyzed. Semantic network analysis is used as an approach for this study.

Objective: To explore academic trends and knowledge system in the physiotherapy research in the Journal of International Academy Physical Therapy (J of IAPTR)

Study design : Literature review

Method: Semantic network analysis was conducted using the titles of 272 articles published in the Journal of IAPTR from 2010 to 2019.

Results: Frequency analysis revealed following most frequently used key words; Stroke (27 times), Balance (21 times), Elder (13 times), Forward head posture (FHP, 11 times), Muscle activity (9 times). The relationship between the presented keywords is divided into six subgroups (FHP and pain, walk and quality, elder and balance, stroke and apoptosis, muscle strength and function) according to their correlation and frequency to be used together.

Conclusion: The study is considered to be of help to researchers who want to identify research trends in physiotherapy.

Key words: *Physical therapy research, Journal of International Academy Physical Therapy, Semantic network analysis,*

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INTRODUCTION

Physiotherapy is a treatment that can include the use of hyperthermia, electrotherapy, phototherapy, hydrotherapy, mechanical and instrumental therapy, massage, functional training, body alignment exercises, rehabilitation training, and the application of medicine that are required for these therapies.¹ The aim of physiotherapy is to improve, maintain, and recover motor and functional abilities of patients and help people whose motor and physical functions are challenged by aging, injury, disease, disability, or environmental factors.¹ Recently, at-home physiotherapy,² task-oriented training,³ and functional games⁴ have been applied to the disabled who stay at

home, stroke patients, and knee replacement patients to improve their daily activities, prevent depression, and increase their quality of life.

Although there have been numerous studies on various domains and subjects of physiotherapy, there are few studies that have systematically analyzed the trends and characteristics of these studies. To achieve this, semantic network analysis is used as a new approach. This approach is one of the important analytical techniques of informatics, which involves extracting keywords from a selection of literature with a specific subject domain and calculating the co-occurrence of each pair of keywords and their associations to create and analyze a network.⁵ Furthermore, it not only calculates the frequency of keywords but

also visualizes the structures and patterns of the organic relationships between each keyword.⁶

Network analysis methodology has recently been actively studied in various fields, such as educational sociology, social science, and library and information science. Kim⁽²⁰¹⁸⁾ reported that the network analysis methodology can be used to understand the research trends of music education and provide the direction for future studies.⁶ In addition, Jo et al.⁽²⁰¹⁹⁾ have shown that the network analysis methodology can also be used to provide basic data for future railroad track installments by analyzing the changes in characteristics of the railway traffic network and the alterations in status between cities.⁷ Furthermore, according to No (2019), the network analysis methodology can provide concepts of central connectivity in the research of children with developmental delays, and the direction of future studies.⁸

As studies using the network analysis methodology are rare in the field of physiotherapy, it is difficult to understand its research trends and characteristics. Therefore, the first aim of this study is to determine the major keywords presented in the papers published in the Journal of International Academy Physical Therapy (J of IAPTR) and to analyze the characteristics of the overall network structure. The second aim is to determine how many subcategories the keywords presented in the papers published in J of IAPTR can be divided into and to preliminarily analyze their characteristics in order to understand the correlation among physiotherapy studies and their research trends as well as to provide the direction for future studies.

SUBJECTS AND METHODS

Subjects

In this study, the keywords from 273 papers published in the initial issue (Vol 1, Issue 1, 2010) to the current issue (Vol 10, Issue 2, 2019) of (J of IAPTR) were selected as subjects. Since the keywords presented in each paper were chosen by the authors to best represent the entire study, it was assumed that their analysis would lead to the understanding of the overall research trends and characteristics. A total of 1,091 keywords were presented and 741 of these were used for the final analysis after excluding overlapping words. The keywords presented in each paper ranged between 2 and 8 with the average number of 4.

Semantic network analysis process

The semantic network analysis process can be divided into four steps. The first step is creating data required by the KrKwic program.⁹ To achieve this, keywords presented in each paper were collected and a total of 741 keywords were selected as units for the analysis. The second step is choosing major keywords for the analysis. The major keywords with a frequency higher than a certain threshold that are most suitable for deriving clarity and implication of the study results are selected through a series of preliminary analyses. Therefore, our study also selected major keywords with frequency sufficient for clarifying study results and properly deducing implications through preliminary analysis. Forty keywords were

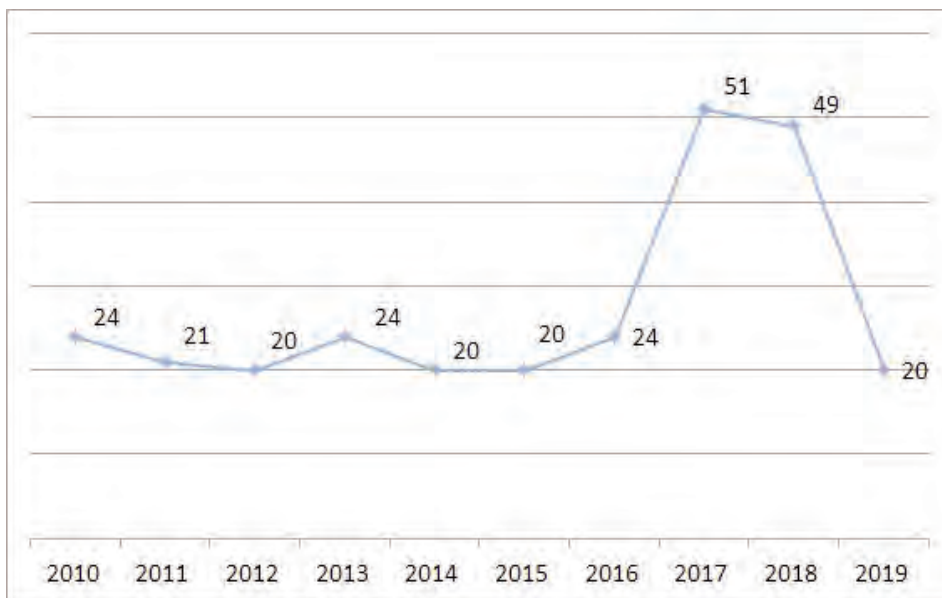


Fig. 1. The number of articles published by (J of IAPTR)

presented 4 times or more (22,5%), and 61 keywords were presented 3 times or more (28,5%). For the comprehensiveness of the study results, the 61 keywords with a frequency of 3 or more were selected as major keywords for the analysis. There were 583 keywords that were presented one time (53,4%), indicating various topics which have been covered by numerous studies. The third step is creating matrices between the major keywords using the KrKwic program. To briefly describe this process, if the keywords a, b, c, and d are presented in paper A, the following 6 combinations of co-occurrence can be obtained: (a-b), (a-c), (a-d), (b-c), (b-d), and (c-d). When the keywords a, c, and e are presented in paper B, the weighted value of the co-occurrence combination (a-c) is increased, as well as the centrality of the keywords a and c. If the keywords b and f are presented in paper C, the co-occurrence combination (b-f) is generated. In this case, f is only linked to b, and b serves as a mediator between f and other keywords (a, c, d, and e).¹⁰ Repeating this process for the entire range of keywords presented in every paper produces the matrix data. As 61 keywords were selected in this study, 61×61 matrix data were created. The fourth step is conducting mathematical analysis of the matrix data obtained from the previous step using UCINET and visualizing these data using NetDraw.¹¹ To summarize, the KrKwic program was used to calculate the frequency of keywords and create matrices of their co-occurrence, and these matrix data were used for network analysis and visualization using UCINET and NetDraw.

RESULTS

Subjects

To examine the keywords frequently presented in J of IAPTR, their frequency and degree centrality were analyzed. The degree centrality indicates the sum of the number of nodes linked in the network and allows the determination of keywords that serve as a hub in the entire network.¹² In other words, the keywords with high degree centrality indicates its frequent appearance with other keywords, which suggests their role in the overall network structure.

The results from the frequency analysis showed that the keywords stroke (27 times), balance (21 times), elder (13 times), FHP (11 times), and muscle activity (9 times) appeared most frequently. In addition, the degree centrality analysis also showed that stroke (.093), balance (.058), elder (.045), and FHP (.011)

played a critical role in the overall network structure. These results suggest that a number of studies published in J of IAPTR focused on the keywords stroke, balance, elder, and FHP. Figure 1, shows the visualization of the links between keywords based on the Spring Embedded algorithm. This algorithm puts keywords showing high co-occurrence with other keywords in the center of the overall network structure, and the keywords with strong associations are placed in proximity.¹³ In addition, the lines between two keywords are thicker when the frequency of their co-occurrence is high.

Subgroup analysis

A subgroup analysis was conducted in order to determine the number of dimensions each link between the keywords is divided into. The optimal subgroups were explored based on their modularity with the application of the Newman Community Detection (NCD) algorithm.¹⁴ Here, the modularity refers to the level of clear categorization of groups as the components of a subgroup do not overlap with those of other groups and the number of links within a group is larger than the number of links between groups. The maximum value is 1. In this study, categorization of 6 subgroups was most desirable when the modularity was .505.

Group 1 includes the following 18 keywords: forward head posture (FHP) muscle activity, kinesio taping, pain, range of motion, joint mobilization, pulmonary function, muscle tone, physical therapy, stren, posteroanterior mobilization, EHSA, stiff, stretch, kinematic taping, body composition, grip stren, and low back pain. Among these keywords, FHP, EHSA, stiff, muscle tone, and pain had important statuses within the network. These were in regard to studies examining the cause and results of turtle neck posture, and group 1 was thereby named FHP and pain.”

Group 2 includes the following 9 keywords: walk, quality of life, cerebral palsy, muscle fatigue, proprioceptive neuromuscular facilitation, AODL, COP, electromyograph, and swiss ball. Among these keywords, walk, quality of life, and muscle fatigue had important statuses within the network. These were in regard to studies on the association between walking and quality of life, and group 2 was thereby named “walk and quality of life.”

Group 3 includes the following 5 keywords: forced vital capacity, fatigue, forced expiratory volume in one second, breathing exercise, and respiratory function. Among these keywords, forced vital capacity, fatigue, forced expiratory volume in one second, and breathing exercise had important statuses within the

Table 1. The keywords frequently presented in J of IAPTR,, their frequency and degree centrality were analyzed

Keyword	Frequency	Degree centrality		Keyword	Frequency	Degree centrality	
		value	Rank			value	Rank
stroke	27	.093	1	streth	4	.013	25
balance	21	.058	2	posteroanterior mobilization	4	0	59
elder	13	.045	3	balance ability	4	.011	35
FHP*	11	.045	3	EHS*	4	.013	25
muscle activity	9	.011	35	AODL*	4	.008	44
walk	7	.024	10	fatigue	4	.011	35
kinesio taping	6	.019	16	manipulate	4	.003	54
QOL*	6	.019	16	tap	4	.011	35
pain	6	.024	10	stiff	4	.016	19
NEES*	6	.04	6	joksamri	3	.029	8
proprioception	6	.013	25	stretch	3	.005	47
muscle stren	6	.013	25	FEV1	3	.021	13
ischemia	6	.045	3	kinematic taping	3	0	59
ROM*	6	.016	19	COP*	3	.005	47
static balance	5	.011	35	EMG	3	.003	54
joint mobilization	5	.013	25	necross	3	.024	10
cerebral palsy	5	.013	25	body composition	3	0	59
FVC*	5	.032	7	grip stren	3	.003	54
mobilization	5	.008	44	LBP*	3	0	59
pulmonary function	5	.013	25	self stretching	3	.005	47
dementia	5	.016	19	group exercise	3	.013	25
flexibility	5	.011	35	LSE*	3	.005	47
muscle tone	5	.011	35	LEA*	3	.016	19
resistance exercise	5	.019	16	breathing exercise	3	.005	47
FESA*	4	.021	13	swiss ball	3	.003	54
gait	4	.011	35	respiratory function	3	.016	19
physical therapy	4	.005	47	depression	3	.013	25
cognitive function	4	.016	19	FAI*	3	.008	44
muscle fatigue	4	.011	35	apoptosis	3	.026	9
electromyography	4	.003	54	SDT*	3	.005	47
PNF*	4	.021	13				

FHP=Forward Head Posture, QOL=Quality of Life, NEES=Needle Electrode Electrical Stimulation, ROM=Range of Motion, FVC=Forced Vital Capacity, FESA=Funcional Electrical Stimulus, PNF=Proprioceptive Neuromuscular Facilitation, EHS=Ejenth-Hamberg Stretching, AODL=Activities of Daily living, COP=Center of Pressure, LBP=Low Back Pain, LSE=Lumbar Stabilization Exercise, LEA=Lower Extremities Activit, FAI=Functional Ankle Instability, SDT=Spinal Decompression Therapy

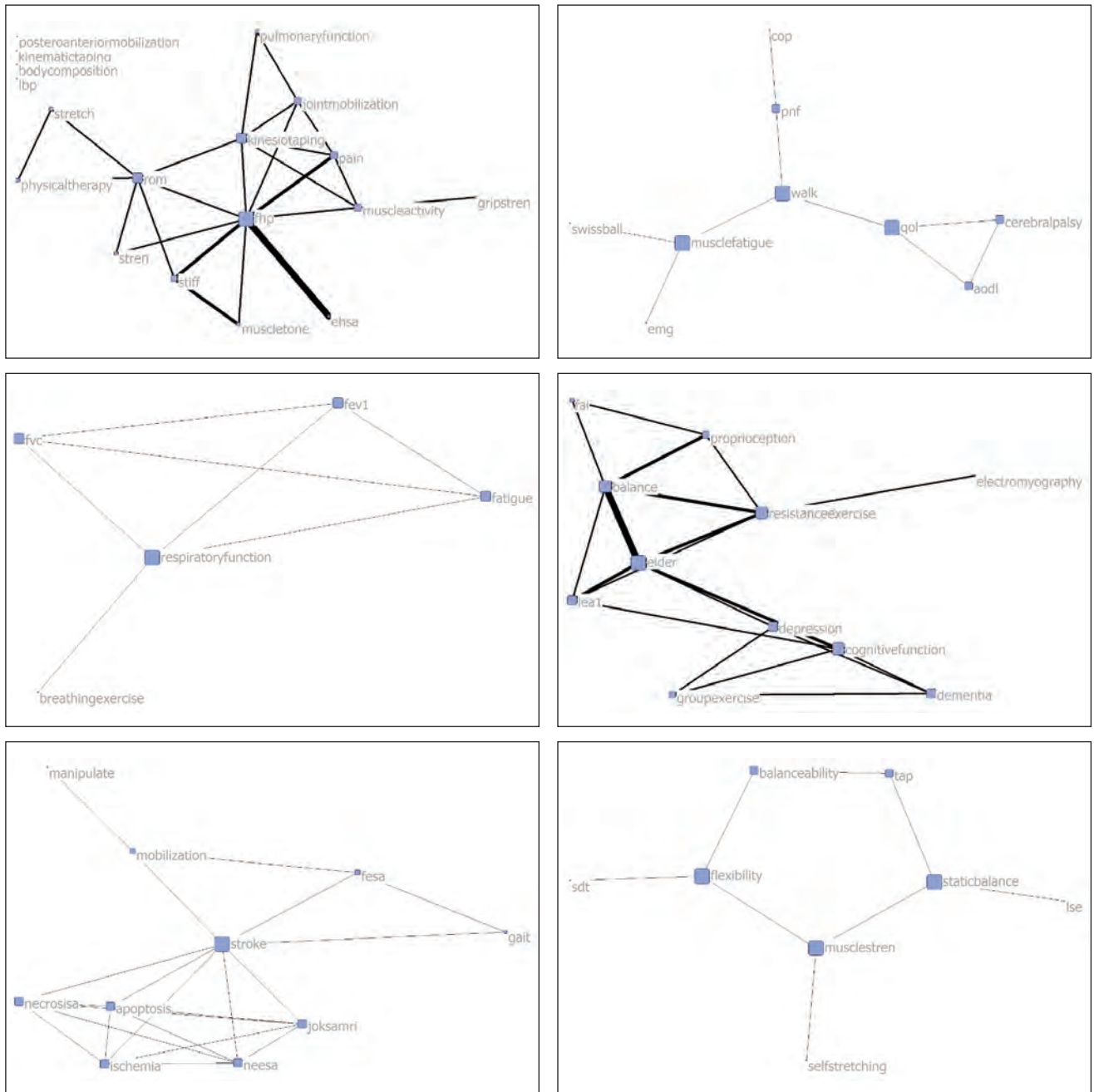


Fig. 3. The visualization of the network structure for each group.

DISCUSSION

Physiotherapy is a type of medical service that treats and manages pain either through massage and manipulation with bare hands or by applying heat, light, electromagnetic waves, or external force non-invasively to the nerves, muscles, and skeletal system for functional recovery and rehabilitation in patients with an impaired musculoskeletal system. The goal of physiotherapy is to overcome functional decline in motor skills caused by aging, injury, disease, or environmental factors and to consistently improve motor ability and functionality by developing fitness programs promoting health and physical activity. Therefore, analyzing current trends and outcomes of physiotherapy research is crucial to promote national health.

In this study, a new methodology of semantic network analysis, which has not yet been adopted in the field of physiotherapy, was used to analyze the associations between keywords presented in 273 papers. From this analysis, the major keywords serving as a hub of the network and the associations between each keyword were examined.

Results from the frequency analysis showed that stroke (27 times), balance (21 times), elder (13 times), FHP (11 times), and muscle activity (9 times) were the keywords with highest frequency. Results from the degree centrality analysis also showed that stroke (.093), balance (.058), elder (.045), and FHP (.011) played a critical role in the overall network structure.

Due to recent advancements in medicine and the economy, life expectancy is increasing and hence the percentage of elderly people among total population is also growing. The number of people aged 65 or older accounted for 13,1% of the total population in 2015, which is an increase of 2 million people in comparison to 10 years previously (2005), and this is expected to increase up to 40% by 2060. Moreover, the old age dependency ratio was 17,9 in 2015 which indicates 5,6 working age individuals (age 15–64) supporting one elderly person. It is predicted that 2,6 working age individuals will be supporting one elderly person in 2030 (National Statistical Office, 2017) and the cost for elderly care will also increase. The incidence of stroke, a disease which frequently occurs at old age, is showing a gradual increase and the number of deaths caused by stroke is also increasing.¹⁴ Hence, rehabilitation for motor, sensory, and cognitive impairment caused by brain disease is essential, in particular language impairment is a critical problem in today's society with the fast-growing elderly population.^{15,16} A rapid increase of THE elderly population

is expected to cause various problems. Therefore, numerous studies are being conducted on the potential outcomes and problems resulting from an increasing elderly population.

Amidst structural changes that today's society is undergoing, including industrialization and informatization, the lifestyle of people now involve spending a huge amount of time sitting due to the extensive use of computers for work and the development of smartphones.^{17,18} The muscle imbalance and joint stress caused by such abnormal posture can lead to chronic structural changes of the musculoskeletal system when continued,¹⁹ and more people are complaining of pain and disability of the neck and shoulder areas.²⁰ The frequency of FHP was not as high as other keywords, but the fact that its degree centrality was fairly high suggests that it is used for comparison in other studies with different subjects.

In this study, semantic network analysis, which has not yet been adopted in other fields related to physiotherapy, was used to analyze the associations between keywords that were presented in a total of 273 papers. There were 61 keywords that were used 3 times or more, and the total frequency of these keywords was 313. Stroke showed the highest frequency of 27 times, followed by balance (21 times), elder (13 times), FHP (11 times), muscle activity (9 times), and walk (7 mes). The degree centrality analysis showed that the top 6 keywords were placed in the center of the overall network structure and their frequencies were also high. This indicates that research related to physiotherapy mainly focuses on geriatric disease and daily activities.

This study systematically analyzed physiotherapy-related research by determining the main keywords used in these studies and their associations. However, our study has the following limitations. Firstly, the analysis was limited to the keywords presented in the paper. Expanding the scope of the study to include titles and abstracts of papers may lead to trends and characteristics of physiotherapy research that are different from the results here. Secondly, subjective views from the researchers could not be excluded when unifying similar keywords during the extraction of keywords. Thirdly, as the physiotherapy research analyzed in this study was limited to the studies published in J of IAPTR, the overall field of physiotherapy was not accurately reflected. Therefore, future studies should include papers published in other journals covering all issues of physiotherapy in the analysis.

CONCLUSION

In this study, the keywords presented in 273 papers from the initial issue (Vol 1, Issue 1, 2010) to the current issue (Vol 10, Issue 2, 2019) of *J of IAPTR* were selected as study subjects and examined using semantic network analysis. The results are as follows. Results from the frequency analysis showed that the keywords that appeared the most were stroke (27 times), balance (21 times), elder (13 times), FHP (11 times), and muscle activity (9 times). The links between the presented keywords were divided into 6 subgroups: FHP and Pain, walk and quality, elder and balance, stroke and apoptosis, and muscle strength and function.

The present study has examined the trends of physiotherapy-related research which can provide a guideline for future studies and new study designs. Through meticulous analysis of keywords with relatively low frequency, the research domains that have been overlooked despite their importance and necessity can be determined and analyzed more actively.

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