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Trends in Infertility Research in South Korea: Text Network Analysis and Topic Modeling Analysis

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Abstract

This study was conducted to identify the research trends and key concepts of fertility-related research published in Korea. For the analysis of this study, target papers published from 2014 to 2023 were collected by entering the keywords of 'infertility' or 'Sterility'. 155 papers were analyzed. The co-occurrence network of key words was developed and analyzed, and the research trends were examined through topic modeling of the LSD, and visualized word cloud and sociogram were used. The most common key words across the 155 research studies were infertility, infertile women, assisted reproductive technology, women, and depression. Highly connected keywords were the same as the top 5 most frequent keywords, and highly mediated keywords were fertility, infertile women, assisted reproductive technology, bioethics, and low birthrate. The four topics analyzed were identified as 'infertile women's experiences and care,' 'psychological problems of infertile women,' 'Korean medicine approaches to infertility,' and 'low fertility and fertility procedures'. Based on the results of this study has identified themes and trends in infertility research over the past decade and suggests that future research should focus on intervention studies and policy development for psychological issues related to infertility.

Keywords: *Infertility, Research trend, Text network analysis, Topic modeling*

1. Introduction

The total fertility rate was 0.65 in the fourth quarter of 2023, the lowest since 4.53 in 1970, according to Statistics Korea, and the proportion of elderly mothers aged 35 or older was 36.3%, up 0.6% from the previous year [1]. The number of infertile couples who want to give birth but are unable to do so is increasing due to the increase in the number of elderly mothers, and the number of infertile people in Korea and the medical expenses incurred by them are also increasing rapidly [2].

In order to solve the problem of infertility, not only financial support, but also psychological problems such as depression and stress caused by infertility should be managed in an integrated manner [3], and related research should be continued. A recent study suggests that most infertility research in Korea has focused on psychological experiences, and only a few studies have tested the effectiveness of counseling to solve practical infertility problems [4]. Therefore, there is a need to explore whether infertility research is being conducted

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from a variety of perspectives, including policy, psychosocial, and economic. Among the various factors associated with infertility, it is necessary to identify lifestyle factors that can lead to practical changes [5], but studies published in Korea have failed to include a variety of variables other than medical examination results and infertility diagnosis [6]. In addition, there is a lack of research analyzing the health effects of infertility treatments, which have recently been expanded with state support to address infertility [7], suggesting the need for more research.

When people are diagnosed with infertility, they seek information. Previous studies have shown that infertile people often turn to accessible online sources for relevant information, which poses a serious problem for the reliability of information [8]. This indirectly points to the lack of reliable research. In addition, a recent policy report emphasized the need to provide quality information based on infertility treatment experiences and case studies, and suggested conducting related research [9].

Advances in medical technology, artificial intelligence, and digital services are changing the way we manage infertility. Big data-based fertility fitness measurement and coaching services tailored to individual characteristics have increased the likelihood of pregnancy in preparation for pregnancy or infertility treatment [10]. Especially in Korea, the health insurance coverage standards for assisted reproductive technologies for infertility treatment are gradually expanding and being applied [11], so there is a need for research on objective performance verification.

Based on the above, as infertility-related research accumulates, it is necessary to analyze the infertility-related research topics that have been conducted so far to see which research topics are focused and to explore which topics need more research. Therefore, this study aims to identify trends in the core topics of infertility-related research published in the past decade using text network analysis and topic modeling, and to explore the structure of infertility-related research topics by visualizing the topics with sociograms. The results of the analysis of research topics will provide a basis for suggesting the direction of infertility problem management.

2. Method

2.1 Study design

This study is a content analysis study that extracted key words from academic studies published in Korea related to infertility and derived results using the methods of network analysis (analyzing betweenness and mediation centrality using keywords) and topic modeling.

2.2 Research procedure

This study consisted of collecting academic research data and extracting key words using bibliographic information, creating and analyzing co-occurrence networks, and analyzing topic modeling.

2.2.1 Academic research data collection

The bibliographic information was collected from Korea Citation Index (KCI), Research Information Sharing Service (RISS), Scholar, and DBpia, among other databases. The search scope was domestic academic papers, keywords were 'infertility' or 'sterility', and the bibliographic information of all identified papers was extracted into an excel file for the 10-year period from 2014 to 2023. Excluding the duplicates, the final number of extracted papers was 9 in 2014, 16 in 2015, 16 in 2016, 11 in 2017, 13 in 2018, 16 in 2019, 21 in 2020, 16

in 2021, 19 in 2022, and 24 in 2023, for a total of 201 papers.

For the analysis of the data, we organized the Korean keywords, and in cases where only English keywords were provided, we supplemented the Korean keywords by finding the original files of the papers, and excluded the six papers that did not provide the keywords. In the end, 155 papers with Korean keywords were used for the analysis. The identified keywords were subjected to preprocessing of the analysis data, such as setting designated words for network analysis [12].

2.2.2 Create co-occurrence networks and statistical analysis

The keyword data organized through the preprocessing process was converted into a 1-mode matrix using NetMiner (version 4.4) and analyzed through the frequency of occurrence of keywords. Next, the meaning was derived by betweenness centrality, which checked the number of nodes directly connected to the key words with high frequency of appearance, and mediational centrality analysis using the shortest distance between the key words. Finally, we analyzed the types of studies by analyzing the key words of the studies conducted over the past 10 years using the LSD method of topic modeling, and presented the data visualized as word clouds and sociograms.

3. Results

3.1 Relationships among key words in infertility research

There were 334 key words in 155 research papers on infertility topics published in the last 10 years. When analyzing the frequency of occurrence of key words, the top 15 are shown in Table 1. The frequency of ‘infertility’ was 90 times, ‘infertile women’ was 29 times, ‘assisted reproductive techniques’ was 20 times, ‘female’ was 18 times, and ‘depression’ was 15 times. The word cloud generated using the frequency of occurrence of the key words is shown in Figure 1.

Figure 1. Word cloud using appearance frequency

The betweenness centrality analysis of the key words presented in the analyzed studies showed that the key words ‘infertility’, ‘infertile women’, ‘assisted reproductive techniques’, ‘women’, and ‘depression’ were identified as highly influential, and the order of their frequency was the same as the order of their ranking from 1 to 5. The highest ranking keywords in the mediational centrality analysis were identified as 'infertility', 'infertile women', 'assisted reproductive techniques', 'bioethics', and 'low birthrate' (Table 1). Key words with high centrality values indicate strong connections to other topics and potential for expansion, making them key topics to consider for further research.

Table 1. Relationships between key word

No	Keyword	Frequency	Keyword	Betweenness centrality	Keyword	Mediational centrality
1	Infertility	90	Infertility	0.545	Infertility	0.610
2	Infertile women	29	Infertile women	0.219	Infertile women	0.213
3	Assisted reproductive techniques	20	Assisted reproductive techniques	0.167	Assisted reproductive techniques	0.113
4	Women	18	Women	0.122	Bioethics	0.058
5	Depression	15	Depression	0.108	Low birthrate	0.048
6	Quality of life	12	Low birthrate	0.09	IVF	0.042
7	Stress	10	Quality of life	0.087	Depression	0.040
8	IVF	10	Stress	0.076	Women	0.035
9	Chinese Medicine	9	IVF	0.07	Artificial insemination	0.035
10	Pregnancy	8	Pregnancy	0.067	Quality of life	0.028
11	Artificial insemination	7	Bioethics	0.061	Chinese Medicine	0.025
12	Low birthrate	7	Chinese Medicine	0.061	Policy	0.024
13	Chinese medicine treatment	7	Artificial insemination	0.047	Infertile women	0.023
14	Sterility	6	Policy	0.044	Stress	0.021
15	Infertility stress	5	Surrogacy	0.041	Infertility treatment	0.020

3.2 Trends in fertility studies

Topic modeling analysis was conducted to analyze the trend of fertility-related research topics conducted in Korea over the last 10 years from 2014 to 2023. The number of topics to be extracted was set to four with the advice of three university professors with experience in topic modeling analysis, and topic names were set based on the key words analyzed (Table 2).

Table 2. Research trends by topic modeling analysis

Topics	Frequency n (%)	Top keywords (ranked 1-5)
1. Infertile women's experience and care	44 (28.4)	Infertility, Women, Assisted reproductive techniques, Qualitative study, Nurse
2. Psychological problems of infertile people	39 (25.2)	Infertile women, Depression, Infertility, Quality of life, Stress
3. Chinese medicine approach to infertility’	39 (25.2)	Infertility, Chinese Medicine, Chinese medicine treatment, Sterility, Infertile women
4. low birthrate and infertility procedures	34 (21.9)	Infertility, Artificial insemination, Assisted reproductive techniques, IVF, Low birthrate

The main keywords included in the four themes analyzed are shown in Table 2, and the themes are named as ‘infertile women's experience and care’, ‘psychological problems of infertile people’, ‘Chinese medicine approach to infertility’, and ‘low birthrate and infertility procedures’. A visual representation of the relationship between the main key words in the four topics is shown in Figure 1.

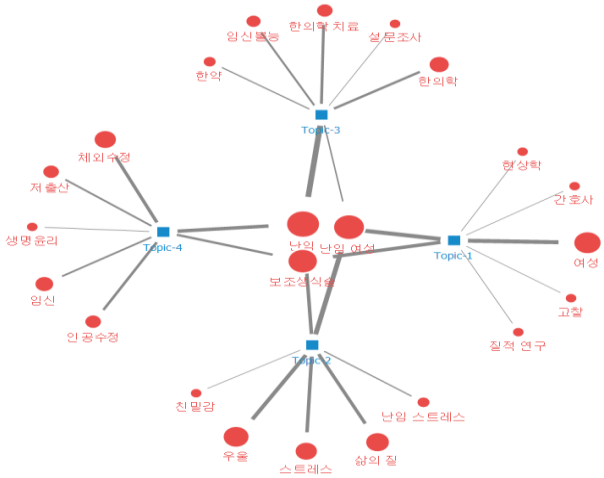

Figure 2. Sociogram using topic modeling

4. Discussion and conclusion

This study analyzed the key words in infertility research published in the last 10 years and presented the results of centrality and research trends in four themes. The detailed meanings of these findings will be discussed.

In Korea, about 9 to 24 studies related to infertility were published annually. Although the need to conduct research that comprehensively explores various aspects of infertility has been suggested [13], it is thought that research is being conducted to a limited extent due to difficulties in selecting and accessing subjects. In addition, this study was limited to articles published in domestic journals, so it was not possible to determine whether the number of studies reported in overseas journals has increased.

The top five recurring key words with high betweenness centrality across the 155 studies analyzed in this study were ‘infertility’, ‘infertile women’, ‘assisted reproductive techniques’, ‘women’, and ‘depression’. These findings show that infertility is focused on women rather than couples, and that assisted reproductive technologies and depression are among the psychological issues studied in women. Infertility is a challenge experienced by both men and women and needs to be studied in both genders [4], and previous studies have reported that infertile men experience social problems that are directly related to psychological distress, which can escalate into larger problems [14]. Future research should include a broader range of physical and psychological issues, rather than limiting infertility to women.

The top five key words in the mediational centrality analysis of this study are 'infertility', 'infertile women', 'assisted reproductive techniques', 'bioethics', and 'low birthrate', and 'bioethics' and 'low birthrate' are key words that appeared higher than the ranking in the frequency and connection centrality analysis. Therefore, it can be interpreted that the topics of bioethics and low birthrate can be prioritized to expand the research area on infertility. As the increase in infertility has been suggested as one of the main causes of the declining birthrate, and as previous research [15] explains that the crisis caused by the declining birthrate is due to a

negative perception of life, emphasizing only rights without considering responsibilities, it is possible to conduct research that explores aspects of bioethics together.

In this study, topic modeling analysis identified research trends in four themes: ‘Infertile women's experience and care’, 'Psychological problems of infertile people', 'Chinese medicine approach to infertility', and 'Low birthrate and infertility procedures'. The results showed that infertility continues to be a research topic that explores experiences, and psychosocial issues such as depression, stress, and quality of life are being studied. Although there is an emphasis on procedural and Chinese medicine approaches to help solve the problem of infertility through childbirth, interventional approaches such as counseling for psychological problems that accompany infertility are also important [16]. However, there is a lack of research on the provision of counseling or nursing interventions to solve infertility-related problems. In addition, the key words for policy proposals to solve infertility problems, which are emerging as a social problem, are not included in the main topics, so it is necessary to conduct research to suggest policies.

The significance of this study is that it explored all domestic infertility-related research published in the last 10 years without limiting the topics to specific subjects, identifying and presenting research trends and suggesting directions for further research. However, this study has limitations in that it did not include theses published in international journals, dissertations, and reports presented in articles on domestic subjects. Also, since the analysis was conducted using the key words presented in the papers, it may not reflect all the details of the research.

Based on the results of this study, it is suggested that research should be conducted on various intervention programs to address psychological problems in addition to the physical problems caused by infertility. It is also suggested that research should be conducted as a basis for the development of institutions and laws that provide strategies to address infertility-related problems at the policy stage.

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