

Changes in medical research trends of North Korea after economic sanctions

A PRISMA-compliant systematic literature review of North Korean medical journals

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Abstract

Background: In the 1980s, North Korea established a socialist health care system. However, following the food crisis and the economic sanctions, it is estimated that North Korea's health care system has experienced continuous deterioration. Thus, in the present study, we estimated the current medical research trends of North Korea through an analysis of the medical journal Korean Medicine, published in North Korea.

Methods: We analyzed the studies in Korean Medicine, which is the only North Korean medical journal accessible to foreigners with more than 30 years of data available, based on PRISMA guidelines. We analyzed the issues of the journal published for a total of 7 years, from 1985 onwards at 5-year intervals until 2015. To evaluate changes in the North Korean medical research trends, we compared and analyzed the issues published before and after the implementation of economic sanctions against North Korea.

Results: In this study, we analyzed 775 articles of Korean Medicine. Following economic sanctions, the number of publications on approved services (conventional therapy and diagnosis)-related articles was decreased. In contrast, the articles related to non-conventional therapy increased sharply in number. This showed a similar pattern to North Korean medical research trends seen during the food crisis of 1995 to 1997.

Conclusions: After placement of economic sanctions on North Korea, North Korean medical research trends changed significantly. These could be indirectly estimated results suggesting that recently, the North Korean health care system had deteriorated, similarly to in the food crisis of 1995 to 1997.

Abbreviation: PRISM = the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Keywords: Democratic People's Republic of Korea, health care surveys, review literature as topic

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H-JY and SHW contributed equally to this work.

Because this study involved published literature, there was no need for a protocol review by the institutional review board.

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1. Introduction

At the end of World War II in 1945, the Korean Peninsula was divided along the 38th parallel by the United States Army in the south and the Soviet Army in the north. In 1948, the Republic of Korea was established in South Korea and the Democratic People's Republic of Korea was established in North Korea.^[1] In 2018, exactly 70 years had passed since each government was formally established. Over the past 70 years, there has been an increase in the socioeconomic disparities and the heterogeneity of language and culture between North and South Korea.^[2]

Because North and South Korea have different political systems, their respective health care systems have also developed in different manners. South Korea established a health care system in the form of a "National Health Insurance" system, in which the private sector is responsible for the supply of health care services and the government is responsible for filling the same role as that of the insurer. Conversely, North Korea established a socialist health care system, which is characterized by the provision of free health care services, the presence of community-based physicians, and a policy that focuses on preventive medicine.^[3]

Seventy years have passed in the different health care systems, and due to differences in historical experiences and imbalances in economic power, the quality gap of health care services between South and North Korea is increasing. As a result, the health level gap between South and North Korean residents is growing as well.^[4] Moreover, it is estimated that the health level gap between South and North Korean residents continuously has been increasing after the economic sanctions were put in place against North Korea in the last decade.^[5]

However, this belief is a conclusion drawn from statistical data produced by international organizations such as the World Health Organization or from studies on refugees from North Korea. Notably, it is an estimated conclusion based on the limited information available. In other words, it is unreasonable to consider it as an accurate reflection of the current situation of the health care system in North Korea. Also, the North Korean government states that the North Korean socialist health care system is still operating well. Therefore, there has been a continuing demand for data that can more accurately represent the current situation of the health care system in North Korea.

For this reason, the authors sought to evaluate the research trends of medical practice in North Korea through an analysis of the medical journal *Korean Medicine*, published in North Korea. Through this, we estimate the current situation of the health care system and the health status of North Korean residents more accurately. Based on these analyses, we evaluate the impact of economic sanctions against North Korea in the last decade on the North Korean health care system.

2. Methods

We performed our systematic literature review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.^[6] Because this study was an analysis of previously published journals, the review of the institutional review board has been omitted.

2.1. Study data

Korean Medicine is the only North Korean medical journal accessible to foreigners with more than 30 years of data available.

There were nine medical journals published in North Korea in 2015.^[7] Of them, at least 5 cover medical science or internal medicine. However, all of these journals except *Korean Medicine* allow access only to recent data since the mid-2000s. Therefore, *Korean Medicine* is the only medical journal that could be used to perform time series analysis.

Korean Medicine is a representative medical journal of North Korea published 4 times a year. *Korean Medicine* was published as *Juche Medicine* beginning in 1954, but was changed to *Korean Medicine* in 1998.^[8] The topics of articles published in *Korean Medicine* are diverse and include clinical medicine, preventive medicine, pharmacy, social science, biomedical science, and biomedical engineering. The journal effectively includes articles on most topics related to medicine.

To estimate medical research trends of medical practice in North Korea, we analyzed all of the issues published in a year. To evaluate changes in the medical research trends of North Korea, we analyzed issues published for a total of 7 years, from 1985 onwards at 5-year intervals until 2015. The issues of *Korean Medicine* used in the analysis were copied from the North Korean Data Center under the Ministry of Unification of South Korea. The articles were classified according to the topic of each article, and the 2 authors assigned to each topic independently analyzed and cross-checked the results.

2.2. Study design

The total number of articles and the total number of pages in the issues published annually were analyzed to evaluate the general characteristics of *Korean Medicine*. Then, the types of articles were classified and analyzed. The classifications for article type included case report, case-control study, cross-sectional study, cohort study, nonrandomized clinical trial, randomized clinical trial, laboratory study, meta-analysis, systemic review, literature review, and specialist opinion.^[9]

We analyzed the countries where the references used in articles in *Korean Medicine* were published. Because the number of references differed for each article, we counted references as 1 per article regardless of the number of references. In cases in which the article cited references from multiple countries, we permitted a duplicate count. Since the number of articles published each year is different, the comparative analysis used the percentage of articles citing references published in the top 5 countries. Furthermore, we classified and analyzed the research fields of the articles, which included social science, natural science, engineering, medicine, and pharmacy.^[10]

To evaluate the impact of economic sanctions on North Korean medical research, we compared and analyzed the *Korean Medicine* issues published before and after the economic sanctions were put into place against North Korea. The articles published in 2005, just before the initiation of economic sanctions, were included in the "before the economic sanctions" group. Articles published in 2015, which are expected to fully reflect the impact of economic sanctions, were included in the "after the economic sanctions" group.

We compared the amount of foreign aid provided to North Korea with respect to the 2 groups. The amount of foreign aid was defined as the total amount of aid from 2000 to 2005 and the total amount of aid from 2006 to 2015. The amount of aid for each year was calculated based on the data of the financial tracking service of the United Nations Office for the Coordination of Humanitarian Affairs.

We classified and analyzed articles by type of therapeutic service as well. The classifications of type of medical service included conventional therapies, nonconventional therapies, and diagnostic services. Conventional therapies were divided into the categories of medications and surgery. Nonconventional therapies were divided into the categories of traditional medicine and alternative medicine. An article related to alternative medicine was defined as an article whose study model was an equivalence test.

Additionally, we analyzed changes in conventional therapies and nonconventional therapies seen in medical research since 1985. Since the number of articles published each year was different, the comparative analysis used the percentage of articles among all articles published in Korean Medicine issues in that year.

2.3. Statistical analysis

Statistical analyses were performed using the SPSS Statistics ver. 18.0 for Windows software (IBM Corp., Armonk, NY). Collected data were analyzed for differences in the published Korean Medicine issues before and after the economic sanctions were implemented against North Korea by use of the chi-squared test and the Mann-Whitney U test.

3. Results

In this study, we analyzed 775 articles (28 journals) of Korean Medicine published for a total of seven years. The structure of articles published is presented in Figure 1. One of the unique characteristics of articles published is the relatively small number of pages. Especially, the articles published after 2000 did not

exceed 2 pages on average. This was consistent with a previous study reporting that North Korean medical research articles are very short.^[7] Another unique characteristic is that the first sentence of the introduction of the article is always written by quoting Kim Il-sung, Kim Jong-Il, or Kim Jong-un. In addition, there is typically no discussion of the research results.

The general characteristics of Korean Medicine issues can be seen in Table 1. The most common type of article of Korean Medicine was the laboratory study. The countries where the references were published can be seen in Table 2. The proportion of articles citing references published in the Soviet Union has continually decreased. On the other hand, the proportion of articles citing references published in the United States has increased gradually. The research fields of articles published can be seen in Table 3, indicating a relatively constant pattern without significant change.

Observed differences in the published Korean Medicine issues with respect to research trends before and after the economic sanctions were put in place against North Korea can be seen in Table 4. The trend of North Korean medical research changed significantly after the economic sanctions. Changes in medical research trends in Korean Medicine issues since 1985 are presented in Figure 2. Especially, changes in medical research trends related to alternative medicines are presented in Figure 3.

4. Discussion

To our knowledge, this study is the first to evaluate the medical research trends of North Korea through a bibliographic review of a North Korean medical journal. We found that the medical

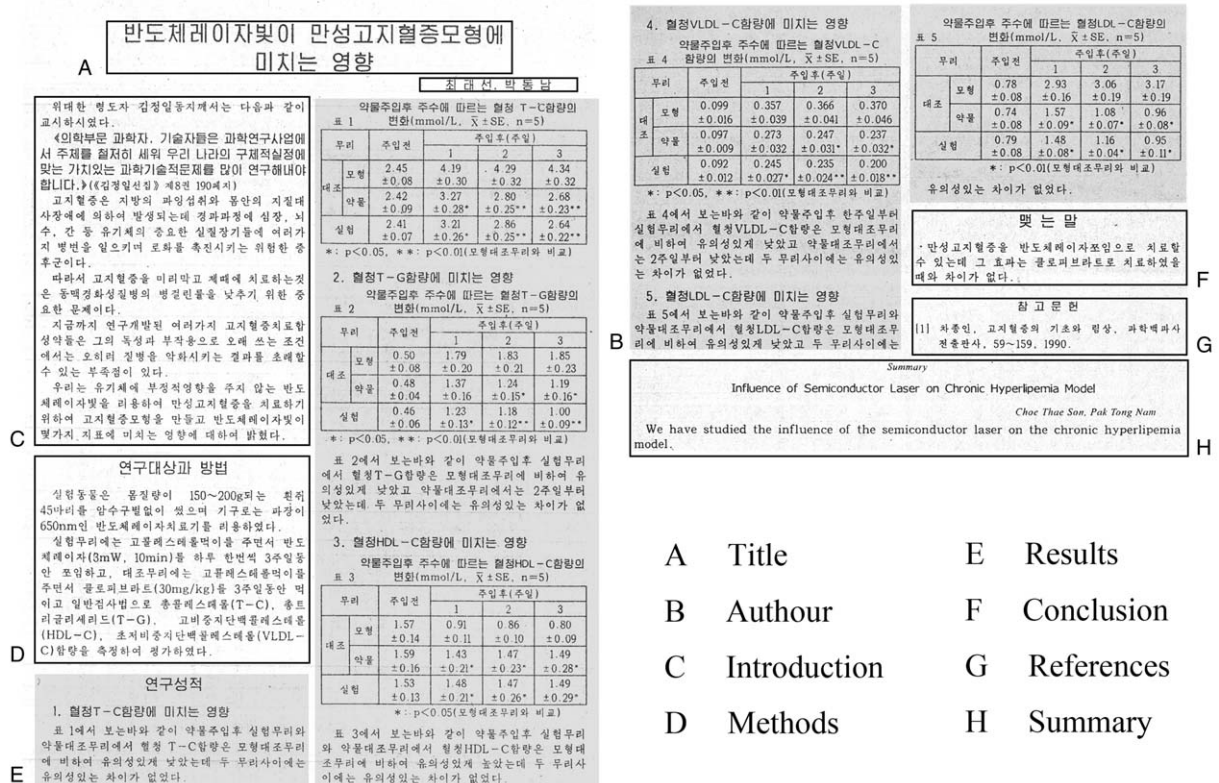


Figure 1. Composition of the published articles in Korean Medicine issues.

Table 1**General characteristics of the analyzed *Korean Medicine* issues.**

	1985	1990	1995	2000	2005	2010	2015
Number of articles	48	67	76	95	150	159	180
Number of pages	245	249	188	190	221	228	224
Type of article							
Case report	1	2					
Case-control study							
Cross-sectional study	9	20	18	17	43	43	23
Cohort study					1		
Non-randomized clinical trial	9	10	16	24	36	39	26
Randomized clinical trial							
Laboratory study	26	27	34	49	62	49	91
Meta-analysis							
Systemic review							
Literature review	2	2	2	1	4	23	35
Specialist's opinion	1	5	6	4	4	5	5

Table 2**Top 5 source countries of references published in the analyzed *Korean Medicine* issues.**

	1985 (n = 48)	1990 (n = 67)	1995 (n = 76)	2000 (n = 95)	2005 (n = 150)	2010 (n = 159)	2015 (n = 180)
North Korea	38 (79.2%)	44 (62.7%)	58 (76.3%)	69 (72.6%)	89 (59.3%)	99 (62.3%)	113 (62.8)
Soviet Union / Russia	40 (83.3%)	48 (71.6%)	33 (43.4%)	21 (22.1%)	8 (5.3%)	3 (1.9%)	0 (0%)
China	10 (20.8%)	20 (29.9%)	34 (44.7%)	60 (63.2%)	68 (45.3%)	45 (28.3%)	29 (16.1%)
Japan	35 (72.9%)	37 (55.2%)	40 (52.6%)	9 (9.5%)	2 (1.3%)	2 (1.3%)	2 (1.1%)
United States	21 (43.8%)	24 (35.8%)	37 (48.7%)	35 (36.8%)	59 (39.3%)	106 (66.7%)	123 (68.3%)

Table 3**Research fields of analyzed articles in *Korean Medicine*.**

	1985 (n = 48)	1990 (n = 67)	1995 (n = 76)	2000 (n = 95)	2005 (n = 150)	2010 (n = 159)	2015 (n = 180)
Medicine and pharmacy	34 (70.8%)	43 (64.2%)	48 (63.2%)	57 (60%)	90 (60%)	85 (53.5%)	72 (40%)
Engineering	6 (12.5%)	10 (14.9%)	11 (14.5%)	20 (21.1%)	25 (16.7%)	41 (25.8%)	45 (25%)
Natural science	7 (14.6%)	9 (13.4%)	10 (13.2%)	14 (14.7%)	28 (18.7%)	26 (16.4%)	53 (29.4%)
Social science	1 (2.1%)	5 (7.5%)	7 (9.2%)	4 (4.2%)	7 (4.7%)	7 (4.4%)	10 (5.6%)

Table 4**Differences of medical study trends in *Korean Medicine* before and after the economic sanctions.**

	Before the economic sanctions (2000 and 2005)	After the economic sanctions (2010 and 2015)	<i>p</i>
Amount of foreign aid (USD, million)	263 (148.7–365)	59 (34.9–92.8)	.009
Conventional therapies			
Medication	38 (25.3%)	28 (15.6%)	.027
Surgery	14 (9.3%)	9 (5%)	.124
Nonconventional therapies			
Traditional medicine	26 (17.3%)	15 (8.3%)	.014
Alternative medicine	10 (6.7%)	103 (57.2%)	<.001
Diagnosis	62 (41.3%)	25 (13.9%)	<.001

USD = United States dollar.

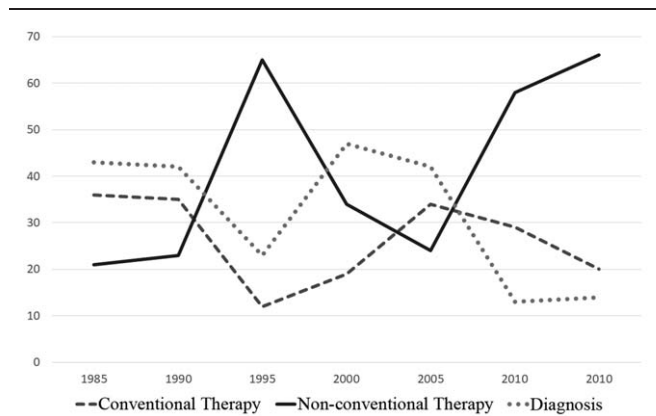


Figure 2. Changes in medical research trends in Korean Medicine issues. North Korean medical research trends notably show a similar pattern to those observed during the food crisis of 1995 to 1997.

research trends of North Korea were different according to changes in foreign aid. We also found that economic sanctions over the last decade have had a major impact on North Korean medical research trends. This suggests that the medical research trends of North Korea actively reflect the needs of North Korean society.

Over the past three decades, North Korea has undergone tremendous changes, both politically and economically. Until the 1980s, North Korea was politically and economically stable under the foreign aid of the communist bloc, represented by the Soviet Union. However, the collapse of the Soviet Union in 1991 and the abandonment of foreign aid from the communist bloc led to a deteriorating economy in North Korea. During the food crisis of 1995 to 1997, the mortality rate of North Koreans increased sharply and their health levels deteriorated.^[11] About one million North Korean were known to have died from famine during this period.^[12]

Since 2000, with the aid of many United Nations agencies, such as the United Nations Children’s Fund and the World Food

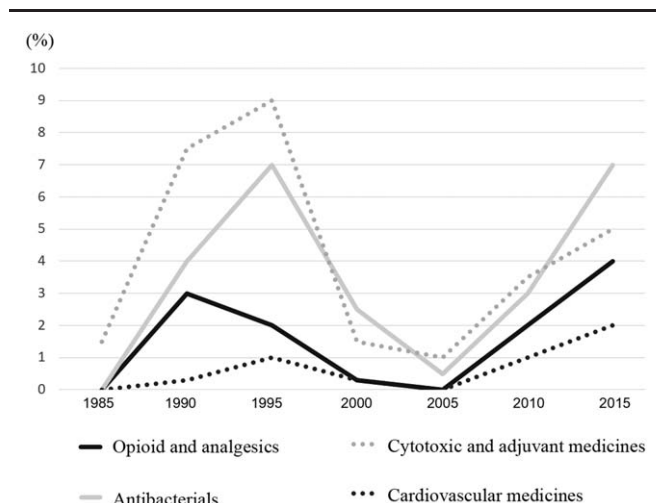


Figure 3. Changes in medical research trends related to alternative drug replacement of essential drugs. The proportion of alternative drugs for essential drug-related articles, which had greatly decreased in number after the increase of foreign aid, sharply increased again following the economic sanctions.

Program as well as the South Korean government and international nongovernmental organizations, the economic situation in North Korea has improved and, as a result, the health level of North Koreans has recovered to the level it was at prior to the famine period of the 1990s.^[13] However, the health level of North Koreans that had been recovering has subsequently been showing deterioration again since 2006. In response to the nuclear provocative acts of the North Korean government that began in 2006, UN and the United States government imposed economic sanctions. These economic sanctions have resulted in a shortage of essential goods, and as a result the health of North Koreans has been threatened.^[14]

According to the results of the present study, the most common type of article of Korean Medicine was laboratory studies, meaning that laboratory studies composed the highest proportion of published studies regardless of the publication time. Clinical trials took up the second highest proportion, but all were nonrandomized; there were no randomized type studies observed. This is a significantly different result from recent global trends that suggest that the proportion of randomized clinical trials in medical studies is continually increasing.^[15] It should also be noted that the proportion of literature reviews has increased sharply since the economic sanctions began. These changes likely resulted from the deterioration of the medical study environment caused by economic sanctions.

The results of this study show that the countries in which the references were published have changed dramatically over the last 30 years. Before the collapse of the Soviet Union, the proportion of articles citing references published in the Soviet Union was very high, at more than 70%. However, there has been a continual decline in this percentage since then, and in 2015 there was no article citing references published in Russia. On the other hand, the proportion of articles citing references published in the United States has demonstrated a different trend. Over the past few years, the proportion of articles citing references published in the United States has increased gradually, although there have been clear increases and decreases. In 2015, the proportion increased to 68.3%. It is likely that United States-based medical studies have made up for the absence of Socialist medical studies.

The research fields of the identified articles showed a relatively constant pattern without significant change. Unusually however, in 2015 the articles belonging to the medicine and pharmacy categories were considerably decreased in numbers and the articles belonging to the natural science category were increased sharply in number as compared with before 2015. These changes seem to be associated with the North Korean government’s natural science-fostering policy that began in 2012.

We observed that the total amount of foreign aid received changed between before and after the economic sanctions. We also found that the trend of North Korean medical research changed significantly after the economic sanctions. The articles related to medications, traditional medicine, and diagnosis were significantly decreased in number following the sanctions. Conversely, the articles related to alternative medicine increased sharply in number. After the economic sanctions were implemented, the number of publications of approved therapeutic services (medication & diagnosis)-related articles decreased, and the majority of the articles published appeared to be related to alternative medicine, not conventional therapies. These changes are likely associated with the shortage of medicines due to economic sanctions.

However, the prevalence of traditional medicine-related articles showed a somewhat different pattern, in that it has steadily declined after the economic sanctions. In the late 1950s, Pavlov's theory, which was popular in socialist medicine, was introduced in North Korea. North Korean traditional medicine and Pavlov's theory attach importance to metaphysical pathology. Also, they emphasize treatment at the individual level rather than at the cellular level. As a result, the status of traditional medicine in North Korea has become special, and traditional medicine has become one of the various fields of medicine in North Korea.^[16] After the 1990s, the North Korean government implemented policies to integrate traditional medicine into the health care system.^[17] The trends observed in this study are expected to be associated with this policy.

Similar changes were seen in our analysis of the changes in medical research trends in Korean Medicine since 1985. The proportion of conventional therapy and diagnosis-related articles, which had increased in number after the increase of foreign aid, was significantly decreased again after the economic sanctions. On the other hand, the proportion of non-conventional therapy-related articles, which had greatly decreased in number after the increase of foreign aid, sharply increased again following the economic sanctions. These more recent North Korean medical research trends notably show a similar pattern to those observed during the food crisis of 1995 to 1997. These findings are indirect indications that the North Korean health care system has deteriorated, just as it did in the food crisis of 1995 to 1997.

The present study has the following limitations. First, because of the nature of North Korea as a closed country with little information released to the outside world, we were able to analyze the single accessible North Korean medical journal. However, as Korean Medicine is the only comprehensive North Korean medical journal, it is expected to represent the trend of medical research in North Korea. Second, this study was analyzed using only published issues collected from 1985 to 2015 for a total of 7 years at 5-year intervals—that is, it is not a consideration of all published issues during that period, so there may be errors in the analysis. To obtain more accurate results, it is necessary to carry out additional analysis of the whole journal's timespan. Third, because the authors' affiliations and positions are not included in the issues of Korean Medicine, it was not possible to analyze the differences of research trends associated with the authors' characteristics. Fourth, for the accuracy of the analysis, 2 authors who majored in medicine evaluated studies on this subject by way of cross-validation and consensus after the analysis independently, but these authors ultimately also had to analyze the articles belonging to the categories of natural science and engineering, not just those in the categories of medicine or pharmacy. However, as the articles that belonged to the natural science and engineering fields were still related to medicine, it was estimated that the error of analysis in this manner is not large.

In conclusion, after economic sanctions on North Korea, North Korean medical research trends changed significantly. These could be indirect evidence that the North Korean health

care system has deteriorated, similarly to in the food crisis of 1995 to 1997.

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