Observational Study

Medicine

OPEN

Relationship between hospital specialization and health outcomes in patients with nonsurgical spinal joint disease in South Korea

A nationwide evidence-based study using national health insurance data

Boyoung Jung, PhD[a], Jiyoon Yeo, MPH[b], Sun Jung Kim, PhD[c], In-Hyuk Ha, KMD, PhD[b,*]

Abstract

Previous studies on hospital specialization in spinal joint disease have been limited to patients requiring surgical treatment. The lack of similar research on the nonsurgical spinal joint disease in specialized hospitals provides limited information to hospital executives.

To analyze the relationship between hospital specialization and health outcomes (length of stay and medical expenses) with a focus on nonsurgical spinal joint diseases.

The data of 56,516 patients, which were obtained from the 2018 National Inpatient Sample, provided by the Health Insurance Review and Assessment Service, were utilized. The study focused on inpatients with nonsurgical spinal joint disease and used a generalized linear mixed model with specialization status as the independent variable. Hospital specialization was measured using the Inner Herfindahl–Hirschman Index (IHI). The IHI (value $\leq$1) was calculated as the proportion of hospital discharges accounted for by each service category out of the hospital's total discharges. Patient and hospital characteristics were the control variables, and the mean length of hospital stay and medical expenses were the dependent variables.

The majority of the patients with the nonsurgical spinal joint disease were female. More than half of all patients were middle-aged (40–64 years old). The majority did not undergo surgery and had mild disease, with Charlson Comorbidity Index score $\leq$1. The mean inpatient expense was 1265.22 USD per patient, and the mean length of stay was 9.2 days. The specialization status of a hospital had a negative correlation with the length of stay, as well as with medical expenses. An increase in specialization status, that is, IHI, was associated with a decrease in medical expenses and the length of stay, after adjusting for patient and hospital characteristics.

Hospital specialization had a positive effect on hospital efficiency. The results of this study could inform decision-making by hospital executives and specialty hospital-related medical policymakers.

Abbreviations: CCI = Charlson Comorbidity Index, HHI = Herfindahl–Hirschman Index, HIRA-NIS = Health Insurance Review & Assessment Service-National Inpatient Sample, IHI = Inner Herfindahl–Hirschman Index, KCD = Korean Standard Classification of Diseases.

Keywords: health outcome, hospital specialization, length of stay, medical expense, spinal joint disease

Editor: Ediriweera Desapriya.

The study was approved by the Institutional Review Board of Jaseng Hospital of Korean Medicine in Seoul, Republic of Korea (JASENG 2019-08-012).

The authors have no funding and conflicts of interest to disclose.

Supplemental Digital Content is available for this article.

The datasets generated during and/or analyzed during the present study are available from the corresponding author on reasonable request.

[a] Department of Health Administration, Hanyang Women's University, 200 Salgoji-gil, Seongdong-gu, Seoul, Republic of Korea, [b] Jaseng Spine and Joint Research Institute, Jaseng Medical Foundation, 3F 538 Gangnam-daero, Gangnam-gu, Seoul, Republic of Korea, [c] Department of Health Administrations and Management, College of Medical Science, Soonchunhyang University, Asan, Republic of Korea.

[*] Correspondence: In-Hyuk Ha, Jaseng Spine and Joint Research Institute, Jaseng Medical Foundation, 3F, 538 Gangnam-daero, Gangnam-gu, Seoul 06110, Republic of Korea (e-mail: hanihata@gmail.com).

How to cite this article: Jung B, Yeo J, Kim SJ, Ha IH. Relationship between hospital specialization and health outcomes in patients with nonsurgical spinal joint disease in South Korea: a nationwide evidence-based study using national health insurance data. Medicine 2021;100:32(e26832).

Received: 3 June 2020 / Received in final form: 14 June 2021 / Accepted: 16 July 2021

http://dx.doi.org/10.1097/MD.0000000000026832

1. Introduction

Hospital specialization generally refers to the process of a hospital focusing on areas of disease within a limited scope, or obtaining the ability to provide specific medical care that is not commonly available.[1,2] Hospital specialization is a management strategy that small- and medium-sized hospitals can employ to gain a competitive advantage in the market and improve the quality of healthcare within the rapidly changing healthcare environment.

Globally, many researchers have investigated hospital specialization from various perspectives since the early 1990s.[3–5] The majority of the studies conducted outside Korea evaluated the effect of hospital specialization on patients' clinical outcomes at the individual level.[6–10] However, Korean studies have frequently attempted to evaluate the relationship between hospital specialization and hospital performance. In general, previous Korean studies on specialized hospitals either have focused on a specific disease or have shown mixed results on the relationship between specialization and length of stay, as well as between specialization and medical expenses. Hagen et al[11] analyzed the relationship between hospital specialization and postoperative outcomes within the field of orthopedics; they reported that the clinical outcomes of patients in the specialized hospital group (ie, as measured by the mortality rate within 90 days postoperation and the incidence of deep vein thrombosis, pulmonary embolism, hemorrhage, infection, or myocardial infarction) were superior to that of the patients in a nonspecialized hospital group. Hwang et al[12] reported that the mortality rate of patients who were discharged from a hospital specialized in cardiology was lower than that of patients discharged from a nonspecialized hospital. However, Cram et al[9] reported no statistically significant differences. Subsequently, hospital specialization has been presented as a management strategy that contributes to reducing production costs and improving the quality of medical services.[5,13–14] Barro et al[15] explained that the strategy of being patient-centered through hospital specialization has a positive effect on health outcomes and on the community by providing more specialized services to patients, reducing production costs, and improving the quality of medical services.

Kim et al[16] described the characteristics of patients with spinal joint diseases in specialized hospitals using data from 823 hospitals in Korea, including 17 spine specialty hospitals. However, since the study included mostly patients who required surgical treatment, it is difficult to extrapolate these findings to those with nonsurgical spinal joint disease. Another study reported that increased hospital specialization was associated with significant decreases in length of stay and medical expenses of patients.[17] However, the generalizability of these findings is also limited because the analysis only included patients with lumbar spine disease who underwent surgery. In addition, Yoo and Kim[18] found that increased hospital specialization was associated with decreased length of stay but increased medical expenses, using the data from the Health Insurance Review and Assessment Service-National Inpatient Sample (HIRA-NIS). The HIRA-NIS is a representative database that can grasp all information pertaining to patients utilizing institutional medical services. However, the level of hospital specialization was measured using Diagnosis Related Group, and therefore its present-day application, using data from 2010 to 2013, is difficult. Another study from 2016[19] that used the data from the HIRA-NIS found that increased hospital specialization for joint diseases was associated with decreased length of stay and decreased medical expenses. However, only patients with joint diseases were included, and that the latest data were not used. Korea has a dual healthcare system that includes both traditional Korean medicine and modern Western medicine.[20,21] The management of small- and medium-sized hospitals is continuing to deteriorate owing to increasing competition for the supply of medical services and the allocation of patients to tertiary general hospitals. In response, the Korean Ministry of Health and Welfare institutionalized the designation of specialized hospitals in 2005 to promote hospital specialization based on the community demands.[22] As of today, in 2020, approximately 300 medical institutions are designated as specialized hospitals.[23]

The previous studies in Korea on specialized hospitals either used old data or were limited to specific diseases. The majority of the studies conducted on spinal joint disease[16] have focused on those patients requiring surgical treatment; therefore, the data on nonsurgical spinal joint disease are limited. In addition, although the previous studies consistently reported that hospital specialization reduces the length of hospital stay, the association between hospital specialization and cost of treatment remains unclear. Therefore, in this study, we used the 2018 HIRA-NIS data to investigate the correlation between hospital specialization and health outcomes (length of stay and medical expenses), with a focus on nonsurgical spinal joint diseases.

2. Methods

2.1. Study design and population

Korea has a universal health insurance system; the National Health Insurance covers about 98% of all Koreans. Claims data from the HIRA include 49 million patients annually, representing 90% of the total Korean population.[27]. The claims data include information such as the patient's diagnosis, treatment, procedure, surgical history, and prescription drugs, providing a valuable resource for healthcare service research. The HIRA claims data consist of 10% of inpatients and 90% of outpatients; therefore, the National Patient Sample may not have enough cases to investigate inpatient services for severe health conditions. Therefore, the HIRA-NIS has been developed to increase reliability and representativeness by including samples from specific areas.[24] The raw data used in this study were from the 2018 HIRA-NIS. These data were sampled (inpatient sampling rate of 13%; approximately 1 million patients) from the 2018 National Health Insurance Claims Database for the purpose of research.[24,25]

This study was approved by the Institutional Review Board of Jaseng Hospital of Korean Medicine in Seoul, Korea (JASENG 2019-08-012), with a waiver for informed consent because the database is available upon approval for data sharing from the HIRA healthcare big data Hub website [https://opendata.hira.or.kr/op/opc/selectPatDataAplInfoView.do]. In line with recommendations from previous research, only the patients who visited a medical institution for a particular disease were included in the study population, to control for the status of patients' health that affects medical utilization.[26,27] There has been a rapid increase in the prevalence of spinal joint diseases[28] because of the aging population and increased use of smart devices. Affected patients use not only Western medicine but also many traditional Korean medicines.[29] The mainstay treatment of spinal joint disease is pain alleviation therapy. Patients with the nonsurgical spinal joint disease were selected as the target population for this study because of relatively similar severity among patients and the recent increase in the use of traditional Korean spinal joint-specialized hospitals for nonsurgical treatment.[30] Korean Standard Classification of Diseases (KCD) codes for nonsurgical spinal joint diseases, as defined by the Korean Ministry of Health and Welfare in "the guideline for traditional spinal specialty hospital medical quality assessment survey,"[31] were as follows: spondylosis (M41, M430, M431, M45, M461, M47, M470, M 471, M 472, M 478, M 479, and M 480), dorsopathy (M438, M439, M538, M539, M54, M541, M542, M543, M544, M545, M546, M548, and M549), sprain and strain (S136, S230, S233, S33, S330, S335, and S337), intervertebral disc disease (M500, M501, M502, M503, M508, M509, M510, M511, M512, M513, M518, and M19), fracture (S32, S320, S321, S322, and S327), and others (M436 and U303).

The inclusion criteria for defining the sample were as follows: Western or Korean traditional inpatient claims; hospital level or higher institutions (to minimize the heterogeneity among the institutions); and specialized hospitals (health clinics, nursing hospitals, psychiatric hospitals, and military-related hospitals). The exclusion criteria were as follows: patients whose claims were for diseases other than spondylosis, back pain, sprain and strain, intervertebral disc disease, or fracture; patients who were veterans or were hospitalized at clinic-level institutions; and patients whose length of stay was less than 1 day. To prevent outliers from skewing the data, patients with a length of stay longer than 120 days were also excluded. Moreover, traditional Korean spinal joint-specialized hospitals with fewer than 20 patients were excluded from the sample. Claims with no medical expenses were also excluded. The final study sample comprised 959 hospitals and 56,516 patients (70,457 claims; Fig. 1).

2.2. Variables

2.2.1. Independent variable. The main independent variable in this study was each hospital's specialization status, defined using the inner Herfindahl–Hirschman Index (IHI). The IHI reinterpreted the Herfindahl–Hirschman Index (HHI), which measures the market concentration for analyzing the market structure in microeconomics, in terms of hospital centralization.[5] The IHI is an index that measures the specialization of a medical institution based on the level of focus on the service provided and is similar to the HHI.[32] The HHI is calculated by squaring the share of each firm competing in a market and then summing the resulting numbers[33]. The IHI uses a similar method, but it can satisfy both the ease and sensitivity requirements of measuring a hospital's specialization status and was used in this study.[17] The IHI was calculated according to Equation 1, as the proportion of a hospital's discharges accounted for by each service category out of the hospital's total discharges. The value of the IHI was 1 or less. If a hospital only provided 1 service category, the IHI of the hospital was 1. Therefore, the narrower the scope of services provided in a hospital, the greater the value of IHI.[5]

$$\mathrm{IHI} = \sum_{\mathrm{i}} (\mathrm{P}_{\mathrm{i}}^{2}) \tag{1}$$

where P_i represents the proportion of hospital discharges accounted for by the *i*th service category.

2.2.2. Dependent variable. The dependent variables of this study were the length of stay and medical expenses. The length of stay and medical expenses are often used as indices of operational efficiency or operational performance of hospitals in many medical studies.[14] In general, a longer length of stay is associated with lower bed turnover in a hospital and lower medical expenses per day for the inpatients. Managing the length of stay is important not only for the efficiency and profitability of hospital management but also for the reduction of patient medical expenses, funding for health insurance, and management of national medical expenses.[15,34] The total costs of care (combining out-of-pocket costs and costs covered by insurance) were used to calculate the medical expenses. The primary outcome is the relationship between hospital specialization and the length of stay, and the secondary outcome is that between hospital specialization and medical expenses in patients with nonsurgical spinal joint diseases.

2.2.3. Covariate. In this study, variables that were known to affect the length of stay and medical expenses were adjusted for using multilevel (patient-hospital) control. Patient characteristics were categorized into sociodemographic and clinical characteristics. Sociodemographic factors included variables such as sex, age, and type of insurance coverage. Severity and treatment via surgery, which are clinical characteristics of patients, were also controlled. To adjust for the severity of patients' comorbid diseases, the Charlson Comorbidity Index[35] was used. Hospital characteristics included the level of the hospital, the number of hospital beds, the location, and the number of medical professionals. The levels of the hospitals included tertiary general hospitals, general hospitals, Western hospitals, and traditional Korean hospitals. In accordance with the Korean Hospital Association's guidelines,[36] the number of hospital beds was classified as "100 beds or fewer," "between 100 beds and 300 beds," and "300 beds or more." The hospital location included Seoul, metropolitan cities, and others.[37] Furthermore, the number of doctors and nurses for each hospital was categorized into quartiles depending on the number of doctors and nurses for every 50 beds and was used in the analysis as categorical variables.

2.3. Statistical analysis

Patient and hospital characteristics were all processed into categorical variables, and frequencies and percentages were reported for each variable. The length of stay, medical expenses, and IHI were used as continuous variables, means, standard deviations, and quartiles were reported.

To examine the effects of the IHI on the length of stay and medical expenses, the natural logs of the length of stay and medical expenses were entered as the dependent variables, and the IHI was entered as the independent variable to use a generalized linear mixed model for the analysis. To normalize the distributions of the length of stay and medical expenses and to examine the changes in percentage, the natural logs of the 2 variables were taken to convert the variables. Since the distributions of continuous dependent variables (inpatient expense and length of stay) were skewed,[38] log transformation was used to improve the distribution characteristics of the data.[39] For easy interpretation, the IHI value (between 0 and 1), was multiplied by 10, and the regression coefficient was changed by 0.1. Patient characteristics and hospital characteristics were

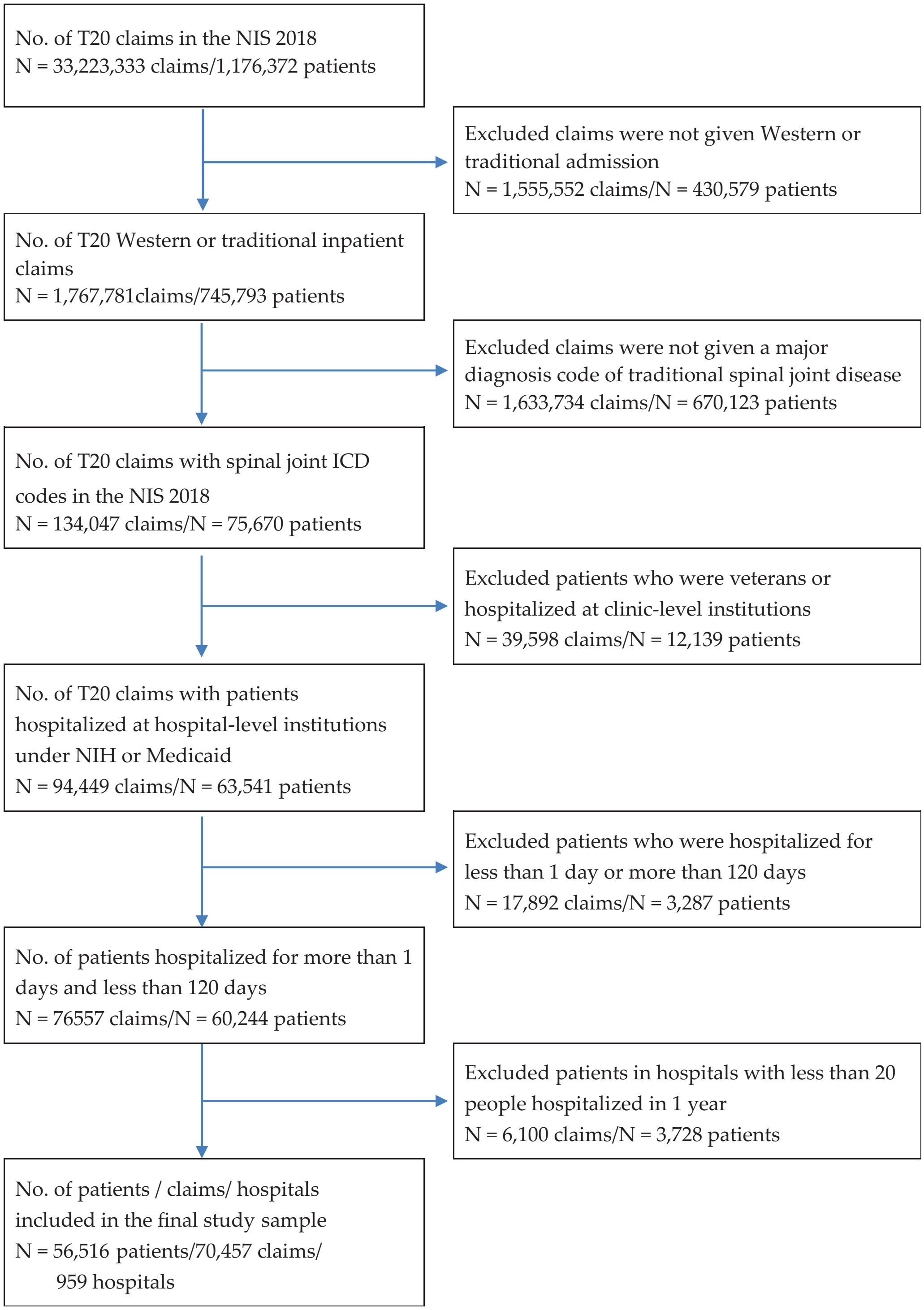

Figure 1. Flowchart of the study sample.

used as control variables. Statistical significance was assumed when the *P* value was less than .05. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

2.4. Ethics statement

The study utilized HIRA data, which are third-party data and thus not owned by the authors. The data generated and/or analyzed in the current study are available in the HIRA-NIS repository and can be obtained upon direct request via email or fax, submission of the request form and declaration of data use, which are downloadable from the HIRA website, and payment of a data request fee.[40] The study was approved by the Institutional Review Board of Jaseng Hospital of Korean Medicine in Seoul, South Korea (JASENG 2019-08-012).

3. Results

Table 1 shows the baseline characteristics of the patients with nonsurgical spinal joint diseases. There were more female patients (57.05%) than male patients (42.95%). The mean medical expense per hospitalization was higher for female patients (1316.89 USD) than for male patients (1196.61 USD), and the length of stay was longer for female patients (9.83 days) than for male patients (8.36 days). More than half of all patients were middle-aged (40–64 years old). Among the elderly (≥65 years old), the medical expenses were higher, and the length of stay was longer. More than 70% of the patients had the minor disease (Charlson Comorbidity Index ≤1; 70.13%) and did not undergo surgery (79.29%). Most of the nonsurgical spinal joint diseases consisted of intervertebral disc disorders (48.77%) and spondylosis (22.60%). Analysis of hospital characteristics showed that patients used Western hospitals, general Western hospitals, and traditional Korean general hospitals. The majority of the hospitals were small in size (100 hospital beds or fewer) and located in nonmetropolitan areas. The mean inpatient charge was 1265.22 USD per patient with nonsurgical spinal joint disease, and the mean length of stay was 9.2 days.

Table 1, Supplemental Digital Content, http://links.lww.com/MD/G349 examines the relationship between medical expenses, which represent a dependent variable, and specialization status. Model 1 (unadjusted) shows that a 0.1 unit increase in specialization status (IHI) was associated with a 28.5% decrease in medical expenses. Model 2 shows results after adjusting for patient characteristics and shows that a 0.1 unit increase in specialization status (IHI) was associated with a 24.1% decrease in medical expenses. Model 3 shows results after adjusting for patient characteristics and hospital characteristics and shows that a 0.1 unit increase in specialization status (IHI) was associated with a 0.5% decrease in medical expenses. In all models, specialization status and medical expenses were found to have a negative correlation. In Models 1 and 2, the *P* value was significant at <.0001. However, in Model 3, after adjusting for both patient and hospital characteristics, the correlation between specialization and medical expenses was less significant (*P* value = .081) when compared with Model 2. In particular, negative correlations were more often observed in medical institutions at the hospital level or in those located in a capital city compared with tertiary general hospitals.

Table 2, Supplemental Digital Content, http://links.lww.com/MD/G350 examines the relationship between the length of stay, which is a dependent variable, and specialization status. Model 1 shows unadjusted results and shows that a 0.1 unit increase in specialization status (IHI) was associated with a 12% decrease in the length of stay. Model 2 shows results after adjusting for patient characteristics and shows that a 0.1 unit increase in specialization status (IHI) was associated with an 8.1% decrease in the length of stay. Model 3 shows results after adjusting for patient characteristics and hospital characteristics and shows that a 0.1 unit increase in specialization status (IHI) was associated with a 1.9% unit decrease in the length of stay. In all models, specialization status and length of stay were found to have a negative correlation. In particular, this trend was clearer among middle-aged (40–64 years old) and elderly (≥65 years old) patients compared with younger patients, among patients covered under National Health Insurance compared to patients covered under Medicaid, and among patients who underwent surgeries. The shorter length of stay was observed in the group with a greater number of hospital beds in comparison with the group with a smaller number of hospital beds; in addition, a shorter length of stay was also observed when there were greater numbers of doctors and nurses. Although negative correlations were observed among hospitals in urban areas, they were not statistically significant.

Table 3, Supplemental Digital Content, http://links.lww.com/MD/G351 examines the sensitivity analyses to investigate the robustness of the study results. Consequently, the fitted value of the dependent variable (log of medical expense and log of length of stay) was consistent with Model 3.

Table 2 examines the relationship between medical expenses, which represent a dependent variable, and specialization status according to the disease type. After adjusting for patient characteristics and hospital characteristics, a 0.1 unit increase in the specialization status (IHI) decreased medical expenses by 2.3% for spondylosis, 2% for back pain, and 3% for sprain/strain. In contrast, the medical expenses for intervertebral disc disorders and fractures increased by 0.5% and 5.8%, respectively.

Table 3 examines the relationship between the length of stay, which represents a dependent variable, and specialization status according to disease type. After adjusting for patient characteristics and hospital characteristics, the length of stay for spondylosis, intervertebral disc disorders, and fracture decreased by 1.9%, 2.9%, and 9.5%, respectively. In contrast, the length of stay for back pain and sprain/strain increased by 2% and 3%, respectively.

4. Discussion

In this study, we examined the effects of specialization status on medical expenses and length of stay of patients with nonsurgical spinal joint diseases using the HIRA-NIS dataset, which represents the general Korean population. The results of this study can be used to inform decision-making by hospital organizations to develop strategies for hospital specialization, as well as by specialty hospital-related policymakers.

In this study, we found that the specialization status of hospitals for nonsurgical spinal joint diseases showed a negative correlation with the length of stay. These research findings are consistent with those of previous studies on the relationship between hospital specialization and length of stay.[15,41] The length of stay is a representative index that shows the efficiency of medical services. Shortening the length of stay through specialization can reduce the burden of medical expenses for patients while also increasing the bed turnover and profitability for hospitals. According to previous research,[41] a mean 10% increase in a hospital's specialization status has the effect of reducing a patient's length of stay by about 8 h (one-third day), owing to increased operational efficiency. Therefore, hospitals can strategize their specialization by investing heavily in available organizational resources and capabilities in particular areas. For example, medical staff and professionals can use standard guidelines for systematic patient care and medical improvement by consulting with experts in the field.

Our findings also demonstrated that the specialization status of a hospital for nonsurgical spinal joint diseases showed varying effects across different disease types. For spondylosis (22.60%), hospital specialization showed negative correlations with medical expenses and length of stay. For back pain (8.88%) and sprain and strain (9.74%), medical expenses decreased with increased

Table 1

Baseline characteristics of the study population.

	N (%)	Expense per case (USD)*			Length of stay (days)		
		Mean	SD	t value (pr > t)	Mean	SD	t value (pr > t)
Patient level factors							
Sex							
Male	30,264 (42.95)	1196.61	1597.67	–	8.36	7.37	–
Female	40,193 (57.05)	1316.89	1644.56	9.73 (<0.001)	9.83	8.09	24.85 (<0.001)
Age.							
Under 40	13,668 (19.4)	742.68	865.47	–	7.34	6.29	–
40 < age ≤ 64	38,181 (54.19)	1082.12	1362.42	21.89 (<0.001)	8.77	7.53	18.63 (<0.001)
≥65	18,608 (26.41)	2024.73	2191.31	73.17 (<0.001)	11.45	8.86	47.48 (<0.001)
Comorbidity level (CCI)†							
Minor (CCI ≤ 1)	49,410 (70.13)	1103.01	1402.97	–	8.65	7.47	–
Moderate (CCI = 2)	7309 (10.37)	1605.62	1937.76	24.96 (<0.001)	10.35	8.29	17.41 (<0.001)
Severe (CCI ≥ 3)	13,738 (19.5)	1667.55	2039.42	36.43 (<0.001)	10.55	8.54	25.31 (<0.001)
Insurance type							
Medicare	4463 (6.33)	1736.92	1999.92	–	13.10	8.94	–
NHI	65,994 (93.67)	1233.32	1592.17	−20.09 (<0.001)	8.94	7.67	−34.71 (<0.001)
Surgery							
No	55,868 (79.29)	787.41	793.83	–	8.23	7.29	–
Yes	14,589 (20.71)	3094.97	2475.49	186.63 (<0.001)	12.91	8.66	66.21 (<0.001)
Primary diagnosis‡							
Spondylosis	15,926 (22.6)	1193.16	1540.25	–	5.39	4.73	–
Back pain	6256 (8.88)	1854.24	2356.67	1.8 (0.0723)	9.87	8.56	2.49 (0.0129)
Sprain and strain	6862 (9.74)	827.78	710.35	−0.99 (0.321)	10.10	6.34	2.61 (0.009)
Intervertebral disc disorders	34,359 (48.77)	827.21	581.40	−0.99 (0.3202)	10.29	5.81	2.72 (0.0065)
Fracture	7036 (9.99)	999.03	1229.64	−0.53 (0.5976)	7.71	7.24	1.29 (0.1971)
Other disease	18 (0.03)	2048.19	1903.93	2.32 (0.0202)	13.11	9.65	4.28 (<0.001)
Hospital level factors							
Hospital type							
Tertiary general hospital	3043 (4.32)	3537.69	3392.07	–	9.90	7.84	–
General hospital	17,018 (24.15)	1817.38	2001.81	−58 (<0.001)	10.64	9.64	5.09 (<0.001)
Western hospital	38,680 (54.9)	930.88	1173.62	−91.88 (<0.001)	7.11	6.27	−20.02 (<0.001)
Traditional hospital	11,716 (16.63)	976.79	548.91	−83.52 (<0.001)	13.81	6.96	25.99 (<0.001)
Bed grade							
Under 100 beds	32,134 (45.61)	863.01	893.49	–	8.98	6.97	–
100–300 beds	27,002 (38.32)	1238.35	1423.88	29.75 (<0.001)	8.81	7.98	−2.66 (0.0078)
More than 300 beds	11,321 (16.07)	2470.97	2726.13	96.28 (<0.001)	10.76	9.4	20.95 (<0.001)
Region							
Capital city	12,035 (17.08)	1469.72	2155.54	–	7.40	7.95	–
Metropolitan area	25,657 (36.42)	1301.73	1567.39	−9.38 (<0.001)	10.37	7.74	34.6 (<0.001)
Nonmetropolitan area	32,765 (46.5)	1161.52	1423.23	−17.83 (<0.001)	8.95	7.70	18.75 (<0.001)
No. of WM doctors per 50 beds							
0 < n ≤ 3	20,111 (28.54)	915.03	675.15	–	11.92	7.25	–
3 < n ≤ 5	16,382 (23.25)	1028.2	1167.25	6.82 (<0.001)	8.26	7.43	−45.58 (<0.001)
5 < n ≤ 7	17,041 (24.19)	1230.49	1530.59	19.23 (<0.001)	7.68	7.58	−53.4 (<0.001)
n > 7	16,923 (24.02)	1945.8	2473.7	62.71 (<0.001)	8.40	8.27	−44.22 (<0.001)
No. of KM doctors per 50 beds							
0 < n ≤ 1	60,929 (86.48)	1310.52	1727.89	–	8.50	7.64	–
1 < n ≤ 2	6368 (9.04)	926.77	366.63	−17.97 (<0.001)	13.45	4.79	49.31 (<0.001)
2 < n ≤ 3	975 (1.38)	979.36	503.48	−6.33 (<0.001)	14.33	7.35	23.67 (<0.001)
n > 3	2185 (3.1)	1116.13	1005.17	−5.51 (<0.001)	14.00	12.45	33.14 (<0.001)
No. of nurses per 50 beds							
0 < n ≤ 7	17,769 (25.22)	878.51	593.59	–	11.65	6.28	–
7 < n ≤ 18	16,775 (23.81)	944.67	1101.50	3.94 (<0.001)	8.33	8.10	−40.11 (<0.001)
18 < n ≤ 30	18,505 (26.26)	1194.43	1434.45	19.3 (<0.001)	8.29	8.27	−41.58 (<0.001)
n > 30	17,408 (24.71)	2044.11	2473.25	70.12 (<0.001)	8.51	7.97	−38.21 (<0.001)
Total	70,457 (100)	1265.22	1625.66		9.20	7.82	–
	Mean	SD	Min	1/4 Quartile	Median	3/4 Quartile	Max
Expense per patient	1265.22	1625.66	5.45	311.65	782.31	1481.04	40,017.99
Length of stay	9.20	7.82	2.00	3.00	7.00	14.00	116.00

CCI = Charlson Comorbidity Index, NHI = National Health Insurance, SD = standard deviation, TM = traditional medicine, WM = Western Medicine.

* Expense per patient was converted with an annual average exchange rate of the year 2018 (1USD = 1100.58KRW).

† Comorbidity level was measured using the CCI, defined as the sum of weights related to each condition for which a patient submitted claims.

‡ The primary diagnosis was as defined according to guidelines for traditional spinal specialty hospital medical quality assessment surveys provided by the Ministry of Health and Welfare.

Table 2

Associations between medical expenses per case and IHI according to disease.

	Spondylosis			Back pain			Sprain and strain			Intervertebral disc disorders			Fracture		
Parameter	**Estimate**	**SE**	**Pr > t**	**Estimate**	**SE**	**Pr > t**	**Estimate**	**SE**	**Pr > t**	**Estimate**	**SE**	**Pr > t**	**Estimate**	**SE**	**Pr > t**
IHI	−0.023	0.01	0.000	−0.020	0.01	0.016	−0.030	0.01	<0.0001	0.005	0.00	0.142	0.058	0.01	<0.0001
IHI (quadratic)	0.002	0.00	0.005	0.002	0.00	0.004	0.003	0.00	<0.0001	0.000	0.00	0.692	−0.007	0.00	<0.0001
ln (length of stay)	0.900	0.01	<0.0001	0.972	0.01	<0.0001	0.941	0.01	<0.0001	0.914	0.00	<0.0001	0.737	0.01	<0.0001
Sex															
Male		ref.			ref.			ref.			ref.			ref.	
Female	0.037	0.01	<0.0001	0.007	0.01	0.373	−0.004	0.01	0.570	−0.009	0.00	0.050	−0.013	0.01	0.219
Age															
Under 40		ref.			ref.			ref.			ref.			ref.	
40–64	0.003	0.02	0.8819	0.024	0.01	0.0094	0.020	0.01	0.013	0.052	0.01	<0.0001	0.042	0.02	0.0702
65≤	0.088	0.02	<0.0001	0.076	0.01	<0.0001	0.070	0.01	<0.0001	0.154	0.01	<0.0001	0.145	0.02	<0.0001
Comorbidity level (CCI)†															
Minor (CCI ≤ 1)		ref.			ref.			ref.			ref.			ref.	
Moderate (CCI = 2)	0.024	0.01	0.024	0.005	0.01	0.739	0.003	0.01	0.851	0.014	0.01	0.086	0.013	0.01	0.323
Severe (CCI ≥ 3)	0.031	0.01	0.0002	0.005	0.01	0.6409	0.000	0.01	0.9854	0.031	0.01	<0.0001	0.006	0.01	0.5972
Insurance type															
Medicare		ref.			ref.			ref.			ref.			ref.	
NHI	0.047	0.01	0.0002	0.138	0.02	<0.0001	0.101	0.01	<0.0001	0.062	0.01	<0.0001	0.040	0.02	0.0095
Surgery															
No		ref.			ref.			ref.			ref.			ref.	
Yes	0.953	0.01	<0.0001	0.728	0.04	<0.0001	0.677	0.03	<0.0001	0.817	0.01	<0.0001	0.447	0.01	<0.0001
Hospital type															
Tertiary general hospital		ref.			ref.			ref.			ref.			ref.	
General hospital	−0.172	0.02	<0.0001	−0.136	0.03	<0.0001	0.137	0.06	0.0139	−0.106	0.02	<0.0001	−0.175	0.02	<0.0001
Western hospital	−0.514	0.02	<0.0001	−0.513	0.03	<0.0001	−0.165	0.06	0.0042	−0.558	0.02	<0.0001	−0.399	0.03	<0.0001
Traditional hospital	−0.312	0.04	<0.0001	−0.476	0.04	<0.0001	−0.014	0.06	0.8179	−0.560	0.03	<0.0001	−0.538	0.08	<0.0001
Bed grade															
Under 100 beds		ref.			ref.			ref.			ref.			ref.	
100–300 beds	0.039	0.01	<0.0001	0.060	0.02	0.0001	0.121	0.01	<0.0001	0.036	0.01	<0.0001	0.110	0.01	<0.0001
More than 300 beds	0.029	0.02	0.0845	0.120	0.02	<0.0001	0.158	0.02	<0.0001	0.078	0.01	<0.0001	0.155	0.02	<0.0001
Region															
Capital city	−0.027	0.01	0.006	−0.023	0.02	0.182	0.022	0.02	0.170	−0.065	0.01	<0.0001	0.027	0.01	0.063
Metropolitan area	0.036	0.01	<0.0001	0.037	0.01	0.0001	0.029	0.01	0.0009	0.024	0.01	<0.0001	−0.013	0.01	0.2361
Nonmetropolitan area		ref.			ref.			ref.			ref.			ref.	
No. of WM doctors per 50 beds															
0 < n ≤ 3		ref.			ref.			ref.			ref.			ref.	
3 < n ≤ 5	0.121	0.02	<0.0001	0.125	0.02	<0.0001	0.075	0.02	<0.0001	0.030	0.01	0.0009	0.076	0.02	<0.0001
5 < n ≤ 7	0.115	0.02	<0.0001	0.074	0.03	0.0053	0.075	0.02	0.0001	0.052	0.01	<0.0001	0.108	0.02	<0.0001
n > 7	0.170	0.02	<0.0001	0.170	0.03	<0.0001	0.104	0.02	<0.0001	0.118	0.01	<0.0001	0.143	0.02	<0.0001
No. of TM doctors per 50 beds															
0 < n ≤ 1		ref.			ref.			ref.			ref.			ref.	
1 < n ≤ 2	−0.283	0.04	<0.0001	0.030	0.01	0.021	0.015	0.01	0.216	−0.031	0.02	0.112	−0.031	0.08	0.707
2 < n ≤ 3	−0.161	0.06	0.010	0.034	0.02	0.120	0.017	0.02	0.423	−0.013	0.03	0.662	0.053	0.12	0.648
3 < n	−0.251	0.04	<0.0001	−0.017	0.02	0.482	−0.074	0.02	0.001	0.062	0.02	0.006	−0.017	0.10	0.857
No. of nurses per 50 beds															
0 < n ≤ 7		ref.			ref.			ref.			ref.			ref.	
7 < n ≤ 18	0.003	0.01	0.864	0.099	0.02	<0.0001	0.096	0.01	<0.0001	0.035	0.01	0.0001	0.065	0.02	0.0005
18 < n ≤ 30	0.009	0.02	0.5955	0.130	0.03	<0.0001	0.210	0.02	<0.0001	0.046	0.01	<0.0001	0.168	0.02	<0.0001
n > 30	0.138	0.02	<0.0001	0.172	0.03	<0.0001	0.272	0.02	<0.0001	0.110	0.01	<0.0001	0.286	0.02	<0.0001
Intercept	11.885	0.03	<0.0001	11.565	0.04	<0.0001	11.285	0.06	<0.0001	11.861	0.02	<0.0001	12.224	0.04	<0.0001

Notes: A generalized linear mixed model was performed by adjusting for covariates. The dependent variable is the natural log of expense per patient, and the independent variable is the IHI. The model was adjusted for patient characteristic covariates (sex, age, comorbidity level, insurance type, surgery, and primary diagnosis) and hospital characteristic covariates (hospital type, bed grade, the number of WM doctors, KM doctors, and nurses per 50 beds).

CCI = Charlson Comorbidity Index, IHI = Inner Herfindahl–Hirschman Index, NHI = National Health Insurance, SE = standard error, TM = traditional medicine, WM = Western medicine.

specialization status. However, the length of stay did not decrease; this may be because the diseases were chronic in nature, requiring long-term treatment.[42,43] For intervertebral disc disorders (48.77%), increased specialization status was associated with increased medical expenses but decreased length of stay. Previous research has shown that increased specialization enables the hospital to narrow the scope of its services, develop expertise, and ultimately obtain financial benefits.[44–46] Furthermore, providing specialized care services reduces production costs to bring in financial benefits.[18] Ultimately, hospitals that have specialized care services provide enhanced individual care services, which has a positive effect on hospitals' operational efficiency[47–48] and can ensure the continuum of care at small hospitals within the medical system.

In this study, we showed that having a greater number of medical professionals was associated with a greater decrease in length of stay. Although not statistically significant, the length of stay was also shorter in the group with at least 3 traditional Korean doctors per 50 beds (Table 2, Supplemental Digital Content, http://links.lww.com/MD/G350). The efficient management of healthcare professionals is an important part of ensuring hospitals' operational efficiency. These findings are consistent

Table 3

Associations between the length of stay and IHI according to disease.

	Spondylosis			Back pain			Sprain and strain			Intervertebral disc disorders			Fracture		
Parameter	Estimate	SE	Pr > t	Estimate	SE	Pr > t	Estimate	SE	Pr > t	Estimate	SE	Pr > t	Estimate	SE	Pr > t
IHI	−0.019	0.01	0.001	0.020	0.01	0.009	0.033	0.01	<0.0001	−0.029	0.00	<0.0001	−0.095	0.01	<0.0001
IHI (quadratic)	0.002	0.00	0.003	−0.002	0.00	0.016	−0.003	0.00	<0.0001	0.003	0.00	<0.0001	0.010	0.00	<0.0001
ln (total expense)	0.724	0.00	<0.0001	0.798	0.01	<0.0001	0.815	0.01	<0.0001	0.735	0.00	<0.0001	0.940	0.01	<0.0001
Sex															
Male		ref.			ref.			ref.			ref.			ref.	
Female	0.013	0.01	0.051	0.011	0.01	0.151	0.017	0.01	0.013	0.035	0.00	<0.0001	0.030	0.01	0.013
Age															
Under 40		ref.			ref.			ref.			ref.			ref.	
40–64	0.025	0.02	0.1442	0.005	0.01	0.5792	0.002	0.01	0.7552	−0.018	0.00	0.0002	0.008	0.03	0.76
≥65	0.014	0.02	0.4346	0.009	0.01	0.5026	−0.015	0.01	0.1935	−0.036	0.01	<0.0001	−0.111	0.03	<0.0001
Comorbidity level (CCI)[†]															
Minor (CCI ≤ 1)		ref.			ref.			ref.			ref.			ref.	
Moderate (CCI = 2)	0.005	0.01	0.605	−0.010	0.01	0.464	−0.003	0.01	0.801	0.010	0.01	0.172	−0.007	0.01	0.628
Severe (CCI ≥ 3)	0.006	0.01	0.4575	−0.005	0.01	0.6122	0.010	0.01	0.3115	0.006	0.01	0.3121	−0.004	0.01	0.74
Insurance type															
Medicare		ref.			ref.			ref.			ref.			ref.	
NHI	−0.137	0.01	<0.0001	−0.155	0.01	<0.0001	−0.130	0.01	<0.0001	−0.151	0.01	<0.0001	−0.088	0.02	<0.0001
Surgery															
No		ref.			ref.			ref.			ref.			ref.	
Yes	−0.309	0.01	<0.0001	−0.394	0.03	<0.0001	−0.366	0.03	<0.0001	−0.281	0.01	<0.0001	−0.428	0.01	<0.0001
Hospital type															
Tertiary general hospital		ref.			ref.			ref.			ref.			ref.	
General hospital	0.229	0.01	<0.0001	0.096	0.02	<0.0001	−0.030	0.05	0.5642	0.114	0.01	<0.0001	0.249	0.03	<0.0001
Western hospital	0.368	0.02	<0.0001	0.319	0.03	<0.0001	0.172	0.05	0.0014	0.346	0.02	<0.0001	0.369	0.03	<0.0001
Traditional hospital	0.457	0.04	<0.0001	0.396	0.04	<0.0001	0.132	0.06	0.0202	0.628	0.02	<0.0001	0.596	0.09	<0.0001
Bed grade															
Under 100 beds		ref.			ref.			ref.			ref.			ref.	
100–300 beds	−0.020	0.01	0.0235	−0.027	0.01	0.056	−0.083	0.01	<0.0001	−0.017	0.01	0.0019	−0.043	0.02	0.0119
More than 300 beds	0.014	0.02	0.3659	−0.080	0.02	0.0003	−0.101	0.02	<0.0001	−0.025	0.01	0.0161	−0.064	0.02	0.0059
Region															
Capital city	−0.032	0.01	0.000	−0.018	0.02	0.244	−0.032	0.01	0.032	0.015	0.01	0.012	−0.040	0.02	0.016
Metropolitan area	0.012	0.01	0.1303	−0.012	0.01	0.1505	−0.007	0.01	0.3643	0.024	0.00	<0.0001	0.051	0.01	<0.0001
Nonmetropolitan area		ref.			ref.			ref.			ref.			ref.	
No. of WM doctors per 50 beds															
0 < n ≤ 3		ref.			ref.			ref.			ref.			ref.	
3 < n ≤ 5	−0.146	0.01	<0.0001	−0.171	0.02	<0.0001	−0.124	0.01	<0.0001	−0.083	0.01	<0.0001	−0.059	0.02	0.0057
5 < n ≤ 7	−0.181	0.01	<0.0001	−0.158	0.02	<0.0001	−0.158	0.02	<0.0001	−0.144	0.01	<0.0001	−0.113	0.02	<0.0001
n > 7	−0.239	0.02	<0.0001	−0.265	0.02	<0.0001	−0.207	0.02	<0.0001	−0.209	0.01	<0.0001	−0.174	0.03	<0.0001
No. of TM doctors per 50 beds															
0 < n ≤ 1		ref.			ref.			ref.			ref.			ref.	
1 < n ≤ 2	0.262	0.04	<0.0001	−0.031	0.01	0.007	−0.019	0.01	0.087	0.050	0.02	0.005	0.133	0.09	0.148
2 < n ≤ 3	0.190	0.06	0.001	−0.024	0.02	0.216	−0.021	0.02	0.304	0.069	0.03	0.010	0.005	0.13	0.967
n > 3	0.120	0.04	0.003	−0.031	0.02	0.167	−0.007	0.02	0.735	−0.041	0.02	0.045	0.113	0.11	0.294
No. of nurses per 50 beds															
0 < n ≤ 7		ref.			ref.			ref.			ref.			ref.	
7 < n ≤ 18	−0.073	0.01	<0.0001	−0.128	0.02	<0.0001	−0.118	0.01	<0.0001	−0.072	0.01	<0.0001	−0.114	0.02	<0.0001
18 < n ≤ 30	−0.090	0.01	<0.0001	−0.163	0.02	<0.0001	−0.195	0.02	<0.0001	−0.093	0.01	<0.0001	−0.220	0.02	<0.0001
n > 30	−0.215	0.02	<0.0001	−0.232	0.03	<0.0001	−0.264	0.02	<0.0001	−0.170	0.01	<0.0001	−0.361	0.03	<0.0001
Intercept	−7.895	0.06	<0.0001	−8.715	0.08	<0.0001	−8.768	0.09	<0.0001	−8.022	0.04	<0.0001	−10.789	0.11	<0.0001

Notes: A generalized linear mixed model was performed by adjusting for covariates. The dependent variable is the natural log of length of stay, and the independent variable is the IHI. The model was adjusted for patient characteristic covariates (sex, age, comorbidity level, insurance type, surgery, and primary diagnosis) and hospital characteristic covariates (hospital type, bed grade, the number of WM doctors, KM doctors, and nurses per 50 beds).

CCI = Charlson Comorbidity Index; IHI = Inner Herfindahl–Hirschman Index; NHI = National Health Insurance; SE = standard error; TM = traditional medicine; WM = Western medicine.

with those of previous studies.[49–51] Hospitals' attainment of a certain number of care professionals positively affects patient outcomes and hospitals' operational efficiency. Therefore small- and medium-sized hospitals should also focus on maximizing expertise (in other words, human capital, such as experiential knowledge and technical know-how).[52]

The study has the following limitations. First, although there is a specialized hospital repository in Korea, it was difficult to identify specialized hospitals owing to data limitations. In this study, the study population was selected based on KCD.[31] Although HIRA-NIS is representative of the general Korean population and examines all institutional medical services utilized by patients, it is an administrative database established for the purposes of claims. It is possible that using KCD alone for patient selection limits the classification of patient groups. Moreover, the validity of the KCD codes used in this study is limited; therefore, the results must be interpreted carefully. Second, this study used secondary data. The data on hospital characteristics were limited, suggesting the potential for bias. For example, the characteristics of the medical service providers (eg, doctor, traditional Korean doctor, and nurse) are important factors for hospital utilization. However, owing to the limitations of using a claims database, the characteristics of the medical service providers could not be obtained. If hospital-related variables can be obtained in the future, the relationship between a hospital's specialization status and performance can be analyzed in more detail. Third, we assessed the patients who have been hospitalized with nonsurgical spinal joint diseases. Since hospital-level institutions mainly treat inpatients, clinic-level institutions for outpatient were excluded. In addition, there was a mismatch in the data between the levels of hospitals and the number of hospital beds. This may have resulted from a mismatch between the number of hospital beds suggested by Korean medical laws and the actual number of hospital beds in hospitals.

Last, the establishment of causal effects is limited, in addition to generalizability to other populations, because this study only included the data of patients with nonsurgical spinal joint diseases in 2018. Although this study found a significant relationship between specialization status and health outcomes of hospitals with regard to nonsurgical spinal joint diseases, the results were not identical for all diseases. Therefore, hospital executives must be careful and rely on objective evidence, while making decisions on which disease group the hospital should strive to specialize in. Despite these limitations, this was the first study to be conducted on patients with nonsurgical spinal joint diseases using the most recent (2018) HIRA-NIS data. Although there is previous research on specialized hospitals for surgical spinal joint diseases,[16] the generalizability of those findings to nonsurgical spinal joint diseases is limited. The specialization of hospital care is a strategy that differentiates the size of resources and the level of care according to the patient's demand for medical services. In this study, the specialization status and hospital operational performance (medical expenses and length of stay) were found to have a negative correlation. In particular, negative correlations were more often observed in the small- and medium-sized hospitals, compared with tertiary general hospitals. It is important for small- and medium-sized hospitals that are struggling amid fierce competition not only to secure adequate human resources but also to secure adequate human capital capabilities such as expertise, experience, knowledge, and technical know-how.[53] These outcomes can help hospital executives in the medical services or policymakers in the government to understand the effects of the hospital specialization strategy.

5. Conclusions

The hospital specialization status was found to have a negative correlation with health outcomes (medical expenses and length of stay) in nonsurgical spinal joint diseases. The results of this study will serve as the basis for the identification of efficient and qualitative medical services in hospitals facing management difficulties due to loss of competitiveness.

Author contributions

Conceptualization, BJ; methodology, JY; software, BJ and JY; validation, IHH and SJK; formal analysis, BJ and JY; investigation, BJ; resources, IHH; data curation, BJ and JY; writing—original draft preparation, BJ and JY; writing—review and editing, IHH and SJK; supervision, IHH and BJ.
Conceptualization: Boyoung Jung.
Data curation: Boyoung Jung, Jiyoon Yeo.
Formal analysis: Boyoung Jung, Jiyoon Yeo.
Investigation: Boyoung Jung.
Methodology: Jiyoon Yeo.
Resources: In-Hyuk Ha.
Software: Boyoung Jung, Jiyoon Yeo.
Supervision: Boyoung Jung, In-Hyuk Ha.
Validation: Sun Jung Kim, In-Hyuk Ha.
Writing – original draft: Boyoung Jung, Jiyoon Yeo.
Writing – review & editing: Sun Jung Kim, In-Hyuk Ha.

References

[1] Dayhoff DA, Cromwell J. Measuring differences and similarities in hospital caseloads: a conceptual and empirical analysis. Health Serv Res 1993;28:292.
[2] Eastaugh SR. Hospital specialization and cost efficiency: benefits of trimming product lines. Hosp Health Serv Adm 1992;37:223–36.
[3] Farley DE, Hogan C. Case-mix specialization in the market for hospital services. Health Serv Res 1990;25:757–83.
[4] Dayhoff DA, Cromwell J. Measuring differences and similarities in hospital caseloads: a conceptual and empirical analysis. Health Serv Res 1993;28:292–312.
[5] Zwanziger J, Melnick GA, Simonson L. Differentiation and specialization in the California hospital industry 1983 to 1988. Med Care 1996; 34:361–72. https://doi.org/10.1097/00005650-199604000-00007.
[6] Cram P, Vaughan-Sarrazin MS, Wolf B, Katz JN, Rosenthal GE. A comparison of total hip and knee replacement in specialty and general hospitals. J Bone Joint Surg Am 2007;89:1675–84. https://doi.org/10.2106/JBJS.F.00873.
[7] Cram P, Rosenthal GE, Vaughan-Sarrazin MS. Cardiac revascularization in specialty and general hospitals. N Engl J Med 2005;352:1454–62. https://doi.org/10.1056/NEJMsa042325.
[8] Cram P, House JA, Messenger JC, Piana RN, Horwitz PA, Spertus JA. Percutaneous coronary intervention outcomes in US hospitals with varying structural characteristics: analysis of the NCDR. Am Heart J 2012;163:222–9. https://doi.org/10.1016/j.ahj.2011.10.010.
[9] Cram P, Bayman L, Popescu J, Vaughan-Sarrazin MS. Acute myocardial infarction and coronary artery bypass grafting outcomes in specialty and general hospitals: analysis of state inpatient data. Health Serv Res 2010;45:62–78. https://doi.org/10.1111/j.1475-6773.2009.01066.x.
[10] Katz JN, Bierbaum BE, Losina E. Case mix and outcomes of total knee replacement in orthopaedic specialty hospitals. Med Care 2008;46:476–80. https://doi.org/10.1097/MLR.0b013e31816c43c8.
[11] Hagen TP, Vaughan-Sarrazin MS, Cram P. Relation between hospital orthopaedic specialisation and outcomes in patients aged 65 and older: retrospective analysis of US Medicare data. BMJ 2010;340:c165https://doi.org/10.1136/bmj.c165.
[12] Hwang CW, Anderson GF, Diener-West M, Powe NR. Comorbidity and outcomes of coronary artery bypass graft surgery at cardiac specialty hospitals versus general hospitals. Med Care 2007;45:720–8. https://doi.org/10.1097/MLR.0b013e3180537192.
[13] Farley DE. Measuring casemix specialization and the concentration of diagnoses in hospitals using information theory. J Health Econ 1989;8:185–207. https://doi.org/10.1016/0167-6296(89)90003-9.
[14] Schneider JE, Miller TR, Ohsfeldt RL, Morrisey MA, Zelner BA, Pengxiang Li. The economics of specialty hospitals. Med Care Res Rev 2008;65:531–53. https://doi.org/10.1177/1077558708316687.
[15] Barro JR, Huckman RS, Kessler D. The effects of cardiac specialty hospitals on the cost and quality of medical care. J Health Econ 2006;25:702–21. https://doi.org/10.1016/j.jhealeco.2005.11.001.
[16] Kim SJ, Yoo JW, Lee SG, Kim TH, Han KT, Park EC. Governmental designation of spine specialty hospitals, their characteristics, performance and designation effects: a longitudinal study in Korea. BMJ Open 2014;4:e006525https://bmjopen.bmj.com/content/4/11/e006525.short.
[17] Kim JH, Park EC, Kim TH, Lee KS, Kim YH, Lee SG. The impact of hospital specialization on length of stay per case and hospital charge per case. Health Policy Manag 2016;26:107.
[18] Yoo HW, Kim KH. Relationship between medical service specialization and operational performance in hospitals: focusing on length of stay and medical expense. Kor J Health Serv Manag 2016;10:1–11.
[19] Seulki Seo JC. Does hospital specialization matter in length of stay and inpatient charges? Multilevel analysis of patients with colon-rectal, joint, and cerebrovascular diseases. Health Serv Manag Rev 2019;13:17–26. http://210.101.116.28/kiss5/preview.asp.
[20] Bodeker GJB. Lessons on integration from the developing world's experience. BMJ 2001;322:164–7. https://doi.org/10.1136/bmj.322.7279.164.

[21] Jung B, Bae S, Kim S. Use of Western medicine and traditional Korean medicine for joint disorders: a retrospective comparative analysis based on Korean nationwide insurance data. Evid Based Complement Alternat Med 2017;2017:2038095https://doi.org/10.1155/2017/2038095.
[22] Yoo MS. Status of Operation and Promotion of Special Hospital Designation and Evaluation System In HIRA Health Policy. 2012;12–9.
[23] Korean Special Hospital Association Korean Special Hospital Association. 2019. Available at: http://xn–vk1bx9mc9aq6uptae6ag83drjbx5a.com/clinic/clinic3.html?cate_idx=20. Accessed March 9, 2020.
[24] Kim L, Kim JA, Kim S. A guide for the utilization of health insurance review and assessment service national patient samples. Epidemiol Health 2014;36.
[25] Kim JA, Yoon S, Kim LY, Kim DS. Towards actualizing the value potential of Korea Health Insurance Review and Assessment (HIRA) data as a resource for health research: strengths, limitations, applications, and strategies for optimal use of HIRA data. J Kor Med Sci 2017;32:718.
[26] Lee JC, Kim KH, Kim HN, Park YH. Factors associated with the hypertension outpatients' choice of healthcare providers in Korea. J Kor Med Assoc 2011;54:9–15.
[27] Lee JC, Kim KH, Kim HN, Kim NS. Factors associated with diabetes outpatient use of tertiary or general hospitals as their usual source of care in Korea. J Kor Med Assoc 2012;55:12–8.
[28] Lee CH, Chung CK, Kim CH, Kwon JW. Health care burden of spinal diseases in the Republic of Korea: analysis of a nationwide database from 2012 through 2016. Neurospine 2018;2018:66–70. https://doi.org/10.14245/ns.1836038.019.
[29] Choi JH, Kang S, You CH, Kwon YD. The determinants of choosing traditional Korean medicine or conventional medicine: findings from the Korea health panel. Evid Based Complement Alternat Med 2015;2015:147408https://doi.org/10.1155/2015/147408.
[30] You CH, Kwon YD. Factors influencing medical institution selection for outpatient services. J Kor Med Assoc 2012;55:898–910.
[31] Korea Ministry of Health and Welfare. *The Guideline for Traditional Spinal Specialty Hospital Medical Quality Assessment Survey*, 2019.
[32] Wachtel RE, Dexter F, Barry B, Applegeet C. Use of state discharge abstract data to identify hospitals performing similar types of operative procedures. Anesth Analg 2010;110:1146–54. https://doi.org/10.1213/ANE.0b013e3181d00e09.
[33] Calkins S. The new merger guidelines and the Herfindahl–Hirschman Index. Calif L Rev 1983;71:402.
[34] Eastaugh SR. Hospital costs and specialization: benefits of trimming product lines. J Health Care Finance 2001;28:61–71.
[35] Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. J Clin Epidemiol 2004;57:1288–94. http://doi.org/10.1016/j.jclinepi.2004.03.012.
[36] Korean Hospital Association. *Statistics for Hospital Management*. 2016.
[37] Lee KS, Chun KH, Lee JS. Reforming the hospital service structure to improve efficiency: urban hospital specialization. Health Policy 2008;87:41–9. https://doi.org/10.1016/j.healthpol.2007.10.003.
[38] Barber J, Thompson S. Multiple regression of cost data: use of generalised linear models. J Health Serv Res Policy 2004;9:197–204. https://doi.org/10.1258/1355819042250249.
[39] Diehr P, Yanez D, Ash A, Hornbrook M, Lin DY. Methods for analyzing health care utilization and costs. Annu Rev Public Health 1999;20:125–44. https://doi.org/10.1146/annurev.publhealth.20.1.125.
[40] Kim D, Ko SG, Lee EK, Jung B. The relationship between spinal pain and temporomandibular joint disorders in Korea: a nationwide propensity score-matched study. BMC Musculoskelet Disord 2019;20:631https://doi.org/10.1186/s12891-019-3003-4.
[41] Capkun V, Messner M, Rissbacher C. Service specialization and operational performance in hospitals. Int J Operat Prod Manag 2012;32:468–95.
[42] Dionne C, Turcotte F, Tennina S. Length of stay in a comprehensive rehabilitation programme for chronic low-back pain and residual disability five years after. Int J Rehabil Res 1994;17:87–94. https://doi.org/10.1097/00004356-199403000-00011.
[43] Russell-Weisz D, Hindle D. High length-of-stay outliers under casemix funding of a remote rural community with a high proportion of aboriginal patients. Aust Health Rev 2000;23:47–61. https://doi.org/10.1071/ah000047.
[44] Eastaugh S. Hospital specialization: benefits-focused product line planning. J Health Care Finance 2015;41:1–10.
[45] Krishnan RA, Joshi S, Krishnan H. The influence of mergers on firms' product-mix strategies. Strat Manag J 2004;25:587–611.
[46] Huckman RS, Zinner DE. Does focus improve operational performance? Lessons from the management of clinical trials. Strat Manag J 2008;29:173–93.
[47] Dranove D. Rate-setting by diagnosis related groups and hospital specialization. RAND J Econ 1987;18:417–27.
[48] Schneider JE, Ohsfeldt RL, Morrisey MA, Li P, Miller TR, Zelner BA. Effects of specialty hospitals on the financial performance of general hospitals, 1997–2004. Inquiry 2007;44:321–34. https://doi.org/10.5034/inquiryjrnl_44.3.321.
[49] Lee H, Ko YK, Kim MW. The effects of medical staffing level on length of stay. J Korean Acad Nurs 2011;17:327 335.
[50] Nelson A, Powell-Cope G, Palacios P, et al. Nurse staffing and patient outcomes in inpatient rehabilitation settings. Rehabil Nurs 2007;32:179–202. https://doi.org/10.1002/j.2048-7940.2007.tb00173.x.
[51] Kim Y, Cho SH, June KJ, Shin SA, Kim J. Effects of hospital nurse staffing on in-hospital mortality, pneumonia, sepsis, and urinary tract infection in surgical patients. J Korean Acad Nurs 2012;42:719–29. https://doi.org/10.4040/jkan.2012.42.5.719.
[52] Covell CL. The middle-range theory of nursing intellectual capital. J Adv Nurs 2008;63:94–103. https://doi.org/10.1111/j.1365-2648.2008.04626.x.
[53] Kim WK, Chung HI. Effects of intellectual capital on organizational performance of nurses in medium and small hospitals. J Kor Acad Nurs Admin 2012;18:452–9.