

## Nationwide big data analysis of inguinal hernia surgery trends in South Korea (2016–2022)

Hyunjeong Ki<sup>1,2</sup>, Seyoung Koo<sup>2</sup>, Gil Ho Kang<sup>3</sup>, Jiyoung Sul<sup>1,2</sup>, Junbeom Park<sup>1,2</sup>

<sup>1</sup>Department of Surgery, Chungnam National University Hospital, Daejeon, Korea

<sup>2</sup>Department of Surgery, College of Medicine, Chungnam National University, Daejeon, Korea

<sup>3</sup>Department of Surgery, Hansarang Hospital, Ansan, Korea

**Purpose:** This study aimed to analyze nationwide trends and regional disparities in inguinal hernia surgeries in South Korea between 2016 and 2022. Additionally, we aimed to evaluate changes in surgery frequency, including urban concentration and the introduction of robotic surgery.

**Methods:** This retrospective review used nationwide data on inguinal hernia surgeries from the Health Insurance Review and Assessment Service database.

**Results:** From 2016 to 2022, 254,367 inguinal hernia surgeries were performed in South Korea, with males accounting for 88.9% of cases. The annual number of surgeries fluctuated, particularly in 2020, owing to the coronavirus disease 2019 pandemic. Medical costs increased from \$1,218.4 to \$1,970 on average, whereas patient copayments rose from \$180.2 to \$293.3. Robotic inguinal hernia surgeries, introduced in 2019, increased to 226 cases in 2022. Pediatric surgeries steadily declined, whereas adult surgeries remained stable, with a slight increase in 2022. The average hospital stay did not change significantly but varied between pediatric and adult patients. Regional disparities were notable, especially in pediatric surgery rates between metropolitan areas, such as Seoul and the surrounding provinces.

**Conclusion:** This study highlights stable overall surgery rates, a decline in pediatric cases, and an increase in robotic inguinal hernia surgeries. The persistent concentration of healthcare services in metropolitan areas suggests a need for policy interventions to address regional disparities and ensure equitable healthcare access. The findings underscore the importance of ongoing efforts to improve healthcare distribution and the need for long-term strategies to address changing surgical trends.

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**Key Words:** Data analysis, Healthcare, Inguinal hernia, Surgery

### INTRODUCTION

Inguinal hernia is a common condition requiring surgical intervention worldwide. It occurs when abdominal contents protrude through the inguinal canal, posing significant health risks if untreated, including incarceration or strangulation, which can lead to bowel necrosis [1]. The global incidence of inguinal hernia is high, with an estimated prevalence of 27%–

43% in males and 3%–6% in females [2]. Despite advancements in surgical techniques and postoperative care, inguinal hernias remain a substantial disease burden, especially in developing countries where limited healthcare access exacerbates the issue [3].

Research using nationwide big data can identify surgical trends in a country and provide evidence to identify current issues and improvement areas. Almost all Korean citizens have

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**Corresponding Author: Junbeom Park**

Department of Surgery, Chungnam National University College of Medicine, 282 Munhwa-ro, Jung-gu, Daejeon 35015, Korea

Tel: +82-42-280-7175, Fax: +82-42-257-8024

E-mail: jbpark@cnu.ac.kr

ORCID: <https://orcid.org/0000-0002-4804-5254>

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been enrolled since the establishment of the National Health Insurance Service (NHIS) in Korea [4]. Medical information about these citizens has been made accessible after a thorough review [5]. The first study to use big data for inguinal hernia surgery in Korea was published in 2019 by Han et al. [6]. This study presents useful information, such as the impact of implementing the diagnosis-related group (DRG) system, a major medical system introduced in Korea between 2007 and 2015, the rapid increase in laparoscopic surgery, and the continuous increase in medical costs.

This study aimed to examine the ongoing changes by comparing the findings with those of a previously published study from 2007 to 2015, using data from the Health Insurance Review & Assessment Service (HIRA) database from 2016 to 2022. This database contains comprehensive health-related data spanning numerous years and covers the entire population [5]. We investigated how the frequency of inguinal hernia surgery has changed in relation to the recently emerging social phenomenon of concentration in metropolitan areas. Furthermore, we aimed to examine the prevalence of robotic surgery, whose frequency has been increasing in hernia surgery, and consider fee-related issues, including the DRG.

## METHODS

Ethical approval for the study was obtained from the Institutional Review Board of Chungnam National University Hospital under protocol number of CNUH 2024-01-056. As the study was retrospective and used de-identified data, the requirement for informed consent was waived.

Data on inguinal hernia surgeries performed between 2016 and 2022 were retrieved from the HIRA database of South Korea. The dataset includes information on the year of surgery, patient sex and age, associated medical costs (total and shared costs), and relevant procedure codes for inguinal hernia surgery. Additional factors, such as hospital grades, DRG ratios, type of insurance coverage, total hospital days (sum of all hospital stays), and regional distribution of surgical procedures, were included.

Data collection involved the following steps: (1) Surgical data for all operations conducted during the study period were electronically collected, with the HIRA reviewing and confirming all medical expenses from January 2016 to December 2022. (2) Procedure codes covering various types of inguinal hernia repairs, including procedures with posterior wall reconstruction or those involving recurrent or femoral hernia repairs, were extracted electronically. All relevant surgeries were categorized using type, and bowel resections were noted where applicable. Fee codes Q2753-56, QA753-56, and Q2757, as outlined in the 2017 edition of the Medical Care Benefit Cost Book, were used for the cost analysis. However, only the total values of the

variables could be analyzed, preventing comparisons between groups based on the extracted data.

The retrospective analysis categorized patients into the pediatric (0–18 years) and adult (19 years and above) groups. Adolescents were included in this study. The analysis covered sex, age, insurance type, hospital level, cost sharing, regional distribution, total costs, and hospital stay over the 7 years. Statistical analyses were performed using R software ver. 3.5.1 (The R Foundation), with data stored on a secure HIRA server [7]. Additional data on robotic inguinal hernia surgery were provided by the device manufacturer (Intuitive Surgical Korea, Inc.). Comparative statistics on the medical costs for other surgeries were sourced from the Korean Statistical Information Service's website [8].

## RESULTS

From 2016 to 2022, 254,367 inguinal hernia surgeries were performed in South Korea, with male accounting for approximately 88.9% of cases. The number of annual surgeries decreased in 2020 owing to the coronavirus disease 2019 pandemic but increased to 32,495 in 2022. Medical costs gradually increased from \$1,218.4 to \$1,970 (average, \$1,638), whereas patient copayment increased from \$180.2 to \$293.3 (average, \$236.6). Robotic inguinal hernia surgery initiated in 2019 increased to 226 in 2022 (Table 1). The overall average length of hospital stay did not change significantly during the study period. However, hospital stays increased from 2.6 days in 2016 to 3.4 days in 2022 for pediatric patients, whereas a decrease from 3.8 days in 2016 to 3.3 days in 2022 was observed for adult patients.

Pediatric surgeries steadily declined from 10,048 in 2016 to 5,326 in 2022, with 50,296 performed over the study period. In contrast, adult surgeries remained relatively stable, with a slight increase in 2022, peaking at 30,986, resulting in a total of 204,071. These data suggest a decreasing trend in pediatric cases alongside stable adult surgery rates, which could be related to the decrease in national birth rates (Fig. 1).

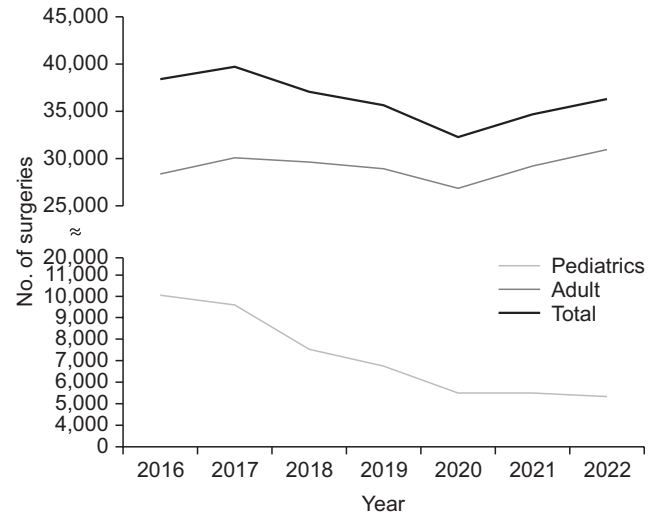
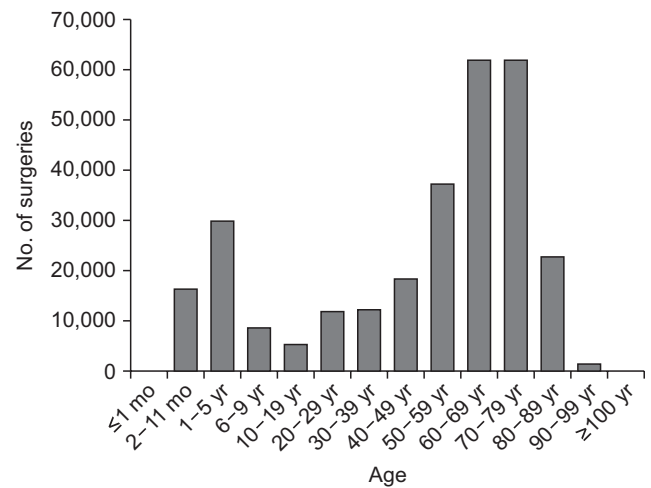
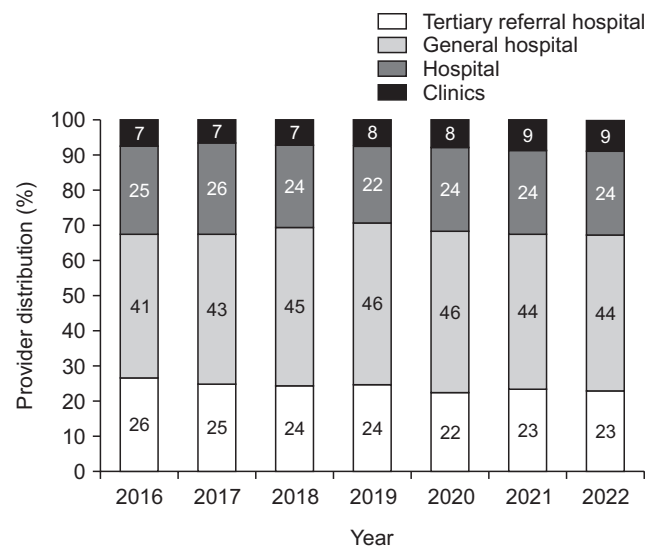
The highest incidence rates were observed in children aged 1–5 years and adults aged 60–69 years (Fig. 2). The overall composition of healthcare provider types did not differ significantly; however, surgeries in general hospitals increased by approximately 3%, whereas surgeries in tertiary referral hospitals decreased (Fig. 3).

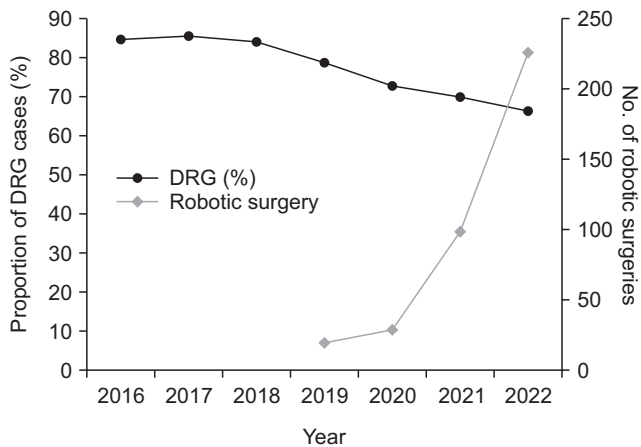
The proportion of DRG cases decreased from 85% to 66%, whereas robotic inguinal hernia surgery increased after 2019 (Fig. 4). The total medical costs per surgery gradually increased over the years. The proportion of patient copayments was 14.8% in 2016 and 14.9% in 2022 (Fig. 5). During the study period, the total medical cost and patient copayment increased at an average annual rate of 7.32% per year. The rate of increase in

**Table 1.** Incidence and demographic characteristics

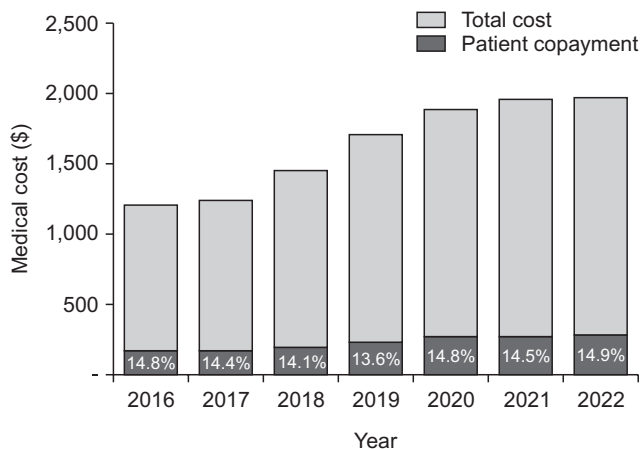
Characteristic	Year									
	2016	2017	2018	2019	2020	2021	2022	Total		
No. of cases	38,464	39,724	37,165	35,666	32,330	34,706	36,312	254,367		
Male sex, n (%)	33,951 (88.3)	35,075 (88.3)	32,874 (88.4)	31,590 (88.6)	29,019 (89.8)	31,087 (89.6)	32,495 (89.5)	226,091 (88.9)		
Adult, n (%)	28,416 (73.9)	30,112 (75.8)	29,632 (79.7)	28,910 (81.1)	26,808 (82.9)	29,207 (84.2)	30,986 (85.3)	204,071 (80.2)		
Pediatric, n (%)	10,048 (26.1)	9,612 (24.2)	7,533 (20.3)	6,756 (18.9)	5,522 (17.1)	5,499 (15.8)	5,326 (14.7)	50,296 (19.8)		
Average hospital stay (day)	3.5	3.4	3.5	3.6	3.5	3.5	3.3	3.5		
Average patient copayment (\$)	180.2	179.8	206.2	232.3	278.9	285.3	293.3	236.6		
Average total cost (\$)	1,218.4	1,246.1	1,460.2	1,712.4	1,888.9	1,969.6	1,970.1	1,638.0		
Tertiary referral hospital (%)	26	25	24	24	22	23	23	24		
General hospital (%)	41	43	45	46	46	44	44	44		
Hospital (%)	25	26	24	22	24	24	24	24		
Clinics (%)	7	7	7	8	8	9	9	8		
Public health center (%)	0	0	0	0	0	0	0	0		
DRG (%)	85	85	84	79	73	70	66	78		
No. of robot surgeries	NA	NA	NA	19	28	98	226	371		

DRG, diagnosis-related group; NA, not applicable.


**Fig. 1.** Trend of inguinal hernia surgery in pediatrics and adults.

**Fig. 2.** Distribution of inguinal hernia surgery by age.

**Fig. 3.** Distribution of healthcare providers for inguinal hernia surgery.



**Fig. 4.** Changes of proportion in the diagnose-related group (DRG) and reported robotic inguinal hernia surgery.

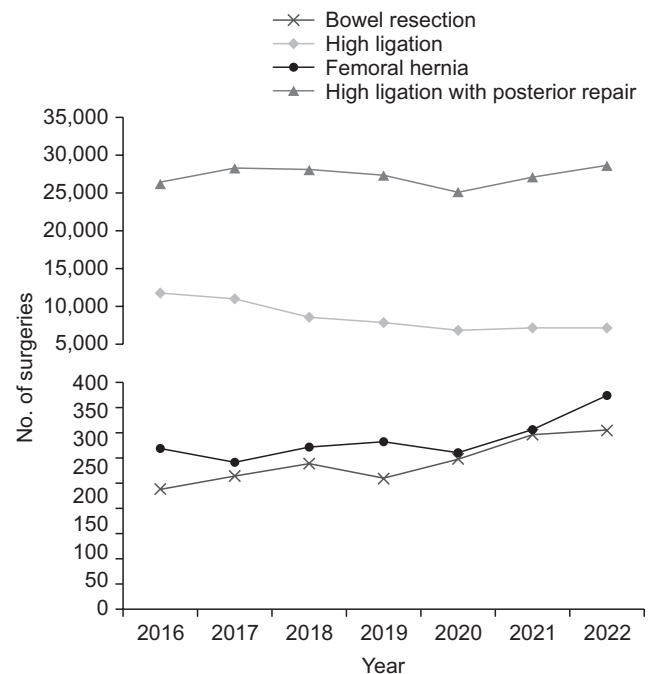


**Fig. 5.** Changes in medical cost of inguinal hernia surgery.

total medical costs plateaued since 2021.

High ligation with posterior repair had the highest volume (190,568 procedures over 7 years), followed by high ligation in 59,961 cases. Bowel resections were less frequent, with 1,825 cases. Femoral hernia surgery was the least common, with 2,013 cases. The data highlight a steady volume of high ligation-related procedures, whereas femoral hernia surgeries have slightly increased from 283 in 2016 to 376 in 2022 (Fig. 6).

The regional distribution of pediatric surgeries significantly differed between metropolitan cities and adjacent provinces. Surgeries per 10,000 childbirths in Seoul outweighed those in other regions. Seoul consistently recorded the highest surgery rates per 10,000 births across all years, peaking at 637.8 in 2022. In contrast, adjacent regions, such as Gyeonggi, had significantly lower rates, peaking at only 110.8 in 2018 and dropping to 76.3 in 2022 (Fig. 7A). Compared with adjacent regions, other metropolitan cities, such as Daejeon, Daegu, and Busan, showed similar patterns (Fig. 7B, D, F), whereas Gwangju had no definite difference between regions (Fig. 7C). For adult



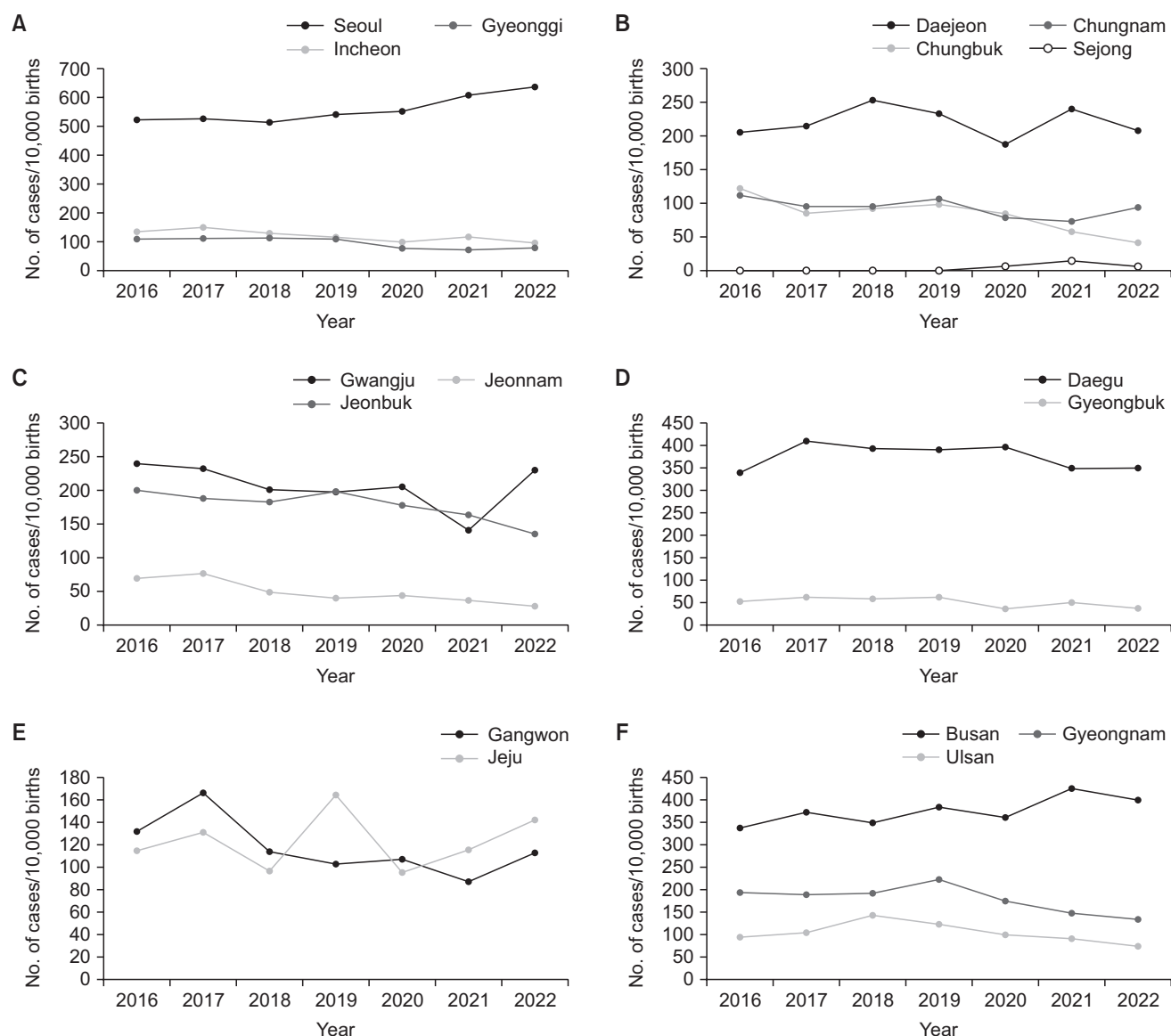
**Fig. 6.** Trend of inguinal hernia surgery by procedures.

patients, the regional disparities were not as significant as those for pediatric patients. Seoul consistently recorded the highest surgery rates, maintaining approximately 84 from 2016 to 2022. In contrast, surrounding regions, such as Gyeonggi, showed progressively increasing figures, approximately 114.86 in 2022, indicating a rising demand for surgeries on the outskirts. Other major cities, such as Busan and Daegu, had significantly lower but stable figures, remaining at approximately 29 and 20 surgeries, respectively. Smaller regions, such as Jeju and Sejong, recorded the lowest rates (Fig. 8E). Surgeries per unit population (surgeries per 10,000 childbirths in pediatrics and 100,000 population in adults) in Seoul and Gyeonggi Province showed over 80 surgeries per 100,000 population, whereas other regions ranged from 2.9 (Sejong) to 29 (Busan) (Fig. 8). Fig. 9 shows the trend toward urban concentration for pediatric and adult patients per population unit.

## DISCUSSION

Inguinal hernia surgery is a common procedure in general surgery with a long history [1,2]. However, few studies have examined surgical trends using national-level big data [6]. In Korea, the NHIS and the associated HIRA system provide highly reliable national big data because almost all citizens are enrolled in this system [9]. However, the details present in the collected data are insufficient, limiting their availability. The ability to obtain nationwide data for a single surgery is highly valuable [5].

The frequency of hernia surgeries performed from 2016 to

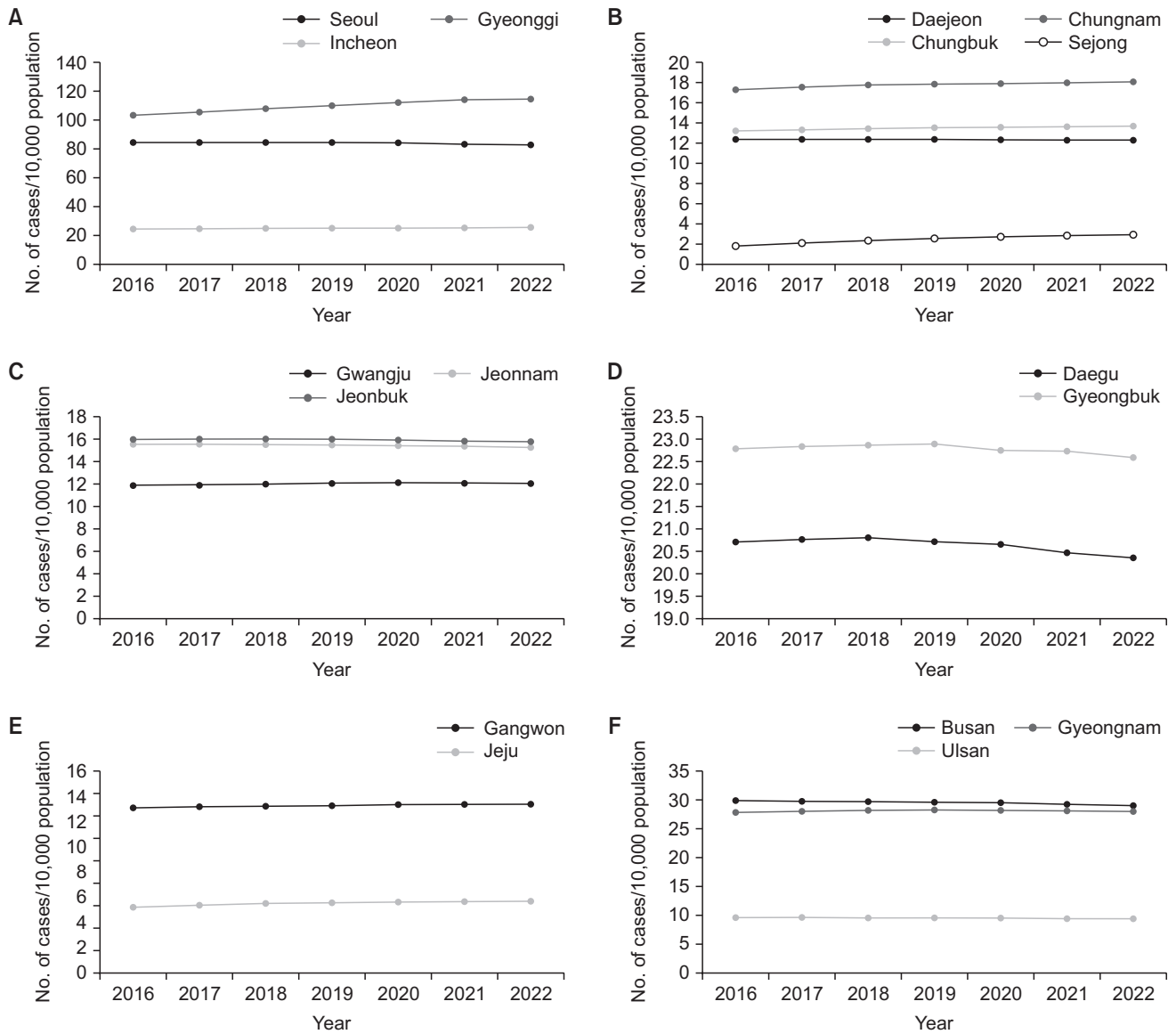


**Fig. 7.** Regional distribution of pediatric patients. (A) Seoul, Incheon, and Gyeonggi. (B) Daejeon, Chungbuk, Chungnam, and Sejong. (C) Gwangju, Jeonbuk, and Jeonnam. (D) Daegu and Gyeongbuk. (E) Gangwon and Jeju. (F) Busan, Ulsan, and Gyeongnam.

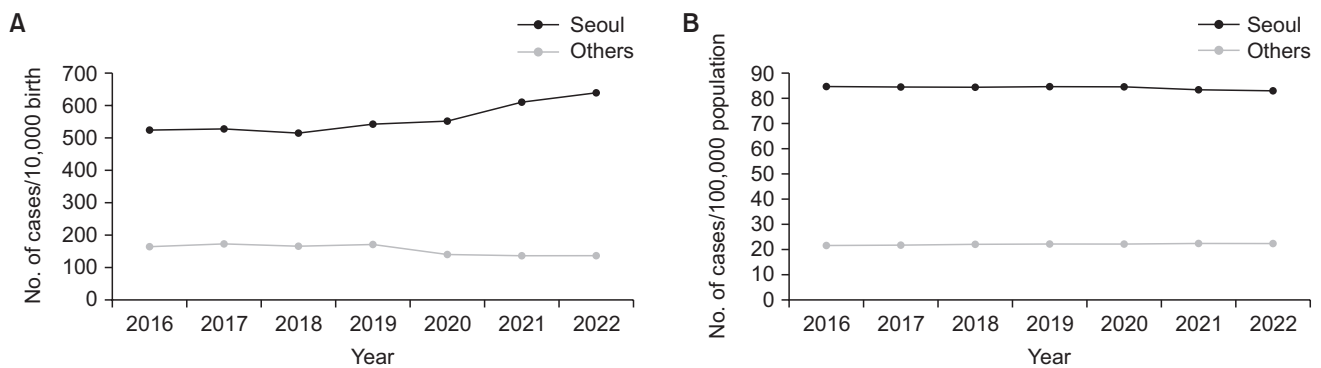
2022 averaged 36,228 annually, showing relatively consistent numbers compared with those reported in 2015. However, a significant decrease has been observed in the frequency of pediatric hernia, which was more pronounced in 2016 [6]. When examining the changes in birth rates in Korea during the same period, a similar decline was observed. Given that the ratio of surgeries per birth showed no significant differences, a correlation might exist between these factors. In contrast, the frequency of adult hernia surgeries has gradually increased, which is presumed to be related to the aging population, advancements in early screening, and developments in geriatric surgery [1,10,11]. Previous studies have reported no significant difference in the frequency of hernia surgeries; however, a 20%

reduction in surgeries was observed in 2020 during our study period. This reduction appears to be linked to the coronavirus disease 2019 pandemic, although further research is needed to determine the direct and indirect associations between surgical frequency and the pandemic [12].

Regarding the length of hospital stay, a steady decreasing trend was observed from 2007 to 2015. During the study period, the length of hospital stay remained stable without significant changes, suggesting that hernia surgery has been considerably standardized, with consistent results across different surgeons. Similarly, this phenomenon is observed in other European countries, such as the United Kingdom, where strict guidelines for inguinal hernia surgery have resulted in reduced and stable



**Fig. 8.** Regional distribution of adult patients. (A) Seoul, Incheon, and Gyeonggi. (B) Daejeon, Chungbuk, Chungnam, and Sejong. (C) Gwangju, Jeonbuk, and Jeonnam. (D) Daegu and Gyeongbuk. (E) Gangwon and Jeju. (F) Busan, Ulsan, and Gyeongnam.



**Fig. 9.** Regional comparison between Seoul and other regions. (A) Pediatric patient group and (B) adult patient group.



hospital stays [13].

Since 2007, medical costs have increased due to the introduction of laparoscopy, the development of various treatment materials, and rising health insurance fees [14,15]. Likewise, patient copayments have also increased at a similar rate to total medical costs, indicating a proportional rise in both expenses despite the implementation of the DRG system [16].

Recently, the use of robotic surgery has significantly increased worldwide [17], expanding into hernia and cancer surgeries [18]. In Korea, robotic inguinal hernia surgery was not covered by the NHIS until 2019. Before that, it could only be performed experimentally in a limited number of cases without proper cost coverage [19]. However, since 2019, private insurance has provided coverage under self-pay, leading to an increase from 19 cases in 2019 and rapidly increasing to 226 cases in 2022, indicating a continuing upward trend. The proportion of DRG implementations led by the government during this period gradually decreased, possibly owing to the increased coverage by private insurance. DRG systems can limit medical advancements; therefore, a more flexible operational system is necessary [20]. Recently, the Korean DRG system has explored changes from multiple perspectives, such as separately recognizing certain treatment materials [7]. Developing a more rational health insurance fee structure that reflects recent changes in surgical trends is essential for the future.

An unavoidable social issue in the current healthcare delivery system of South Korea is the overconcentration of medical services in metropolitan areas [21], which was observed in this study. Particularly when comparing Seoul, the representative city of Korea, with surrounding cities, for adults, Seoul had a significantly higher rate of adult hernia surgeries, ranging from 83.0 to 84.7 surgeries per 100,000 population, which is approximately four times higher than the other cities' averages. For pediatrics, the surgery frequency relative to the birth rate in Seoul and surrounding Gyeonggi Province showed a more pronounced difference. In Seoul, pediatric surgery rates increased by 18%, from 523.5 cases in 2016 to 637.8 cases in 2022, whereas the rates decreased by 25%, from 107.7 cases in 2016 to 76.3 cases in 2022 in Gyeonggi Province. This finding correlates with a previous study on socioeconomic inequity in the regional distribution of healthcare resources, which can have a greater impact on pediatric patients [22].

Regional disparities in surgery rates and economic burdens highlight the inequity in access to surgical care. Higher surgery rates in metropolitan areas, such as Seoul and Gyeonggi Province, suggest better access to healthcare services. Conversely, lower rates in rural areas may be attributed to limited healthcare infrastructure and resources, leading to delays in treatment and adversely affecting outcomes [23].

While our study results do not directly explain the regional differences in trends for pediatric inguinal hernia surgeries, we

can infer the existence of an urban centralization phenomenon. This is likely due to the relative ease of access to and preference for larger facilities. Considering the higher incidence of inguinal hernias in premature infants, we anticipate a trend where patients, especially those from more vulnerable populations, prefer larger centers for their surgeries. The data suggests a potential correlation between the concentration of surgeries in urban areas and the preference for larger medical facilities, particularly for treating conditions that are more prevalent in high-risk groups such as premature infants.

These findings suggest an urgent need for policymakers to address healthcare disparities and ensure equitable access to high-quality surgical care across the country. The concentration of surgeries in metropolitan areas, along with the sharp decrease in pediatric surgeries, could potentially worsen pediatric care and surgical infrastructure in rural areas, negatively affecting the balanced development of regional healthcare.

This study had some limitations. While the national repository of big data covers almost the entire population, the retrospective approach and availability of limited details make it difficult to derive more specific inferences about the recurrence rates and surgical outcomes or perform comprehensive cost analyses [5,9,24]. For instance, the HIRA data structurally lacks information on medical costs beyond those calculated as insurance benefits, particularly for procedures such as robotic surgery where costs can vary significantly between hospitals.

Despite these limitations, our observations of a sharp decline in pediatric surgeries, a rapid increase in robotic surgeries, and a concentration of surgeries in metropolitan areas provide valuable insights. These data can aid in developing future medical systems, including health insurance fees and healthcare delivery systems. The development of disease-specific registries could be helpful in constructing a more sophisticated database for future surgical studies [25].

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### Conflict of Interest

No potential conflict of interest relevant to this article was reported.

### ORCID iD

Hyunjeong Ki: <https://orcid.org/0000-0001-6524-8232>

Seyoung Koo: <https://orcid.org/0009-0003-1585-827X>

Gil Ho Kang: <https://orcid.org/0009-0004-8403-4212>

Jiyoung Sul: <https://orcid.org/0000-0001-6634-9481>

Junbeom Park: <https://orcid.org/0000-0002-4804-5254>

**Author Contribution**

Conceptualization: JP, JS, GHK  
 Formal Analysis: HK, SK  
 Investigation: SK

Methodology: HK

Project Administration: JP, HK

Writing – Original Draft: HK, JP

Writing – Review & Editing: All authors

**REFERENCES**

- Öberg S, Andresen K, Rosenberg J. Etiology of inguinal hernias: a comprehensive review. *Front Surg* 2017;4:52.
- Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. *Lancet* 2003;362:1561-71.
- Ohene-Yeboah M, Abantanga FA. Inguinal hernia disease in Africa: a common but neglected surgical condition. *West Afr J Med* 2011;30:77-83.
- Song YJ. The South Korean health care system. *JMAJ* 2009;52:206-9.
- 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 Korean Med Sci* 2017;32:718-28.
- Han SR, Kim HJ, Kim NH, Shin S, Yoo RN, Kim G, et al. Inguinal hernia surgery in Korea: nationwide data from 2007-2015. *Ann Surg Treat Res* 2019;97:41-7.
- Health Insurance Review & Assessment Service (HIRA), National Health Insurance Service. National Health Insurance statistical yearbook 2022 [Internet]. HIRA; 2023 [cited 2024 Oct 18]. Available from: <https://www.hira.or.kr/bbsDummy.do?pgmid=HIRAA020045020000&brdScnBltno=4&brdBltno=2315&pageIndex=1&pageIndex2=1>
- Korean Statistical Information Service. Statistics on domestic healthcare [Internet]. Statistics Korea; 2022 [cited 2024 Oct 18]. Available from: [https://kosis.kr/statHtml/statHtml.do?orgId=350&tblId=TX\\_35004\\_A016](https://kosis.kr/statHtml/statHtml.do?orgId=350&tblId=TX_35004_A016)
- Kim MK, Han K, Lee SH. Current trends of big data research using the Korean national health information database. *Diabetes Metab J* 2022;46:552-63.
- Köckerling F, Simons MP. Current concepts of inguinal hernia repair. *Visc Med* 2018;34:145-50.
- Burton V, Perez AJ. Comparison of open and laparoscopic inguinal hernia repair. *Mini-invasive Surg* 2021;5:26.
- Köckerling F, Köckerling D, Schug-Pass C. Elective hernia surgery cancellation due to the COVID-19 pandemic. *Hernia* 2020;24:1143-5.
- Jenkins JT, O'Dwyer PJ. Inguinal hernias. *BMJ* 2008;336:269-72.
- Ielpo B, Nuñez-Alfonse J, Duran H, Diaz E, Fabra I, Caruso R, et al. Cost-effectiveness of randomized study of laparoscopic versus open bilateral inguinal hernia repair. *Ann Surg* 2018;268:725-30.
- Eklund A, Carlsson P, Rosenblad A, Montgomery A, Bergkvist L, Rudberg C, et al. Long-term cost-minimization analysis comparing laparoscopic with open (Lichtenstein) inguinal hernia repair. *Br J Surg* 2010;97:765-71.
- Choi JW, Kim SJ, Park HK, Jang SI, Kim TH, Park EC. Effects of a mandatory DRG payment system in South Korea: analysis of multi-year nationwide hospital claims data. *BMC Health Serv Res* 2019;19:776.
- Sheetz KH, Claflin J, Dimick JB. Trends in the adoption of robotic surgery for common surgical procedures. *JAMA Netw Open* 2020;3:e1918911.
- Choi SI. The feasibility of robotic inguinal hernia repair in Korea. *J Minim Invasive Surg* 2023;26:108-9.
- Jung S, Lee JH, Lee HS. Early outcomes of robotic transabdominal preperitoneal inguinal hernia repair: a retrospective single-institution study in Korea. *J Minim Invasive Surg* 2023;26:128-33.
- Asadi F, Sabahi A, Ramezanghorbani N, Emami H. Challenges of implementing diagnostic-related groups and healthcare promotion in Iran: a strategic applied research. *Health Sci Rep* 2023;6:e1115.
- Park EC, Jang SI. The diagnosis of healthcare policy problems in Korea. *J Korean Med Assoc* 2012;55:932-9.
- Jeon BY, Choi SM, Kim CY. Socioeconomic equity in regional distribution of health care resources in Korea. *Korean J Health Policy Adm* 2012;22:85-108.
- Douthitt N, Kiv S, Dwolatzky T, Biswas S. Exposing some important barriers to health care access in the rural USA. *Public Health* 2015;129:611-20.
- Lee YH, Jang YJ, Lee SK. Obstacles to health big data utilization based on the perceptions and demands of health care workers in South Korea: web-based survey study. *JMIR Form Res* 2023;7:e45913.
- Stey AM, Russell MM, Ko CY, Sacks GD, Dawes AJ, Gibbons MM. Clinical registries and quality measurement in surgery: a systematic review. *Surgery* 2015;157:381-95.