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# A Nationwide Report on Metabolic and Bariatric Surgery in 2019–2022: Utilizing the Korean Society of Metabolic and Bariatric Surgery Database Registry

**Hayemin Lee [1], Yeon-Ju Huh [2], Won Jun Seo [3], Yoonhong Kim [4], Dong Jin Kim [1], on behalf of the Informatics Committee of the Korean Society for Metabolic and Bariatric Surgery**

[1]Department of Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea
[2]Department of Surgery, Seoul National University Hospital, Seoul, Korea
[3]Department of Surgery, Korea University Guro Hospital, Seoul, Korea
[4]Department of Surgery, Kosin University, College of Medicine, Busan, Korea

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**Corresponding author:**
**Dong Jin Kim**
Division of Gastrointestinal Surgery, Department of Surgery, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 1021 Tongil-ro, Eunpyeong-gu, Seoul 03312, Korea.
Tel: +82-2-2030-4383
Fax: +82-2-2030-4647
Email: djdjcap@catholic.ac.kr



**ORCID iDs**
Hayemin Lee
https://orcid.org/0000-0003-1057-0157
Yeon-Ju Huh
https://orcid.org/0000-0001-6745-7097
Won Jun Seo
https://orcid.org/0000-0003-3447-7790
Yoonhong Kim
https://orcid.org/0000-0003-1611-5390
Dong Jin Kim
https://orcid.org/0000-0001-5103-5607

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## ABSTRACT

**Purpose:** The introduction of insurance coverage in Korea has led to a rise in the number of bariatric and metabolic surgeries. This study aims to provide a comprehensive report on the nationwide status of these surgeries from 2019 to 2022, utilizing data from the Korean Society of Metabolic and Bariatric Surgery (KSMBS) database registry.
**Materials and Methods:** This study analyzed data from the KSMBS registry, collected from 68 certified surgeons across 58 institutions from January 2019 to December 2022. After excluding non-relevant cases, the final analysis included 7,377 patients.
**Results:** Annually, data for 1,869, 1,934, 1,782, and 1,792 patients were collected from 2019 to 2022, respectively. The rate of revisional operations accounted for 7.1%, 8.2%, 4.6%, and 4.5% of the total cases each year. The most common primary surgery was Sleeve Gastrectomy (SG, ranging from 71.1% to 78.9%), followed by Roux-en-Y Gastric Bypass (RYGB, ranging from 9.6% to 13.4%). The surgeries demonstrated a high safety profile, with a low morbidity rate (0.5% to 0.9%) and a zero mortality rate over the 4 years. Within 2 years post-operation, the Total Weight Loss Percentage was similar among patients who underwent SG, RYGB, and Sleeve Plus procedures.
**Conclusion:** The number of bariatric and metabolic surgeries in Korea has increased significantly since the introduction of national insurance coverage. SG was the most performed primary procedure. All surgical procedures showed safe short-term outcomes and yielded reasonable results upon follow-up, indicating a positive impact of insurance coverage on the accessibility and safety of surgeries.

**Keywords:** Metabolic surgery; Bariatric surgeries; Registries

## INTRODUCTION

Bariatric and metabolic surgeries are recognized as the most effective treatments for severe obesity and related metabolic disorders, with numerous studies underscoring their efficacy

**Conflict of Interest**

None of the authors have any conflict of interest.

**Author Contributions**

Conceptualization: Kim DJ; Data curation: Lee H, Hur YJ, Seo WJ, Kim Y; Formal analysis: Hur YJ, Seo WJ, Kim Y; Investigation: Lee H; Methodology: Kim DJ, Lee H; Project administration: Kim DJ; Resources: Seo WJ, Kim Y; Software: Hur YJ, Kim Y; Supervision: Kim DJ; Validation: Kim DJ, Lee H; Visualization: Hur YJ, Kim Y; Writing - original draft: Lee H, Hur YJ, Seo WJ, Kim Y; Writing - review & editing: Kim DJ, Lee H.

[1,2]. The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) plays a crucial role in this domain by gathering global data on these surgeries and compiling it into an annual report [3]. The Korean Society of Metabolic and Bariatric Surgery (KSMBS) has contributed to this international endeavor by documenting the progression and status of bariatric and metabolic surgeries within Korea, with reports covering the periods of 2003–2013 and 2014–2017 [4,5]. A significant milestone in Korea was the introduction of insurance coverage for these surgeries in 2019, which coincided with the KSMBS's initiation of an electronic data registry. This registry not only catalogs the activities of certified surgeons but also aligns with the accreditation system to ensure quality and standardization. The advent of insurance coverage has notably increased the volume of bariatric and metabolic surgeries in Korea, facilitating the systematic and detailed accumulation of data via the registry. In light of these developments, our objective is to present a comprehensive report on the national landscape of bariatric and metabolic surgeries in Korea from 2019 to 2022, drawing from the data meticulously recorded in the KSMBS registry.

## MATERIALS AND METHODS

This study conducted its analysis using the data from the KSMBS registry, which began recording surgeries after the implementation of health insurance coverage for severe obesity and metabolic surgery in January 2019 in South Korea. Only surgeries performed by KSMBS-certified surgeons were eligible for registration. A total of 68 certified surgeons from 58 institutions contributed data to this registry. Data extraction was performed on November 20, 2023, and included patients who underwent surgery from January 2019 to December 2022. It's important to note that the data in the registry may be updated periodically, leading to potential differences in content compared to previous reports based on this registry.

From the 8,487 entries available as of November 20, 2023, we excluded 253 cases due to surgery dates before 2019 or unspecified dates, 35 cases with missing surgery names, 1 case categorized as irrelevant, and 821 cases with surgeries performed in 2023. This resulted in a total of 7,377 patients being included in the analysis. We adapted the definitions for basic data entry items from the IFSO reporting format. Given the unique representation of surgical types in Korea, we adjusted the classifications for this study. The revised classifications for primary surgeries included Adjustable Gastric Band (AGB), Sleeve Gastrectomy (SG), Roux-en-Y Gastric Bypass (RYGB), Sleeve plus Duodenal Bypass, Sleeve plus Jejunal Bypass, Sleeve plus Other, and Other Procedures. Due to the ambiguity in the IFSO definitions for procedures such as Single Anastomosis Duodenal-ileal Bypass or Duodenal Switch and the common practice of duodenojejunal bypass in Korea, all "Sleeve Plus" surgeries were collectively categorized in this study, owing to the difficulty in differentiating between Roux-en-Y type and loop type bypasses. Patients who had undergone previous bariatric surgeries were categorized as the revisional surgery group, which included procedures like AGB removal and RYGB limb revision.

Our analysis primarily consisted of descriptive statistics. We evaluated the distribution of annual surgical volumes and the types of hospitals involved. The analysis was presented with distinctions between primary and revisional surgeries, focusing on basic information and surgical types. Surgical types were further analyzed across 3 body mass index (BMI) groups (BMI <35, 35≤ BMI <50, BMI ≥50). For post-operative follow-up, weight changes were compared among 3 surgical groups: SG, RYGB, and Sleeve Plus.

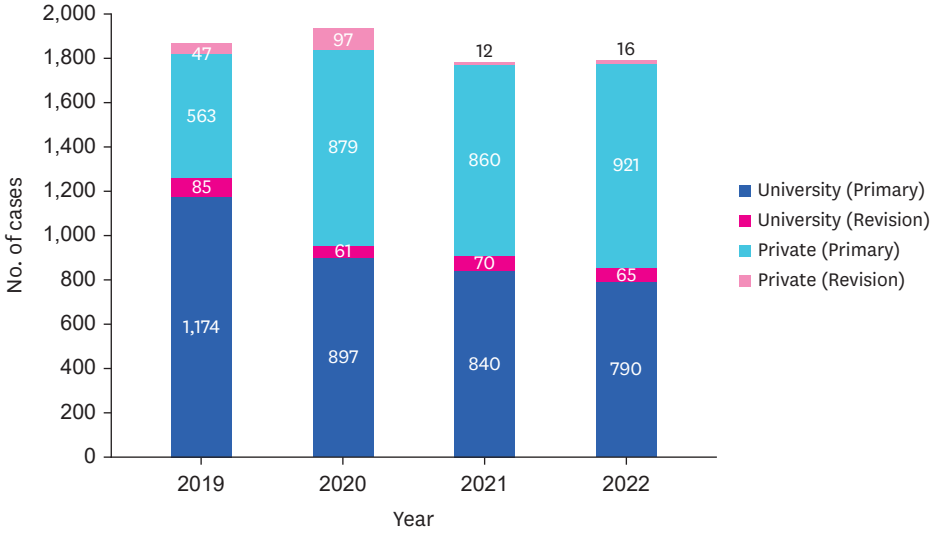


**Fig. 1.** The number of annual operation cases according to type of hospital.

### 1. Statistical analysis

Most analyses were conducted using descriptive statistics. Student's t-test was used for continuous variables, and $\chi^2$ test for nominal variables. Variables with a P value <0.05 were considered statistically significant. Comparisons of weight changes according to operation type (SG vs. RYGB vs. Sleeve Plus) were performed by a parametric analysis of variance.

## RESULTS

### 1. Hospital type and surgical volume distribution

Between 2019 and 2022, the number of patients recorded annually was 1,869, 1,934, 1,782, and 1,792, respectively. The proportion of patients undergoing surgery at university hospitals showed a gradual decrease over these years (**Fig. 1**). In 2019, a university hospital accounted for the center with an annual surgical volume exceeding 300 cases, while from 2020 to 2022, this was achieved by a private hospital (**Table 1**). The majority of centers performed between 10 to 50 cases in 2019, with this number dropping to below 10 cases from 2020 to 2022.

### 2. Basic characteristics of patients

The proportion of revisional surgeries to the total number of cases was 7.1%, 8.2%, 4.6%, and 4.5% for the years 2019 to 2022, respectively (**Table 2**). Patients who underwent revisional surgeries tended to be older and had lower BMIs compared to those undergoing primary surgeries. For primary surgeries, the largest group of patients, accounting for 36.5%, had BMIs ranging from 35 to 40, followed by 26.3% with BMIs from 30 to 35.

**Table 1.** The distribution of bariatric and metabolic surgery based on the type of hospital and surgical volume

| No. of operation | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|
| | Private | University | Private | University | Private | University | Private | University |
| >300 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 101–300 | 3 | 1 | 3 | 2 | 2 | 2 | 1 | 2 |
| 51–100 | 1 | 1 | 0 | 2 | 0 | 3 | 2 | 2 |
| 10–50 | 2 | 21 | 2 | 13 | 3 | 14 | 2 | 13 |
| <10 | 4 | 13 | 4 | 19 | 3 | 15 | 2 | 21 |


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**Table 2.** Basic clinical characteristics and comorbidities of the patients

| Year | 2019 | | | 2020 | | | 2021 | | | 2022 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Primary (n=1,737) | Revisional (n=132) | P | Primary (n=1,776) | Revisional (n=158) | P | Primary (n=1,700) | Revisional (n=82) | P | Primary (n=1,711) | Revisional (n=81) | P |
| Age (years) | 36.8±10.2 | 39.0±8.6 | 0.007 | 36.4±10.5 | 39.2±8.9 | <0.001 | 36.8±10.3 | 39.3±9.3 | 0.026 | 36.5±10.0 | 40.2±8.9 | 0.001 |
| Male | 546 (31.4) | 26 (19.7) | 0.006 | 459 (25.8) | 26 (16.5) | 0.012 | 436 (25.6) | 20 (24.4) | 0.900 | 416 (24.3) | 13 (16.0) | 0.116 |
| Female | 1,191 (68.6) | 106 (80.3) | | 1,317 (74.2) | 132 (83.5) | | 1,264 (74.4) | 62 (75.6) | | 1,295 (75.7) | 68 (84) | |
| Preoperative BMI (kg/m$^2$) | 39.1±6.4 | 36.4±7.0 | <0.001 | 38.4±5.9 | 34.8±6.1 | <0.001 | 38.5±6.2 | 33.4±7.0 | <0.001 | 39.2±6.7 | 35.0±6.5 | <0.001 |
| BMI <25 | 2 (0.1) | 5 (3.8) | <0.001 | 2 (0.1) | 10 (6.3) | <0.001 | 2 (0.1) | 11 (13.4) | <0.001 | 3 (0.2) | 4 (4.9) | <0.001 |
| 25≤ BMI <30 | 34 (2.0) | 11 (8.3) | | 36 (2.0) | 18 (11.4) | | 22 (1.3) | 18 (22.0) | | 29 (1.7) | 13 (16.0) | |
| 30≤ BMI <35 | 434 (25.0) | 39 (29.5) | | 490 (27.6) | 52 (32.9) | | 480 (28.2) | 23 (28.0) | | 419 (24.5) | 24 (29.6) | |
| 35≤ BMI <40 | 603 (34.7) | 44 (33.3) | | 651 (36.7) | 51 (32.3) | | 632 (37.2) | 18 (22.0) | | 639 (37.3) | 27 (33.3) | |
| 40≤ BMI <45 | 395 (22.7) | 18 (13.6) | | 355 (20.0) | 22 (13.9) | | 332 (19.5) | 5 (6.1) | | 352 (20.6) | 9 (11.1) | |
| 45≤ BMI <50 | 159 (9.2) | 9 (6.8) | | 165 (9.3) | 2 (1.3) | | 147 (8.6) | 6 (7.3) | | 150 (8.8) | 2 (2.5) | |
| BMI ≥50 | 110 (6.3) | 6 (4.5) | | 77 (4.3) | 3 (1.9) | | 85 (5.0) | 1 (1.2) | | 119 (7.0) | 2 (2.5) | |
| Type 2 diabetes | 555 (34.4) | 31 (25.0) | 0.042 | 548 (33.2) | 36 (23.7) | 0.022 | 565 (35.3) | 10 (12.3) | <0.001 | 565 (35.9) | 20 (26.7) | 0.133 |
| Oral medication | 407 (76.9) | 20 (87.0) | | 415 (80.7) | 30 (85.7) | | 387 (77.9) | 5 (83.3) | | 430 (83.7) | 14 (73.7) | |
| Insulin | 122 (23.1) | 3 (13.0) | | 99 (19.3) | 5 (14.3) | | 110 (22.1) | 1 (16.7) | | 84 (16.3) | 5 (26.3) | |
| Hypertension | 663 (40.8) | 38 (30.6) | <0.001 | 647 (38.7) | 42 (27.8) | 1.000 | 670 (41.4) | 18 (22.0) | 1.000 | 647 (40.8) | 21 (28.4) | 1.000 |
| Depression | 164 (10.3) | 18 (14.8) | 0.161 | 192 (11.7) | 11 (7.4) | 0.143 | 195 (12.2) | 14 (17.3) | 0.243 | 215 (13.8) | 20 (26.3) | 0.004 |
| Increased risk of DVT or PE[a] | 26 (1.6) | 7 (5.8) | 0.004 | 17 (1.1) | 0 (0.0) | 0.413 | 29 (1.8) | 1 (1.2) | 1.000 | 28 (1.8) | 1 (1.3) | 1.000 |
| Musculo skeletal pain | 119 (7.5) | 11 (9.2) | 0.617 | 120 (7.4) | 10 (6.8) | 0.911 | 116 (7.3) | 4 (4.9) | 0.558 | 96 (6.2) | 5 (6.7) | 1.000 |
| Sleep apnea | 414 (25.9) | 19 (15.6) | 0.015 | 480 (29.6) | 19 (12.7) | <0.001 | 437 (27.6) | 4 (4.9) | <0.001 | 400 (25.4) | 8 (10.4) | 0.004 |
| Dyslipidemia | 446 (27.7) | 27 (21.4) | <0.001 | 495 (30.0) | 42 (27.6) | 1.000 | 603 (37.8) | 10 (12.2) | 1.000 | 793 (50.0) | 15 (19.5) | 1.000 |
| GERD | 303 (18.9) | 46 (37.7) | <0.001 | 349 (21.3) | 75 (50.0) | <0.001 | 329 (20.7) | 34 (42.0) | <0.001 | 368 (23.7) | 21 (26.9) | 0.608 |

Values are presented as mean ± standard deviation, or number (%).
BMI = body mass index, DVT = deep vein thrombosis, PE = pulmonary embolism, GERD = gastroesophageal reflux disease.
[a]Defined as any one or more of the following: history or known risk factor for deep vein thrombosis/pulmonary embolus, venous edema with ulceration, vena cava filter, obesity hypoventilation syndrome.

Hypertension and diabetes were the most prevalent comorbidities among patients undergoing primary surgeries, with rates of 37.9% and 32.3%, respectively. In the revisional surgery group, these rates were 26.3% for hypertension and 21.4% for diabetes. Among diabetic patients, 20.2% of those undergoing primary surgeries and 16.9% of those undergoing revisional surgeries were on insulin treatment. Obstructive sleep apnea was observed more frequently in the primary surgery group than in the revision group.

## 3. Detailed procedure of bariatric and metabolic surgery

Throughout 2019 to 2022, SG was the most commonly performed primary surgical procedure (**Table 3**, **Fig. 2**), accounting for 71.1% to 78.9% of all cases, followed by RYGB, which ranged from 9.6% to 13.4%. SG was also the predominant revisional procedure in 2019, 2020, and 2022, while AGB removal was the most common in 2021 (**Table 4**). The SG procedure was most frequently performed in the BMI group of 35 to 50, compared to those with BMIs below 35 or above 50. Among patients with a BMI over 50, a higher proportion underwent RYGB compared to other BMI groups.

## 4. Postoperative morbidity and mortality

In primary operations, the incidence rates of common complications such as leakage, bleeding, and obstruction were 0.5% (36/6,599), 0.9% (62/6,549), and 0.5% (31/6,582), respectively (**Table 5**). Notably, the leakage rate has gradually decreased over the years, with a notable drop to 0.31% (5/1,615) in 2022. While the rates of bleeding exhibited annual variations, they remained consistently the most common complication. The incidence


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**Table 3.** Detailed operation procedures in primary surgery

| Primary surgery | 2019 | | | | 2020 | | | | 2021 | | | | 2022 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total (n=1,737) | BMI <35 (kg/m²; n=470) | 35≤ BMI <50 (kg/m²; n=1,157) | BMI ≥50 (kg/m²; n=110) | Total (n=1,776) | BMI <35 (kg/m²; n=528) | 35≤ BMI <50 (kg/m²; n=1,171) | BMI ≥50 (kg/m²; n=77) | Total (n=1,700) | BMI <35 (kg/m²; n=504) | 35≤ BMI <50 (kg/m²; n=1,111) | BMI ≥50 (kg/m²; n=85) | Total (n=1,711) | BMI <35 (kg/m²; n=451) | 35≤ BMI <50 (kg/m²; n=1,141) | BMI ≥50 (kg/m²; n=119) |
| Gastric Band | 57 (3.3) | 18 (3.8) | 38 (3.3) | 1 (0.9) | 73 (4.1) | 32 (6.1) | 38 (3.2) | 3 (3.9) | 26 (1.5) | 6 (1.2) | 20 (1.8) | 0 (0.0) | 33 (1.9) | 16 (3.5) | 17 (1.5) | 0 (0.0) |
| Sleeve gastrectomy | 1,396 (80.4) | 354 (75.3) | 962 (83.1) | 80 (72.7) | 1,376 (77.5) | 382 (72.3) | 940 (80.3) | 54 (70.1) | 1,329 (78.2) | 387 (76.8) | 878 (79.0) | 64 (75.3) | 1,413 (82.6) | 359 (79.6) | 971 (85.1) | 83 (69.7) |
| RYGB | 223 (12.8) | 78 (16.6) | 124 (10.7) | 21 (19.1) | 186 (10.5) | 53 (10.0) | 119 (10.2) | 14 (18.2) | 238 (14.0) | 68 (13.5) | 155 (14.0) | 15 (17.6) | 206 (12.0) | 65 (14.4) | 113 (9.9) | 28 (23.5) |
| Sleeve + duodenal bypass | 28 (1.6) | 7 (1.5) | 16 (1.4) | 5 (4.5) | 96 (5.4) | 41 (7.8) | 50 (4.3) | 5 (6.5) | 67 (3.9) | 28 (5.6) | 35 (3.2) | 4 (4.7) | 33 (1.9) | 6 (1.3) | 20 (1.8) | 7 (5.9) |
| Sleeve + jejunal bypass | 33 (1.9) | 13 (2.8) | 17 (1.5) | 3 (2.7) | 45 (2.5) | 20 (3.8) | 24 (2.0) | 1 (1.3) | 40 (2.4) | 15 (3.0) | 23 (2.1) | 2 (2.4) | 23 (1.3) | 2 (0.4) | 20 (1.8) | 1 (0.8) |
| Sleeve + Other | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 2 (0.1) | 2 (0.4) | 0 (0.0) | 0 (0.0) |
| Other | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (0.1) | 1 (0.2) | 0 (0.0) | 0 (0.0) |

Values are presented as number (%).
BMI = body mass index, RYGB = Roux-en-Y Gastric Bypass.

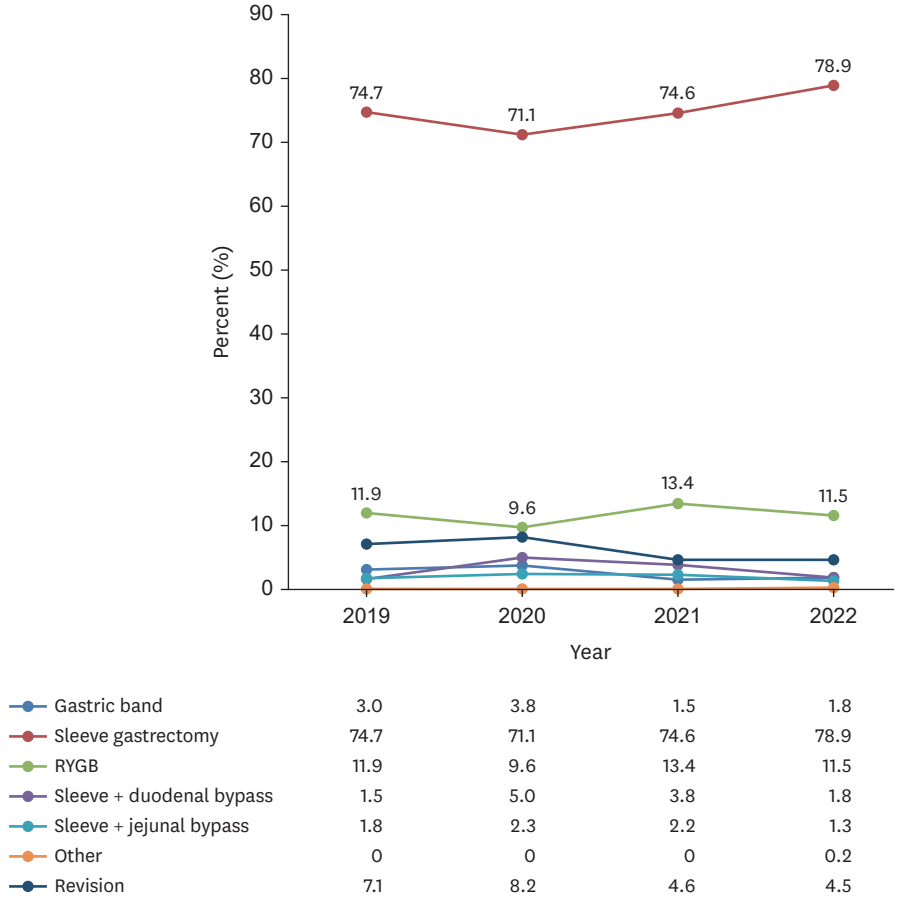


**Fig. 2.** Trend in bariatric and metabolic surgical procedures.
RYGB = Roux-en-Y Gastric Bypass.


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**Table 4.** Detailed operation procedures in revisional surgery

| Revisional surgery | 2019 | | | | 2020 | | | | 2021 | | | | 2022 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total (n=132) | BMI <35 (kg/m²; n=55) | 35≤ BMI <50 (kg/m²; n=71) | BMI ≥50 (kg/m²; n=6) | Total (n=158) | BMI <35 (kg/m²; n=80) | 35≤ BMI <50 (kg/m²; n=75) | BMI ≥50 (kg/m²; n=3) | Total (n=82) | BMI <35 (kg/m²; n=52) | 35≤ BMI <50 (kg/m²; n=29) | BMI ≥50 (kg/m²; n=1) | Total (n=81) | BMI <35 (kg/m²; n=41) | 35≤ BMI <50 (kg/m²; n=38) | BMI ≥50 (kg/m²; n=2) |
| Gastric Band | 1 (0.8) | 1 (1.8) | 0 (0.0) | 0 (0.0) | 2 (1.3) | 1 (1.2) | 1 (1.3) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (1.2) | 1 (2.4) | 0 (0.0) | 0 (0.0) |
| Sleeve gastrectomy | 79 (59.8) | 25 (45.5) | 48 (67.6) | 6 (100.0) | 60 (38.0) | 25 (31.2) | 33 (44.0) | 2 (66.7) | 20 (24.4) | 9 (17.3) | 10 (34.5) | 1 (100.0) | 23 (28.4) | 8 (19.5) | 13 (34.2) | 2 (100.0) |
| RYGB | 22 (16.6) | 10 (18.2) | 12 (16.9) | 0 (0.0) | 47 (29.7) | 23 (28.8) | 23 (30.7) | 1 (33.3) | 22 (26.8) | 14 (26.9) | 8 (27.6) | 0 (0.0) | 22 (27.2) | 12 (29.3) | 10 (26.3) | 0 (0.0) |
| OAGB | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (1.2) | 1 (1.9) | 0 (0.0) | 0 (0.0) | 1 (1.2) | 0 (0.0) | 1 (2.6) | 0 (0.0) |
| Band removal | 23 (17.4) | 15 (27.3) | 8 (11.3) | 0 (0.0) | 42 (26.6) | 29 (36.2) | 13 (17.3) | 0 (0.0) | 34 (41.5) | 23 (44.2) | 11 (37.9) | 0 (0.0) | 22 (27.2) | 16 (39.0) | 6 (15.8) | 0 (0.0) |
| Sleeve + duodenal bypass | 3 (2.3) | 1 (1.8) | 2 (2.8) | 0 (0.0) | 4 (2.5) | 1 (1.2) | 3 (4.0) | 0 (0.0) | 4 (4.9) | 4 (7.7) | 0 (0.0) | 0 (0.0) | 8 (9.9) | 3 (7.3) | 5 (13.2) | 0 (0.0) |
| Sleeve + jejunal bypass | 3 (2.3) | 2 (3.6) | 1 (1.4) | 0 (0.0) | 1 (0.6) | 0 (0.0) | 1 (1.3) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| RY limb length revision | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 3 (3.7) | 0 (0.0) | 3 (7.9) | 0 (0.0) |
| Other | 1 (0.8) | 1 (1.8) | 0 (0.0) | 0 (0.0) | 2 (1.3) | 1 (1.2) | 1 (1.3) | 0 (0.0) | 1 (1.2) | 1 (1.9) | 0 (0.0) | 0 (0.0) | 1 (1.2) | 1 (2.4) | 0 (0.0) | 0 (0.0) |

Values are presented as number (%).
BMI = body mass index, RYGB = Roux-en-Y Gastric Bypass, OAGB = One Anastomosis Gastric Bypass, RY = Roux-en-Y.

**Table 5.** Morbidity and mortality rate after bariatric and metabolic surgery

| Year | 2019 | | 2020 | | 2021 | | 2022 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Primary | Revision | Primary | Revision | Primary | Revision | Primary | Revision | Primary | Revision |
| Leakage | 0.6% (11/1,696) | 0% (0/129) | 0.6% (10/1,702) | 0% (0/154) | 0.6% (10/1,586) | 1.2% (1/81) | 0.3% (5/1,615) | 1.3% (1/79) | 0.5% (36/6,599) | 0.5% (2/443) |
| Bleeding | 0.7% (12/1,693) | 0% (0/128) | 1.0% (16/1,677) | 0% (0/154) | 0.9% (14/1,578) | 0% (0/82) | 1.2% (20/1,601) | 0% (0/80) | 0.9% (62/6,549) | 0% (0/444) |
| Obstruction | 0.9% (16/1,691) | 0.8% (1/128) | 0.4% (7/1,688) | 1.3% (2/151) | 0.4% (6/1,585) | 0% (0/81) | 0.1% (2/1,618) | 1.3% (1/78) | 0.5% (31/6,582) | 0.9% (4/438) |
| Mortality | 0% (0/1,729) | 0% (0/131) | 0% (0/1,746) | 0% (0/157) | 0% (0/1,691) | 0% (0/81) | 0% (0/1,686) | 0% (0/79) | 0% (0/6,852) | 0% (0/448) |

of obstruction demonstrated a downward trend, reducing to 0.12% (2/1,618) in 2022. In contrast, revisional operations saw leakage, bleeding, and obstruction rates at 0.45% (2/443), 0% (0/444), and 0.90% (4/438), respectively, which were comparable to or lower than those in primary operations, except for a higher rate of obstruction at 0.9% (4/438).

There were no mortality cases in both primary (0/6,852) and revisional (0/448) operations, indicating a mortality rate of 0%.

## 5. Weight changes following primary bariatric procedures

Weight changes post-primary bariatric procedures were analyzed among the surgical groups: SG, RYGB, and Sleeve Plus (**Table 5**, **Fig. 3**). The initial mean BMIs varied slightly across the groups, with SG at 38.8±6.1 kg/m² (n=5,514), RYGB at 39.4±7.3 kg/m² (n=853), and Sleeve Plus at 38.7±7.5 kg/m² (n=367), showing a significant difference (P=0.034). Post-operatively, the mean BMIs decreased in all groups, with SG patients recording 32.6±5.8 kg/m², 30.0±5.7 kg/m², 28.6±5.3 kg/m², and 29.3±5.6 kg/m² at 3, 6, 12, and 24 months, respectively. RYGB patients showed mean BMIs of 31.8±6.3 kg/m², 29.6±5.6 kg/m², 27.9±4.7 kg/m², and 27.7±4.5 kg/m² at the corresponding time points. Sleeve Plus patients had mean BMIs of 33.4±7.0 kg/m², 30.4±5.8 kg/m², 28.1±5.1 kg/m², and 29.2±6.9 kg/m². RYGB led to a significantly lower BMI than SG and Sleeve Plus at 1- and 3-months post-operation (P=0.026 at 1 month


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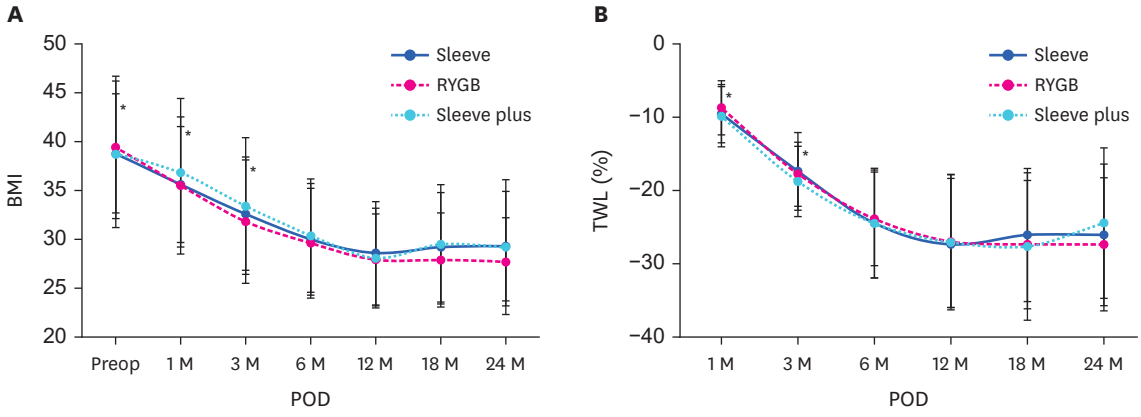


| | Preop | 1 M | 3 M | 6 M | 12 M | 18 M | 24 M |
|---|---|---|---|---|---|---|---|
| Primary surgery total | 6,734 | 2,772 | 1,912 | 1,166 | 1,020 | 398 | 251 |
| Sleeve | 5,514 | 1,061 | 1,654 | 999 | 835 | 347 | 222 |
| RYGB | 853 | 177 | 267 | 218 | 140 | 91 | 67 |
| Sleeve plus | 367 | 99 | 149 | 129 | 110 | 56 | 30 |

| Preop | 1 M | 3 M | 6 M | 12 M | 18 M | 24 M |
|---|---|---|---|---|---|---|
| 6,734 | 2,772 | 1,912 | 1,166 | 1,020 | 398 | 251 |
| 5,514 | 1,061 | 1,654 | 999 | 835 | 347 | 222 |
| 853 | 177 | 267 | 218 | 140 | 91 | 67 |
| 367 | 99 | 149 | 129 | 110 | 56 | 30 |

**Fig. 3.** Differences in BMI (A) and estimated percentage of weight change from baseline (B) by surgical procedure type.
BMI = body mass index, POD = postoperative day, RYGB = Roux-en-Y Gastric Bypass, TWL = Total Weight Loss.

**Table 6.** Weight changes following primary bariatric procedures according to surgical procedure

| Procedure | Sleeve (n=5,514) | RYGB (n=853) | Sleeve Plus (n=367) | P |
|---|---|---|---|---|
| BMI (months) | | | | |
| Preoperative BMI | 38.8±6.1 | 39.4±7.3 | 38.7±7.5 | 0.034 |
| 1 | 35.6±5.9 | 35.5±7.0 | 36.8±7.6 | 0.026 |
| 3 | 32.6±5.8 | 31.8±6.3 | 33.4±7.0 | 0.033 |
| 6 | 30.0±5.7 | 29.6±5.6 | 30.4±5.8 | 0.470 |
| 12 | 28.6±5.3 | 27.9±4.7 | 28.1±5.1 | 0.238 |
| 18 | 29.2±5.6 | 27.9±4.8 | 29.5±6.1 | 0.099 |
| 24 | 29.3±5.6 | 27.7±4.5 | 29.2±6.9 | 0.117 |
| TWL (months) | | | | |
| 1 | 9.5±4.0 | 8.7±3.7 | 9.9±4.1 | <0.001 |
| 3 | 17.4±5.3 | 17.8±4.4 | 18.8±4.8 | 0.007 |
| 6 | 24.5±7.5 | 23.9±6.4 | 24.6±7.4 | 0.495 |
| 12 | 27.4±9.0 | 27.0±9.1 | 27.1±9.3 | 0.850 |
| 18 | 26.1±9.1 | 27.4±8.8 | 27.7±10.1 | 0.326 |
| 24 | 26.1±9.7 | 27.4±9.1 | 24.5±10.3 | 0.390 |

Values are presented as mean ± standard deviation.
RYGB = Roux-en-Y Gastric Bypass, BMI = body mass index, TWL = Total Weight Loss.

and P=0.033 at 3 months), with no significant differences noted thereafter. While the BMI continued to slightly decrease after 12 months in the RYGB group, SG and Sleeve Plus groups experienced their lowest BMI at 12 months, followed by a slight increase (**Table 6**, **Fig. 3A**).

Regarding Total Weight Loss Percentage (TWL%), at 3 months, the TWL% for SG, RYGB, and Sleeve Plus were 17.4±5.3%, 17.8±4.4%, and 18.8±4.8%, respectively. By 6 months, these values increased to 24.5±7.5%, 23.9±6.4%, and 24.6±7.4%. At 12 months, TWL% reached 27.4±9.0%, 27.0±9.1%, and 27.1±9.3%, and at 24 months, they were 26.1±9.7%, 27.4±9.1%, and 24.5±10.3%, respectively. From 6 months onwards, all groups maintained TWL% values above 20, indicating significant and sustained weight loss post-surgery (**Table 6**, **Fig. 3B**).


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## DISCUSSION

Since the 2000s, South Korea has experienced a rapid increase in obesity rates due to economic growth and lifestyle changes. As of 2021, 7% of Korean adults were diagnosed with obesity, according to the Organization for Economic Cooperation and Development health status database [6]. Bariatric surgery was introduced in Korea in the early 2000s, and it was only offered to extremely obese patients, and access was limited due to high surgical costs and a shortage of specialized medical professionals [7]. The number of bariatric surgeries gradually increased as about less than 100 cases at early 2000s, but it reached around 1,666 cases in 2013 with most of them were adjustable band procedure [4]. After serious complication of well-known singer in 2014, the number of surgery dramatically decreased as 531 cases at 2017 [5]. After insurance coverage, according to our study, the number of bariatric surgeries was increased up to 1,792 cases in 2022 and the surgical procedures performed were diverse, with 78.9% underwent SG, 11.5% underwent RYGB, and others underwent other surgical methods including revision surgery in 2022 (**Fig. 2**).

SG is the most performed bariatric surgery in the United States, while RYGB is the preferred surgical method in Europe [8-10]. SG was performed 72.7% of cases in United States as in this Korea registry data (78.9%) [8]. SG is the preferred choice for RYGB due to its straightforward surgical technique and proven efficacy of weight loss as RYGB procedure. RYGB procedure is still most common procedure in Europe but it markedly decreases over time [9,10]. According to the Scandinavian Obesity Surgery Registry, RYGB is more effective than SG in terms of consistent weight loss [10]. However, our study also confirmed that both RYGB and SG can achieve consistent surgical results (**Table 6**). It is worth noting that this might be attributed to the KSMBS's certification system of its members' surgical education since 2018. Until 2023, about 96 surgeons certified by KSMBS, and certification renewal occurs every 3 years based on entry into the surgical data registry, attendance at conferences, or evaluation of scientific papers.

Revisional metabolic bariatric procedures are classified by the IFSO registry as surgeries conducted to convert one type of metabolic bariatric procedure into another. The 8th IFSO registry report from 2022 indicates that, on a global scale, approximately 450,000 primary surgeries were performed compared to about 25,000 revisional surgeries, resulting in a revisional surgery rate of around 6.5% [11]. RYGB was the most frequently performed revisional procedure, accounting for 48% of such surgeries, whereas SG, despite being the most common primary procedure, was reported at a considerably lower rate of 23% for revisions. In South Korea, SG was predominantly chosen for revisional surgery, with this choice being notably higher from 2019 to 2020. However, in the surveys of 2021 and 2022, SG and RYGB were performed at similar rates for revisions. This trend might be attributed to revisions from previously popular gastric band procedures and potentially the relatively high incidence of gastric cancer in South Korea, though the exact reasons for choosing revisional surgery were not specifically investigated, highlighting the need for further research in this area [4,12].

This survey has included data about post-operative complications and mortality rates, compared to previous reports. The absence of any mortality cases during the survey period is considered a notable achievement. Furthermore, the incidence of early post-operative complications such as leakage, bleeding, and obstruction was found to be similar or lower when compared with data from other countries and studies [13,14]. This indicates that


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bariatric metabolic surgery is being performed with a relatively high degree of safety in South Korea. However, there are differences in the consensus on complication items between this registry's survey and those from other national and global registry surveys, which may pose limitations for detailed comparative research [15].

In conclusion, in Korea, the number of patients who underwent bariatric and metabolic surgery was increased after 2019 with an introduction of national insurance coverage. SG was most frequent primary procedure in Korea. Between 2019 and 2022, all bariatric and metabolic surgical procedures demonstrated safe short-term outcomes and yielded reasonable results upon follow-up. Details of bariatric and metabolic surgery successfully investigated through an electric database registry of KSMBS.

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