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Review

Nationwide Trends in Coronary Artery Bypass Grafting in the Republic of Korea, 2005–2022: A Comparison with International Data

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Coronary artery bypass grafting (CABG) remains a key revascularization strategy for ischemic heart disease; however, nationwide trends in the Republic of Korea have not been thoroughly investigated. Using data from the Korean National Health Insurance Service, we analyzed adult patients who underwent isolated CABG between 2005 and 2022. We evaluated surgical volume, patient demographics, procedural strategies (off-pump vs. on-pump), and outcomes. International comparisons were conducted using national cardiac surgery registry data. A total of 51,923 CABG cases were identified. Annual surgical volume declined until 2013 but gradually increased thereafter, reaching 3,717 cases in 2022. Despite this recovery, Korea's per capita CABG rate remains among the lowest worldwide. In contrast, more than 60% of procedures were performed off-pump—the highest rate worldwide. Over time, the average patient age and prevalence of diabetes increased, whereas in-hospital mortality showed a modest decline. Compared with other countries, the Republic of Korea demonstrated a uniquely low procedural volume and a strong preference for off-pump CABG. This nationwide analysis highlights Korea's distinctive CABG practice patterns and provides valuable insights for optimizing future clinical and policy decisions in cardiac surgical care.

Keywords: Coronary artery bypass grafting, Nationwide trend, International comparison

Introduction

Coronary artery bypass grafting (CABG) has long been widely recognized as the most effective treatment for patients with multivessel disease or left main coronary artery disease [1,2]. In the Republic of Korea, CABG has also been established as a primary therapeutic strategy for ischemic heart disease since the 1990s [3] and has proven to be a reliable procedure providing stable, long-term outcomes across diverse clinical contexts.

However, the application and characteristics of CABG differ substantially among countries. In particular, Korea has a relatively low annual CABG volume compared to other developed nations, while exhibiting distinct surgical practices [4,5]. For example, the proportion of off-pump CABG (OPCAB) is exceptionally high in Korea—a pattern observed only in a few countries such as Japan [6,7]. This unique practice likely reflects structural and cultural features of CABG surgery in Korea.

Despite these distinct practice patterns, Korea lacks a

comprehensive, nationwide public registry that systematically collects and analyzes CABG volume and outcome data. The absence of such a registry limits the ability to objectively identify trends and perform meaningful international comparisons.

Therefore, this study aimed to analyze long-term trends in CABG procedures in Korea using national administrative data and to quantitatively characterize the features of current CABG practice. Additionally, we sought to place Korea's CABG trends within an international context by comparing them with global data, thereby providing an evidence-based foundation for future improvements in clinical and policy strategies.

Materials and Methods

Source of data and inclusion criteria

Korean CABG data were obtained from the National Health Insurance Service (NHIS) database, covering the period from 2005 to 2022. The inclusion criteria were as follows: (1) patients aged ≥18 years and (2) those who underwent primary isolated CABG. Patients with a history of prior cardiac surgery or those who underwent concomitant procedures were excluded. Surgical cases were identified using specific procedural codes. For international comparison, data were extracted from publicly available national registry reports or previously published studies based on established national cardiac surgery registries. Countries were selected based on the availability of reliable data and annual reports. For Japan, information was obtained from annual reports published on the Japanese Association for Coronary Artery Surgery (JACAS) website (https://www.jacas.org/eng/) and the Japan Adult Cardiovascular Surgery Database (JCVSD). For the United States, data were sourced from the Society of Thoracic Surgeons (STS) database through peer-reviewed publications and annual reports. For Germany (https://www.dgthg.de/), Sweden (https://www.swedeheart.se/), and Australia and New Zealand (https://anzscts.org/database/), information was cited from annual reports available on their respective official websites. When discrepancies occurred between different reports, the most recently published report was used as the primary reference.

Data extraction and presentation

For South Korean data, the annual number of primary isolated CABG procedures was identified. Baseline patient characteristics were extracted, and the operative strategy (OPCAB versus on-pump CABG [ONCAB]) was determined based on surgical codes and the recorded use of cardiopulmonary bypass. On-pump beating-heart procedures were categorized as ONCAB because they could not be separately identified within the dataset. Early outcomes, including in-hospital mortality and length of hospital stay, were also collected. Temporal trends were analyzed for annual CABG volume, patient characteristics, operative strategies, and 30-day mortality.

For international data, relevant variables—including annual CABG volume, distribution of ONCAB and OPCAB, patient age, sex, and mortality—were extracted from national registry reports or peer-reviewed publications. Only publicly available and credible sources were used.

Statistical analysis

Continuous variables were presented as medians with interquartile ranges or means with standard deviations, as appropriate. Categorical variables were summarized as frequencies and percentages. Temporal trends in patient demographics, surgical strategies (OPCAB vs. ONCAB), and clinical outcomes were descriptively evaluated across the 2005–2022 period.

All data management and analyses were conducted using SAS ver. 9.4 (SAS Institute Inc.). Given the descriptive design of the study, no formal hypothesis testing was performed, and statistical significance was not assessed.

Results

Annual volume of coronary artery bypass graft surgery

According to data from the NHIS, approximately 2,600 CABG procedures were performed in South Korea in 2005. This number steadily declined from 2007 to 2013, reaching a nadir of 2,275 cases in 2013. Since then, the annual volume has gradually increased, achieving an all-time high of 3,717 cases in 2022 (Fig. 1). Despite this upward trend, the CABG rate per population in South Korea remains among the lowest compared with other developed countries (Fig. 2A). In contrast, South Korea demonstrates a distinctively high proportion of OPCAB procedures—a unique characteristic that distinguishes it from global surgical practices (Fig. 2B).

In the United States, the annual number of isolated CABG procedures is well documented through the STS database.

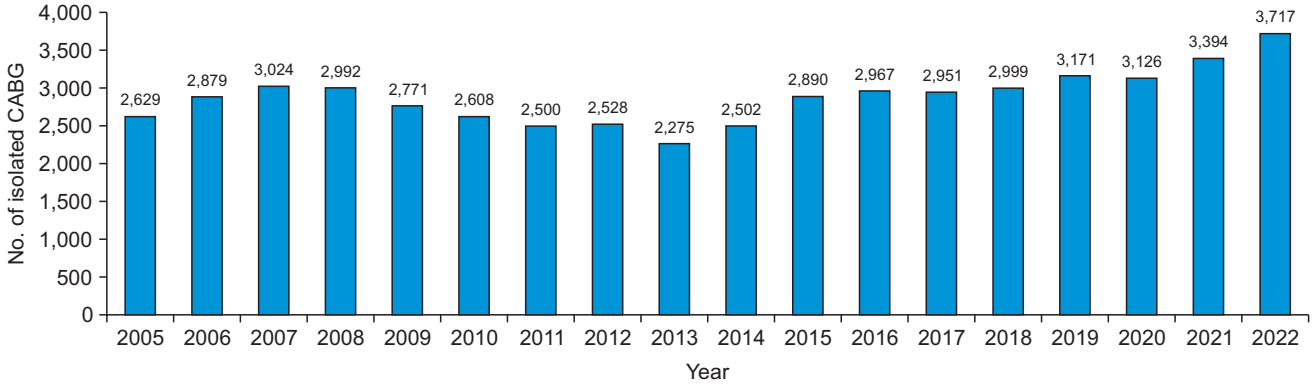

Fig. 1. Annual isolated coronary artery bypass grafting (CABG) procedures in South Korea from 2005 to 2022.

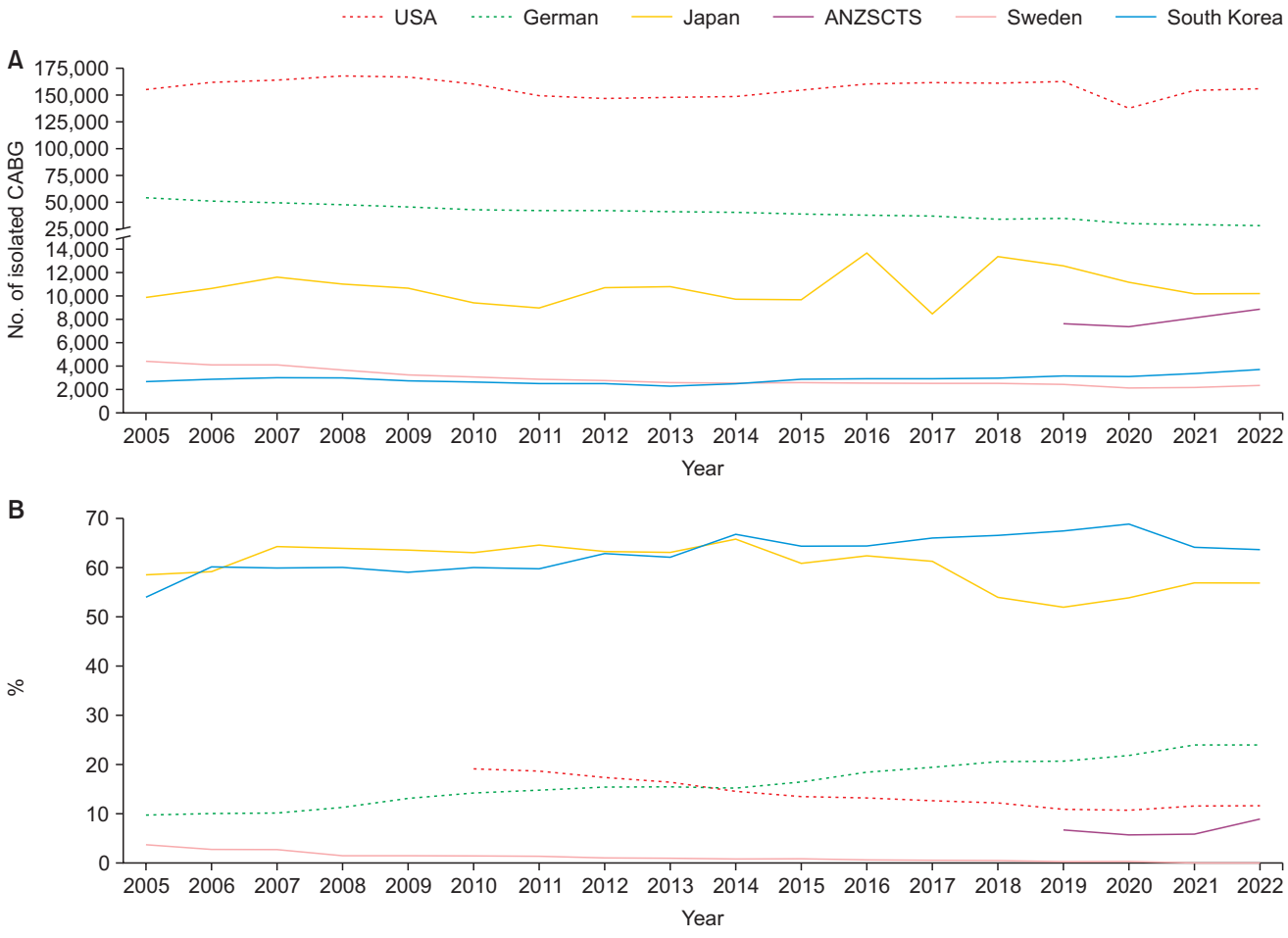

Fig. 2. Annual country-specific trends in isolated coronary artery bypass grafting (CABG). (A) Annual isolated CABG cases by country. (B) Trends in the proportion of off-pump coronary artery bypass by country. ANZSCTS, Australian and New Zealand Society of Cardiac and Thoracic Surgeons.

Each year, more than 200,000 CABG procedures are performed, including approximately 160,000 isolated cases, accounting for over 60% of all cardiac surgeries nationwide. This represents not only the highest CABG volume in a single country but also one of the highest per capita rates worldwide. Although the number of procedures declined to below 140,000 in 2020 due to the COVID-19 pandemic, it has since rebounded to over 150,000 annually

[7,8]. Since 2005, the annual CABG volume in the United States has remained relatively stable at around 160,000 cases for nearly 2 decades (Fig. 2A). In Germany, the number of isolated CABG procedures has shown a continuous decline over the past 2 decades. More than 50,000 cases were performed in 2005; however, by 2015 the number had decreased to below 40,000 and further declined to under 30,000 by 2020. Despite this downward trend, Germany's per capita CABG rate remains approximately 5 times higher than that of South Korea [9,10]. In Sweden, more than 4,400 isolated CABG procedures were performed in 2005, but the annual volume has steadily decreased, falling below 2,300 cases after 2020 [11]. Nonetheless, Sweden's per capita CABG rate remains comparable to that of other European nations.

In Japan, the annual number of isolated CABG procedures has fluctuated around 10,000. A notable increase occurred in 2016, followed by a marked decline in 2017 and a subsequent rise in 2018. These fluctuations likely reflect differences in data collection methodologies rather than genuine changes in clinical volume. Prior to 2015, and including 2017, the data were primarily collected and reported by the JACAS, which relied on manual submissions and survey-based reporting [12]. This approach introduced potential inaccuracies and incomplete case capture. By contrast, data for 2016 and from 2018 onward were compiled by the JCVSD and the National Clinical Database, both of which employ comprehensive, mandatory, and institution-based reporting systems. The transient rise in reported cases during these years likely reflects improved data capture rather than a true increase in surgical activity. Since 2018, however, a gradual decline in isolated CABG volume has been observed, suggesting a genuine downward trend in recent years [13]. Another well-organized national CABG registry is maintained by the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS). Since 2019, the ANZSCTS has collected cardiac surgery data from major hospitals across both countries and released comprehensive annual reports. According to these reports, the number of isolated CABG procedures in Australia and New Zealand has shown a gradual upward trend in recent years [14].

Proportion of off-pump coronary artery bypass grafting by country

The characteristics of CABG vary considerably across countries, and this is particularly evident in the use of OPCAB. Although the United States performs the largest number of CABG procedures worldwide, it maintains one of the lowest OPCAB rates. In 2010, the OPCAB proportion in the United States approached 19%, but it has steadily declined over time, stabilizing at approximately 11%–12% since 2018 [7].

Europe generally exhibits a low overall proportion of OPCAB, though variations exist across countries. In Germany, while the total number of CABG procedures has steadily declined, the proportion of OPCAB has gradually increased. In 2005, the OPCAB rate was approximately 10%, but it has consistently risen, surpassing 20% by 2018 and approaching 25% by 2022 [8]. In contrast, Sweden has maintained an extremely low OPCAB rate. In 2005, only 3.8% of CABG procedures were performed using the OPCAB approach, and the rate has declined further over time. By 2022, only 3 OPCAB cases were reported nationwide, corresponding to a rate of merely 0.1% [11]. The Australia and New Zealand region shows the lowest preference for OPCAB globally. According to ANZSCTS reports, although a slight increase was observed in 2022, the OPCAB rate still remained below 10%, representing the lowest proportion among the countries analyzed [14].

In contrast, Northeast Asia—particularly Japan and South Korea—has consistently reported markedly high rates of OPCAB. In Japan, OPCAB accounted for approximately 65% of all CABG procedures until the mid-2010s. Although a gradual decline has occurred in recent years, the OPCAB rate has remained above 55%, ranking Japan among the highest users of the technique worldwide [12, 13].

South Korea likewise demonstrates one of the strongest preferences for OPCAB globally. Since 2010, the proportion of OPCAB procedures has consistently exceeded 60%, and by 2020, nearly 70% of all CABG operations were performed using the off-pump approach [15]. This represents a particularly distinctive aspect of CABG practice in South Korea, where the overall CABG volume per capita remains among the lowest in the world (Fig. 2B).

Characteristics and trends of CABG patients in South Korea

Over the past 18 years, a total of 51,923 isolated CABG procedures were performed in South Korea. Male patients accounted for approximately 3-quarters of all cases, while female patients were more frequently represented in the older age group. A history of percutaneous coronary intervention before surgery was observed in 16.9% of patients, and 1% had experienced cardiopulmonary resuscitation

prior to CABG. A previous myocardial infarction was reported in 30% of cases, and more than one-quarter of patients had a history of cerebrovascular accident. OPCAB was performed in 63% of all patients, and 8.5% underwent surgery for single-vessel disease (Table 1).

Table 1. Baseline characteristics of patients undergoing isolated CABG in Korea (2005–2022)

Characteristic	Value
Total	51,923
Age (yr)	66.0 (59.0–72.0)
Age distribution	
<55	7,634 (14.7)
≥55 to <65	15,510 (29.9)
≥65 to <75	19,826 (38.2)
≥75	8,953 (17.2)
Male	38,895 (74.9)
Smoking (n=38,137)	
None	18,358 (48.1)
Ex-smoker	10,735 (28.2)
Current smoker	9,044 (23.7)
Alcohol use (n=18,715)	
None	4,987 (26.7)
Three or less times a week	13,002 (69.5)
Four or more times a week	726 (3.9)
Previous PCI	8,766 (16.9)
Previous CPR	493 (1.0)
Comorbidities	
Hypertension	46,912 (90.4)
Diabetes mellitus	40,521 (78.0)
Dyslipidemia	47,199 (90.9)
Acute myocardial infarction	15,995 (30.8)
Congestive heart failure	18,402 (35.4)
Atrial fibrillation or flutter	4,521 (8.7)
Arrhythmia	10,451 (20.1)
Peripheral vascular disease	20,602 (39.7)
Stroke	13,983 (26.9)
Chronic kidney disease	7,307 (14.1)
Chronic obstructive pulmonary disease	9,620 (18.5)
Liver cirrhosis	1,860 (3.6)
Cancer	11,525 (22.2)
Diagnosis on the index date	
Acute myocardial infarction	13,898 (26.8)
Surgical technique	
Off-pump CABG	32,716 (63.0)
On-pump CABG	19,207 (37.0)
No. of bypassed coronary arteries	
1	4,385 (8.5)
≥2	47,538 (91.6)
In-hospital duration (day)	14 (10–20)

Values are presented as median (interquartile range) for continuous variables and number frequency of (%) for categorical variables.
CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention; CPR, cardiopulmonary resuscitation.

Since 2013, the annual number of isolated CABG procedures in South Korea has steadily increased following a period of decline that lasted until 2013. The growth has been more pronounced among male patients than among females (Fig. 3A). The mean age of CABG patients has also shown a consistent upward trend, rising from 63.4±9.0 years in 2005 to 66.2±10.1 years in 2022 (Fig. 3B). Although the annual number of ONCAB procedures has remained relatively stable over the past 2 decades with minor fluctuations, the number of OPCAB procedures has increased steadily since 2013 (Fig. 3C). In addition, the prevalence of diabetes mellitus (DM) among CABG patients has risen markedly, from 62.0% in 2005 to over 86.9% in recent years (Supplementary Fig. 1). Notably, despite the increases in both mean age and DM prevalence, in-hospital mortality has shown modest improvement. Whereas mortality exceeded 3.5% between 2011 and 2013, it has remained around 3% since 2013 (Fig. 3D).

The overall 1-year and 5-year survival rates following surgery were 92.3% and 81.1%, respectively (Fig. 4). Although male patients exhibited higher survival rates than female patients, this difference is likely attributable to the age gap between the sexes at the time of surgery (Supplementary Fig. 2).

Recent comparison of country-specific characteristics of CABG in 2022

As noted above, CABG demonstrates distinct national characteristics. In 2022, South Korea recorded the lowest per-capita CABG rate, with only 72 procedures per million population. In contrast, it had the highest proportion of OPCAB procedures worldwide, showing a striking contrast with other countries except Japan. Japan displayed a similar trend, though its per-capita CABG rate was slightly higher at 81.7 per million. Outside East Asia, most countries reported more than 200 CABG procedures per million population, with the United States exhibiting the highest rate at 473 per million. In these regions, OPCAB rates generally ranged from 10% to 20%, while Sweden reported that OPCAB was performed only rarely. Across all surveyed countries, CABG was predominantly performed in male patients, and the mean patient age clustered in the late 60s [16] (Table 2).

Discussion

This study utilized data from the NHIS of South Korea, which encompasses nearly all patients who have undergone

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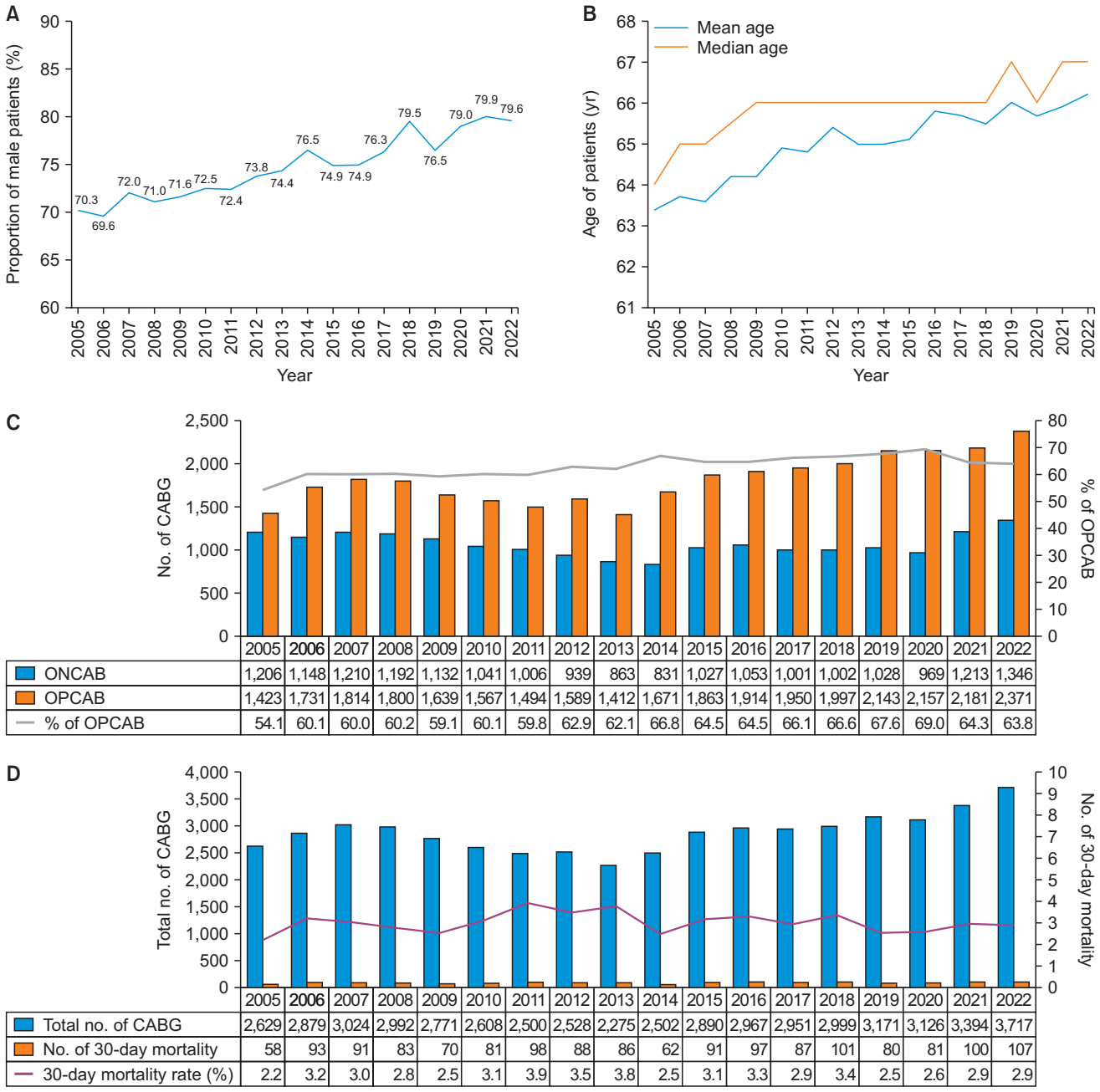

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
ONCAB	1,206	1,148	1,210	1,192	1,132	1,041	1,006	939	863	831	1,027	1,053	1,001	1,002	1,028	969	1,213	1,346
OPCAB	1,423	1,731	1,814	1,800	1,639	1,567	1,494	1,589	1,412	1,671	1,863	1,914	1,950	1,997	2,143	2,157	2,181	2,371
% of OPCAB	54.1	60.1	60.0	60.2	59.1	60.1	59.8	62.9	62.1	66.8	64.5	64.5	66.1	66.6	67.6	69.0	64.3	63.8

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total no. of CABG	2,629	2,879	3,024	2,992	2,771	2,608	2,500	2,528	2,275	2,502	2,890	2,967	2,951	2,999	3,171	3,126	3,394	3,717
No. of 30-day mortality	58	93	91	83	70	81	98	88	86	62	91	97	87	101	80	81	100	107
30-day mortality rate (%)	2.2	3.2	3.0	2.8	2.5	3.1	3.9	3.5	3.8	2.5	3.1	3.3	2.9	3.4	2.5	2.6	2.9	2.9

Fig. 3. Changes in the characteristics and trends of isolated coronary artery bypass grafting (CABG) in South Korea. (A) Changes in the proportion of male patients undergoing CABG. (B) Changes in the age of patients undergoing CABG. (C) Trends in surgical strategies for CABG. (D) Trends in 30-day mortality among patients undergoing CABG. ONCAB, on-pump CABG; OPCAB, off-pump CABG.

coronary revascularization within the country. To our knowledge, this is the first nationwide report to describe trends in CABG in South Korea. Through this analysis, several distinctive characteristics of Korean CABG practice were identified. South Korea performs one of the lowest numbers of CABG procedures per capita globally yet exhibits an exceptionally high rate of OPCAB, reflecting a distinctive surgical preference. Furthermore, the majority of CABG patients were male, and an unusually high prevalence of DM was observed—a pattern that has become even more pronounced in recent years.

CABG is the most frequently performed cardiac surgical procedure worldwide, accounting for over 60% of all cardiac operations in the United States [17]. In contrast, South

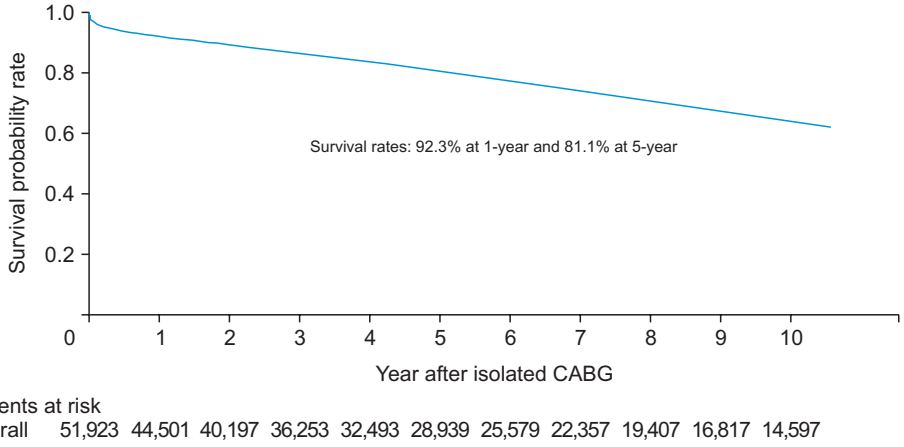

Fig. 4. Long-term survival rate of patients undergoing coronary artery bypass grafting (CABG) in South Korea.

Table 2. Characteristics of isolated CABG procedures by country in 2022

Characteristic	South Korea	Japan	USA	Germany	Sweden	ANZSCTS
No. of CABG procedures	3,717	10,226	157,275	27,944	2,241	8,862
CABG procedures per million population	72.0	81.7	473.7	335.8	214.4	293.6
Age (yr)	66.2	69.9[a]	65.9	66.6[b]	68.0	66.2
Male (%)	86.9	80.3[a]	70.0[c]	79.0	83.5	83.6
Rate of OPCAB (%)	63.8	56.9	11.6	24.0	0.1	9
30-day mortality (%)	2.9	1.8[a]	1.8	2.5	1.1	1.1

CABG, coronary artery bypass grafting; ANZSCTS, Australian and New Zealand Society of Cardiac and Thoracic Surgeons; OPCAB, off-pump coronary artery bypass; JCVSD, Japan Adult Cardiovascular Surgery Database; JACAS, Japanese Association for Coronary Artery Surgery; STS, Society of Thoracic Surgeons.
[a]Data for 2022 were not available in the JCVSD annual report. Therefore, the value was derived by referencing the trends reported in the 2020 JACAS annual report and estimated accordingly. [b]Mean age was not reported in the German Heart Surgery Report; therefore, it was obtained from an official nationwide report published in Germany [16]. [c]Sex-specific data were not reported in the 2022 STS annual report; therefore, the values were estimated based on previously published studies.

Korea demonstrates one of the lowest CABG utilization rates internationally [18]. A similar trend has been noted in Japan, another East Asian nation, although Japan's per capita CABG rate is higher than that of Korea [19,20]. Given the rapidly aging populations in both countries, the relatively low surgical volume in East Asia warrants further investigation.

One plausible explanation is the generally lower body mass index among East Asian populations, which may contribute to a lower prevalence of advanced coronary artery disease (CAD) requiring surgical intervention. Another factor may relate to Korea's healthcare system structure, in which cardiologists typically serve as gatekeepers for patients with CAD [18]. Notably, 2 landmark trials that have significantly influenced international CAD treatment guidelines were conducted in Korean institutions under the leadership of cardiology departments. Both studies reported favorable outcomes for percutaneous coronary intervention compared to surgical approaches [21,22]. These findings may have led Korean cardiologists to adopt a higher threshold for referring patients to surgery.

Between 2007 and 2013, the annual number of CABG procedures in Korea gradually declined but subsequently showed a steady increase. This reversal is likely attributable to multiple interacting factors. First, the aging population and the increasing prevalence of diabetes, non–ST-segment elevation myocardial infarction, and multivessel disease have expanded the pool of surgical candidates. Second, contemporary American Heart Association/American College of Cardiology and European Society of Cardiology guidelines consistently emphasize the survival benefits of CABG for patients with left main disease, multivessel disease, and severe left ventricular dysfunction, thereby encouraging Heart-Team–based decision-making. Third, several landmark trials have reaffirmed the long-term superiority of CABG, particularly for patients with diabetes, multivessel disease, or left main lesions, resulting in wider clinical adoption. Collectively, these factors appear to have contributed to the recent resurgence in CABG volume.

As Korean society continues to age, the average age of

patients undergoing CABG has also increased. This trend is particularly pronounced among women, likely due to their longer life expectancy relative to men. Another noteworthy finding is the increasing prevalence of DM among CABG patients. This pattern reflects broader societal changes in Korea, where economic growth and lifestyle shifts have led to rising rates of diabetes and obesity, both now recognized as major public health concerns.

This study has several limitations that warrant acknowledgment. First, the analysis was based on administrative claims data from the NHIS, which—although comprehensive in coverage—lacks detailed clinical information such as coronary anatomy, left ventricular function, surgical technique, and graft configuration. Second, reliance on surgical and diagnostic codes may result in misclassification. Specifically, on-pump beating-heart procedures and conventional ONCAB could not be distinguished using the current coding system. Additionally, outcomes for OPCAB versus ONCAB reflect an as-treated rather than intention-to-treat classification, which should be considered when interpreting the findings. Third, long-term outcomes such as major adverse cardiac events, graft patency, and postoperative functional recovery could not be assessed due to dataset limitations. Fourth, because the study relied on administrative data, comorbidities such as DM, stroke, chronic obstructive pulmonary disease, and peripheral vascular disease may have been overestimated. Although a gradual increase in the proportion of CABG patients with DM was observed, this finding should be interpreted cautiously in light of potential administrative overestimation. Lastly, international comparisons were derived from national registry reports and peer-reviewed publications; thus, differences in data collection methods, coding practices, and healthcare systems may limit the direct comparability of results across countries.

Despite these limitations, this study has notable strengths. It represents the first nationwide analysis of CABG trends in South Korea using comprehensive NHIS data, which cover nearly the entire national population. The large sample size spanning 18 years allows a robust evaluation of temporal trends in surgical volume, operative strategy, and patient demographics. Furthermore, by incorporating registry data from multiple countries, this study provides valuable international context, highlighting Korea's unique position within global cardiac surgical practice.

Conclusion

This nationwide analysis of CABG in South Korea provides critical insights into the country's distinctive surgical trends and patient characteristics. Despite having one of the lowest CABG rates per capita among developed nations, South Korea exhibits a remarkably high proportion of OPCAB procedures, distinguishing its surgical practice from that of other countries. Over the past 2 decades, there has been a gradual increase in surgical volume, mean patient age, and diabetes prevalence, accompanied by a modest improvement in in-hospital mortality. These findings underscore important epidemiologic and procedural patterns that can inform future clinical decision-making and health policy. Continued monitoring and incorporation of more detailed clinical data will be essential for further elucidating long-term outcomes and optimizing revascularization strategies for the Korean population.

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Conceptualization: MHJ, JHL, HYH, HKC. Methodology: MHJ, JHL. Formal analysis: MHJ, JHL, YJK. Writing—original draft preparation: MHJ, JHL. Writing—review and editing: HJK, HYH, SYY, HJK, YNY, WSK, MJB, HKC. Supervision: HYH, HKC. Approval of final manuscript: all authors

Conflict of interest

Ho Jin Kim serves as an editor of the *Journal of Chest Surgery*, but has no role in the decision to publish this article. Except for that, no potential conflict of interest relevant to this article was reported.

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Supplementary materials

Supplementary materials can be found via https://doi.org/10.5090/jcs.25.101. **Supplementary Fig. 1.** Diabetes mellitus prevalence among coronary artery bypass grafting patients. **Supplementary Fig. 2.** Long-term survival rate of patients undergoing coronary artery bypass grafting in South Korea according to sex.

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