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# Epidemiology of Gastric Cancer in Korea: Trends in Incidence and Survival Based on Korea Central Cancer Registry Data (1999–2019)

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## ABSTRACT

This study investigated the trends of gastric cancer in Korea by adding the latest updated gastric cancer data from 2019. Gastric cancer incidence between 1999 and 2019 was reviewed using data from the Korea Central Cancer Registry. The study period was divided into 3 periods: period I (1999–2005), period II (2006–2012), and period III (2013–2019). The incidence, mortality, tumor location, histology, stage, and treatment were analyzed. Between 1999 and 2019, 577,502 patients were newly diagnosed with gastric cancer in Korea, accounting for 33.2% of patients aged ≥70 years. The age-standardized incidence rate (per 100,000) significantly decreased from 2011 (43.0) to 2019 (29.6), with an annual percent change of −4.50. Additionally, the age-standardized mortality rate (per 100,000) markedly decreased from 1999 (23.9) to 2019 (6.7). The proportions of patients with cardia and fundus cancers remained consistent. The proportion of localized stage cases increased, while those of regional and distant stages decreased. The rate of surgical treatment increased in localized and regional stages from 2006 to 2019. The overall 5-year relative survival (5YRS) rate of gastric cancer (per 100,000) increased from 55.7% in period I to 77.0% in period III. From 2013 to 2019, the 5YRS rates of patients (per 100,000) who underwent surgical treatment were 100.6% and 70.5% in the localized and regional stages, respectively. The results of this study demonstrated several changes in the epidemiology of gastric cancer in Korea. This study provides information to help understand the current trends in gastric cancer in Korea.

**Keywords:** Epidemiology; Gastric cancer; Survival rate; Incidence

## INTRODUCTION

Gastric cancer is the fifth most common cancer globally, with the fourth-highest mortality rate [1]. The Korea Central Cancer Registry (KCCR) data reported that gastric cancer occurred in 29,279 individuals and was the most common cancer among all cancers in 2018 [2]. As the national gastric cancer screening program has expanded and treatments have advanced, the epidemiology of gastric cancer has changed dramatically in terms of incidence and survival in Korea. Knowing exact information about this change is crucial for medical

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

**Author Contributions**
Conceptualization: P.S.H., J.K.W.; Data curation: K.M.J., Y.E.H., J.K.W.; Formal analysis: K.M.J., Y.E.H., J.K.W.; Writing - original draft: P.S.H., K.M.J.; Writing - review & editing: J.K.W.

personnel to properly manage patients with gastric cancer and for health policy authorities to plan appropriate strategies. This study investigated the trends in gastric cancer by adding the latest updated gastric cancer data from 2019. The present study analyzed the incidence, survival, and clinicopathological features of gastric cancer from 1999 to 2019.

## MATERIALS AND METHODS

### Data source

Epidemiological data were retrieved from the KCCR using the Korea National Cancer Incidence Database [3]. This study included patients registered as having C16 (gastric cancer) based on the International Classification of Diseases, tenth revision (ICD-10) codes from 1999 to 2019 [4]. Tumor location was categorized as cardia and fundus (C16.0, C16.1), body (C16.2), antrum and pylorus (C16.4), or unspecified (C16.5–C16.9) [5]. The Surveillance, Epidemiology, and End Results (SEER) stage has been published by the KCCR since 2006. The SEER stage at diagnosis was classified as localized (invasive cancer limited to the organ of origin), regional (tumor extension beyond the limits of the organ of origin), distant (spread to distant areas from the primary tumor), and unknown [6]. Histology was categorized into six groups based on ICD-O-3 morphology codes [7]: tubular adenocarcinoma (8140/3, 8143/3, 8144/3, 8190/3, 8210/3, 8221/3, 8255/3, 8261/3-8263/3); signet ring cell carcinoma (8145/3, 8490/3); other carcinoma, carcinoid tumor (8013/3, 8153/3, 8240/3-8246/3, 8249/3, 9364/3, 9473/3); non-epithelial (8004/3, 8011/3, 8680/3, 8711/3, 8720/3, 8800/3-8804/3, 8806/3, 8810/3, 8811/3, 8830/3, 8850/3-8855/3, 8858/3, 8890/3-8891/3, 8896/3, 8900/3, 8920/3, 8935/3, 8936/3, 8963/3, 8980/3, 8990/3, 9064/3, 9080/3, 9085/3, 9120/3, 9133/3, 9490/3, 9540/3,itit9560/3, 9581/3); and unclassified (8000/3, 8001/3, 8010/3, 8142/3, 8050/3, 8052/3) [5]. The "first course of treatment" was grouped into three categories, which referred to documented cancer-directed treatment methods within the first 4 months of initial diagnosis [6]: surgical (surgery alone, surgery with chemotherapy, surgery with radiotherapy, surgery with chemotherapy and radiotherapy), non-surgical (chemotherapy alone, chemotherapy with radiotherapy, radiotherapy alone), and no active/unknown treatment [8]. In the registry, the surgical treatment group included endoscopic mucosal resection or submucosal dissection, which cannot be differentiated from surgery.

This study complied with the principles of the 1964 Declaration of Helsinki and was approved by the Institutional Review Board of the National Cancer Center, Korea (NCC 2022-0186-0001), which waived the requirement for patient consent owing to the use of anonymized data.

### Statistical analysis

The study was divided into periods I (1999–2005), II (2006–2012), and III (2013–2019). The rates are presented as crude rate (CR) and age-standardized rate (ASR) per 100,000 individuals. The CRs were calculated as the total number of incidence/mortality cases divided by the mid-year population of the specified years. The ASR was a weighted average rate calculated by weighting the proportion of the standard population corresponding to each age group. Calculating the ASR based on the same standard population allows comparisons of incidence and mortality rates between regions or periods with different age structures. The ASRs in the present study were calculated according to Segi's world standard population [9]. The annual percent change (APC) of the ASRs and the average APC (AAPC) as a weighted average of the APCs for the entire study period were computed. Relative survival rates were calculated based on the Ederer II method with minor modifications [10] using an algorithm


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written in SAS provided by Paul Dickman. All statistical tests were two-tailed, and results were considered statistically significant for P<0.05. The statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA) and Joinpoint 4.7.0.0 (National Cancer Institute, Bethesda, MD, USA).

## RESULTS

### Patient characteristics

Between 1999 and 2019, 577,502 patients were newly diagnosed with gastric cancer in Korea. Of these, 33.2% were aged 70 years or older and 66.8% were male (**Table 1**). The most frequent tumor locations were the antrum and pylorus, followed by the body and cardia and fundus. The number of patients with cardia and fundus cancer increased over time. However, the proportion remained stable (6.8% [1999] to 6.5% [2019]), while those of body cancer increased (35.3% [1999] to 45.2% [2019]), and antrum and pylorus cancers decreased (57.8% [1999] to 48.3% [2019]) after excluding patients with unspecified locations. More than 80% of gastric cancer patients had localized or regional disease. The proportion of localized stage cases increased from period II to III, while those of regional and distant stages decreased. Surgical "first course of treatment" was administered to >70% of patients with gastric cancer. The proportion of patients with surgical treatment gradually increased over time, whereas the proportion of those with no active/unknown treatment decreased. Tubular adenocarcinoma was the most common histological type, followed by signet ring cell carcinoma. The distribution of each histological group remained stable between 1999 and 2019 (**Table 2**).

**Table 1.** Characteristics of patients with gastric cancer in Korea, 1999–2019

| Characteristics | Total (n=577,502) | Period I (1999–2005) (n=161,852) | Period II (2006–2012) (n=205,742) | Period III (2013–2019) (n=209,908) |
|---|---|---|---|---|
| Age at diagnosis (yr) | | | | |
| 0–29 | 3,510 (0.6%) | 1,780 (1.1%) | 1,151 (0.6%) | 579 (0.3%) |
| 30–39 | 22,248 (3.9%) | 9,226 (5.7%) | 7,899 (3.8%) | 5,123 (2.4%) |
| 40–49 | 66,972 (11.6%) | 21,509 (13.3%) | 25,468 (12.4%) | 19,995 (9.5%) |
| 50–59 | 126,662 (21.9%) | 33,594 (20.8%) | 45,818 (22.3%) | 47,250 (22.5%) |
| 60–69 | 166,259 (28.8%) | 50,333 (31.1%) | 58,080 (28.2%) | 57,846 (27.6%) |
| 70–79 | 139,636 (24.2%) | 34,532 (21.3%) | 50,575 (24.6%) | 54,529 (26.0%) |
| ≥80 | 52,213 (9.0%) | 10,878 (6.7%) | 16,751 (8.1%) | 24,584 (11.7%) |
| Sex | | | | |
| Male | 385,822 (66.8%) | 106,550 (65.8%) | 138,136 (67.1%) | 141,136 (67.2%) |
| Female | 191,680 (33.2%) | 55,302 (34.2%) | 67,606 (32.9%) | 68,772 (32.8%) |
| Location | | | | |
| Cardia and fundus | 28,144 (4.9%) | 6,666 (4.1%) | 10,037 (4.9%) | 11,441 (5.5%) |
| Body | 178,843 (31.0%) | 36,494 (22.6%) | 64,520 (31.4%) | 77,829 (37.1%) |
| Antrum and pylorus | 230,707 (40.0%) | 55,468 (34.3%) | 86,124 (41.9%) | 89,115 (42.5%) |
| Unspecified | 139,808 (24.2%) | 63,224 (39.1%) | 45,061 (21.9%) | 31,523 (15.0%) |
| SEER stage | | | | |
| Localized | 242,285 (58.3%) | - | 109,494 (53.2%) | 132,791 (63.3%) |
| Regional | 92,028 (22.1%) | - | 49,795 (24.2%) | 42,233 (20.1%) |
| Distant | 46,955 (11.3%) | - | 24,336 (11.8%) | 22,619 (10.8%) |
| Unstaged | 34,382 (8.3%) | - | 22,117 (10.8%) | 12,265 (5.8%) |
| First course of treatment | | | | |
| Surgical* | 413,371 (71.6%) | 100,062 (61.8%) | 149,479 (72.7%) | 163,830 (78.1%) |
| Non-surgical | 39,704 (6.9%) | 10,940 (6.8%) | 14,650 (7.1%) | 14,114 (6.7%) |
| No active treatment or unknown | 124,427 (21.6%) | 50,850 (31.4%) | 41,613 (20.2%) | 31,964 (15.2%) |

SEER = Surveillance, Epidemiology, and End Results.
*Surgical treatment included surgery and endoscopic resection.


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**Table 2.** Histology distribution, 1999–2019

| Study period | Tubular adenocarcinoma | | Signet ring cell carcinoma | | Other carcinoma | | Carcinoid tumor | | Non-epithelial tumor | | Unclassified | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (n=409,344) | ASR | (n=107,489) | ASR | (n=17,195) | ASR | (n=3,987) | ASR | (n=6,736) | ASR | (n=32,751) | ASR |
| Period I (1999–2005) | 108,151 (66.8%) | 29.3 | 28,474 (17.6%) | 7.3 | 5,028 (3.1%) | 1.4 | 534 (0.3%) | 0.1 | 1,424 (0.9%) | 0.4 | 18,241 (11.3%) | 4.8 |
| Period II (2006–2012) | 149,332 (72.6%) | 30.8 | 37,914 (18.4%) | 7.9 | 6,065 (2.9%) | 1.3 | 1,329 (0.6%) | 0.3 | 2,060 (1.0%) | 0.4 | 9,042 (4.4%) | 1.7 |
| Period III (2013–2019) | 151,861 (72.3%) | 23.7 | 41,101 (19.6%) | 7.1 | 6,102 (2.9%) | 1.0 | 2,124 (1.0%) | 0.4 | 3,252 (1.5%) | 0.5 | 5,468 (2.6%) | 0.7 |

ASR = age-standardized rate.

## Temporal trends in incidence and mortality rates

The annual number of gastric cancer cases increased from 20,902 in 1999 to 32,016 in 2011 and then decreased to 29,493 in 2019. The CR for gastric cancer incidence in both sexes increased from 1999 (44.3 per 100,000) to 2011 (63.9), and then decreased until 2019 (57.4). The CR for mortality was stable until 2003 (24.4), and then decreased until 2019 (14.9; **Fig. 1A**). The ASR for the incidence rate significantly decreased from 2011 (43.0) to 2019 (29.6), with an APC of −4.50 (95% confidence interval [CI], −5.10, −3.90). Overall, the AAPC for gastric cancer incidence from 1999 to 2019 was −1.97 (95% CI, −2.27, −1.66). The ASR for mortality decreased steadily between 1999 (23.9) and 2019 (6.7; **Fig. 1B**). The APC for mortality was −1.90 (95% CI, −3.91, 0.16) from 1999 to 2002, and −6.11 (95% CI, −6.26, −5.96) from 2002 to 2019, and the AAPC for gastric cancer mortality from 1999 to 2019 was −5.49 (95% CI, −5.79, −5.19). These trends were similar for both males and females. The age-specific incidence rates decreased in all age groups and were more marked among those aged >60 years since 2011 (**Fig. 2**).

In 2019, the number of gastric cancer cases was highest in Gyeonggi-do, whereas the CR and ASR were highest in Chungcheongnam-do (**Fig. 3**).

## Temporal trends in treatment patterns

From 2006 to 2019, the proportion of cases undergoing surgical treatment within the first 4 months after the initial diagnosis increased from 81.0% to 92.0% in the localized stage (**Fig. 4A**) and 80.7% to 83.1% in the regional stage (**Fig. 4B**). The non-surgical "first course of treatment" rate remained low in the localized (1.4% to 0.6%) and regional stages (5.4% to 5.9%), while it increased from 37.2% to 50.5% for the distant stage (**Fig. 4C**). In the distant stage, the surgical "first course of treatment" rate decreased but remained >20%. The rate of no active/unknown treatment decreased over time in all three stages.

## Survival outcomes of gastric cancer

The overall 5-year relative survival (5YRS) rate of patients with gastric cancer in Korea increased from 55.7% in period I to 77.0% in period III (P<0.0001). The 5YRS rate increased in both localized (94.4% [period II] to 96.8% [period III]) and regional stages (57.8% [period II] to 61.8% [period III]; **Fig. 5A**). In subgroup analysis, according to the SEER stage, patients who underwent surgical "first course of treatment" had a better prognosis than those who underwent non-surgical or no active/unknown treatment. In period III, the 5YRS rate of those with surgical "first course of treatment" was 100.6% in the localized stage and 70.5% in the regional stage (**Fig. 5B**).


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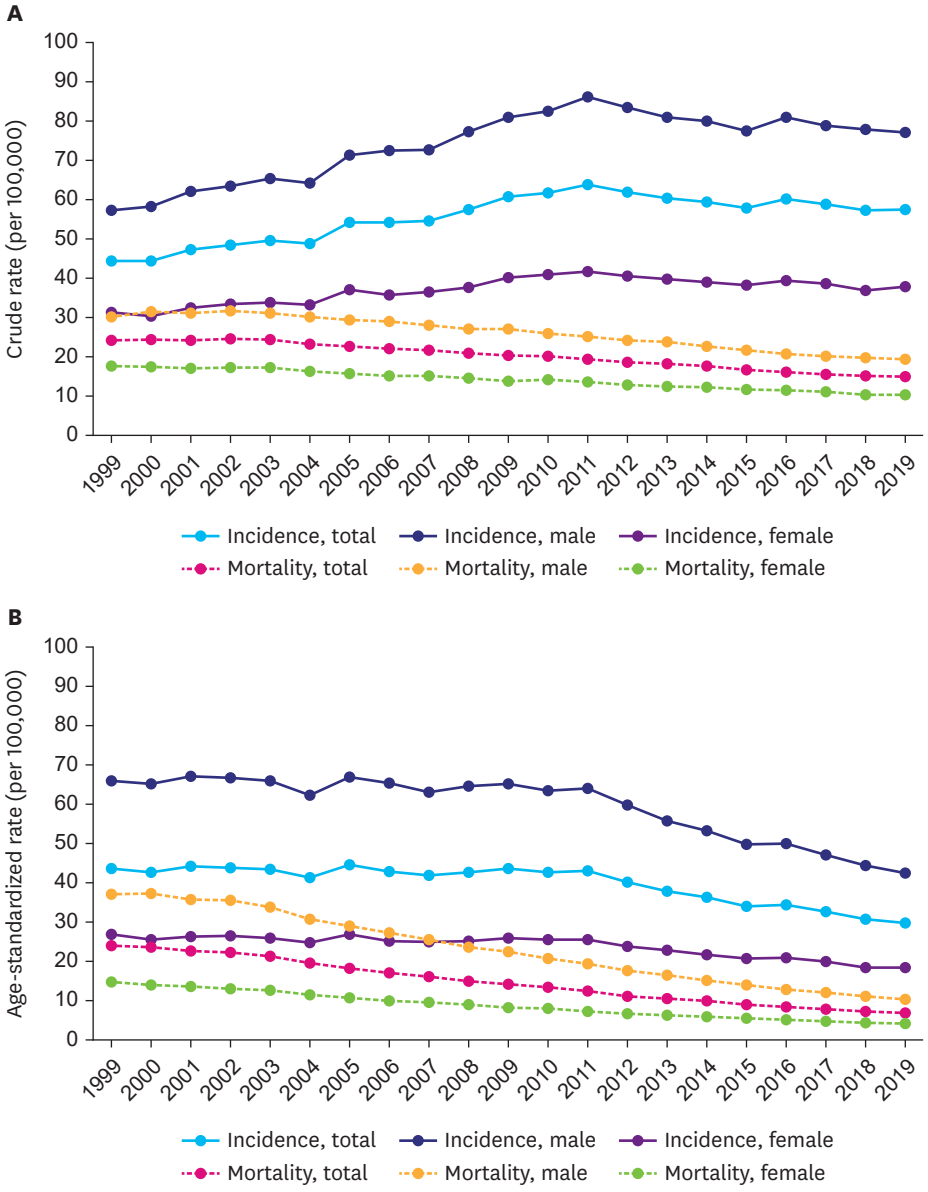


**Fig. 1.** Incidence and mortality rates of gastric cancer, 1999–2019.
(A) Crude rate and (B) Age-standardized rate.

## DISCUSSION

The results of this study showed the current trends in gastric cancer, including the incidence, mortality, tumor location, histology, and SEER stage, based on KCCR data. From 1999 to 2019, the incidence and mortality (age-standardized) of gastric cancer gradually decreased, whereas tumor location and histology remained stable. The proportion of localized stage cases increased from 2006 to 2019, whereas those of regional and distant stages decreased. In addition, the 5YRS increased for localized and regional stages but not for distant stages in period III compared to period II.


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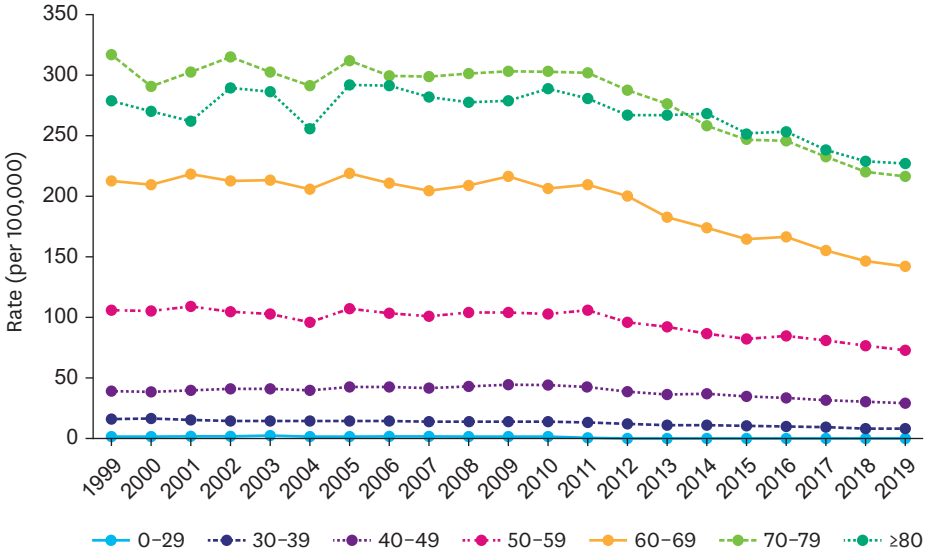


**Fig. 2.** Incidence rates of gastric cancer by age groups.

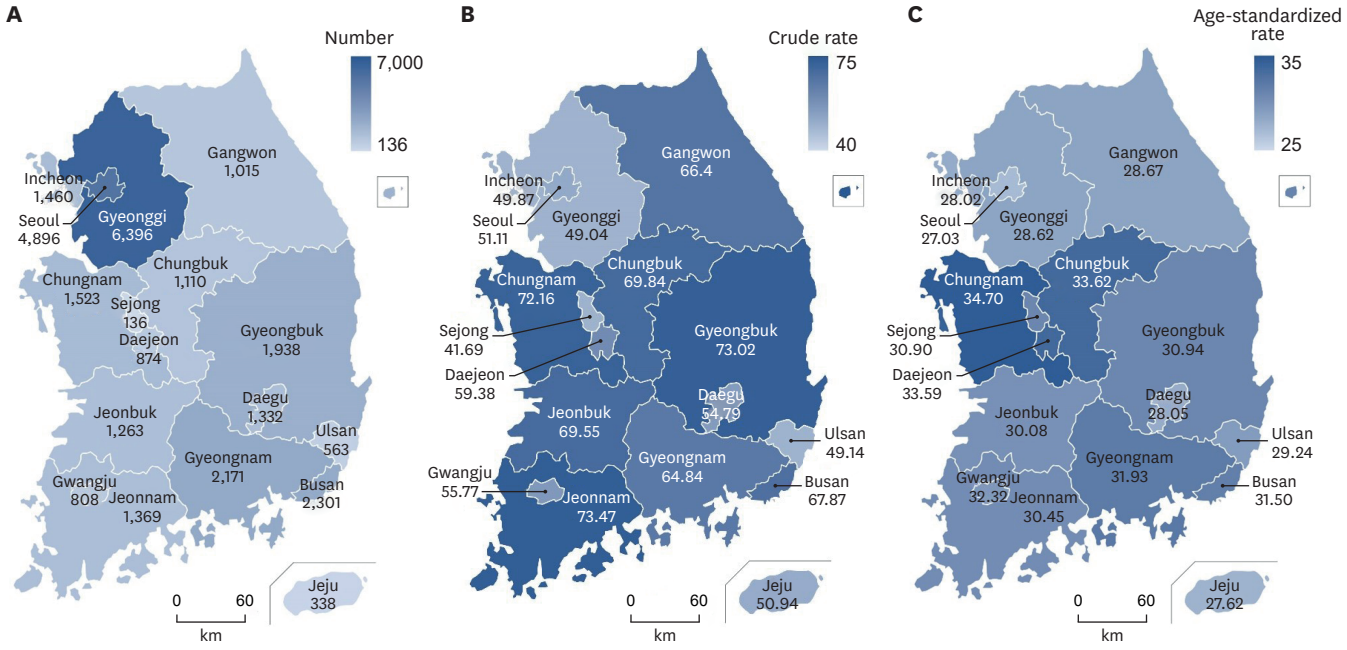


**Fig. 3.** Incidence of gastric cancer by region in 2019.
(A) Cases, (B) Crude rate, and (C) Age-standardized rate.

The proportion of patients aged >70 years with gastric cancer has gradually increased, with the number of patients aged >80 years particularly increased compared to those aged >70 years after 2014. As the average life expectancy increases, the elderly population also increases, with an increased probability of cancer. Consequently, the number of elderly patients is expected to continue to increase [11].

Contrary to the findings of a previous study [12], the proportion of upper third gastric cancer cases was similar, while that of body and antrum cancers changed after excluding unspecified locations.


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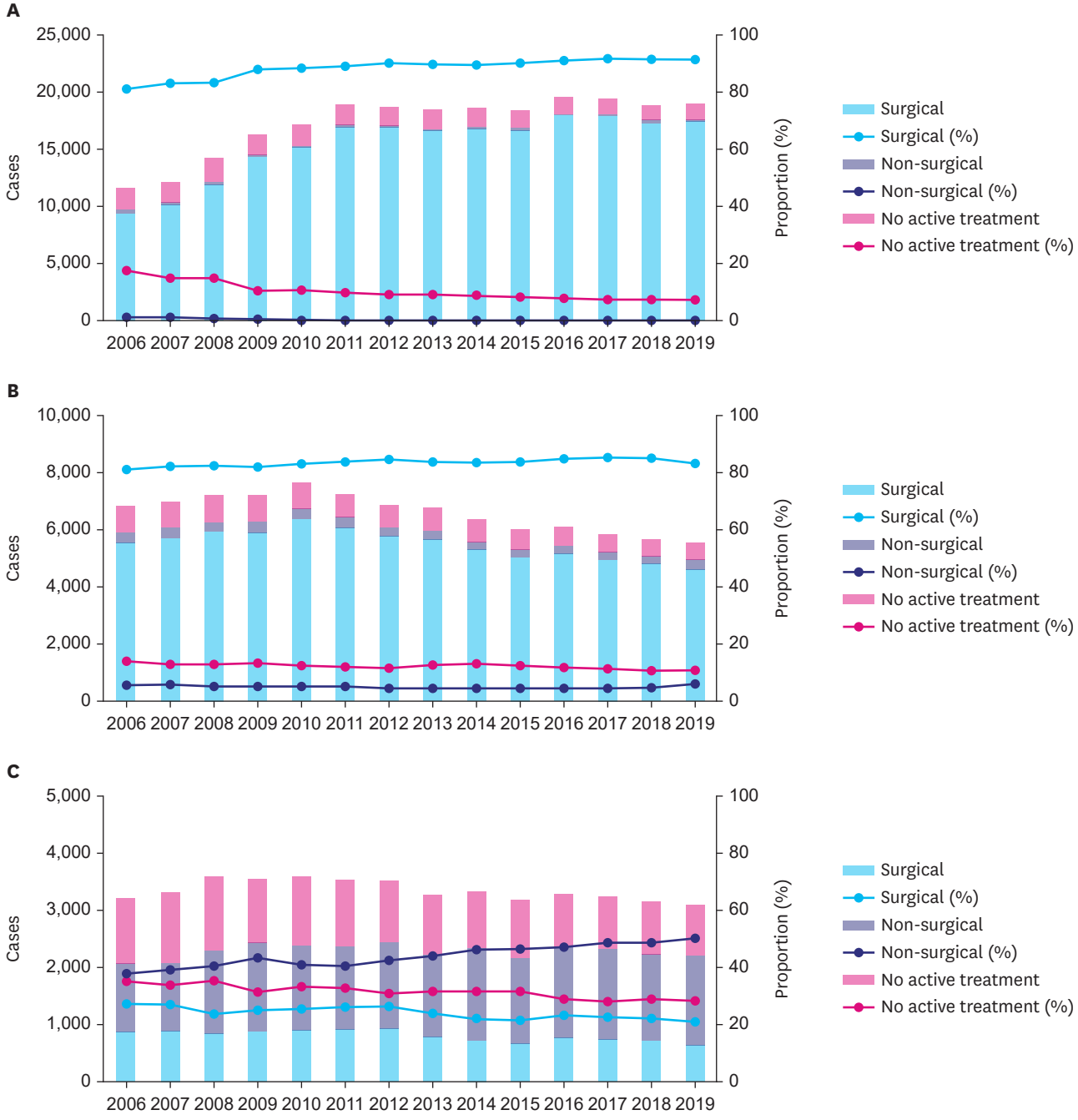


**Fig. 4.** First course of treatment according to Surveillance, Epidemiology, and End Results stage.
(A) Localized, (B) Regional, and (C) Distant.
The surgical treatment group included surgery and endoscopic resection.

The proportion of localized stage cases in period III, 63.3%, was 10% higher than that in period II. The high incidence of localized stage cases might be attributable to the national cancer screening program in Korea [13]. Surgical "first course of treatment" was performed in >70% of patients with gastric cancer. In contrast, no active/unknown treatments tended to decrease dramatically. The overall 5YRS and 5YRS rates for localized and regional stages also increased, which might be attributed to early diagnosis and advances in treatment methods [14].


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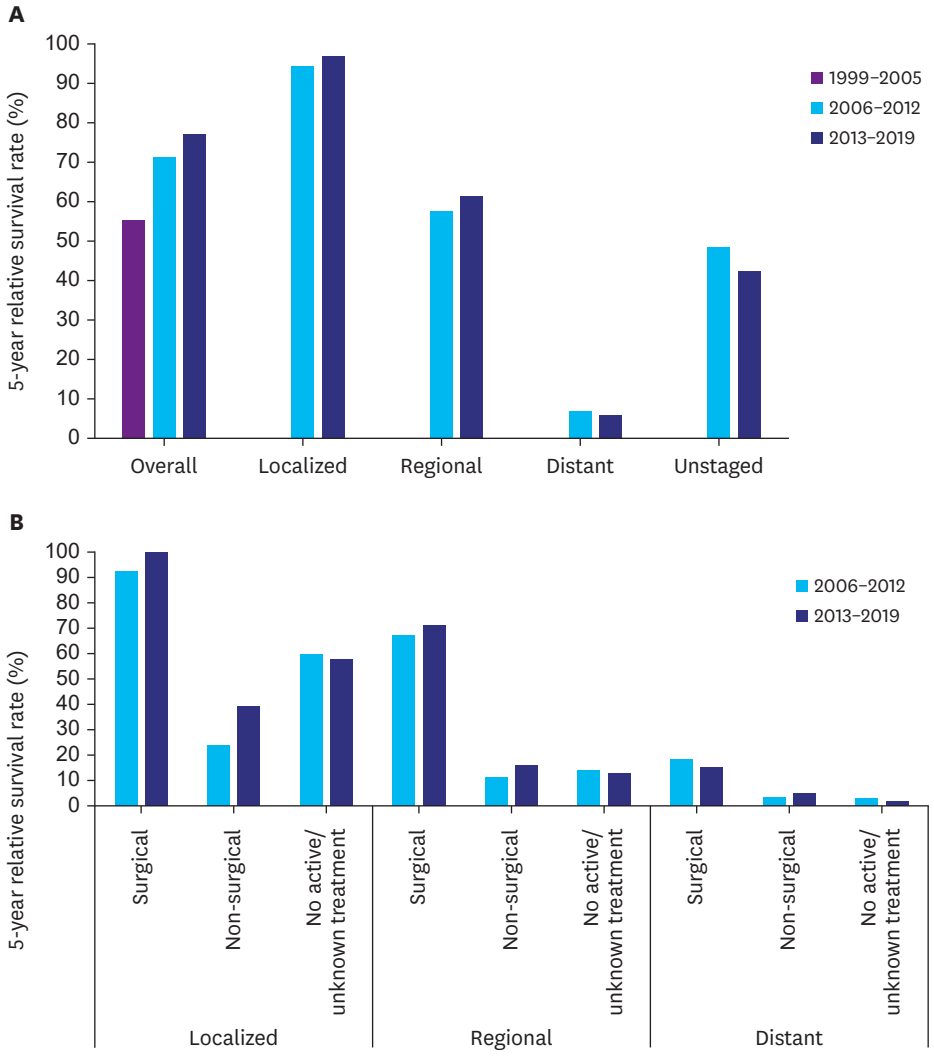


**Fig. 5.** Overall 5-year relative survival rates.
(A) According to the SEER stage and (B) According to the SEER stage and first course of treatment. The surgical treatment group included surgery and endoscopic resection.
SEER = Surveillance, Epidemiology, and End Results.

This study has several limitations. First, the unspecified location group comprised codes C16.5 (lesser curvature), C16.6 (greater curvature), C16.8 (overlapping lesion), and C16.9 (stomach unspecified), which represented cases where locations from the cardia to pylorus were not identified. Similarly, unstaged cases included those in which the exact stage could not be identified from the medical records. Although the proportion of cases with unspecified locations decreased, compared to the past, unspecified locations still accounted for 15% of cases. Similarly, the proportion of unstaged SEER cases was 5.8%. Therefore, accurate medical records are required. Second, the no active treatment rate decreased from 19.1% in 2006 to 10.5% in 2019 and still accounted for a large proportion of cases. Furthermore, the results of no active treatment were superior or comparable to those of non-surgical treatment in the localized and regional stages. Since the initial treatment for gastric cancer was included only in cases treated within the first 4 months of the initial diagnosis in the KCCR database, information on treatment performed after 4 months might have been omitted. More precise information on localized non-surgical treatment is mandatory for


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precise epidemiological evaluations. Third, although surgical treatment included endoscopic mucosal resection or submucosal dissection, surgery alone, and surgery with adjuvant chemotherapy, it was difficult to distinguish between endoscopic treatment and surgery as an initial treatment. Although nationwide data on surgical resection are available, exact nationwide data on endoscopic resection are not [12].

In conclusion, this study demonstrated epidemiologic trends in the incidence, survival, and clinicopathological characteristics of gastric cancer between 1999 and 2019. These results will help understand the current status of gastric cancer in Korea.

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