



Incidence and mortality of gastric cancer in 2018 and their trends from 2010 to 2018 in Henan Province, China: results from a provincial population-based cancer registry

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Background: Endoscopic screening program was carried out in Henan Province, China to reduce the large gastric cancer burden, and its effect evidence is insufficient. Knowledge on current status and time-trend of gastric cancer is need for policy makers to optimize the strategy of gastric cancer control.

Methods: Gastric cancer data were pooled from registries in the Henan Cancer Registration System which may reflect the whole province cancer incidence and mortality. The pooled registration data, stratified by area (urban/rural), gender, and age groups, was combined with the provincial population data to estimate the incidence and mortality of gastric cancer in Henan Province. The Segi's world standard population was applied to calculate the age-standardized rate. Joinpoint regression was used to analyze the time-trend in the incidence and mortality.

Results: Gastric cancer was diagnosed in 33,971 patients in 2018, ranking second among all cancers. The crude incidence and age-standardized incidence rate (ASIRW) per 100,000 population were 31.15 and 23.05, respectively. In 2018, there were an estimated 25,921 gastric cancer-related deaths, ranking second among all cancer-related deaths. The crude mortality rate and age-standardized mortality rate by world standard population (ASMRW) were respectively 23.77 and 16.80 per 100,000 population. Gender and geographical differences were observed. Notably, the ASIRW and ASMRW were higher in males than females and higher in rural areas than urban areas. For ASIRW and ASMRW, the male to female ratio was 2.50 and 2.71, respectively, and the rural to urban ratio was 1.23 and 1.24, respectively. Declines in the incidence [average annual percent change (AAPC): -3.9%, P=0.001] and mortality (AAPC: -3.1%, P=0.004) of gastric cancer were observed in rural areas due to declines in the incidence and mortality among residents aged 40–69 years. The overall trend of ASIRW and ASMRW were observed to decline with AAPCs of -3.5% (P=0.003) and -2.8% (P=0.007), respectively.

Conclusions: Gastric cancer incidence and mortality decreased in Henan Province, China, from 2010 to 2018, which may due to the implementation of endoscopic screening for gastric cancer in rural areas.

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The disease burden, however, remains high, and screening strategies and measures to reduce it should be strengthened.

Keywords: Gastric cancer; incidence; mortality; trend; cancer registration

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Introduction

Gastric cancer is a public health concern around the world. There have been steady declines in the incidence over the last few decades, which may be explained by improved hygiene, improved food conservation, a high intake of fresh fruits and vegetables, and *H. pylori* eradication. However, the disease burden remains high, and it is the 5th most commonly diagnosed malignancy, and the 4th most common cause of cancer-related deaths (1). The burden of gastric cancer varies greatly in different geographical regions, and it is highest in East Asian countries and low in Southern Asia, North and East Africa, North America, and Australia. National screening strategy was initiated in high-risk countries including Korea and Japan to reduce gastric cancer incidence and mortality (2-4). China is one of the countries with the highest incidence and mortality rates (5), and vast geographical differences in the gastric cancer burden also exist in different parts of China. The middle-western provinces of China, including Henan, Hebei, Shanxi, Shaanxi, and Gansu, had the highest gastric cancer mortality rates based on 2 national mortality surveys conducted in 1970s and 1990s (6). However, the data on the incidence of gastric cancer were not clear due to the lack of population-based cancer registration data for these areas in those periods.

To reduce the gastric cancer burden, endoscopic screening programs have been implemented in high-risk areas since 2008 supported by national fund. Endoscopic examination with iodine staining and indictive biopsy were performed on residents aged 40-69 years old to detect precancerous lesions such as high-grade intraepithelial neoplasia (HGIEN) and low-grade intraepithelial neoplasia (LGIEN), as well as early-stage cancer such as intramucosal cancer or submucosal cancer, and appropriate treatment advice was given based on the severity of the lesions. Patients with severe dysplasia or carcinoma *in situ* or intramucosal cancer were advised to receive endoscopic mucosal resection (EMR) and argon plasma coagulation,

while patients with submucosal cancer and advanced cancer were advised to receive gastric cancer resection, radiotherapy, and other standard treatments (7). Cancer registries have also been established to evaluate the effects of the widespread screening programs. These high-risk areas now have a solid population-based cancer registration system (8), however, the report for the gastric cancer epidemiological characteristics were still insufficient (9) which are important for evaluating the screening effect and optimizing strategies and measures for prevention and control of gastric cancer.

To extend understandings of the gastric cancer burden in the high-risk areas, we sought to describe the incidence and mortality of gastric cancer and their trends in recent years in middle China (Henan Province) using well-established cancer registration data. We present the following article in accordance with the STROBE reporting checklist (available at <https://atm.amegroups.com/article/view/10.21037/atm-22-4100/rc>).

Methods

The gastric cancer burden and temporal trends were evaluated using cancer registration data based on a number of indexes, such as the incidence, mortality, proportion, annual percent change (APC), and the average annual percent change (AAPC).

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Henan Cancer Registration System

The first cancer registry in Henan Province, as well as the first cancer registry in China, was established in Linzhou in 1959 (8). The Chinese government established the national cancer registration program in 2018, and sustainable funding was provided to support the program's ongoing expansion (8). Since then, the number of cancer registries

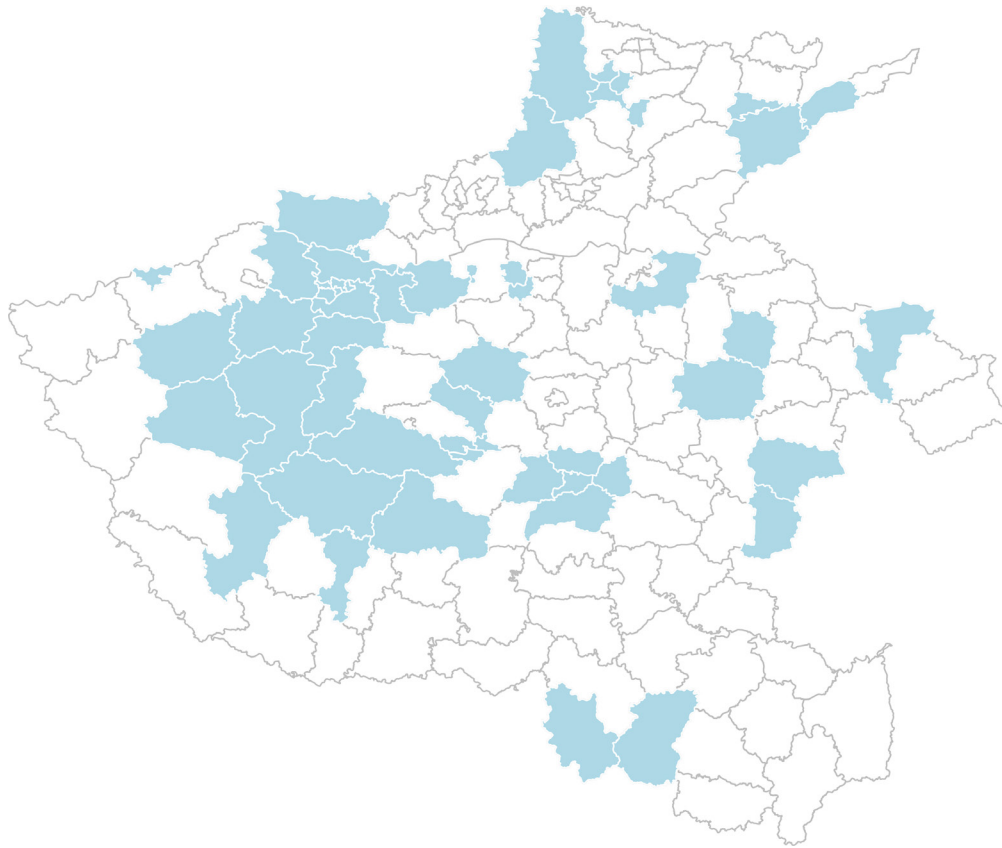


Figure 1 Map for distribution of cancer registries in the Henan Cancer Registration system.

in Henan Province has grown dramatically, and it had increased to 39 by the end of 2021, covering 30.51% of the province's population. Since these cancer registries are geographically evenly distributed in the East, North, West, and South of Henan Province, the results from them may reflect the cancer incidence and mortality of the entire Province (*Figure 1*).

Data sources

The gastric cancer data (International Classification of Diseases 10th Revision, ICD10: C16.0–C16.9) included in our analysis were extracted from the Henan Provincial Cancer Registration Database for which the data are collected and initially evaluated by each local cancer registry, and then submitted to the Henan Provincial Cancer Registry, which is in charge of the quality control and routine management of the cancer registration data for the whole province. The main sources of cancer cases for

each local cancer registry included hospitals, community healthcare centers, and village doctors. The supplementary data sources included the health insurance system, new rural cooperative medical system, and vital statistical system. Data transferred from other provinces also provided a source of data on cancer cases.

Patients who had been diagnosed with malignant gastric cancer between January 1, 2018 and December 31, 2018, or had died of gastric cancer during the same period as recorded by each cancer registry were enrolled in this analysis, and patients who had been diagnosed with carcinoma *in situ* of gastric cancer were excluded.

Gastric cancer age-standardized incidence rate by world standard population (ASIRW) and age-standardized mortality rate by world standard population (ASMRW) data for the period of 2010 to 2018 were also extracted from the Henan Provincial Cancer Registration Database to evaluate changing trends in the incidence and mortality of gastric cancer.

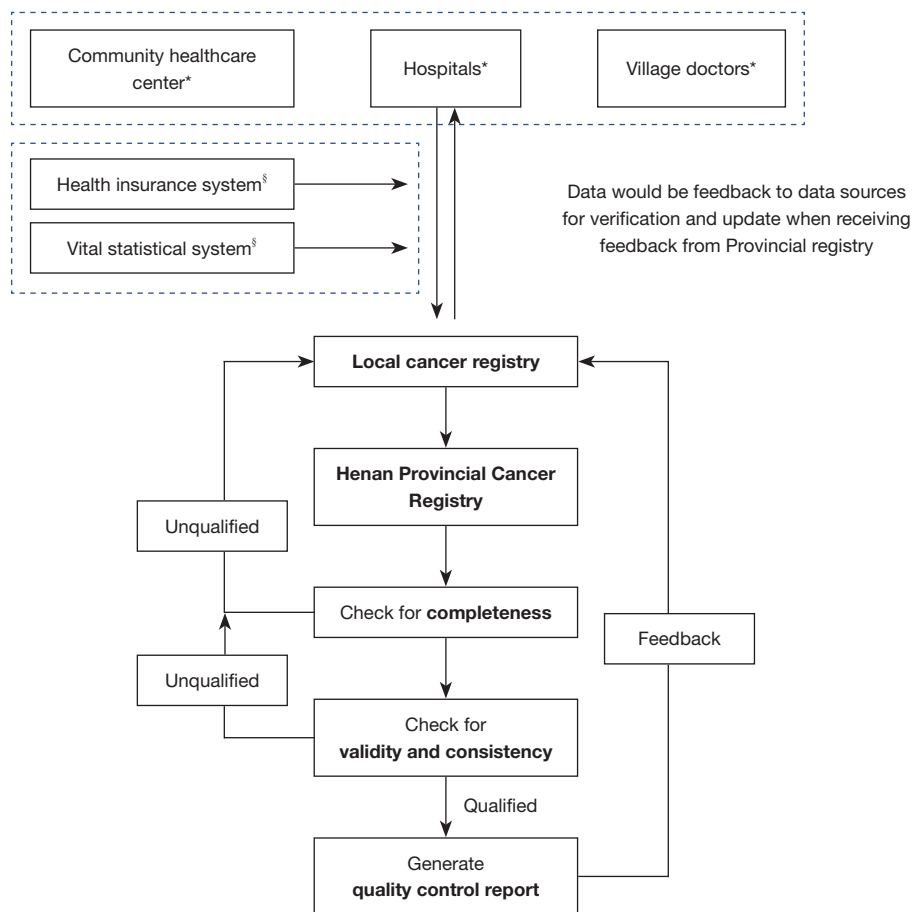


Figure 2 Flow chart of quality control procedure for cancer registration data. *, main data sources; §, supplementary data sources.

Quality control

The data quality was evaluated according to the criteria set out in the Guidelines for Chinese Cancer Registration (10) and the International Agency for Research on Cancer/International Agency for Cancer Registration (IARC/IACR) (11,12). The quality indexes, including the mortality to incidence (M:I) ratio, the proportion of cases with morphological verification (MV%), the percentage of cancer cases with an unknown basis (UB%), and the percentage of cases with a death certificate only (DCO%), were used to assess the completeness, comparability, and validity of the cancer registration data.

As *Figure 2* shows, each data source unit checks the internal consistency of the registration data by assessing the validity of the data items (e.g., date of birth, incidence date, age, sex, site, morphology, behavior, and grade) or data item combinations (e.g., gender/site, site/histology, age/

site/histology, behavior/site, behavior/histology, and sex/histology). The data are then reported to the local registry, and the provincial cancer registry assesses the completeness and validity of the data, and a quality report is provided to the local registry as the basis for the verification and supplementation of the data.

Statistical analysis

The incidence and mortality of gastric cancer in Henan Province were stratified by area (urban or rural), gender, and age groups (0, 1–4, 5–9, 10–14,, 75–79, 80–84, and 85+ years) and estimated using data from the 39 cancer registries and the 2018 population data for Henan Province, China. The National Cancer Center's definitions of urban and rural areas were adopted in this study. Segi's standardized population was used to calculate the ASIRW, and the census population data for 2000 were used to

Table 1 Gastric cancer data quality of population-based cancer registration in Henan Province, China

Areas	Gender	MV%	DCO%	M:I
All	Total	79.02	1.53	0.77
	Male	79.83	1.26	0.77
	Female	77.14	2.14	0.76
Urban areas	Total	78.66	1.98	0.76
	Male	79.37	1.71	0.78
	Female	76.85	2.65	0.73
Rural areas	Total	79.13	1.39	0.77
	Male	79.97	1.13	0.77
	Female	77.23	1.99	0.77

MV%, the proportion of cases with morphological verification; DCO%, the percentage of cases with a death certificate only; M:I, the mortality to incidence ratio.

calculate the ASIRC to control for the confounding effect of age in comparison to other areas. The incidence and mortality rates for gastric cancer stratified by age groups (15–39, 40–69, and >70 years) were re-calculated. The APC and the AAPC for the period of 2010–2018 were calculated using the Joinpoint Regression Program to assess changing trends in the incidence and mortality of gastric cancer. The analysis was conducted using SAS software (Version 9.4 SAS Institute Inc., Cary, NC, USA) and Joinpoint Trend Analysis Software (Version 4.9.1.0). In our analysis, the significance threshold of the statistical test is set to 0.05.

Results

A total of 42 cancer registries submitted cancer incidence and mortality data in 2018 to the Henan Provincial Cancer Registration Database; however, data from 3 cancer registries (i.e., Gushi, Anyang, and Xinxiang) were excluded due to lack of completeness. Ultimately, data from 39 cancer registries were included in the analysis, which covered a population of 33,271,234 and accounted for 30.51% of the whole population in Henan Province, China. In 2018, 79.02% of the cases were pathologically diagnosed, the M:I ratio was 0.77, and the DCO% was 1.53% (see *Table 1*).

Estimated number of new gastric cancer cases and incidence rates

Table 2 sets out the estimated number of new gastric cancer

cases and the incidence of gastric cancer in 2018. Overall, it was estimated that there were 33,971 new gastric cancer cases in 2018, accounting for 11.89% of all new cancer cases. Among them, 23,780 and 10,191 were male and female, respectively, and 9,460 lived in urban areas and 24,511 lived in rural areas.

The crude incidence was 31.15 per 100,000 population, and the ASIRW and ASIRC were 23.05 per 100,000 population and 22.85 per 100,000 population, respectively. The incidence of gastric cancer was higher in rural areas than urban areas (ratio: 1.23). The incidence of gastric cancer was also higher in males than females (male to female ratio: 2.50). The difference between the sexes was higher in urban areas than rural areas.

Estimated number of gastric cancer deaths and mortality rates

Table 3 sets out the numbers for the estimated gastric cancer deaths and mortality in 2018. Overall, it was estimated that there were 25,921 gastric cancer-related deaths in 2018, accounting for 15.40% of all cancer-related deaths. Among them, 18,165 and 7,756 were male and female, respectively, and 7,180 lived in urban areas and 18,741 cases lived in rural areas.

The crude mortality was 23.77 per 100,000 population, and the ASMRW and ASMRC were 16.80 per 100,000 population and 16.78 per 100,000 population, respectively. The gastric cancer mortality rate was higher in rural areas than urban areas (ratio: 1.23). The gastric cancer mortality rate was also higher in males than females (male to female ratio: 2.50). The difference between the sexes was higher in urban areas than rural areas.

Age-specific incidence and mortality of gastric cancer rates

The age-specific incidence and mortality of gastric cancer were low among residents aged 0–39 years, increased sharply among residents aged >40 years, and peaked in residents aged 85+ years. Changes in age-specific incidence and mortality with age were similar between males and females, and were also similar between urban areas and rural areas.

The number of estimated new gastric cancer cases and deaths also increased with age, peaked in the 60–64-year age group, and then began to decline. The distribution patterns for the numbers of cases and deaths among different age groups were similar between urban and rural areas (see *Figures 3,4*).

Table 2 Estimated numbers of new gastric cancer cases and the incidence in 2018 in Henan Province, China (per 100,000 population)

Areas	Gender	Cases	Incidence (1/100,000)	ASIRW (1/100,000)	ASIRC (1/100,000)	Proportion (%)
All	Total	33,971	31.15	23.05	22.85	11.89
	Male	23,780	42.02	33.35	32.89	15.91
	Female	10,191	19.42	13.16	13.18	7.48
Urban areas	Total	9,460	27.86	19.95	19.81	9.90
	Male	6,795	39.03	29.93	29.52	13.69
	Female	2,665	16.11	10.61	10.69	5.81
Rural areas	Total	24,511	32.63	24.50	24.27	12.88
	Male	16,985	43.35	34.93	34.46	17.02
	Female	7,526	20.95	14.36	14.35	8.32

ASIRC, age-standardized incidence rate by Chinese standard population; ASIRW, age-standardized incidence rate by World Segi's standard population.

Table 3 Estimated numbers of gastric cancer deaths and mortality in 2018 in Henan Province, China (per 100,000 population)

Areas	Gender	Deaths	Mortality (1/100,000)	ASMRW (1/100,000)	ASMRC (1/100,000)	Proportion (%)
All	Total	25,921	23.77	16.80	16.78	15.40
	Male	18,165	32.10	24.93	24.88	17.67
	Female	7,756	14.78	9.20	9.18	11.85
Urban areas	Total	7,180	21.15	14.52	14.44	13.70
	Male	5,219	29.98	22.53	22.28	16.08
	Female	1,961	11.86	7.23	7.25	9.83
Rural areas	Total	18,741	24.95	17.87	17.89	16.17
	Male	12,946	33.04	26.04	26.09	18.40
	Female	5,795	16.13	10.12	10.09	12.73

ASMRC, age-standardized mortality rate by Chinese standard population; ASMRW, age-standardized mortality rate by World Segi's standard population.

Trends in the incidence and mortality of gastric cancer

The gastric cancer ASIRW and ASMRW were observed to decline significantly during the period of 2010 to 2018 with AAPCs of -3.5% (95% CI: -5.3% to -1.7% , $P=0.003$) and -2.8% (95% CI: -4.5% to -1.0% , $P=0.007$), respectively. The AAPCs of ASIRW and ASMRW for male residents were -3.2% (AAPC: -5.0% to -1.3% , $P=0.006$) and -2.5% (95% CI: -4.2% to -0.8% , $P=0.010$), respectively. Among female residents, they were -4.3% (95% CI: -6.4% to -2.1% , $P=0.002$) and -3.4% (95% CI: -6.0% to -0.7% , $P=0.020$).

When the analysis was stratified by area, no significant trends in ASIRW and ASMRW were observed in urban areas; however, statistically significant declines in ASIRW and ASMRW were observed in rural areas, which had an AAPC of -3.9% (95% CI: -5.5% to -2.1% , $P=0.001$) and -3.1% (95% CI: -4.7% to -1.4% , $P=0.004$). Among rural residents, the ASIRW declined with AAPCs of -3.7% (95% CI: -5.4% to -1.9% , $P=0.002$) and -4.2% (95% CI: -6.4% to -2.1% , $P=0.002$) in males and females, respectively; the AAPCs for the ASMRW for males and females were -3.0% (95% CI: -4.6% to -1.4% , $P=0.003$) and -3.2% (95% CI: -5.8% to -0.5% , $P=0.025$), respectively (see *Figure 5*).

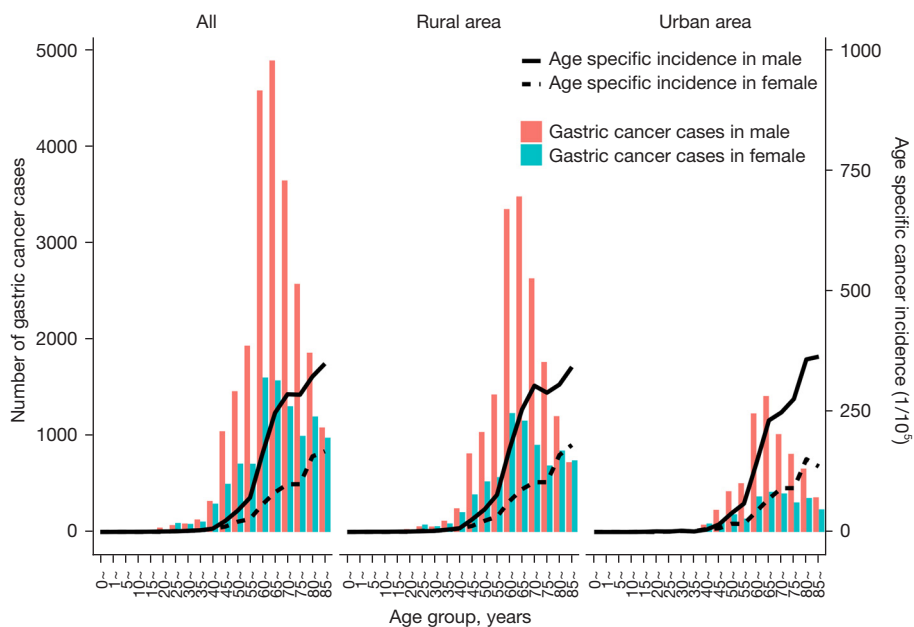


Figure 3 Age-specific incidence of gastric cancer and the distribution of cases by age groups.

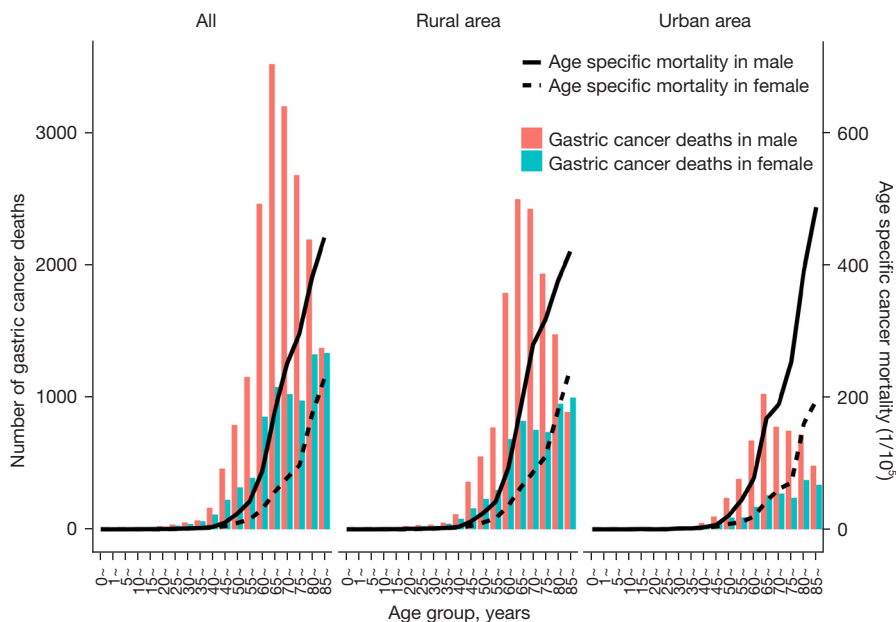


Figure 4 Age-specific gastric cancer mortality and the distribution of deaths by age groups.

Trends in the incidence and mortality of gastric cancer stratified by age

Among the rural areas, the incidence and mortality of gastric cancer for the 40–69-year age group from 2010 to 2018 were observed to decline significantly and had

AAPCs of -4.9% (95% CI: -6.4% to -3.4% , $P < 0.001$) and -4.1% (95% CI: -6.1% to -2.1% , $P = 0.002$). However, no significant decreases or increases were observed for the 15–39- and >70 -year age groups.

In the urban areas, no significant changes in the trends

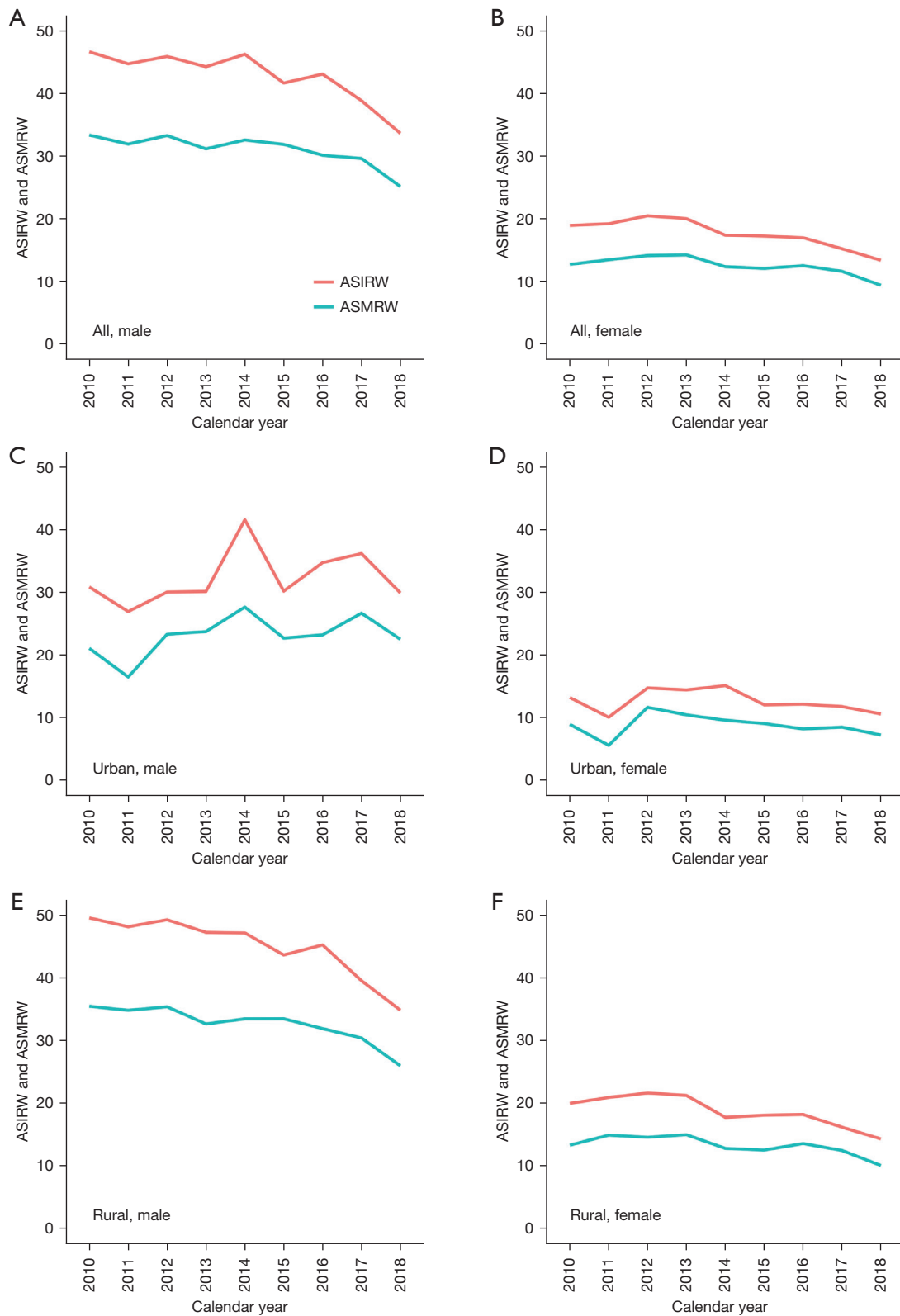


Figure 5 Trends in the incidence and mortality of gastric cancer from 2010 to 2018. ASIRW, age-standardized incidence rate; ASMRW, age-standardized mortality rate by world standard population.

were observed regardless of the incidence and mortality of gastric cancer.

Discussion

Henan Province is located in the middle of China and has a population of >100 million. It was identified as a high-risk area for gastric cancer through the national mortality survey in China (6). To monitor the cancer burden and provide a decision-making basis for cancer control and prevention policies, the Cancer Registration system was established in 2008. With the support of national funding, the cancer registries in Henan have developed rapidly and now cover a population of >33 million, which accounted for about 30% of the total population at the end of 2018. The cancer registration data reflect the cancer incidence and mortality for the whole province (13).

The results of our study showed that the burden of gastric cancer in Henan Province, China remains high; however, a declining trend was observed in the incidence and mortality of gastric cancer in rural areas. In 2018, 33,971 cases were diagnosed, and 25,921 patients died of gastric cancer, ranking Henan Province 2nd among all the cancer sites. The ASIRW and ASMRW in Henan were both higher than the national averages (14); however, a declining trend was observed. Gastric cancer is still a public health threat for residents in Henan, and strategies and measures should be implemented to reduce the burden according to the epidemiological characteristics.

The incidence and mortality of gastric cancer also have age and gender differences that cannot be modified. The incidence and mortality rates increased with age, and peaked in the 85+-year age group, but were low for residents aged <40 years.

Our results also showed that males had higher incidence and mortality rates than females with ratios of 2.50 and 2.71, respectively. This is consistent with national results on the differences between the sexes and results from other areas in the world as reported in the Global Burden of Disease Study 2017 (15). Researchers have found that the sex differences are associated with socioeconomic status and developed countries have greater differences between the sexes than developing countries (15,16). The differences between the sexes in gastric cancer may be due to differences in environmental and genetic risk factors for gastric cancer between males and females, such as helicobacter pylori infection (17), smoking, and alcohol intake (18,19). The differences between the sexes were

also observed to be higher in urban areas with higher levels of socioeconomic status, and this may be due to socioeconomic advantages related to longevity, which have been associated with greater differences between the sexes (15,20).

As one of the high-risk areas for gastric cancer in China, the endoscopic screening program, which has a target population of 40–69-year-old, was first implemented in rural areas in Henan Province in 2008 to reduce the disease burden (7). Precancerous lesions and early cancer are diagnosed and treated as per the screening procedure (21). The screening procedure's implementation is thought to have a significant impact on how effectively it reduces gastric cancer incidence and mortality. Previous research using data from a rural area showed that gastric endoscopic screening reduced the mortality risk by 28% (22). In our study, declining trends in the incidence and mortality of gastric cancer were observed in rural areas, which had AAPCs of -3.9% for ASIRW and -3.1% for ASMRW. The observed declining trend in rural areas was caused by the decline in ASIRW and ASMRW for the 40–69-year-old population, which is consistent with the target population for gastric cancer screening and may be an effect of the screening program. Declines in incidence and mortality were also observed in Hebei Province (9) and China nationally (23,24). Such declines could also be associated with early treatment initiation, deeper understandings of gastric cancer, and developments in technology.

A gastric cancer gap between rural areas and urban areas in Henan Province existed for both sexes. The ASIRW and ASMRW in rural areas were 1.23 and 1.24 times higher, respectively, than those in urban areas. The difference in the incidence of gastric cancer may be due to the socioeconomic status of the populations in rural areas, which have low education levels and low-income levels, which may lead to higher exposure status of risk factors, including *H. pylori* infection, a higher intake of starchy food, and less access to fresh food and vegetables (25). The difference in gastric cancer-related mortality may be due to limited access to high-quality health care for gastric cancer in rural areas (23).

The limitations of this study must be considered when interpreting the results. First, the incidence and mortality rates were estimated using data from cancer registration, which only covered 30% of the total population in Henan Province. Nevertheless, at this level of coverage, population-based cancer registration is thought to be able to provide scientific information for developing cancer control policies (26), and since these registries were evenly

distributed geographically, the results should reflect the epidemiological characteristics of Henan Province. Second, sources of data in the urban cancer registries mainly comprised data from hospitals, and data from other sources were limited; thus, the incidence may have been underestimated. Third, information, including information about the anatomical subsite and TNM stage, were not included in our analysis, and this limited our ability to conduct further analyses. However, the definitions of incidence date, primary cancer and recurrent cancer were consistent with the universal standard criteria of IARC/IACR when collecting data items, and the classification of cancer was also using the standard ICDO3 and ICD10. Thus, the results are comparable to those of other studies.

In conclusion, the gastric cancer burden remains large in Henan Province, China but a decline in its incidence and mortality were observed in rural areas.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at <https://atm.amegroups.com/article/view/10.21037/atm-22-4100/rc>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://atm.amegroups.com/article/view/10.21037/atm-22-4100/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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