Original Article

Trends and incidence of stomach cancer in middle-aged and elderly populations: a global burden of disease analysis

Yubao Tang[1#], Danyang Wang[2,3#], Zhicheng Xu[2], Hanyu Wang[4], Haixia Tian[2], Weijing Wang[2], Dong Hua[2^]

[1]Department of General Surgery, Affiliated Yangzhou Women and Children's Hospital, Yangzhou University School of Medicine, Yangzhou, China; [2]Department of Oncology, The Affiliated Wuxi People's Hospital of Nanjing Medical University, Wuxi, China; [3]Xi'an Medical University, Xi'an, China; [4]Department of Oncology, The Affiliated Children's Hospital of Jiangnan University, Wuxi, China

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[#]These authors contributed equally to this work.

Correspondence to: Dong Hua, MD. Department of Oncology, The Affiliated Wuxi People's Hospital of Nanjing Medical University, No. 299 Qingyang Road, Wuxi 214023, China. Email: jy6668881226@163.com.

Background: Stomach cancer remains a leading cause of cancer deaths in middle-aged and elderly populations. This study aimed to examine global trends in incidence among individuals aged 50–74 years and to explore disparities by age, sex, and region using Global Burden of Disease (GBD) data.

Methods: Data on stomach cancer incidence were extracted from the GBD 2021 database. We analyzed incidence rates for individuals aged 50–74 years, stratified by age, sex, and geographic region. Trends from 1990 to 2021 were evaluated using the Estimated Annual Percentage Change (EAPC) based on log-linear regression models. Pearson correlation was used to examine associations between incidence trends and the Socio-Demographic Index (SDI). Data standardization was based on the GBD world standard population.

Results: From 1990 to 2021, the number of stomach cancer cases among individuals aged 50–74 years increased by 17.32%, while the incidence rates declined from 80.67 to 44.18 per 100,000 (EAPC: −2.15). Males consistently exhibited higher incidence rates than females. The decline was less pronounced in older age groups, particularly those aged 65–74 years, where the number of cases continued to rise, reflecting population aging and cumulative risk exposure. High-SDI regions experienced the largest reductions (e.g., East Asia: EAPC −2.02), whereas progress was limited in low-SDI areas such as Southern and Eastern Sub-Saharan Africa. A strong negative correlation between SDI and incidence trends (ρ=−0.491) underscored the influence of socioeconomic development on disease reduction.

Conclusions: This study reveals marked regional and demographic disparities in stomach cancer trends among aging populations. Socioeconomic development plays a central role in reducing incidence. To reduce global health inequities, efforts should prioritize equitable access to screening and treatment, culturally tailored prevention programs, and investment in healthcare infrastructure in low-SDI regions.

Keywords: Stomach cancer; incidence; middle-aged; elderly populations; global burden

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^ ORCID: 0009-0007-4129-2571.

Introduction

Stomach cancer remains one of the most significant challenges in global oncology, ranking as the fifth most common cancer and the third leading cause of cancer-related deaths worldwide (1). Despite advancements in early detection, treatment, and understanding of its pathophysiology, the global burden of stomach cancer continues to be disproportionately high, particularly among middle-aged and elderly populations (2).

Research into the multifactorial nature of stomach cancer has highlighted key risk factors, including *Helicobacter pylori* infection, unhealthy dietary habits, smoking, and genetic susceptibility. In particular, dietary patterns such as high intake of salted vegetables and fish have been shown to significantly contribute to gastric cancer incidence in East Asian populations, with an estimated 18.6% of cases in Korea in 2018 attributable to diet-related factors (3-5). Recent molecular studies have furthered our understanding by identifying genetic and epigenetic alterations that drive tumorigenesis, offering new opportunities for targeted therapies (2,6). The growing application of genomic technologies has also revealed distinct subtypes of stomach cancer, paving the way for more personalized treatment approaches (7,8).

The aging global population complicates the burden of stomach cancer, especially in low- and middle-income countries/regions where healthcare access and early detection are often limited (9,10). Older adults are particularly vulnerable due to cumulative exposure to risk factors and age-related changes in gastric physiology (11). As life expectancy increases, the number of middle-aged and elderly individuals at risk for developing stomach cancer is expected to rise, making it essential to track the evolving trends of the disease in these age groups (12).

While stomach cancer rates have declined in high-income countries/regions due to improvements in *H. pylori* eradication and healthier lifestyles, the incidence remains alarmingly high in several regions, and rates have even increased in some low- and middle-income countries/regions. These trends underscore the need for comprehensive studies to understand the evolving epidemiology of stomach cancer and inform public health strategies that address the needs of aging populations globally. We present this article in accordance with the STROBE reporting checklist (available at https://jgo.amegroups.com/article/view/10.21037/jgo-2025-151/rc).

Highlight box

Key findings

- This study reveals a 17.32% increase in the number of stomach cancer cases among individuals aged 50–74 years from 1990 to 2021, despite a global decline in the incidence rate from 80.67 to 44.18 per 100,000. The reduction in incidence rate was more pronounced in females and in high Socio-Demographic Index (SDI) regions, while older age groups (65–74 years) experienced slower declines and rising case numbers.

What is known and what is new?

- Stomach cancer remains a major contributor to global cancer burden, especially among older adults. Previous research has shown general declining trends in high-income countries/regions due to improved healthcare and lifestyle changes.
- This manuscript adds a focused analysis of long-term global trends in middle-aged and elderly populations using Global Burden of Disease 2021 data. It identifies substantial regional disparities and a strong negative correlation between SDI and incidence trends, highlighting the uneven progress in reducing stomach cancer across socio-economic strata.

What is the implication, and what should change now?

- Targeted cancer control strategies are urgently needed in low-SDI regions where incidence rates remain high or are declining slowly. Interventions should include equitable access to screening, public health education, *Helicobacter pylori* eradication programs, and age-specific prevention efforts to address the rising burden in older populations. Policymakers should prioritize investment in healthcare infrastructure and culturally tailored programs to reduce stomach cancer disparities globally.

Methods

Data collection and sources

This study utilizes data from the Global Burden of Disease (GBD) Study 2021, which provides comprehensive and authoritative epidemiological information on the health status of countries/regions worldwide (13). The GBD Study aggregates data from multiple sources, including national health surveys, vital registration systems, health system reports, and peer-reviewed literature, aiming to provide consistent and comparable health burden estimates for 204 countries/regions (14).

The study focuses on middle-aged and elderly populations aged 50–74 years, with a particular emphasis on analyzing the trends in stomach cancer incidence within this age group. We specifically collected data disaggregated by age (50–54, 55–59, 60–64, 65–69, 70–74 years), sex (male, female), and region to explore the temporal trends and variations in incidence rates of stomach cancer. The dataset spans from 1990 to 2021, providing a rich longitudinal perspective for analyzing global trends in stomach cancer (14). The GBD Study employs advanced statistical modeling techniques, particularly the Bayesian meta-regression framework, to estimate disease burden in regions with sparse data, ensuring robust and reliable results even in countries/regions with limited data availability (15). In addition, the study explores regional and country-specific differences to reveal the diverse epidemiological patterns of stomach cancer worldwide.

Disease definition

Stomach cancer, or gastric cancer, is a malignancy that originates in the stomach lining. It is classified under the International Classification of Diseases (ICD) as follows: ICD-10: C16, C16.0, C16.1, C16.2, C16.3, C16.4, C16.5, C16.6, C16.8, C16.9; ICD-9: 151, 151.0, 151.1, 151.2, 151.3, 151.4, 151.5, 151.6, 151.8, 151.9, 209.23, V10.04 (13-15). Diagnosis of stomach cancer is typically confirmed through endoscopy, where tissue biopsies are obtained for histopathological examination (16). Additional diagnostic methods may include imaging techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and endoscopic ultrasound, which aid in assessing tumor location, size, and spread to surrounding tissues or lymph nodes (17). Molecular and genetic analyses may also be employed in some cases to identify specific markers (16,17).

Statistical analysis

Temporal trends in the incidence of stomach cancer were evaluated using the Estimated Annual Percentage Change (EAPC), which quantifies the average annual change in incidence rates over time (18). The EAPC was calculated using a linear regression model applied to the natural logarithm of the incidence rates. The model assumes the relationship between time and the logarithm of the incidence rates is linear, where β represents the slope of the regression, and the EAPC is computed as $\text{EAPC} = 100\times(\exp(\beta)-1)$. A positive EAPC indicates an increasing trend in incidence rates, while a negative EAPC indicates a decreasing trend.

Additionally, the relationship between incidence rates and the Socio-Demographic Index (SDI) was assessed both globally and across countries/regions (19). The Pearson correlation coefficient (ρ) was used to evaluate the strength and direction of this association, with statistical significance set at $P<0.05$. All statistical analyses and visualizations were conducted using R software, employing appropriate packages for regression and correlation analysis.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. This study was approved by the Ethics Committee of The Affiliated Wuxi People's Hospital of Nanjing Medical University (No. WP20241109). As this study involved secondary analysis of publicly available data, the ethics committee waived the requirement for informed consent. No personal or identifiable information was used.

Results

Global trends in middle-aged and elderly populations

From 1990 to 2021, the global number of stomach cancer cases in middle-aged and elderly populations (50–74 years) increased from 618,492 [95% uncertainty interval (UI): 553,829 to 679,670] to 725,622 (95% UI: 618,179 to 844,948), representing a 17.32% increase (*Figure 1A* and *Table 1*). However, the incidence rate declined significantly, from 80.67 (95% UI: 72.24 to 88.65) per 100,000 in 1990 to 44.18 (95% UI: 37.64 to 51.45) per 100,000 in 2021, with an EAPC of −2.15 [95% confidence interval (CI): −2.23 to −2.06] (*Figure 1B* and *Table 1*).

Sex-specific trends revealed that stomach cancer incidence rates were consistently higher in males than in females across the study period. In 1990, the incidence rate for males was 112.67 (95% UI: 96.03 to 127.37) per 100,000, decreasing to 65.03 (95% UI: 53.11 to 79.46) in 2021 (EAPC: −1.93; 95% CI: −2.01 to −1.85) (*Figure 1B* and *Table 1*). For females, the incidence rate declined from 50.19 (95% UI: 45.78 to 55.3) in 1990 to 24.36 (95% UI: 21.47 to 27.72) in 2021 (EAPC: −2.66; 95% CI: −2.79 to −2.54) (*Figure 1B* and *Table 1*). Despite the overall decline, the reduction in incidence rate was more pronounced in females than in males.

Differences by age group

Across all age groups (50–74 years), the incidence of stomach cancer demonstrated a declining trend, though the magnitude of decline varied by age. The incidence rate in

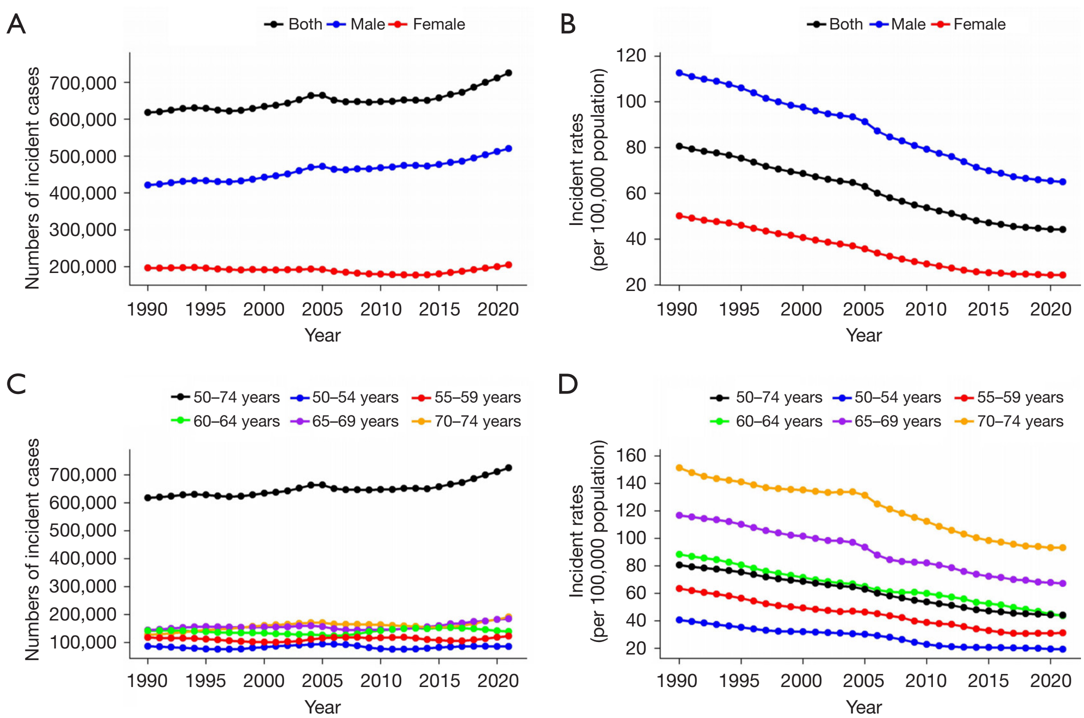

Figure 1 Global stomach cancer burden among middle-aged and elderly populations. (A) Number of stomach cancer cases among middle-aged and elderly populations by sex from 1990 to 2021. (B) Incidence rates of stomach cancer among middle-aged and elderly populations by sex from 1990 to 2021. (C) Number of stomach cancer cases among middle-aged and elderly populations across different age groups from 1990 to 2021. (D) Incidence rates of stomach cancer among middle-aged and elderly populations across different age groups from 1990 to 2021.

the 50–54 age group decreased from 40.58 (95% UI: 35.01 to 44.89) per 100,000 in 1990 to 19.21 (95% UI: 16.31 to 23.11) in 2021 (EAPC: −2.55; 95% CI: −2.73 to −2.38) (*Table 1*). Similarly, the incidence rate in the 55–59 and 60–64 age groups also showed declines, with EAPCs of −2.47 (95% CI: −2.58 to −2.37) and −2.15 (95% CI: −2.22 to −2.09), respectively (*Table 1*).

For the 65–69 age group, the incidence rate decreased from 116.77 (95% UI: 106.68 to 128.31) in 1990 to 67.12 (95% UI: 57.07 to 77.92) in 2021 (EAPC: −1.95; 95% CI: −2.03 to −1.87), while the number of cases increased from 144,340 (95% UI: 131,866 to 158,602) in 1990 to 185,153 (95% UI: 157,412 to 214,943) in 2021 (*Figure 1C,1D* and *Table 1*). Similarly, for the 70–74 age group, the incidence rate declined from 151.37 (95% UI: 138.46 to 168.22) in 1990 to 93.28 (95% UI: 79 to 107.51) in 2021, with an EAPC of −1.68 (95% CI: −1.82 to −1.55), while the number of cases rose from 128,152 (95% UI: 117,220 to 142,419) in 1990 to 192,015 (95% UI: 162,607 to 221,305) in 2021 (*Figure 1C,1D* and *Table 1*). These results indicate that, while the incidence rates of stomach cancer have declined across all age groups, the decline is less pronounced in older age groups, particularly those aged 65–74 years. The increasing absolute number of cases in these age groups suggests a growing burden of the disease in older populations, reflecting demographic changes and sustained risk factors.

Regional differences

Stomach cancer incidence rates have shown significant regional variation, with high-SDI regions experiencing the most substantial declines in recent decades (20). In these regions, the incidence rate decreased from 74.51 per 100,000 in 1990 to 32.34 in 2021 (EAPC: −2.92, 95% CI: −3.00 to −2.84), with the number of cases falling from 140,726 to 106,445 (*Figure 2A,2B* and *Table 1*). Similarly, high-middle SDI regions saw a notable reduction in incidence rates, from 110.54 per 100,000 in 1990 to 63.34 in 2021 (EAPC: −2.06, 95% CI: −2.18 to −1.95), while the number of

Table 1 Global and regional incidence rates and trends of stomach cancer in middle-aged and elderly populations from 1990 to 2021

Characteristics	1990		2021		Cases change	EAPC
	Cases	Rates	Cases	Rates		
Global	618,492 (553,829 to 679,670)	80.67 (72.24 to 88.65)	725,622 (618,179 to 844,948)	44.18 (37.64 to 51.45)	17.32 (2 to 36)	–2.15 (–2.23 to –2.06)
Sex						
Male	421,425 (359,171 to 476,413)	112.67 (96.03 to 127.37)	520,566 (425,089 to 636,068)	65.03 (53.11 to 79.46)	23.53 (1 to 49)	–1.93 (–2.01 to –1.85)
Female	197,067 (179,730 to 217,100)	50.19 (45.78 to 55.3)	205,056 (180,776 to 233,365)	24.36 (21.47 to 27.72)	4.05 (–9 to 21)	–2.66 (–2.79 to –2.54)
Age groups						
50–54 years	86,269 (74,413 to 95,433)	40.58 (35.01 to 44.89)	85,483 (72,588 to 102,838)	19.21 (16.31 to 23.11)	–0.91 (–15 to 19)	–2.55 (–2.73 to –2.38)
55–59 years	117,711 (102,785 to 129,561)	63.56 (55.5 to 69.96)	123,232 (104,531 to 145,418)	31.14 (26.41 to 36.75)	4.69 (–10 to 25)	–2.47 (–2.58 to –2.37)
60–64 years	142,021 (127,514 to 154,893)	88.43 (79.39 to 96.44)	139,740 (120,440 to 161,958)	43.66 (37.63 to 50.6)	–1.61 (–14 to 14)	–2.15 (–2.22 to –2.09)
65–69 years	144,340 (131,866 to 158,602)	116.77 (106.68 to 128.31)	185,153 (157,412 to 214,943)	67.12 (57.07 to 77.92)	28.28 (13 to 48)	–1.95 (–2.03 to –1.87)
70–74 years	128,152 (117,220 to 142,419)	151.37 (138.46 to 168.22)	192,015 (162,607 to 221,305)	93.28 (79 to 107.51)	49.83 (31 to 72)	–1.68 (–1.82 to –1.55)
SDI regions						
High SDI	140,726 (135,195 to 144,386)	74.51 (71.58 to 76.45)	106,445 (100,647 to 113,784)	32.34 (30.58 to 34.57)	–24.36 (–28 to –20)	–2.92 (–3 to –2.84)
High-middle SDI	215,212 (190,935 to 235,710)	110.54 (98.07 to 121.07)	237,515 (195,722 to 286,920)	63.34 (52.19 to 76.51)	10.36 (–8 to 35)	–2.06 (–2.18 to –1.95)
Middle SDI	203,480 (173,012 to 235,854)	96.32 (81.9 to 111.64)	285,629 (233,707 to 346,949)	52.19 (42.71 to 63.4)	40.37 (15 to 74)	–2.16 (–2.26 to –2.05)
Low-middle SDI	40,959 (35,679 to 50,480)	32.96 (28.71 to 40.62)	70,010 (61,495 to 80,607)	24.45 (21.47 to 28.15)	70.93 (52 to 94)	–0.97 (–1.02 to –0.93)
Low SDI	17,693 (14,039 to 20,286)	37.85 (30.04 to 43.4)	25,639 (20,187 to 29,178)	24.84 (19.56 to 28.27)	44.91 (29 to 67)	–1.46 (–1.53 to –1.4)
Location						
Andean Latin America	3,506 (3,081 to 4,019)	89.9 (79 to 103.06)	6,610 (5,285 to 8,289)	59.7 (47.73 to 74.86)	88.56 (47 to 138)	–1.61 (–1.77 to –1.45)
Australasia	1,274 (1,196 to 1,351)	31.7 (29.75 to 33.61)	1,445 (1,317 to 1,576)	16.95 (15.44 to 18.48)	13.44 (2 to 26)	–2.18 (–2.33 to –2.04)
Caribbean	1,766 (1,593 to 1,981)	37.22 (33.57 to 41.76)	2,470 (2,112 to 2,864)	24.6 (21.04 to 28.53)	39.86 (19 to 64)	–1.29 (–1.37 to –1.2)
Central Asia	8,509 (8,091 to 9,006)	89.43 (85.03 to 94.64)	6,777 (6,066 to 7,650)	38.87 (34.79 to 43.87)	–20.35 (–29 to –11)	–2.95 (–3.06 to –2.83)
Central Europe	16,525 (15,845 to 17,145)	58.2 (55.8 to 60.38)	11,912 (10,950 to 12,881)	33.11 (30.43 to 35.8)	–27.92 (–34 to –22)	–2.14 (–2.25 to –2.02)

Table 1 (*continued*)

Table 1 (*continued*)

Characteristics	1990		2021		Cases change	EAPC
	Cases	Rates	Cases	Rates		
Central Latin America	8,930 (8,625 to 9,216)	55.66 (53.76 to 57.44)	16,367 (14,604 to 18,502)	33.94 (30.28 to 38.36)	83.28 (62 to 108)	−2 (−2.12 to −1.87)
Central Sub-Saharan Africa	1,810 (1,326 to 2,234)	36.95 (27.08 to 45.62)	3,076 (2,297 to 3,851)	25.46 (19.01 to 31.87)	69.98 (28 to 126)	−1.37 (−1.45 to −1.3)
East Asia	282,197 (232,019 to 331,156)	157.38 (129.4 to 184.68)	396,977 (306,688 to 503,520)	88.55 (68.41 to 112.31)	40.67 (10 to 87)	−2.02 (−2.15 to −1.88)
Eastern Europe	62,738 (61,340 to 64,039)	114.21 (111.66 to 116.58)	33,350 (30,459 to 36,191)	53 (48.41 to 57.52)	−46.84 (−52 to −42)	−3.18 (−3.4 to −2.95)
Eastern Sub-Saharan Africa	5,402 (4,298 to 6,223)	35.23 (28.03 to 40.58)	7,021 (5,682 to 8,200)	20.29 (16.42 to 23.7)	29.96 (13 to 55)	−2.02 (−2.11 to −1.93)
High-income Asia Pacific	76,878 (72,711 to 79,867)	199.19 (188.39 to 206.93)	47,744 (44,437 to 51,206)	77.08 (71.74 to 82.67)	−37.9 (−42 to −32)	−3.09 (−3.2 to −2.98)
High-income North America	15,249 (14,754 to 15,637)	27.06 (26.18 to 27.75)	17,416 (16,640 to 18,017)	15.84 (15.14 to 16.39)	14.22 (10 to 18)	−1.9 (−2.07 to −1.74)
North Africa and the Middle East	15,829 (11,722 to 17,969)	45.7 (33.84 to 51.87)	25,102 (17,253 to 28,760)	26.68 (18.33 to 30.56)	58.58 (39 to 84)	−1.87 (−1.95 to −1.8)
Oceania	312 (220 to 410)	49.67 (34.97 to 65.32)	581 (447 to 731)	35.59 (27.39 to 44.8)	86.16 (42 to 145)	−1.17 (−1.29 to −1.05)
South Asia	31,289 (26,496 to 39,905)	26.36 (22.32 to 33.61)	55,424 (47,742 to 67,508)	18.92 (16.3 to 23.05)	77.14 (53 to 110)	−1.09 (−1.19 to −1)
Southeast Asia	17,868 (14,207 to 20,597)	34.19 (27.18 to 39.41)	30,625 (26,128 to 36,505)	22.14 (18.89 to 26.39)	71.4 (46 to 111)	−1.75 (−1.87 to −1.62)
Southern Latin America	4,998 (4,721 to 5,320)	58.26 (55.03 to 62.01)	5,456 (4,983 to 5,981)	36.13 (33 to 39.6)	9.16 (−2 to 22)	−1.49 (−1.6 to −1.38)
Southern Sub-Saharan Africa	1,194 (938 to 1,359)	22.65 (17.8 to 25.79)	2,487 (2,064 to 2,798)	21.39 (17.75 to 24.07)	108.35 (83 to 138)	−0.25 (−0.61 to 0.11)
Tropical Latin America	10,183 (9,765 to 10,556)	56.59 (54.26 to 58.66)	15,020 (14,227 to 15,760)	30.65 (29.03 to 32.16)	47.5 (40 to 55)	−2.21 (−2.3 to −2.12)
Western Europe	47,809 (46,253 to 49,098)	50.35 (48.71 to 51.71)	32,392 (30,649 to 33,986)	23.6 (22.33 to 24.76)	−32.25 (−36 to −29)	−2.52 (−2.58 to −2.46)
Western Sub-Saharan Africa	4,226 (3,585 to 4,995)	24.05 (20.41 to 28.43)	7,370 (5,564 to 8,776)	17.84 (13.47 to 21.24)	74.39 (41 to 110)	−0.8 (−0.86 to −0.75)

Data in parentheses are 95% uncertainty intervals for cases and rates, and 95% confidence intervals for EAPC. EAPC, Estimated Annual Percentage Change; SDI, Socio-Demographic Index.

cases increased from 215,212 to 237,515 (*Figure 2A,2B* and *Table 1*). These declines reflect improvements in healthcare, lifestyle changes, and the impact of *H. pylori* eradication programs. In contrast, regions with low and low-middle SDI showed smaller reductions in incidence rates, with the incidence rate in low-middle SDI regions decreasing from 32.96 per 100,000 in 1990 to 24.45 in 2021 (EAPC: −0.97, 95% CI: −1.02 to −0.93), while cases increased from 40,959 to 70,010. Similarly, in low SDI regions, the incidence rate fell from 37.85 per 100,000 in 1990 to 24.84 in 2021 (EAPC: −1.46, 95% CI: −1.53 to −1.40), while the number of cases rose from 17,693 to 25,639 (*Figure 2A,2B* and *Table 1*).

When examining specific locations, considerable regional differences are evident in both incidence rates

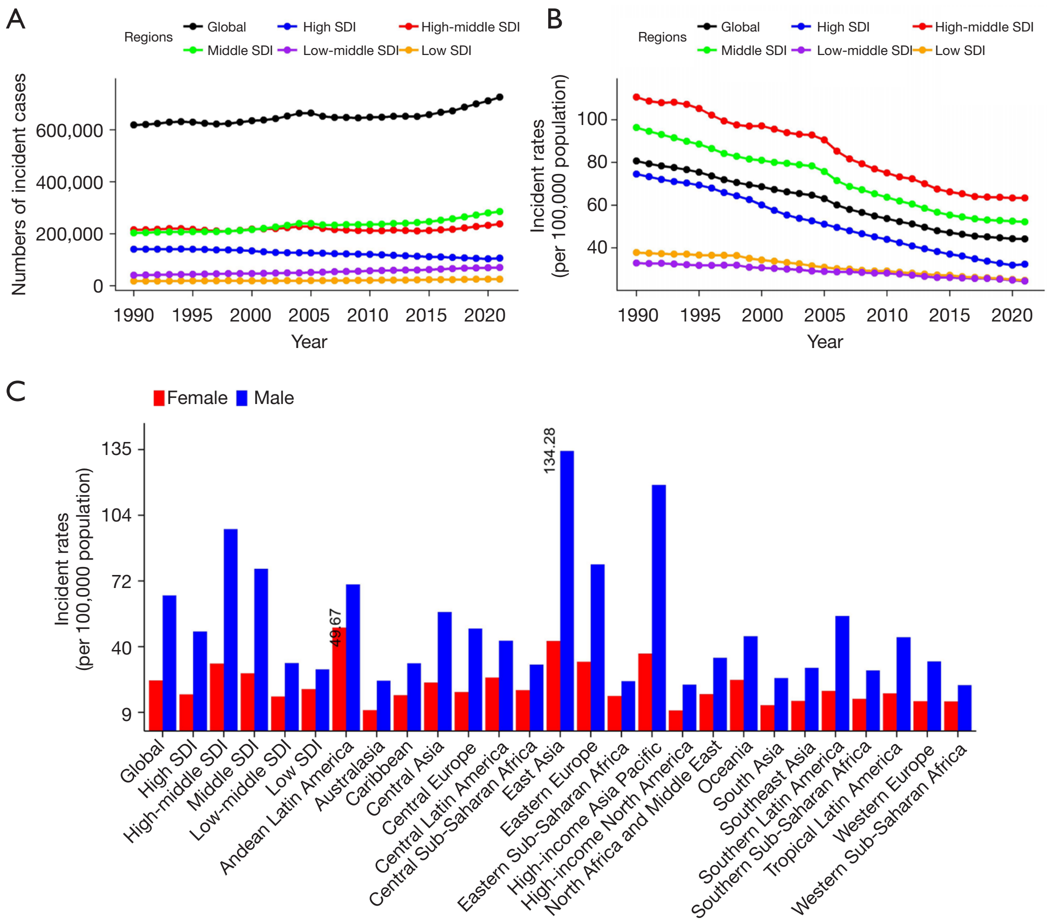

Figure 2 Regional trends in stomach cancer incidence among middle-aged and elderly populations. (A) New cases of stomach cancer in different SDI regions from 1990 to 2021. (B) Incidence rates of stomach cancer in different SDI regions from 1990 to 2021. (C) Sex-specific stomach cancer incidence rates in 2021 at global, SDI regional, and geographical regional levels. SDI, Socio-Demographic Index.

and trends (20). For example, East Asia had one of the highest incidence rates in 1990 (157.38 per 100,000) but showed a significant decrease to 88.55 per 100,000 by 2021 (EAPC: −2.02, 95% CI: −2.15 to −1.88) (*Table 1*). Despite this decrease, East Asia remains one of the regions with the highest burden of stomach cancer, particularly for males, as reflected in the gender-specific incidence rates (*Figure 2C*). Similarly, Western Europe showed a decrease from 50.35 per 100,000 in 1990 to 23.60 per 100,000 in 2021 (EAPC: −2.52, 95% CI: −2.58 to −2.46) (*Table 1*). In contrast, regions with lower SDI, such as Southern Sub-Saharan Africa and Eastern Sub-Saharan Africa, demonstrated smaller declines. Southern Sub-Saharan Africa saw a minimal change in incidence rates, moving from 22.65 per 100,000 in 1990 to 21.39 per 100,000 in 2021 (EAPC: −0.25, 95% CI: −0.61 to 0.11), while Eastern Sub-Saharan Africa had a more significant reduction but still remained relatively high, from 35.23 per 100,000 in 1990 to 20.29 per 100,000 in 2021 (EAPC: −2.02, 95% CI: −2.11 to −1.93) (*Figure 2A,2B* and *Table 1*). Fortunately, although the number of cases may have increased or decreased in some regions, the incidence rates have generally declined across nearly all regions, highlighting a global trend toward a reduced stomach cancer burden despite regional differences.

Differences across countries/regions

For the country-level analysis, the data reveals substantial variability in the incidence and trends of stomach cancer among older adults across different countries/regions (21). Notably, some countries/regions exhibit large changes in both the number of cases and incidence rates. For example,

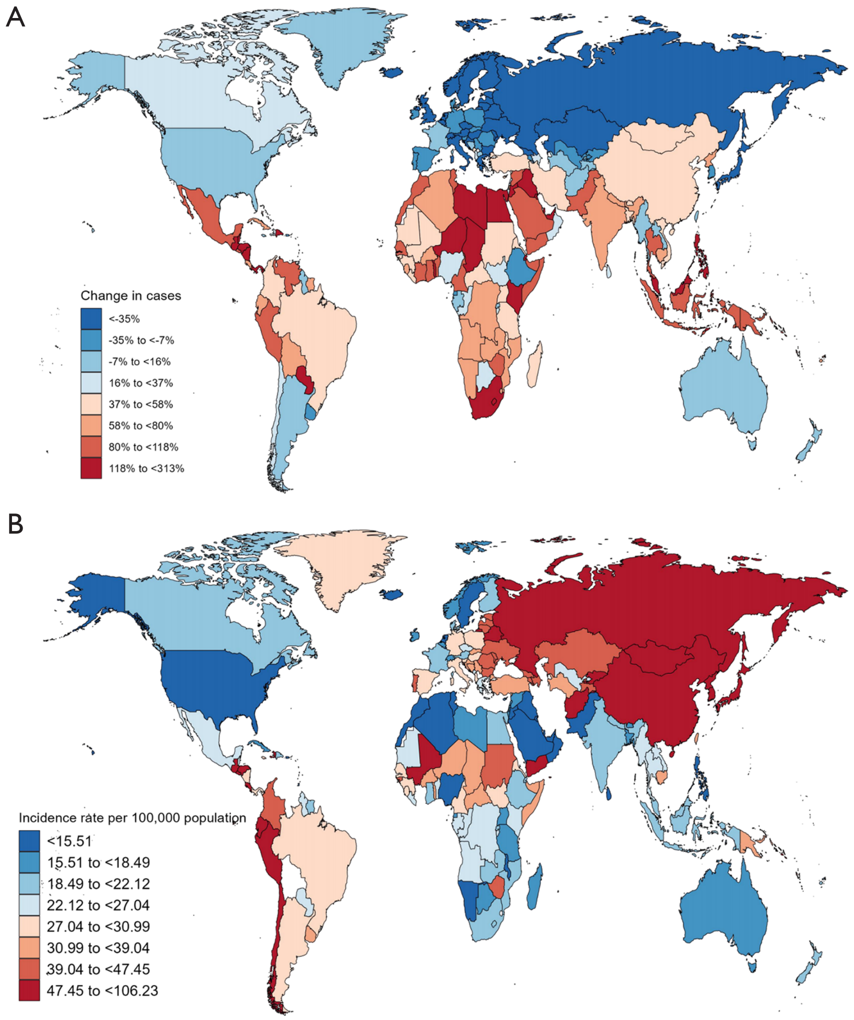

Figure 3 Global distribution of stomach cancer incidence among middle-aged and elderly populations in 204 countries/regions. (A) Percentage change in the number of stomach cancer cases between 1990 and 2021. (B) Stomach cancer incidence rates among middle-aged and elderly populations across countries/regions in 2021.

the United Arab Emirates experienced a sharp increase in the number of cases but a pronounced decline in the incidence rate (36.69 to 10.25 per 100,000; EAPC: −3.66, 95% CI: −4.05 to −3.28), suggesting that the rise in cases mainly reflects demographic expansion rather than a true increase in risk (*Figure 3A*). This sharp rise may be linked to changing lifestyle factors and healthcare improvements in the respective countries/regions. In contrast, Andorra showed a more modest increase in cases, with incidence rates declining from 42.88 per 100,000 in 1990 to 20.99 per 100,000 in 2021, but with a 31.08% increase in the number of cases (EAPC: −2.22, 95% CI: −2.47 to −1.97) (*Figure 3A,3B* and Table S1).

Other countries/regions, such as Germany, saw a notable reduction in incidence rates from 50.68 per 100,000 in 1990 to 28.9 per 100,000 in 2021 (EAPC: −1.95, 95% CI: −2.07 to −1.84), accompanied by a significant decline in the number of cases, from 10,867 in 1990 to 8,228 in 2021 (*Figure 3B*). This decline could be attributed to advances in early detection, improved treatment options, and lifestyle changes. Similarly, Italy and Spain experienced considerable reductions in incidence rates, reflecting similar healthcare and lifestyle changes, with cases dropping from 10,021.59 to 6,147.41 in Italy (EAPC: −2.65, 95% CI: −2.8 to −2.49)

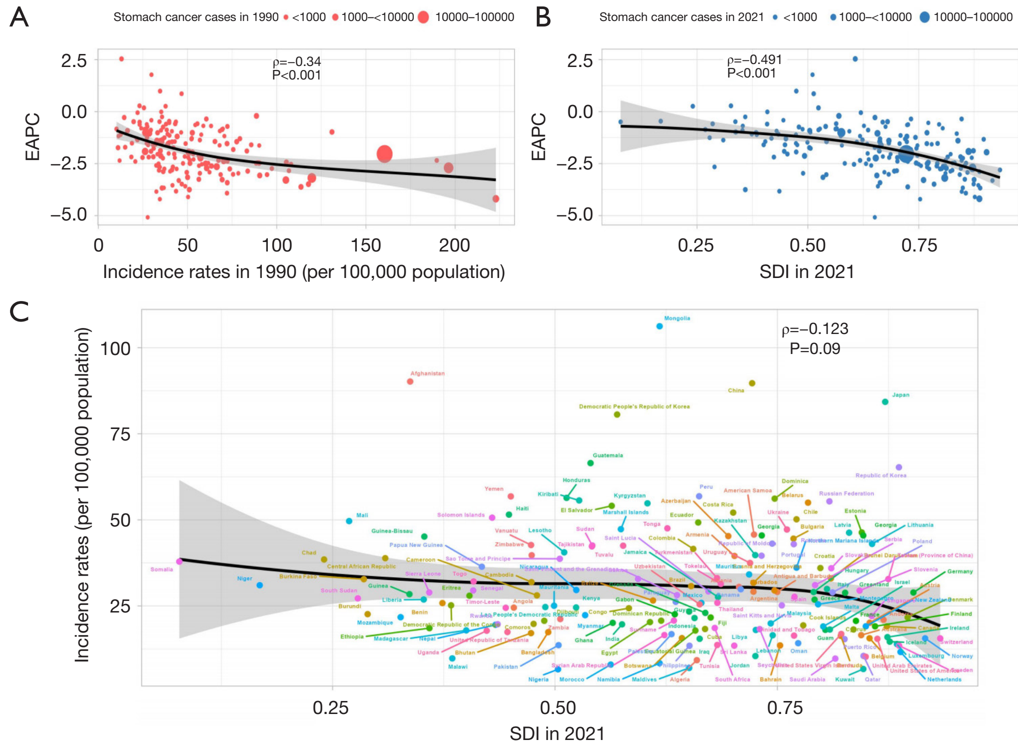

Figure 4 Correlation between stomach cancer incidence, EAPC, and SDI among middle-aged and elderly populations. (A) Correlation between stomach cancer incidence and EAPC in middle-aged and elderly populations in 1990. Each dot represents a country/region, and the dot size indicates the number of stomach cancer cases in 1990. Case count categories are defined as follows: <1,000; 1,000–<10,000; and 10,000–100,000, with lower bounds inclusive and upper bounds exclusive. (B) Correlation between the SDI and EAPC of stomach cancer incidence in 2021. Each dot represents a country/region, and the dot size indicates the number of stomach cancer cases in 2021. Case count categories are defined as follows: <1,000; 1,000–<10,000; and 10,000–100,000, with lower bounds inclusive and upper bounds exclusive. (C) Relationship between stomach cancer incidence and SDI across countries/regions. EAPC, Estimated Annual Percentage Change; SDI, Socio-Demographic Index.

and from 5,639.44 to 4,007.99 in Spain (EAPC: −2.5, 95% CI: −2.58 to −2.43) (*Figure 3B* and Table S1).

However, some countries/regions with lower SDI regions showed slower reductions or even increases in cases. For instance, Nigeria and Mozambique experienced smaller declines in incidence rates (Nigeria: EAPC: −1.73, 95% CI: −1.85 to −1.62, Mozambique: 0.28, 95% CI: 0.09 to 0.47). Moreover, Zimbabwe demonstrated a slight increase in incidence rates, from 34.6 to 39.73 per 100,000, despite a rise in the number of cases from 287.46 to 569.02, with a positive EAPC of 0.99 (95% CI: 0.51 to 1.47) (Table S1). These findings reflect both the increasing burden in some nations, especially those in the lower SDI categories, and the success in reducing incidence rates in high-SDI countries/regions, although challenges remain globally in controlling the rise of stomach cancer among aging populations.

Correlation analysis

Stomach cancer in middle-aged and elderly populations shows significant regional and temporal variation. The incidence trends indicate that countries/regions with higher incidence rates in 1990 generally experienced more substantial declines in recent decades (ρ=−0.34, P<0.001) (*Figure 4A*). Furthermore, a stronger negative correlation exists between the EAPC and the SDI in 2021 (ρ=−0.491, P<0.001), suggesting that higher SDI countries/regions saw more marked reductions in incidence rates (*Figure 4B*). Although the relationship between SDI and current incidence rates is weak (ρ=−0.123, P=0.09), lower SDI regions still show higher incidence rates, reflecting the persistent burden of stomach cancer in these areas (*Figure 4C*). These findings underscore the influence of both historical factors and current socio-economic development on the epidemiology of stomach cancer.

Discussion

Stomach cancer remains a significant global health challenge, especially for middle-aged and elderly populations (22). The findings of this study highlight a complex global landscape, with notable declines in incidence rates in high-SDI regions but continuing challenges in low- and middle-SDI countries/regions. This aligns with existing literature that underscores the role of improved healthcare infrastructure, healthier lifestyles, and public health interventions in reducing the burden of stomach cancer, particularly in higher-income countries/regions. However, despite these achievements, the absolute number of cases continues to rise globally, largely driven by demographic aging and the sustained exposure to risk factors over time. In particular, our study reveals that individuals aged 65–74 years experienced a slower decline in incidence rates, and the number of cases in this age group continued to grow, reflecting the shifting age structure of the global population. These findings underscore the urgency of developing age-specific prevention and early detection strategies, especially as populations continue to age. Additionally, the persistent disparities between high- and low-SDI regions highlight the pressing need to address socioeconomic inequalities in cancer care and prevention efforts worldwide (21).

High-SDI regions, such as Japan and South Korea, have seen substantial decreases in stomach cancer incidence rates, reflecting the successful implementation of *H. pylori* eradication programs, better early detection, and improved treatment options. Similarly, in rural areas of China's Henan Province, population-based endoscopic screening programs were associated with significant declines in both incidence and mortality from 2010 to 2018 (23-25). These trends are consistent with prior studies that have emphasized the positive impact of national screening programs and public health initiatives in reducing stomach cancer prevalence (26). In contrast, many low-SDI regions, including parts of Sub-Saharan Africa and South Asia, have experienced slower declines in incidence rates, and in some cases, a rise in the number of cases (27). This discrepancy is largely due to limited access to healthcare, inadequate screening programs, and persistent risk factors, such as *H. pylori* infection and unhealthy dietary habits, which remain prevalent in these regions (28).

The findings also reveal a critical issue: while the overall incidence rates have declined in high-income countries/regions, the burden of stomach cancer remains disproportionately high among older populations. This is particularly evident in the 65–74 years age group, where the decline in incidence rates has been less pronounced, and the number of cases has continued to rise. The increasing burden of stomach cancer among elderly populations has been noted in other studies, which highlight the cumulative effect of long-term exposure to risk factors, such as smoking, poor diet, and *H. pylori* infection (29,30). As life expectancy increases, the number of older individuals at risk for stomach cancer is expected to continue growing, necessitating targeted screening and preventive measures for this age group.

Moreover, the correlation between incidence rates and the SDI emphasizes the ongoing disparity between high- and low-SDI regions. High-SDI countries/regions tend to have lower incidence rates and more significant reductions over time, reflecting the advantages of better healthcare systems, public health campaigns, and lifestyle modifications. This trend is supported by a previous study that has found similar patterns in the relationship between socio-economic development and cancer outcomes (26). On the other hand, lower SDI regions still face significant challenges in controlling stomach cancer due to factors such as limited healthcare resources, lower awareness of the disease, and persistent cultural and dietary habits that promote the risk factors for stomach cancer (31).

The increase in stomach cancer cases in some low-SDI countries/regions, like Nigeria and Mozambique, highlights the need for urgent public health interventions. As noted in other research, improving access to healthcare, enhancing public awareness, and implementing *H. pylori* eradication programs are crucial steps in mitigating the impact of stomach cancer in these regions (32). Additionally, lifestyle modifications, including reducing salt intake and promoting healthier diets, should be prioritized as part of comprehensive public health strategies. Furthermore, culturally tailored prevention programs and strengthened surveillance systems are essential for effectively addressing regional disparities, especially in underserved and aging populations.

Conclusions

Overall, this study reveals significant regional differences in stomach cancer incidence trends, particularly among middle-aged and elderly populations. High-SDI regions have seen notable declines in both incidence rates and cases, while low and middle-SDI regions show slower reductions. Despite an increase in the absolute number of cases, the decline in incidence rates is smaller in older age groups, especially those aged 65–74 years. Our analysis highlights a strong correlation between higher SDI and reduced incidence rates, underscoring the importance of socio-economic development. These findings stress the need for targeted public health strategies, especially in low-SDI regions, and approaches tailored to the aging global population. These findings stress the need for equitable resource allocation, enhanced surveillance in vulnerable groups, and culturally appropriate strategies to strengthen early detection and prevention, particularly in low-SDI regions and among aging populations.

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Footnote

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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 and its subsequent amendments. This study was approved by the Ethics Committee of The Affiliated Wuxi People's Hospital of Nanjing Medical University (No. WP20241109). As this study involved secondary analysis of publicly available data, the ethics committee waived the requirement for informed consent. No personal or identifiable information was used.

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