Epidemiology of gastric cancer in Saudi Arabia from 2004 to 2017

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Abstract. Gastric cancer (GC), a prevalent disease which globally affects both men and women, was predicted by the International Agency for Research on Cancer in 2020 to have an age-standardized incidence rate (ASIR) in Saudi Arabia of 2.7 per 100,000 individuals for all ages and sexes (ranked 15th), and an age-standardized mortality rate of 2.1 per 100,000 individuals (ranked 12th). The present retrospective study aimed to investigate the prevalence of GC across all administrative regions in Saudi Arabia. Specifically, the present study sought to examine the incidence of diagnosed cases, age-specific incidence rates, crude incidence rates (CIRs) and ASIRs adjusted for age, year and region. To meet this aim, this retrospective descriptive epidemiological analysis was conducted on all cases of GC recorded in the Saudi Cancer Registry (SCR) between January 2004 and December 2017. The collected data were subjected to a range of statistical analyses (using SPSS version 20.0), including descriptive analyses, independent sample t-tests, the Kruskal-Wallis test and sex ratio analysis. In the SCR, a total of 4,066 cases of GC were recorded between 2004 and 2017. The regions with the highest overall ASIRs of GC for both men and women were found to be Riyadh, Najran and the Eastern Region, with rates ranging from 2.2-4.0 per 100,000 individuals. Conversely, Jazan had the lowest ASIRs, with rates of 1.5 and 0.5 per 100,000 individuals for men and women, respectively. The overall ASIRs of GC were found to be significantly higher in men compared with women, with a ratio of 2.8 per 100,000 individuals ($P<0.05$). In conclusion, the present study has revealed that, between 2004 and 2017, there was a slight decrease in the values of both CIR and ASIR of GC in Saudi Arabia.

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Introduction

Gastric cancer (GC) is a prevalent disease globally, affecting both men and women, with ~990,000 new cases diagnosed annually, and it is also responsible for 738,000 deaths per year, making it the third or fourth leading cause of mortality (1-3). The incidence rates of GC vary according to the sex of the patient and country, with men being three times more likely to contract the disease compared with women (1,2). Developing countries account for ~half of the new cases of GC, with the highest rates reported in Central and South America, Eastern Europe and East Asia (China and Japan), and the lowest rates reported in Australia and New Zealand, Southern Asia, North and East Africa, North America and Canada (1,4).

In recent decades, an overall decline in the incidence rate of GC in the majority of countries in the world has been reported (5). However, although the incidence of sporadic intestinal GC has decreased, the incidence of diffuse GC has increased (6,7). The likelihood of developing GC is influenced by various factors, including genetics, nutrition, alcohol consumption and smoking, *Helicobacter pylori* (*H. pylori*) infection and Epstein-Barr virus infection (1).

In the United States, GC constitutes ~1.5% of newly diagnosed cancer cases annually (8). According to the American Cancer Society, 26,380 new cases of GC would be diagnosed in 2022, with 15,900 cases in men and 10,480 cases in women, whereas the disease was anticipated to result in 11,010 deaths, including 6,690 men and 4,400 women (8). Furthermore, the International Agency for Research on Cancer (IARC) predicted that, in 2020, the age-standardized incidence rate (ASIR) of GC in Saudi Arabia would be 2.7 per 100,000 individuals for all ages and sexes, ranking the nation 15th, whereas the age-standardized mortality rate (ASMR) would be 2.1 per 100,000 individuals, being ranked 12th. Furthermore, the ASIRs of GC were considerably lower in Saudi Arabia and Kuwait compared with other Arabian Gulf countries. In 2020, Oman, Qatar, Bahrain and the United Arab Emirates had a higher reported ASIR for all ages and sexes, with rates of 8.0, 5.2, 4.8 and 4.4, per 100,000 individuals, respectively (9).

The main aim of the present retrospective study was to assess the incidence of GC in the Saudi population through analyzing the crude incidence rate (CIR) and ASIR, which were further classified according the year of diagnosis, age group and geographical region. To achieve this objective, an observational descriptive epidemiological investigation of GC was performed, considering the temporal and regional distribution of cases recorded in the Saudi Cancer Registry (SCR) between 2004 and 2017.

Materials and methods

Study population. The objective of the present study was to perform a retrospective observational descriptive epidemiological analysis of all cases of GC identified in all regions of Saudi Arabia between January 2004 and December 2017. Owing to the easy accessibility of GC incidence data in Saudi Arabia through SCR reports, this observational descriptive epidemiological study did not require ethical approval. The Saudi Ministry of Health initiated a population-based cancer registry in 1992, and its records were used as the foundation for this investigation. The first report on cancer in Saudi Arabia was released in 2001, and the most precise cancer reports in Saudi Arabia were published at the beginning of 2004. Moreover, the most current information available from the SCR was gathered in 2017.

Since 2001, SCR has been releasing reports on cancer patterns in Saudi Arabia to describe the spread of the disease. These reports have provided detailed information on the CIRs and ASIRs, adjusted according to the province in Saudi Arabia, the sex of the patient and year of diagnosis for 13 administrative regions between 2004 and 2017 (10).

Statistical analysis. The present study employed SPSS version 20.0 (IBM Corp.) to analyse the data, calculating overall percentages, CIRs and ASIRs stratified by the sex of the patients, geographical region and year of diagnosis. The present study used independent sample t-tests to compare the CIRs and ASIRs of GC between male and female Saudis. $P<0.05$ was considered to indicate a statistically significant difference. Furthermore, the Kruskal-Wallis test was performed to analyse the CIRs and ASIRs of GC across different regions of Saudi Arabia. The Dunn post hoc test, often referred to as the Dunn's test, is a statistical method used in the analysis of variance (ANOVA) and non-parametric statistics. It is used to compare multiple pairs of groups when you have identified a significant difference in a one-way ANOVA or a Kruskal-Wallis test. The primary purpose of the Dunn post hoc test is to determine which specific group differences are statistically significant after an overall significant result in the ANOVA or Kruskal-Wallis test.

Finally, the sex ratio for GC from the age-specific incidence rates, CIRs and ASIRs were also computed for the present study.

Data on the trend of GC in the USA from 2004 to 2019 was sourced from the American Cancer Society (https://cancerstatisticscenter.cancer.org/). This was conducted to compare the GC trend between Saudi Arabia and the USA, and to determine whether it was on an upward or downward trajectory. In addition, the age-standardized incidence and mortality rates of GC for both sexes across all age groups in 2020 were sourced from GLOBOCAN (IARC) (https://gco.iarc.fr/today/home. These data were used to compare the incidence of GC between different countries including Saudi Arabia and to identify which countries had the highest and lowest rates of GC.

Results

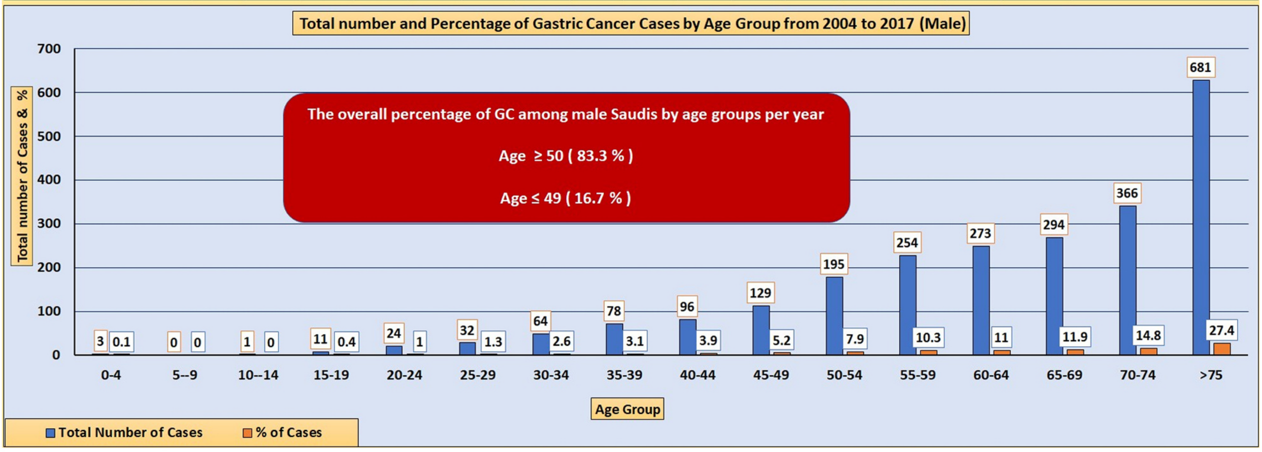
GC among Saudi men. The data revealed the incidence of cases of GC in Saudi Arabia between January 2004 and December 2017. A total of 2,477 cases of GC were reported during this period, accounting for an average of 3.7% of all cancer cases. The number of cases ranged from 141 in 2004 to 208 in 2017, with the corresponding percentages ranging from 4.1 to 3.6% of all cancer cases during the respective years. The ASIR for GC demonstrated fluctuations over time, reaching a peak of 4.4% in 2008 and a low of 3.2% in 2014. The average number of people suffering from GC was 175 per year. Interestingly, there was no significant increase or decrease observed in the incidence of GC during this period, indicating a stable trend in its occurrence (Fig. 1A).

The mean numbers and percentages of cases of GC in Saudi Arabian males, divided by the age group, were calculated using data from the SCR between January 2004 and December 2017. Age groups were classified using a 5-year class width for those aged 0-4, 5-9, 10-14, 15-19, 20-24 years, and so on, up to ≥75 years old (the oldest age group). During the study period, GC was frequently diagnosed in males aged ≥75 years, followed by those aged 70-74 years, accounting for 27.4% of the total (48 overall cases annually) and 14.8% (26 overall cases annually), respectively. Nonetheless, the overall percentage of Saudi men aged ≥50 who were diagnosed with GC was 83.3% between 2004 and 2017. On the other hand, younger male age groups (0-49 years) had the lowest occurrences of GC, with an overall proportion of 16.7% (Fig. 1A). Furthermore, there was a high overall age-specific incidence rate of GC among male Saudis. The average of incidence rate of GC within each age group from 2004 to 2017 showed notable peaks within specific age groups, particularly among individuals aged ≥75 years, 70-74, 65-69 and 60-64, with rates of 37.6, 27.2, 17.2 and 10.9 per 100,000 individuals, respectively. Among Saudi males between the ages of 55 and 64, a male-to-female ratio for the age-specific incidence rate was identified that was 2.9 times higher compared with that of females. Additionally, among Saudi males aged 65-75 years and older, the overall male-to-female ratio of the age-specific incidence rate for GC was 3.6 times greater compared with that of females (Fig. 2). Nevertheless, it is important to note that no significant differences were identified in the age-specific incidence sex ratio for the 0-54-year age group (Fig. 2).

As illustrated in Fig. 3, there was a slight increase in the CIR of cases of GC among Saudi men between 2004 and 2009, followed by a slight decline from 2009 to 2011, and then a stable trend from 2012-2017. The highest CIR was reported in 2009 at 2.2 per 100,000 individuals, and the estimated CIR for 2004 was 1.7 per 100,000 individuals. The overall CIR of GC among Saudi men between 2004 and 2017 was 1.6 per 100,000 individuals, with a 95% confidence interval (95% CI) of 1.3-1.8. The t-test for two independent samples indicated that the CIR of GC in male Saudis was significantly higher compared with females [$t(23)=3.823$; $P<0.001$; data not shown]. However, the male-to-female overall CIR ratio between 2004 and 2017 per 100,000 individuals was found to be 1.5. The average incidence rate of GC within each region from 2004 to 2017 revealed that the highest overall CIRs for GC among Saudi men were reported in the regions of Asir, Makkah and

A

Total Number and Percentage of Gastric Cancer Cases by Age Group (Male)																		
Year of Diagnosis	0-4	5--9	10--14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	≥75	All Ages	% from All Cancer Cases
2004	0	0	0	0	0	1	4	5	5	4	9	12	27	18	13	42	141	4.1
2005	0	0	0	0	3	1	2	6	3	3	8	13	18	20	30	49	156	4.2
2006	0	0	0	0	1	1	7	0	5	13	11	9	16	21	33	45	162	4.2
2007	0	0	0	0	1	2	2	1	6	4	13	20	18	28	27	51	173	4.0
2008	0	0	0	2	2	2	2	5	6	9	13	26	21	17	15	46	166	4.4
2009	1	0	1	1	0	3	0	5	11	13	12	14	22	19	44	55	201	3.6
2010	1	0	0	0	3	4	3	7	3	15	13	15	17	21	25	38	165	3.3
2011	0	0	0	0	2	2	5	6	5	9	23	15	16	17	25	37	162	3.3
2012	0	0	0	0	1	3	3	7	4	8	21	18	20	20	30	51	186	3.7
2013	0	0	0	0	2	1	6	4	7	13	12	22	21	27	27	53	195	3.7
2014	0	0	0	2	0	2	1	11	9	6	14	20	16	20	18	51	170	3.2
2015	1	0	0	2	2	4	5	4	10	9	16	18	15	21	24	54	185	3.4
2016	0	0	0	1	3	2	8	10	8	7	14	26	22	20	30	56	207	3.6
2017	0	0	0	3	4	4	16	7	14	16	16	26	24	25	25	53	208	3.6
Total	3	0	1	11	24	32	64	78	96	129	195	254	273	294	366	681	2477	Mean % = 3.7
Overall	0	0	0	1	2	2	4	6	6	9	14	18	19	21	26	48	175	
%	0.1	0	0	0.4	1	1.3	2.6	3.1	3.9	5.2	7.9	10.3	11	11.9	14.8	27.4	100	



B

Total Number and Percentage of Gastric Cancer Cases by Age Group (Female)																		
Year of Diagnosis	0-4	5--9	10--14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	≥75	All Ages	% from All Cancer Cases
2004	0	0	0	1	1	6	0	3	7	4	5	3	7	11	10	12	70	2.0
2005	0	0	0	0	0	0	4	2	1	5	6	6	13	3	16	12	68	1.8
2006	0	0	0	1	4	3	3	6	8	7	11	6	11	19	16	17	113	2.7
2007	0	0	0	0	3	1	6	7	3	16	14	9	14	14	14	24	126	2.6
2008	0	0	0	0	1	4	5	6	8	6	7	8	11	12	6	26	100	2.2
2009	0	0	0	0	0	3	9	4	8	11	12	11	10	12	12	20	112	2.2
2010	0	0	0	0	1	2	3	8	2	13	16	17	10	4	16	34	126	2.3
2011	0	0	0	1	2	7	4	6	8	5	10	12	16	10	22	30	133	2.2
2012	0	0	0	3	4	3	7	5	7	6	7	7	7	11	15	12	94	2.2
2013	0	0	0	1	2	4	6	9	6	10	15	11	12	12	8	25	121	1.6
2014	0	0	0	0	3	1	7	7	15	10	14	11	9	13	10	30	130	1.9
2015	0	0	0	0	2	6	3	10	10	12	12	18	9	13	9	27	131	2.0
2016	0	0	0	0	2	2	3	5	14	5	13	9	10	14	9	25	111	1.5
2017	0	0	0	0	0	3	3	2	7	13	13	22	17	12	18	30	154	1.5
Total	0	0	0	7	25	45	63	80	104	123	155	150	156	160	181	324	1589	Mean % = 2.1
Overall	0	0	0	1	2	3	5	6	8	9	11	10	11	11	13	23	110	
%	0	0	0	0.4	1.6	2.8	4	5	6.5	7.7	9.8	9.4	9.8	10.1	11.4	20.4	100	

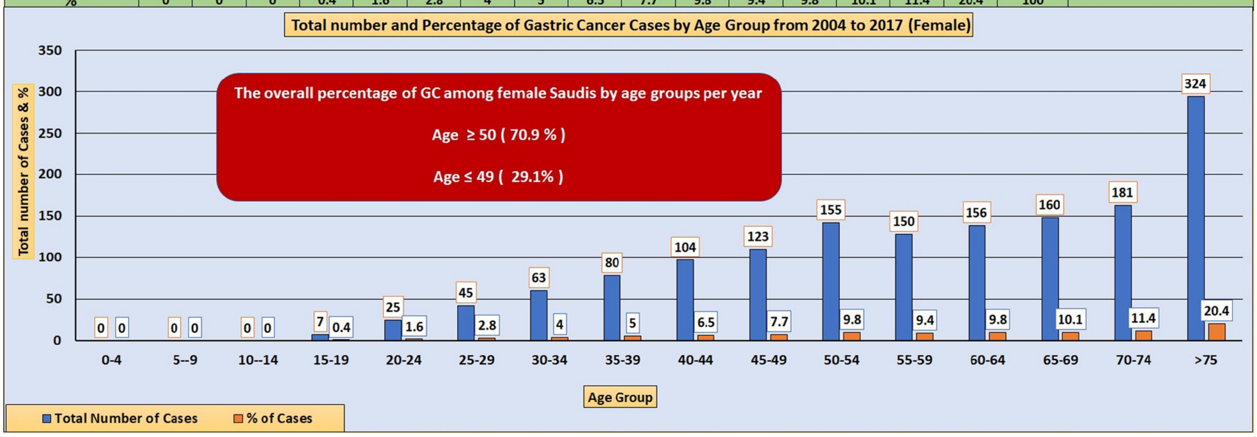


Figure 1. (A) GC cases among male Saudis (Number and percentage) between 2004 and 2014. (B) GC cases among female Saudis (Number and percentage) between 2004 and 2017. GC, gastric cancer.

Overall Age Specific Incidence Rate of Gastric Cancer from 2004 to 2017 Per 100,000 Population					
				Male / Female	Female / Male
Age Group	Male	Female	Difference	AIR Sex Ratio	AIR Sex Ratio
0-4	0.0	0.0	0.0	0.0	0.0
5--9	0.0	0.0	0.0	0.0	0.0
10--14	0.0	0.0	0.0	0.0	0.0
15-19	0.1	0.1	0.0	1.2	0.8
20-24	0.2	0.2	0.0	0.8	1.2
25-29	0.2	0.4	-0.1	0.6	1.6
30-34	0.5	0.7	-0.2	0.8	1.3
35-39	0.9	1.0	-0.1	0.9	1.1
40-44	1.3	1.5	-0.2	0.9	1.1
45-49	2.0	2.2	-0.2	0.9	1.1
50-54	4.2	3.6	0.6	1.2	0.9
55-59	7.2	4.3	2.9	1.7	0.6
60-64	10.9	6.5	4.5	1.7	0.6
65-69	17.2	9.8	7.4	1.8	0.6
70-74	27.2	14.3	12.9	1.9	0.5
≥75	37.6	18.3	19.3	2.1	0.5

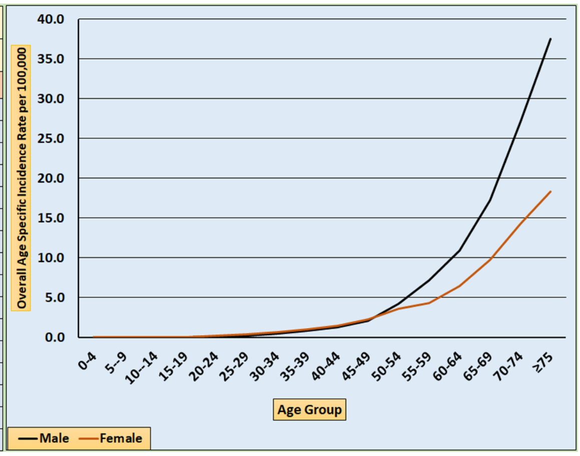


Figure 2. AIR of gastric cancer cases among the Saudi population from 2004 to 2017. AIR, age specific incidence rate.

Crude Incidence Rate of Gastric Cancer per 100,000				Male / Female	Female / Male
Year	Male	Female	Difference	CIR Sex Ratio	CIR Sex Ratio
2004	1.7	0.8	0.9	2.1	0.5
2005	1.8	0.8	1.0	2.3	0.4
2006	1.9	1.3	0.6	1.5	0.7
2007	2.0	1.6	0.4	1.3	0.8
2008	1.8	1.1	0.7	1.6	0.6
2009	2.2	1.3	0.9	1.7	0.6
2010	1.7	1.4	0.3	1.2	0.8
2011	1.7	1.4	0.3	1.2	0.8
2012	1.9	0.9	1.0	2.1	0.5
2013	1.9	1.2	0.7	1.6	0.6
2014	1.7	1.4	0.3	1.2	0.8
2015	1.8	1.3	0.5	1.4	0.7
2016	2.0	1.1	0.9	1.8	0.6
2017	2.0	1.5	0.5	1.3	0.8
Mean	1.6	1.1	0.5	1.5	0.7
Median	1.5	1.2	0.3	1.3	0.8
SD	0.4	0.3	0.1	1.5	0.7
95 % CI : Mean	1.3 - 1.8	0.9 - 1.2			

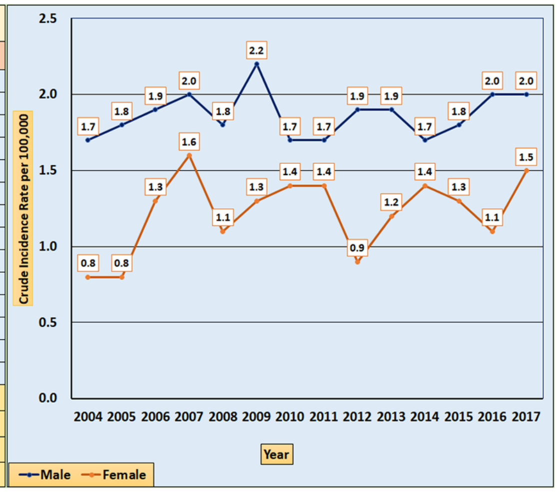


Figure 3. CIR of gastric cancer cases among the Saudi population from 2004 to 2017. CIR, crude incidence rate; SD, standard deviation; CI, confidence interval.

Riyadh, at 2.3, 2.1 and 2.0 per 100,000 individuals, respectively. The application of the Dunn post hoc test in conjunction with the Kruskal-Wallis test showed that these regions were significantly different compared with the reference region of Jazan [2(12, N=181)=52.298; P<0.001; data not shown]. Conversely, the smallest overall CIRs of GC were reported in the Jazan and Jouf regions, at 1.1 per 100,000 individuals (Fig. 4).

The SCR was subsequently used to determine the ASIRs of cases of GC among male Saudis, adjusted for the year of diagnosis between 2004 and 2017 per 100,000 individuals (Fig. 5). The results obtained exhibited a slight increase between 2004 and 2009, followed by a steady decrease from 2010-2017. The ASIR of GC was found to be highest in 2006 and 2009 (3.9 per 100,000 individuals), although it decreased to its lowest rate of 2.4 per 100,000 individuals in 2014. However, the overall ASIR of GC among Saudi males per 100,000 individuals between 2004 and 2017 was 2.8 (95% CI; 2.2-3.2). A t-test for two independent samples indicated that the ASIR of GC in Saudi males was significantly higher compared with that in females [t(20)=8.823; P<0.001; data not shown]. However, between 2004 and 2017, the overall male-to-female ratio of ASIR per 100,000 males was 1.5.

As shown in Fig. 6, Riyadh, Najran and the Eastern region of Saudi Arabia had the highest overall ASIRs for GC, with rates of 4.0, 3.8 and 3.8 per 100,000 individuals, respectively. The Kruskal-Wallis test revealed significant differences among these regions, with the reference region of Jazan [2(12,N=180)=59.556; P<0.001; data not shown]. By contrast, Jazan, Hail and Baha were the regions that had the lowest overall ASIRs of GC, with rates of 1.6, 1.5 and 1.5, respectively.

GC among Saudis women. Between January 2004 and December 2017, a total of 1,589 cases of GC were recorded among Saudi women, accounting for 7.1% of the total diagnosed cancer cases per year. The number of cases of GC was found to fluctuate over the years, with 70 cases (2% of all cancer cases) recorded in 2004, and a peak of 133 cases (2.2% of all cancer cases) in 2011. Between 2012 and 2017, the number of cases of GC ranged from 186 and 208 per year, representing a percentage range of 7.5-8.4% per year (Fig. 1B). Among Saudi women, GC was most commonly diagnosed in those aged ≥75 years, with 23 overall cases per year (20.4%), followed by those aged 70-74 years, with 13 overall cases per year (11.1%). By contrast, younger females aged 0-49 years were

Overall Curde Incidence Rate of Gastric Cancer from 2004 to 2017 Per 100,000 Population						
					Male / Female	Female / Male
Regions	Male	P-value	Female	P-value	CIR Sex Ratio	CIR Sex Ratio
Asir	2.3	0.001	1.4	0.001	1.6	0.6
Baha	1.5	0.12	1.3	0.001	1.2	0.9
Jazan	1.1	Reference	0.4	Reference	2.8	0.4
Madinah	1.4	0.24	1.0	0.01	1.4	0.7
Hail	1.3	0.54	0.8	0.07	1.6	0.6
Qassim	1.8	0.001	0.9	0.05	2.0	0.5
Riyadh	2.0	0.001	1.3	0.001	1.5	0.7
Makkah	2.1	0.001	1.2	0.001	1.8	0.6
Najran	1.9	0.002	1.2	0.001	1.6	0.6
Jouf	1.1	0.80	1.2	0.002	0.9	1.1
Tabuk	1.3	0.48	1.1	0.007	1.2	0.8
Eastern Region	1.8	0.01	1.3	0.001	1.4	0.7
Northern Region	1.2	0.58	0.9	0.07	1.3	0.8

Note 1: Values in yellow colour denote for CIR of Stomach cancer in male Saudis, these regions were significantly higher than, Jazan, Baha, Madinah, Hail, Jouf, Tabuk, and Northern region, P-value <0.05.
Note 2: Values in green colour denote for CIR of Stomach cancer in female Saudis, these regions were significantly higher than Jazan, Hail, and Qassim, P-value <0.05.

Figure 4. CIR of gastric cancer cases among the Saudi population by region from 2004 to 2017. CIR, crude incidence rate.

Age Standardized Incidence Rate of Gastric Cancer per 100,000				Male / Female	Female / Male
Year	Male	Female	Difference	ASIR Sex Ratio	ASIR Sex Ratio
2004	3.2	1.6	1.6	2.0	0.5
2005	3.5	1.6	1.9	2.2	0.5
2006	3.9	2.7	1.2	1.4	0.7
2007	3.6	2.5	1.1	1.4	0.7
2008	3.2	1.9	1.3	1.7	0.6
2009	3.9	2.1	1.8	1.9	0.5
2010	3.1	2.3	0.8	1.3	0.7
2011	2.8	2.3	0.5	1.2	0.8
2012	3.2	1.5	1.7	2.1	0.5
2013	3.3	1.8	1.5	1.8	0.5
2014	2.4	1.7	0.7	1.4	0.7
2015	2.6	1.7	0.9	1.5	0.7
2016	2.9	1.5	1.4	1.9	0.5
2017	2.8	2	0.8	1.4	0.7
Mean	2.8	1.8	1.0	1.5	0.7
Median	2.9	2.0	0.9	1.5	0.7
SD	0.9	0.5	0.4	1.7	0.6
95 % CI : Mean	2.2 - 3.2	1.2 - 2.2			

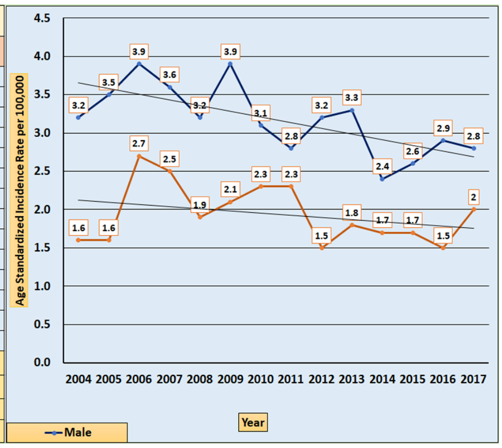
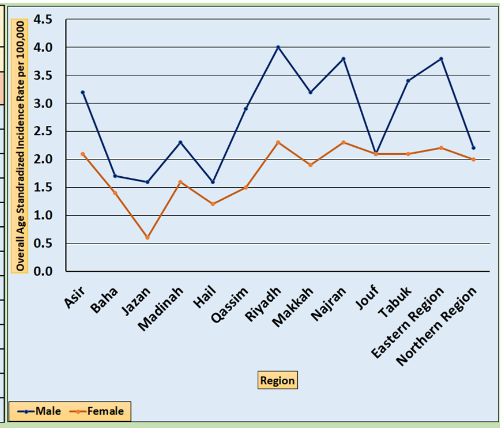


Figure 5. ASIR of gastric cancer cases among the Saudi population from 2004 to 2017. ASIR, age-standardized incidence rate; SD, standard deviation; CI, confidence interval.

Overall Age Standrardized Incidence Rate of Gastric Cancer from 2004 to 2017 Per 100,000 Population						
					Male / Female	Female / Male
Regions	Male	P-value	Female	P-value	ASIR Sex Ratio	ASIR Sex Ratio
Asir	3.2	0.003	2.1	0.002	1.5	0.7
Baha	1.6	0.81	1.4	0.08	1.1	0.9
Jazan	1.5	Reference	0.5	Reference	3.0	0.3
Madinah	2.3	0.17	1.5	0.04	1.5	0.7
Hail	1.5	0.96	1.1	0.18	1.4	0.7
Qassim	2.9	0.01	1.5	0.06	1.9	0.5
Riyadh	4.0	0.001	2.6	0.001	1.5	0.7
Makkah	3.1	0.002	2.0	0.008	1.6	0.6
Najran	3.8	0.001	2.3	0.001	1.7	0.6
Jouf	2.0	0.30	2.0	0.001	1.0	1.0
Tabuk	3.4	0.001	2.1	0.002	1.6	0.6
Eastern Region	3.8	0.001	2.2	0.001	1.7	0.6
Northern Region	2.2	0.24	2.0	0.003	1.1	0.9



Note 1: Values in yellow colour denote for ASIR of Stomach cancer in male Saudis,these regions were significantly higher than Baha, Jazan, Madinah, Hail, Jouf, and Northern region, P-value <0.05.
Note 2: Values in green colour denote for ASIR of Stomach cancer in female Saudis, these regions were significantly higher than Baha, Jazan, Hail, and Qassim, P-value <0.05.

Figure 6. ASIR of gastric cancer cases among the Saudi population by region from 2004 to 2014. ASIR, age-standardized incidence rate.

associated with the lowest overall number of cases of GC, with an average of 29.1% per year. The overall percentage of women aged 50 years or older diagnosed with GC between 2004 and 2017 was 70.9%. The age-specific incidence rate of GC among Saudi women was highest in those aged ≥75 years (18.3 per 100,000 individuals), followed by those aged 70-74 (14.3 per 100,000 individuals), 65-69 (9.8 per 100,000 individuals) and 60-64 (6.5 per 100,000 individuals) (Fig. 2).

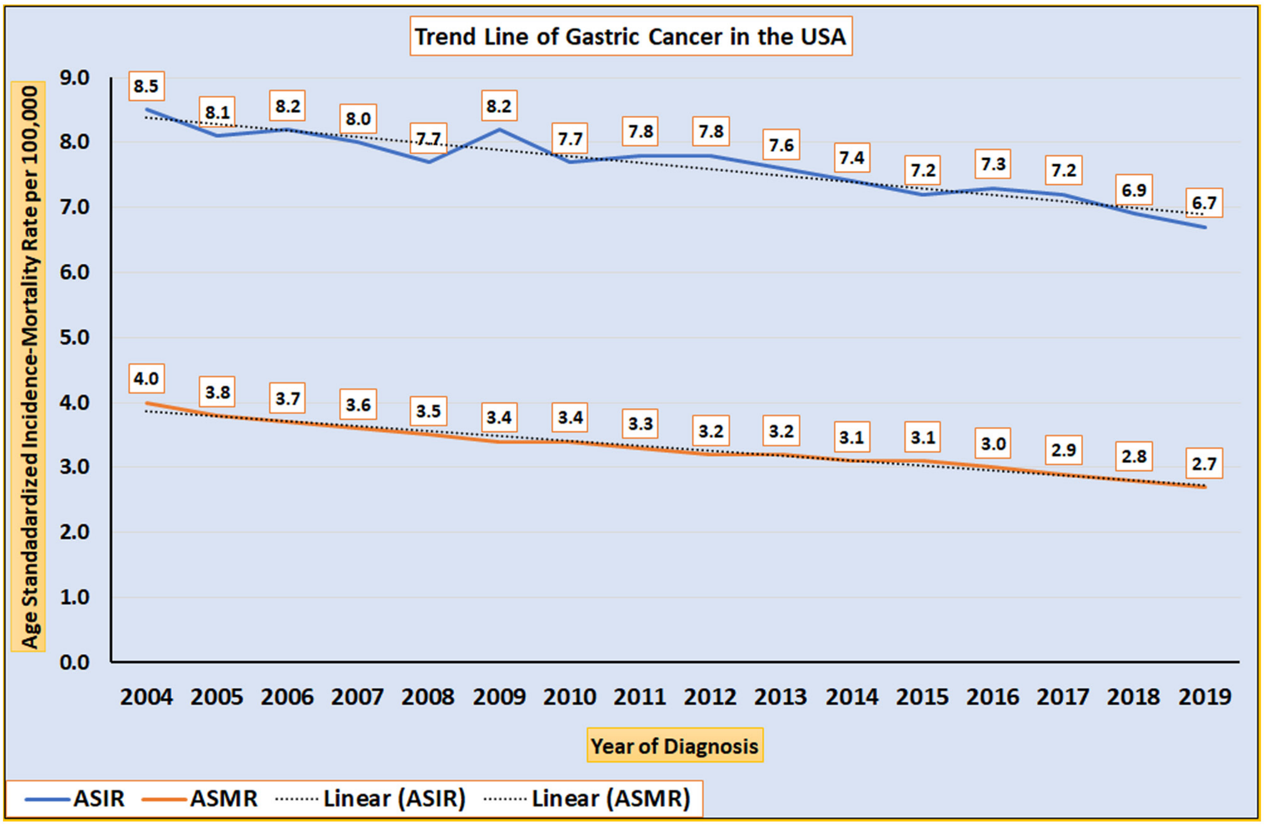


Figure 7. Trend line of gastric cancer in the USA from 2004 to 2019. ASMR, age-standardized mortality rate; ASIR, age-standardized incidence rate.

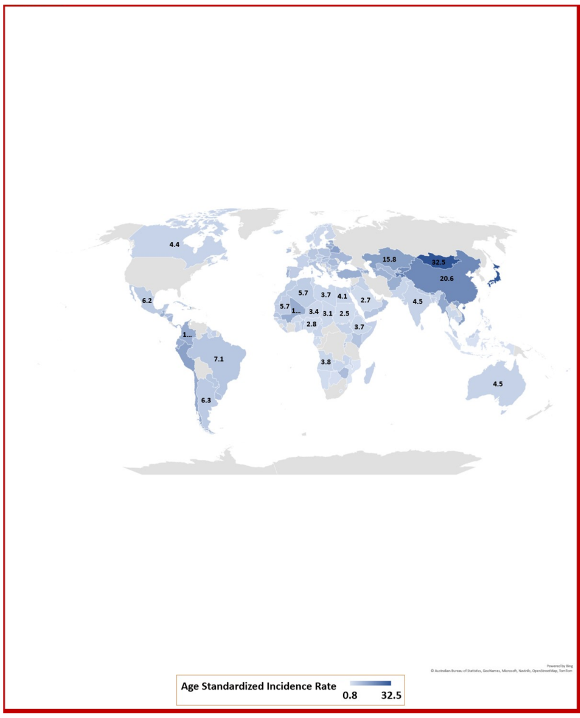
As shown in Fig. 3, the CIRs of cases of GC among females in Saudi Arabia, adjusted according to the year of diagnosis from 2004 to 2017, per 100,000 individuals demonstrated a modest increase between 2004 and 2007, a small reduction from 2008 to 2012, and a steady trend over the years 2013-2017. The estimated CIR for 2004 was 0.8 per 100,000 individuals, and the highest CIR reported by the SCR was 1.7 per 100,000 individuals in 2007. Furthermore, the overall CIR of GC among Saudi women between 2004 and 2017 was 1.1 (95% CI, 0.9-1.2) per 100,000 individuals. The regions of Asir, Riyadh and the Eastern region had the highest overall CIRs for GC among Saudi women, with CIR values identified of 1.4, 1.3 and 1.3, respectively, per 100,000 individuals. The Kruskal-Wallis test revealed significant differences between these locations and other regions of Saudi Arabia [χ^2(12, N=181)=39.689; P<0.001; data not shown]. By contrast, the region of Jazan had the lowest overall CIR of GC, at 0.4 per 100,000 individuals (Fig. 4).

The ASIRs of cases of GC among Saudi women, adjusted according to the year of diagnosis between 2004 and 2017, were documented using the SCR (Fig. 5). Between 2004 and 2006, a modest rise was observed, followed by a constant trend between 2007 and 2017. In 2006, the ASIR of GC was the highest at 2.7 per 100,000 individuals; by contrast, in 2012 and 2016, it was the lowest, at 1.5 per 100,000 individuals. However, the overall ASIR of GC among Saudi women between 2004 and 2017 per 100,000 individuals was 1.8 (95% CI, 1.2-2.2). Furthermore, the overall ASIR of GC stratified according to the Saudi Arabian region between 2004 and 2017 per 100,000 individuals showed that Riyadh, Najran and the Eastern region of Saudi Arabia had the highest overall ASIR for GC at 2.6, 2.3, and 2.2 per 100,000 individuals, respectively. By contrast, the Jazan region had the lowest overall ASIR of GC, at 0.5 per 100,000 individuals (Fig. 6).

A consistent decline in the ASIR trend of GC for both the American and Saudi populations from 2004 to 2017 is illustrated in Fig. 7. The ASIR of GC in Saudi Arabia stood at 2.7 per 100,000 individuals for both sexes in 2019, notably lower than numerous other countries. Among Arabian Gulf countries, Oman registered the highest GC rate for both sexes at 8.0 per 100,000 individuals which was ~2.9 times that of Saudi Arabia (Fig. 8). The ASMR for GC in Saudi Arabia was recorded at 2.1 per 100,000 individuals for both sexes, a slightly lesser rate in comparison with other Arab nations (Fig. 9). Notably, Oman showed the peak ASMR for GC among both sexes in the region, with a rate of 6.9 per 100,000 individuals, which was ~3.2 times that of Saudi Arabia. The ASIR of Saudi Arabia for GC was significantly less than countries such as Mongolia (32.5 per 100,000 individuals), Japan (31.6 per 100,000 individuals) and Korea (27.7 per 100,000 individuals), where the rates were almost 9 to 10-fold higher compared with Saudi Arabia (Fig. 9).

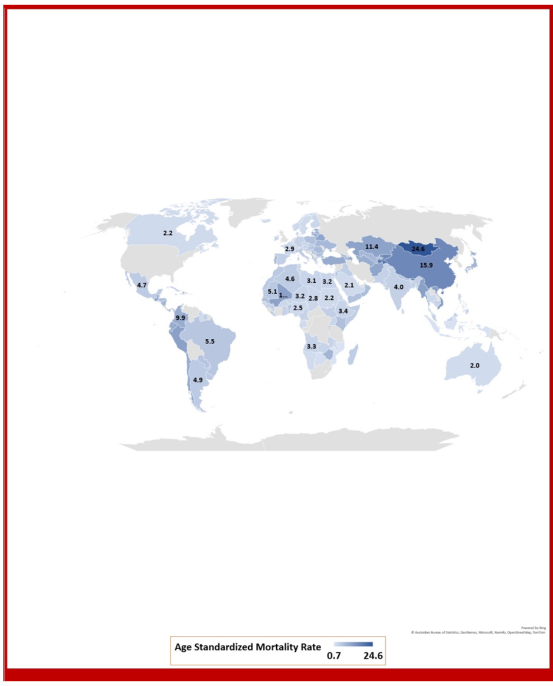
Discussion

It is essential to continuously monitor and update the CIRs and ASIRs of cases of GC across all regions in Saudi Arabia. The aim of the present retrospective study was to examine the trends in CIR and ASIR of GC in Saudi Arabia between 2004 and 2017. To the best of the authors' knowledge, this is the first descriptive epidemiological study on the spatial and temporal



Country	ASIR	Country	ASIR	Country	ASIR	Country	ASIR
Mongolia	32.5	Zimbabwe	9.4	Austria	5.7	United States of America	4.2
Japan	31.6	ElSalvador	9.2	Cyprus	5.7	Egypt	4.1
Korea	27.9	Papua New Guinea	9.2	Guam	5.7	Trinidad and Tobago	4.0
Tajikistan	23.4	Albania	9.2	Morocco	5.7	Norway	4.0
China	20.6	FrenchGuiana	9.1	Algeria	5.7	UnitedKingdom	4.0
Kyrgyzstan	19.8	Panama	8.9	Mauritania	5.7	Cambodia	4.0
CaboVerde	18.4	North Macedonia	8.7	Czechia	5.5	Cameroon	3.9
Bhutan	17.7	Croatia	8.7	Burundi	5.3	Central African Republic	3.9
Iran	17.6	Slovenia	8.4	Bangladesh	5.2	Zambia	3.8
Kazakhstan	15.8	Georgia	8.4	Cuba	5.2	Timor-Leste	3.8
VietNam	15.5	Honduras	8.3	Qatar	5.2	Finland	3.8
Belarus	15.4	Rwanda	8.1	Luxembourg	5.2	Angola	3.8
Peru	15.2	Oman	8.0	TheNetherlands	5.2	Ethiopia	3.7
SaoTome and Principe	14.7	Uruguay	8.0	Gaza Strip and West Bank	5.2	Fiji	3.7
Korea	14.6	Dominican Republic	7.9	Suriname	5.2	Guyana	3.7
Myanmar	13.7	Bolivia	7.8	Israel	5.1	Iceland	3.7
Haiti	13.5	Hungary	7.8	Switzerland	5.1	Philippines	3.7
Russian Federation	13.5	Italy	7.8	Congo	5.1	Libya	3.7
Brunei Darussalam	13.5	Poland	7.8	Togo	5.0	Thailand	3.5
Chile	13.1	Bulgaria	7.6	Madagascar	4.9	South Africa	3.5
Lithuania	13.0	Kenya	7.6	Guinea-Bissau	4.9	Uganda	3.4
Colombia	12.9	French Polynesia	7.5	Iraq	4.9	Malawi	3.4
CostaRica	12.8	Ireland	7.3	SierraLeone	4.8	Niger	3.4
Samoa	12.8	Singapore	7.2	NewZealand	4.8	Sweden	3.3
Mali	12.8	Yemen	7.1	Belize	4.8	Tunisia	3.2
Azerbaijan	12.7	Brazil	7.1	Barbados	4.8	Eritrea	3.1
Turkey	12.6	Senegal	7.0	Bahrain	4.8	Chad	3.1
Ecuador	12.5	Benin	7.0	Somalia	4.7	The Republic of the Gambia	3.0
Afghanistan	12.4	Germany	7.0	France	4.7	Lebanon	3.0
Estonia	12.4	Paraguay	6.9	Liberia	4.7	Equatorial Guinea	3.0
Guatemala	12.2	Serbia	6.8	Côted'Ivoire	4.6	BurkinaFaso	2.9
Latvia	12.0	Venezuela	6.8	SyrianArabRepublic	4.6	Djibouti	2.9
Turkmenistan	11.8	Montenegro	6.7	Congo	4.5	Nigeria	2.8
Armenia	11.1	Mauritius	6.6	India	4.5	Vanuatu	2.7
Portugal	11.0	Argentina	6.3	Australia	4.5	SriLanka	2.7
Slovakia	10.8	Bahamas	6.2	SouthSudan	4.5	SaudiArabia	2.7
France	10.7	Nepal	6.2	Canada	4.4	Kuwait	2.7
Ukraine	10.5	Mexico	6.2	Denmark	4.4	PuertoRico	2.5
Nicaragua	10.4	Greece	6.1	UnitedArabEmirates	4.4	Sudan	2.5
Republic of Moldova	10.0	Malta	6.0	Malaysia	4.3	Gabon	2.5
Uzbekistan	9.8	Jordan	6.0	Tanzania	4.3	Namibia	2.4
France	9.8	Spain	5.8	Guinea	4.2	Solomon Islands	2.3
SaintLucia	9.4	Belgium	5.8	Pakistan	4.2	Botswana	1.8
Romania	9.4	Jamaica	5.8	Ghana	4.2	Lesotho	1.7
						Eswatini	1.6
						Indonesia	1.3

Figure 8. ASIR of gastric cancer (worldwide) in 2020, both sexes, all ages. ASIR, age-standardized incidence rate.



Country	ASMR	Country	ASMR	Country	ASMR	Country	ASMR
Mongolia	24.6	Albania	7.2	Madagascar	4.4	Malawi	3.1
Tajikistan	19.7	Rwanda	7.2	SierraLeone	4.4	Fiji	3.1
Bhutan	15.9	France,Martinique	7.0	Mauritius	4.4	Uganda	3.1
China	15.9	Oman	6.9	Guinea-Bissau	4.4	SouthAfrica	3.0
Kyrgyzstan	15.7	Honduras	6.9	Somalia	4.4	France	2.9
Iran	15.5	ElSalvador	6.8	Bahamas	4.3	Eritrea	2.9
CaboVerde	14.8	Kenya	6.6	Italy	4.3	Switzerland	2.9
VietNam	12.6	Bolivia	6.5	Gaza Strip and West Bank	4.3	Chad	2.8
Myanmar	12.0	Poland	6.5	Bahrain	4.2	Denmark	2.8
Korea	11.9	Croatia	6.4	Liberia	4.2	Gambia	2.8
Peru	11.8	Yemen	6.4	Greece	4.2	BurkinaFaso	2.7
Haiti	11.6	Bulgaria	6.3	Côted'Ivoire	4.1	Finland	2.7
Mali	11.6	Senegal	6.3	Iraq	4.1	Vanuatu	2.7
SaoTome and Principe	11.6	France, Guadeloupe	6.3	SouthSudan	4.1	Equatorial Guinea	2.7
Kazakhstan	11.4	SaintLucia	6.3	Spain	4.1	The Netherlands	2.7
Afghanistan	11.2	France, NewCaledonia	6.2	Guam	4.0	Tunisia	2.7
Lao People's Democratic	11.0	Benin	6.2	Suriname	4.0	Djibouti	2.6
Belarus	10.9	French Guiana	6.0	India	4.0	Lebanon	2.6
Azerbaijan	10.7	Singapore	6.0	Cuba	3.9	NewZealand	2.6
CostaRica	10.3	Montenegro	6.0	United Arab Emirates	3.9	Guyana	2.6
Samoa	10.3	Slovakia	6.0	Guinea	3.8	Thailand	2.6
Turkey	10.2	France, LaRéunion	5.9	Malta	3.8	Belgium	2.5
Guatemala	10.1	Dominican Republic	5.9	Israel	3.8	Nigeria	2.5
Armenia	10.1	Hungary	5.8	Germany	3.8	United Kingdom	2.4
Chile	10.0	Paraguay	5.8	Tanzania	3.8	Norway	2.4
Ecuador	10.0	FrenchPolynesia	5.8	Pakistan	3.7	Kuwait	2.4
Colombia	9.9	Nepal	5.6	Syrian Arab Republic	3.7	Canada	2.2
Russian Federation	9.8	Venezuela	5.6	Ghana	3.7	Sudan	2.2
Turkmenistan	9.7	Brazil	5.5	Central African Republic	3.6	Gabon	2.2
Estonia	9.0	Serbia	5.5	Czechia	3.6	SaudiArabia	2.1
Latvia	9.0	Slovenia	5.4	Luxembourg	3.6	Sweden	2.1
Lithuania	9.0	Jordan	5.1	Cameroon	3.5	PuertoRico	2.1
Brunei Darussalam	8.6	Mauritania	5.1	Malaysia	3.5	Namibia	2.1
Bosnia and Herzegovina	8.3	Uruguay	5.1	Ethiopia	3.4	SriLanka	2.0
Republic of Moldova	8.3	Morocco	5.0	Zambia	3.4	Australia	2.0
Nicaragua	8.3	Cyprus	5.0	Cambodia	3.4	Iceland	1.9
Zimbabwe	8.3	Jamaica	5.0	Angola	3.3	United States of America	1.7
Japan	8.2	Argentina	4.9	Austria	3.3	SolomonIslands	1.6
Uzbekistan	7.9	Burundi	4.8	Barbados	3.3	Lesotho	1.5
Portugal	7.9	Mexico	4.7	Ireland	3.3	Botswana	1.5
Ukraine	7.8	Bangladesh	4.6	Timor-Leste	3.3	Eswatini	1.5
Papua New Guinea	7.5	Algeria	4.6	Egypt	3.2	Comoros	1.2
Panama	7.4	Congo	4.6	Trinidad and Tobago	3.2	Indonesia	1.1
Georgia	7.4	Togo	4.5	Niger	3.2	Mozambique	0.7
Romania	7.4	Belize	4.5	Philippines	3.2		
North Macedonia	7.3	Qatar	4.5	Libya	3.1		

Figure 9. ASMR of Gastric cancer (worldwide) in 2020, both sexes, all ages. ASMR, age-standardized mortality rate.

distribution of GC that has been performed among both men and women in various regions of Saudi Arabia, based on the PubMed database. The present study has shed light on the current status of GC trends, and the significance of the disease, in the Saudi Arabian population.

The present study identified that, between 2004 and 2017, GC accounted for 3.7 and 2.1% of all cancer cases in Saudi men and women, respectively, with totals of 175 and 110 cases confirmed. Furthermore, significantly higher numbers of cases of GC were observed among individuals aged ≥50 years, with males having the higher percentage (83.3%) and females having a percentage of 70.9%. On the other hand, individuals ≤49 years old were less affected by GC, with male and female patients having percentages of 16.7 and 29.0%, respectively. These results are consistent with previous studies, which reported a median age of diagnosis for GC of 72 years, and a diagnosis percentage of ~10% in patients under the age of 45 years (11-13). GC is a disease that often develops over a long period, which is associated with risk factors such as chronic infection with *H. pylori*, smoking and a diet high in salt and preserved foods. Therefore, it is not surprising that the majority of cases were observed in individuals aged ≥50 years, who have had a longer period of exposure to these risk factors.

The incidence rate of GC in Saudi Arabia was investigated, and it was detected that this was higher in men compared with women. Specifically, it was observed that, between 2004 and 2017, the CIR and ASIR values of GC were 2-fold greater in Saudi men compared with women. This finding was consistent with the global trend, as the incidence of GC is known to vary according to sex and geographical location, with men being more commonly affected than women, and with the risk also increasing with age (14). In the United States, previous studies have indicated that the male sex is the most significant risk factor for the development of GC, with a 2:1 male-to-female ratio predominance (15). Moreover, in developed countries, men are 2.2 times more likely than women to be diagnosed with GC (16). The findings of the present study, along with those of other studies, have highlighted the significance of the male sex as a predictor of GC. Moreover, the study conducted by Yang *et al* (17) investigated not only the incidence rates, but also the survival rates of patients with metastatic GC, revealing that male patients had significantly lower survival rates compared with female patients. This finding suggests that sex may not only affect the incidence of GC, but also the prognosis and outcomes of patients with this disease. However, the higher incidence of GC in males compared with females may be due to hormonal differences, as estrogen has been revealed to have a protective effect against GC (18). Additionally, lifestyle factors, including smoking and alcohol consumption, may also contribute to this sex difference observed in incidence rates. Overall, the findings of the present study have highlighted the importance of early detection and prevention efforts for GC, particularly among older individuals and males.

The present study also revealed that the ASIR trend of GC among Saudi men and women dropped steadily between the years 2004 and 2017. This trend is consistent with the gradual decrease in incidence rates of GC that have been observed throughout the world in recent decades, including in the United States (Fig. 7) (1,19). Several factors may have contributed to this decrease, such as improved standards of hygiene, enhanced food preservation and increased intake of fresh fruit and vegetables. Additionally, the widespread implementation of *H. pylori* eradication programs may also have contributed a role towards this downward trend (1,20). The ASIR of GC demonstrated yearly fluctuations for both males and females, with a gradual increase between 2004 and 2006, followed by a slight decline in subsequent years, and furthermore demonstrated sex disparities, as observed with notably higher ASIR for males in certain years like 2009 and 2013, while ASIR for females was comparatively higher in 2010 and 2011. The observed variations in the ASIR of GC can be attributed to several reasons. Population dynamics play a role, where changes in age distributions and demographic factors, such as population growth, migration patterns and aging populations over the years, contribute to fluctuations in the ASIR. Additionally, improvements in diagnostic practices and increased awareness of GC among healthcare professionals and the public may lead to early detection and higher incidence rates, resulting in fluctuations in ASIR over time. Moreover, data completeness and variations in the quality of data reporting in different years can impact the ASIR results. Changes in data collection methods, reporting systems, or healthcare infrastructure may affect the accuracy of recorded cancer cases, influencing the observed ASIR.

The findings of the present study also indicated that GC is more prevalent among male and female residents of the regions Riyadh, Najran and the Eastern region of Saudi Arabia between 2004 and 2017. This implied that individuals in these regions are at a higher risk of developing GC. On the other hand, individuals in Jazan, Saudi Arabia, were less affected by GC, indicating that they may be exposed to protective factors against GC compared with individuals in other regions of Saudi Arabia. However, a more extensive epidemiological study is necessary to identify the potential risk factors that contribute to the increased ASIR of GC among Saudi men and women in the Riyadh, Najran and Eastern regions. In addition, protective factors against GC in the Jazan region should be investigated.

In Saudi Arabia, the ASIR for GC in 2020 was estimated to be 2.7% per 100,000 individuals for both sexes, which is significantly lower compared with other countries. Oman was found to have the highest rate of GC among both sexes in the Arabian Gulf, with a rate of 8.0 per 100,000 individuals, which is 2.9 times higher than that of Saudi Arabia (Fig. 8). Moreover, the ASMR of GC in Saudi Arabia was observed to be 2.1 per 100,000 individuals for both sexes. This mortality rate was slightly lower compared with other Arab countries (Fig. 9). However, Oman had the highest ASMR of GC among both sexes, with a rate of 6.9 per 100,000 individuals, which was 3.2 times higher than that of Saudi Arabia. The results of the present study have indicated that the overall ASIR of GC in Saudi Arabia was considerably lower than in Mongolia (32.5 per 100,000 individuals), Japan (31.6 per 100,000 individuals) and Korea (27.7 per 100,000 individuals), where the rates were 9 to 10 times higher than in Saudi Arabia (9).

To the best of the authors' knowledge, the impact of the COVID-19 pandemic on the incidence rate of GC and those of other types of cancer in Saudi Arabia has not been studied extensively. However, it is important to consider that Saudi Arabia is part of the global community, and therefore the cancer incidence rates may be subjected to the same types of factors that influence the trends and effects as are observed in other parts of the world. The COVID-19 pandemic disrupted healthcare systems, delayed screenings, diagnoses and altered treatment plans, leading to potential changes in the patterns of cancer detection and reporting. One notable effect of the pandemic has been a decrease in cancer screenings and routine healthcare visits. Numerous countries implemented lockdown measures and restrictions on non-essential medical services to curb the spread of the virus. These actions resulted in the postponement or cancellation of screenings such as mammograms, Pap smears, colonoscopies and other tests commonly used for cancer detection. As a consequence, there has been a decline in cancer diagnoses during the pandemic (21).

Furthermore, individuals may have been hesitant to seek medical attention or visit healthcare facilities due to fear of contracting COVID-19 or overwhelming healthcare systems.

This delay in seeking care could lead to missed or delayed cancer diagnoses, potentially impacting cancer incidence rates. The impact of the pandemic on cancer incidence rates may vary according to the type of cancer involved. Certain cancers, such as breast and prostate cancer, heavily rely on routine screenings for early detection. Consequently, their incidence rates may have been more significantly affected by the pandemic. Other types of cancers, such as lung or pancreatic cancer, may not be as heavily dependent on routine screenings, and so their incidence rates could be less severely affected. However, further research is necessary to determine the precise magnitude and long-term implications of these effects (22).

The variations in GC rates in Saudi Arabia over the studied 14-year period can be attributed to several specific factors. Notably, significant events in the Saudi healthcare system could have influenced the GC rates. The substantial investments of the government in expanding and improving healthcare infrastructure across the country during this time may have resulted in increased access to medical facilities, leading to improved screening and diagnostic services for GC, and consequently, more cases being detected, potentially causing an apparent increase in GC rates. Furthermore, changes in lifestyle and dietary habits among the Saudi population over time may have played a role in the observed variations in GC rates. The introduction of fast-food chains, sedentary lifestyles and a shift towards processed foods may have contributed to an increase in risk factors associated with GC. Moreover, increased awareness about GC among both the general population and healthcare professionals could have led to more frequent screenings and early detection, potentially capturing more GC cases. Demographic shifts in the Saudi population, such as increased life expectancy and alterations in age distribution, may have influenced the overall GC incidence rates, as GC is often associated with older age groups. Lastly, improvements in diagnostic techniques and accuracy over time could have led to improved detection and reporting of GC cases, accounting for some of the observed variations in GC rates. Overall, these factors represent crucial aspects to consider when analyzing the fluctuations in GC rates in Saudi Arabia.

During the period from 2004 to 2017, Saudi Health Institutions witnessed significant advancements in diagnostic techniques and enhanced accuracy. These improvements likely contributed to the observed higher incidence rates and fluctuations in ASIR of cancer diseases. In this span of time, there were notable enhancements in medical technology, including the widespread adoption of advanced imaging modalities such as MRI, CT scans and digital radiography. These technologies allowed for earlier and more precise detection of various health conditions, potentially leading to increased diagnoses of certain diseases. Moreover, the genetic testing methods became more prevalent worldwide, enabling healthcare professionals to identify specific genetic markers associated with diseases (23). Cancer diseases pose a significant health challenge globally, affecting individuals of various ages and backgrounds. In the context of Saudi Arabia, where healthcare advancements have been notable, there has been a remarkable improvement in life expectancy. The life expectancy in Saudi Arabia stood at 73 years of age in 2004, and by 2017, it had risen to 76 (https://data.worldbank.org/indicator/SP.DYN.LE00.MA.IN?view=chart). This increase can be attributed to various factors, including advancements in medical care, improved access to healthcare services, and enhanced public health awareness. As life expectancy continues to rise, addressing the prevalence and impact of cancer diseases becomes even more crucial, prompting the healthcare system to further prioritize effective prevention, early detection and comprehensive treatment strategies to ensure the well-being of the population.

The present study has provided valuable insights into the incidence rates of GC in Saudi Arabia and has provided information which should help inform future research and public health initiatives. However, it is important to acknowledge the limitations of the present study, such as the absence of a comparison group and the inability to assess the statistical association between potential risk factors and GC. The lack of information on GC-associated deaths in the SCR reports prevented the determination of average death rates of GC in various regions of Saudi Arabia. Additionally, the limitation of not being able to collect TNM staging information at the initial diagnosis of GC from the SCR is acknowledged. The SCR only provides TNM staging data for the top ten cancer types in Saudi Arabia, and GC is not among those reported. As a result, it was not possible to provide a specific description of the change in TNM stage in the initial diagnosis of GC based on SCR data. This limitation is important to note as it could have implications for the comprehensiveness of the findings of the present study and the potential impact on public health research related to cancer in Saudi Arabia. Future studies with a specific focus on GC and more comprehensive data collection methods may help address this limitation and provide a deeper understanding of TNM stage changes in GC diagnoses in the country.

One significant limitation to the present study is the lack of comparison between the incidence of GC in the years 2004-2017 and 2020-2022, which coincides with the pandemic period. At present, the SCR has not released the report for the years 2020-2022, and thus, the age-specific incidence rates, CIRs, and ASIRs of GC in Saudi Arabia during the COVID period are not available. This limitation hinders the ability to make direct comparisons between the incidence of GC before and during the pandemic, which could have provided valuable insights into any potential impacts or changes in cancer incidence patterns during this challenging time. However, despite this limitation, the primary focus of the study on the incidence of GC from 2004 to 2017 offers crucial baseline data and enhances the comprehension of cancer trends in the pre-pandemic period. By contributing to the existing literature on GC, the present study has shed light on the necessity for additional research to identify and address potential risk factors for this disease in the Saudi population.

Another significant limitation highlighted in the present study is related to the lack of population coverage data and the percentage completeness of recorded cancer cases, which can greatly impact the accuracy and reliability of health-related statistics, particularly in disease surveillance and public health research. These limitations have far-reaching implications, leading to potential underestimation or overestimation of the disease burden, introducing bias in demographic and epidemiological profiles, and hindering accurate disease surveillance and outbreak detection. Moreover, they can impede efforts to monitor health disparities, allocate resources efficiently and affect the validity and generalizability of research findings. To address these issues, it is crucial for health authorities to improve data collection systems, enhance case reporting completeness and ensure comprehensive coverage of population data in registration areas through improved collaboration, accurate recordkeeping, and advanced health information systems.

In conclusion, the present study has demonstrated that there has been a small decline in the CIRs and ASIRs of GC in the Saudi population between 2004 and 2017. Riyadh, Najran and the Eastern Region were revealed to have the highest overall ASIRs of GC among male and female Saudis, whereas Jazan had the lowest rates for both sexes. Between 2004 and 2017, the ratio of cases of GC in male Saudis was detected to be double that of female Saudis. Further epidemiological studies, however, are required to determine the potential risk factors for GC in Saudi Arabia.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are available in the National Health Information Centre's website, https://nhic.gov.sa/en/eServices/Pages/TumorRegistration.aspx.

Author's contributions

IA contributed in the conceptualization, methodology, data analysis, visualization, investigation and supervision of the present study, in the writing and preparation of the original draft as well as in the writing, reviewing and editing of the manuscript. IA confirms the authenticity of all the raw data.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The author declares that he has no competing interests.

References

1. Machlowska J, Baj J, Sitarz M, Maciejewski R and Sitarz R: Gastric cancer: Epidemiology, risk factors, classification, genomic characteristics and treatment strategies. Int J Mol Ici 21: 4012, 2020.
2. Ferlay J, Shin HR, Bray F, Forman D, Mathers C and Parkin DM: Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. Int J Cancer 127: 2893-2917, 2010.
3. Mukkamalla SKR, Recio-Boiles A and Babiker HM: Gastric cancer. In: StatPearls (Internet). StatPearls Publishing, Treasure Island, FL, 2022.
4. Ang T and Fock KM: Clinical epidemiology of gastric cancer. Singapore Med J 55: 621-628, 2014.
5. Ferro A, Peleteiro B, Malvezzi M, Bosetti C, Bertuccio P, Levi F, Negri E, La Vecchia C and Lunet N: Worldwide trends in gastric cancer mortality (1980-2011), with predictions to 2015, and incidence by subtype. Eur J Cancer 50: 1330-1344, 2014.
6. Edwards BK, Noone AM, Mariotto AB, Simard EP, Boscoe FP, Henley SJ, Jemal A, Cho H, Anderson RN, Kohler BA, *et al*: Annual Report to the Nation on the status of cancer, 1975-2010, featuring prevalence of comorbidity and impact on survival among persons with lung, colorectal, breast, or prostate cancer. Cancer 120: 1290-1314, 2014.
7. Kaneko S and Yoshimura T: Time trend analysis of gastric cancer incidence in Japan by histological types, 1975-1989. Br J Cancer 84: 400-405, 2001.
8. American Cancer Society. Key statistics about stomach cancer. American Cancer Society, Atlanta, GA, 2022. https://www.cancer.org/cancer/stomach-cancer/about/key-statistics.html. Accessed September 20, 2022.
9. International Agency for Research on Cancer (IARC): GLOBOCAN. Maps: Section for Cancer Incidence and Mortality. IARC, Lyon, 2020. https://gco.iarc.fr/today/home. Accessed September 20, 2020.
10. Saudi Cancer Registry. Cancer Incidence Report Saudi Arabia 2017. Saudi Cancer Registry, Riyadh, 2017.
11. Kong X, Wang JL, Chen HM and Fang JY: Comparison of the clinicopathological characteristics of young and Elderly patients with gastric carcinoma: A meta analysis. J Surg Oncol 106: 346-352, 2012.
12. Takatsu Y, Hiki N, Nunobe S, Ohashi M, Honda M, Yamaguchi T, Nakajima T and Sano T: Clinicopathological features of gastric cancer in young patients. Gastric Cancer 19: 472-478, 2015.
13. Milne AN, Sitarz R, Carvalho R, Carneiro F and Offerhaus GJ: Early onset gastric cancer: On the road to unraveling gastric carcinogenesis. Curr Mol Med 7: 15-28, 2007.
14. Forman D and Burley V: Gastric cancer: Global pattern of the disease and an overview of environmental risk factors. Best Pract Res Clin Gastroenterol 20: 633-649, 2006.
15. Suryawala K, Soliman D, Mutyala M, Nageeb S, Boktor M, Seth A, Aravantagi A, Sheth A, Morris J, Jordan P, *et al*: Gastric cancer in women: A regional health-center seven year retrospective study. World J Gastroenterol 21: 7805-7813, 2015.
16. Rawla P. and Barsouk A: Epidemiology of gastric cancer: Global trends, risk factors and prevention. Prz Gastroenterol 14: 26-38, 2019.
17. Yang D, Hendifar A, Lenz C, Togawa K, Lenz F, Lurje G, Pohl A, Winder T, Ning Y, Groshen S and Lenz HJ: Survival of metastatic gastric cancer: Significance of age, sex and race/ethnicity. J Gastrointest Oncol 2: 77-84, 2011.
18. Chen C, Gong X, Yang X, Shang X, Du Q, Liao Q, Xie R, Chen Y and Xu J: The roles of estrogen and estrogen receptors in gastrointestinal disease (review). Oncol Lett 18: 5673-5680, 2019.
19. National Cancer Institute (NCI): Cancer of the stomach-cancer stat facts. NCI, Bethesda, MD, 2022. https://seer.cancer.gov/statfacts/html/stomach.html. Retrieved September 26, 2022.
20. Sitarz R, Skierucha M, Mielko J, Offerhaus GJA, Maciejewski R and Polkowski WP: Gastric cancer: Epidemiology, prevention, classification, and treatment. Cancer Manag Res 10: 239-248, 2018.
21. Lombe DC, Mwaba CK, Msadabwe SC, Banda L, Mwale M, Pupwe G, Kamfwa P, Kanduza M, Munkupa H, Maliti B, *et al*: Zambia's national cancer centre response to the COVID-19 pandemic-an opportunity for improved care. Ecancermedicalscience 14: 1051, 2020.
22. Kartik A, Garg D and Singh RB: Implications of reduced health care services for cancer patients in India and similar resource-limited health care systems during COVID-19 pandemic.Asia Pac J Public Health 32: 287-288, 2020.
23. Pulumati A, Pulumati A, Dwarakanath BS, Verma A and Papineni RVL: Technological advancements in cancer diagnostics: Improvements and limitations. Cancer Rep (Hoboken) 6: e1764, 2023.