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Trends of cancer incidence in Qassim Region, a descriptive analysis of data from the Saudi Cancer registry 2002–2016

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ABSTRACT

Objectives: The objectives of the study was to describe cancer incidence in the Qassim region and compare it with the national incidence rate for all reported cancer sites over 15-years (2002–2016).

Methods: A descriptive analysis was conducted using the Saudi Cancer Registry (SCR) data. The annual percentage change (APC) was computed using Joinpoint regression software.

Results: The Qassim region contributed to 4.3% ($n = 6118$) of the total cancer burden in Saudi Arabia (SA). Cancer incidence increased throughout the study period; however, it did not reach statistical significance. The age-standardized rate (ASR) per 100,000 persons was higher in females 68.8 (95% CI: 60.2–77.3) than in males 57.0 (95% CI: 51.9–62.12), $P < 0.001$. Since 2011, colon and rectal cancers have replaced non-Hodgkin lymphoma (NHL) and liver cancer as the leading cancer types among men. In women, the breast is the leading cancer type, and since 2014, the colon and uterus replaced the thyroid and NHL as the second and fourth-most common cancers. ASR of nasopharyngeal, esophageal, and Hodgkin's lymphoma were significantly higher in Qassim as compared to SA. The following cancer types showed significant APC (2002–2016): in males; colon: APC = 7.3%, rectum: APC = 6.1%, bone: APC = 8.3%, and esophageal: APC −5.1%. In females; breast: APC = 6%, colon: APC = 7.2%, uterus: APC = 10.1%, kidney: APC = 15.3%, bone: APC = 8.1%, skin non-melanoma: APC = −8.1%, and myeloid leukemia: APC −14.2%.

Conclusion: The significant changes in cancer incidence in Qassim warrant further studies on the risk factors and preventive measures.

Keywords: Age-standardized rate, annual percentage change, cancer incidence, Qassim, Saudi Arabia

Introduction

Cancer incidence has been rapidly growing in Saudi Arabia (SA) in the past decades, as per previous reports,[1-3] reflecting the rapid growth of population, societal, and economic transition associated with changes in the leading risk factors for cancer.[4] A review of 11,204 cancers between 1975 and 1985 revealed that non-Hodgkin's lymphoma (NHL), lung cancer, esophageal, hepatic, and oral cancers were the most common cancers in men. Breast, lymphoma, oral cavity, thyroid, and cervical cancers were the most common cancers in women.[5] A report spanning from 2001 to 2014 showed a significant increase in the incidence of various types of cancer, for example, among women, breast (10.5%), and thyroid cancers (1.7%).[3] Further reports spanning from 1990 to 2016 showed a 26, 10, and 10-fold increase in the number of thyroid, breast, and colorectal cancers, respectively.[2] Simultaneously, there was a significant increase in SA's total population. In 1975, 1990, and 2018, the Saudi population was 7.4, 16.2, and 33.7 million, respectively.[6] Therefore, the increase in cancer cases could be attributed to an increase in the country's total population. Thus, the age-standardized incidence rate (ASR) per 100,000 persons is the standard for reporting cancer incidence rates, which is followed by the Saudi Cancer Registry (SCR).[7] However, there is an overall increase in the ASR of cancers in SA, with a variation between the 13 administrative regions of SA,[8] which implies differences in cancer risk factors.

Qassim is one of the 13 administrative regions of SA, located in the geographic center and has an area of 73,000 km², representing 3.2% of the total area of SA. The Qassim

region had a total population of 1.45 million, and the annual increase in its population is 2.36%.[9,10] Lymphoma (15%) and esophageal cancer (7.7%) were the most common cancers between 1987 and 1995. In females, thyroid (12.5%) and breast cancer (11.85%) were the most common, while in males, lymphoma (17.4%) and liver cancer (8.57%) were the most prevalent cancers. Interestingly, in a previous report, out of 966 cancer cases, the frequency of colon cancer was 2.5% in men.[11]

There is an imperative need for readily accessible, up-to-date information on the cancer incidence in Qassim. Therefore, this study aimed to assess cancer incidence in the Qassim region and compare it to the national cancer incidence rate over 15 years (2002–2016).

Materials and Methods

A descriptive analysis of cancer incidence in the Qassim region between 2002 and 2016 was conducted using the SCR data. The Ministry of Health established the SCR in 1992 as a population-based registry to provide decision-makers and researchers with reliable, accurately documented data. Therefore, ethical approval was not required for this descriptive study.

The SCR released annual reports since 2002; the last release was in 2016. These reports provide the total number of cases, frequency of different cancer sites, crude incidence rate per 100,000 persons, and ASR per 100,000 persons for 51 primary cancer sites in men and 55 primary cancer sites for women (including other and unspecified) in the 13 administrative regions. ASR is the most frequently used to report cancer incidence and is defined as the incidence rate expressed per 100,000 people if the people had a standard age structure, as proposed by Segi (1960) and modified by Doll (1966).[12,13] The data were extracted for analysis.

The total number of cancer cases and average ASR for both sexes were computed, and each administrative region's proportional contribution to the total cancer burden was used for regions ranking. The annual percentage change (APC) and 95% confidence interval (CI) for ASR of cancers in SA and each of its 13 administrative regions between 2002 and 2016 were computed for significant differences ($P < 0.05$) using Joinpoint regression analysis software version 4.9.01.

The top 20 cancers among males and females in Qassim were ranked using the three-year ASR averages (i.e., between the years 2002 and 2004; 2005 and 2007, 2008 and 2010, 2011 and 2013, and 2014 and 2016), giving rise to a total of five calendar periods; Microsoft Excel for Mac version 16.58 was used. The average ASR and 95% CI were compared for all cancer sites using a *t*-test (two-sided, $P < 0.05$) for significant differences between Qassim and SA using SPSS for Mac (v27; IBM Corp, Armonk, NY, USA).

Results

In total, 143,197 cancer cases were reported in all 13 administrative regions of SA between 2002 and 2016. In the Qassim region, 6118 cancer cases were reported during the study period; cancers in female patients constituted the majority (55%; 3,336), with a male-to-female ratio of 1: 1.19. Over the 15 years, the Qassim region was ranked sixth (4.3%) in the total number of cancer cases among SA regions (males: 4.2% and females: 4.4%) [Figure 1].

To subdivide by average ASR, the Qassim region ranked 6th in cancers in males and 10th in cancers in females, which was lower than the national ASR during the 15-year study period. In contrast, Riyadh and the eastern region had an annual ASR consistently higher than the national ASR. Overall, the ASR of cancers increased nationally and in 13 administrative regions. However, APC from 2002 to 2016 was only statistically significant in Asir (1.5%) among men, and in Asir (2.4%), Hail (3.9%), Jouf (3.6%), Riyadh (2.6%), and the Eastern region (2%) among women, Table 1.

Females had a higher annual ASR of cancers than males during the study period from 2002 to 2016. The mean difference ASR of cancers in SA for females versus males was 80.5 (95% CI: 75.3–85.8) versus 75.5 (95% CI: 71.7–79.3) ($P < 0.001$), respectively; the mean difference in ASR reported in Qassim females versus males was 68.8 (95% CI: 60.2–77.3) versus 57.0 (95% CI: 51.9–62.12) ($P < 0.001$), respectively. Figure 2 illustrates the ASR of cancer in men and women from 2002 to 2016.

The 20 most common types of cancers in Qassim

Table 2 shows the 20 most common cancers in the study period (2002–2016) among males (accounting for 88% of cancers in males). The most common cancers in men were colorectal cancer (14.3%) (colon cancer [7.8%] and rectal cancer [6.5%]), followed by NHL (8.6%), liver cancer (6.5%), Hodgkin's lymphoma (HL) 6.4%, and nasopharyngeal carcinoma (NPC), and stomach cancer (4.9% each). However,

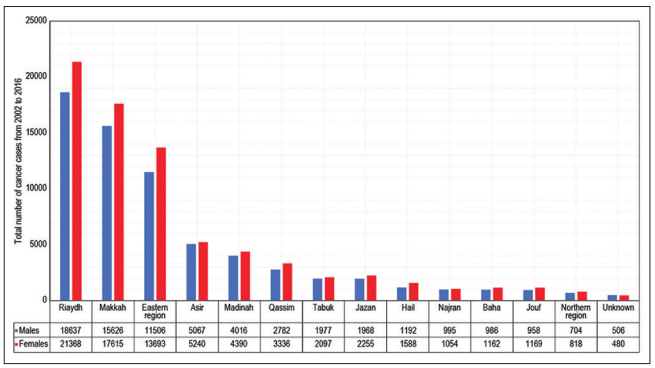

Figure 1: The total number of cancer cases in the 13 administrative regions of Saudi Arabia from 2002 to 2016

Table 1: Annual percentage changes for the Age-standardized incidence rate (ASR) of cancers in Saudi Arabia and its 13 administrative regions from 2002 to 2016

Region	Males					Females				
	ASR (2002)	ASR (2016)	APC (%)	95% CI	*P*-value	ASR (2002)	ASR (2016)	APC (%)	95% CI	*P*-value
Asir	51.8	68.7	1.5	0.8, 2.1	<0.001	52.5	66.2	2.4	1.2, 3.6	0.001
Baha	47.2	49.3	0.1	−1.2, 1.5	0.82	47	37.5	1.1	−2.0, 4.2	0.5
Jazan	30.4	33.7	1.6	−0.5, 3.6	0.12	37.8	40.6	0.5	−3.3, 4.3	0.8
Madinah	47.3	54.7	0.52	−1.7, 2.7	0.62	46.7	60.6	0.9	−1.9, 3.7	0.5
Hail	41	33.7	−0.52	0.5, −1.1	0.28	36.3	64.6	3.9	2.3, 5.5	<0.001
Qassim	56.7	56.5	0.46	−1.8, 2.7	0.66	79.3	80.8	2.1	−1.0, 5.2	0.2
Najran	67.7	53.9	0.8	0.9, −1.0	0.31	56.5	71.7	2.1	−0.6, 5.0	0.1
Jouf	45.5	71.4	0.92	−0.6, 2.4	0.21	34.7	95.5	3.6	1.3, 6.1	<0.01
Tabuk	74.9	67.1	0.02	−2.0, 2.1	0.98	80	78.1	0.3	−2.0, 2.6	0.8
Northern region	32.2	69	1.4	−0.3, 3.2	0.1	53.5	53.8	0.1	−2.4, 2.3	0.9
Riyadh	89.2	96.4	0.6	−0.4, 1.6	0.2	89.5	130.1	2.6	1.8, 3.3	<0.001
Makkah	63.7	73.2	−0.6	−1.4, 0.1	0.1	62.3	87.7	1.2	−0.2, 2.5	0.1
Eastern region	103.4	104.3	0.3	−0.6, 1.3	0.4	87.4	131.3	2.0	1.1, 3.0	<0.001
National	61.7	74.7	0.57	−0.5, 1.6	0.26	60.1	91.3	2.2	1.1_3.3	0.001

ASR: Age-standardized rate per 100.000 males, APC: Annual percentage changes, CI: Confidence interval

Table 2: Top 20 cancers among males in the Qassim region from 2002 to 2016

Cancer site	2002–2004		2005–2007		2008–2010		2011–2013		2014–2016		Overall, 2002–2016	
	ASR	Rank	ASR	Rank	ASR	Rank	ASR	Rank	ASR	Rank	Rank	Frequency (%)
Non–Hodgkin lymphoma	5.1	1	3.3	3	6.0	2	4.1	4	4.1	3	1	8.6
Colon	3.2	7	3.3	2	4.5	3	5.8	1	6.8	1	2	7.8
Liver	4.6	2	3.9	1	6.3	1	4.8	3	2.2	11	3	6.5
Rectum	3.0	9	3.2	4	4.4	4	5.1	2	5.0	2	4	6.5
Hodgkin's lymphoma	2.6	11	2.5	6	2.7	10	2.2	12	2.9	5	5	6.4
Stomach	4.3	3	1.7	14	3.1	6	4.0	6	2.4	10	6	4.9
Nasopharynx	3.2	8	2.2	7	2.9	8	2.6	9	2.8	6	7	4.9
Prostate	3.4	5	1.9	12	2.8	9	3.1	7	3.4	4	8	4.5
Thyroid	2.0	14	2.7	5	1.9	15	2.2	11	2.5	7	9	4.5
Skin (non-melanoma)	4.2	4	1.8	13	3.1	7	2.0	14	2.4	9	10	4.2
Trachea, Bronchus, Lung	2.0	15	2.1	9	2.7	11	4.0	5	2.4	8	11	4.0
Other and unspecified	3.2	6	2.1	8	3.1	5	1.3	16	1.0	19	12	3.6
Lymphoid Leukemia	2.6	12	2.0	10	1.1	20	1.0	20	1.1	18	13	3.4
Brain	1.9	16	1.6	15	1.3	18	1.4	15	0.9	21	14	3.1
Esophageal	2.7	10	2.0	11	1.9	14	1.2	17	1.6	13	15	2.9
Kidney	1.6	17	1.0	17	1.8	16	2.3	10	1.6	12	16	2.8
Urinary Bladder	1.4	18	1.4	16	2.5	12	2.0	13	1.1	17	17	2.7
Myeloid Leukemia	2.2	13	0.8	19	1.4	17	0.7	22	1.2	16	18	2.6
Pancreas	0.8	20	0.8	20	2.0	13	2.9	8	1.2	15	19	2.4
Gallbladder	1.2	19	0.7	37	1.1	19	1.1	19	1.4	14	20	1.5

ASR: Age-standardized rate per 100.000 males

in the last calendar-period (2014–2016), colorectal cancer frequency was (22.1%) (colon cancer [12.7%] and rectal cancer [9.4%]), followed by NHL (7.7%), prostate (6.3%), HL (5.6%), and NPC (5.2%). At the beginning of the study period, NHL and liver cancer were the most frequently diagnosed cancers.

Table 3 shows the 20 most common cancers among females (accounting for 89% of cancers in females). The most frequent cancer in females was breast cancer (28.3%), followed by colorectal cancer (11.2%) (colon cancer [6.6%], rectal cancer [4.6%]), thyroid cancer (9%), and NHL (4.8%). In the last calendar period (2014–2016), breast cancer frequency was

Table 3: Top 20 cancers among females in the Qassim region from 2002 to 2016

Cancer site	2002–2004		2005–2007		2008–2010		2011–2013		2014–2016		Overall, 2002–2016	
	ASR	Rank	ASR	Rank	ASR	Rank	ASR	Rank	ASR	Rank	Rank	Frequency (%)
Breast	13.5	1	13.9	1	23.7	1	21.2	1	24.9	1	1	28.3
Thyroid	3.7	3	6.5	2	8.2	2	6.3	2	6.2	3	2	9
Colon	2.9	5	3.6	3	4.9	3	4.7	3	6.6	2	3	6.6
NHL	2.8	6	2.4	6	4.8	4	3	4	3.5	5	4	4.8
Rectum	4.1	2	2.6	4	4.2	5	2.9	5	2.2	9	5	4.6
Uterus	1.7	14	1.3	13	2.1	12	2.7	6	4.3	4	6	3.5
Other and unspecified	2.4	8	2.5	5	2.3	11	2.2	8	2.3	7	7	3.4
Skin (non-melanoma)	3.2	4	1.6	11	3.1	6	1.2	15	0.9	15	8	3
Ovary	1	19	1.9	7	2.5	9	2.7	7	1.8	11	9	2.9
Hodgkin's lymphoma	1.9	12	1.4	12	1.9	16	1.7	10	2.5	6	10	2.7
Liver	2.3	9	0.9	19	2.8	7	1.8	9	0.7	21	11	2.5
Gallbladder	2	11	1.7	10	2.6	8	1.2	14	0.4	25	12	2.3
Esophagus	2.1	10	1.8	8	1.2	19	1.7	11	1.2	13	13	2.3
Brain	1.3	15	1.1	17	1.9	14	1.4	20	2.1	10	14	2.2
Kidney	0.7	26	0.5	24	2.3	10	1.7	15	2.3	8	15	2.1
Stomach	0.8	24	1.7	9	2	13	1.9	12	0.8	19	16	2
Myeloid Leukemia	2.6	7	1.2	16	1.6	17	1.8	13	0.4	26	17	1.9
Cervix	1.8	13	1.8	20	1.4	18	1.8	14	1.3	12	18	1.9
Trachea, bronchus, lung	0.8	25	0.8	22	1.9	15	1.9	11	0.9	16	19	1.5
Nasopharynx	0.9	23	1.3	15	1	21	0.9	19	1.1	14	20	1.5

ASR: Age-standardized rate per 100.000 women, NHL: Non-Hodgkin lymphoma

Figure 2: The age-standardized incidence rate (ASR) of cancers per 100,000 persons in Saudi Arabia and Qassim from 2002 to 2016

(34%), followed by colorectal cancer (12%) (colon cancer [9%], rectal cancer [3%]), thyroid (8.5%), and uterine cancer (5.8%).

Of the 51 primary cancer sites in males and 55 primary cancer sites in females, three cancers had higher ASR in Qassim than in SA; NPC, esophageal cancer, and HL, presented in Table 4.

The APC

The APC for ASR of cancers in the Qassim region from 2002 to 2016 showed significant changes in five cancer sites among males. Significant increases were in three cancer sites: colon: APC 7.3% (95% CI: 4.5–10.2, $P < 0.001$); rectum APC 6.1% (95% CI 2.4–9.8, $P < 0.01$); and bone APC 8.3% (95% CI: 0.6–16.6, $P < 0.03$). The significant decreases were in two cancers, that is, esophageal cancer: APC −5.1% (95% CI: −9.8–−0.1, $P = 0.04$); and other and unspecified cancers: APC −9.9% (95% CI: −16.5–−2.5, $P = 0.01$). Table 5 presents cancers that showed significant APC in the ASR of cancers among 51 cancer sites in males in the SA and Qassim regions from 2002 to 2016.

Compared to SA, Qassim had a higher APC for rectal, colon, and bone cancers. Figure 3 illustrates the annual ASR of these cancers from 2002 to 2016.

In females, seven cancers showed significant changes; significant increases were seen in 5 cancers: breast: APC 6% (95% CI: 2.6–9.5, $P < 0.01$); colon: APC 7.2% (95% CI: 3.7.6–10.7), $P = 0.001$; uterus: APC 10.1 (95% CI: 2.5–18.2, $P = 0.01$); kidney: APC 15.3% (95% CI: 4.2–27.5, $P < 0.01$), and bone: APC 8.1% (95% CI: 0.5–16.2, $P = 0.03$). The significant decreases were in two cancers: skin non-melanoma: APC −8.1% (95% CI: −14.9–−0.7, $P = 0.03$), and myeloid leukemia: APC −14.2% (95% CI: −20.5–−7.5, $P = 0.001$). Table 6 presents cancers that showed significant APC in the ASR of cancers among 55 cancer sites in females in the SA and Qassim regions from 2002 to 2016.

Table 4: The cancer sites with an age-standardized rate per 100,000 higher in Qassim than in Saudi Arabia from 2002 to 2016

Cancer site	Males					Females				
	Saudi Arabia		Qassim		*P*-value	Saudi Arabia		Qassim		*P*-value
	ASR	95% CI	ASR	95% CI		ASR	95% CI	ASR	95% CI	
Nasopharynx	1.73	1.59–1.86	2.74	2.30–3.18	<0.001	0.68	0.61–0.75	1.02	0.72–1.33	<0.001
Esophageal	1.24	1.14–135	1.87	1.41–2.33	<0.001	1.06	0.91–1.22	1.60	1.25–1.94	<0.001
Hodgkin's lymphoma	2.14	1.98–2.29	2.59	2.08–3.09	<0.001	1.55	1.38–1.72	1.84	1.13–2.56	<0.001

ASR: Age-standardized rate per 100.000 females, CI: Confidence interval

Table 5: The cancer sites in males that had significant annual percentage changes (APC) in ASR from 2002 to 2016

Cancer site	Saudi Arabia				Qassim			
	ASR (2016)	APC (%)	95% CI	*P*-value	ASR (2016)	APC (%)	95% CI	*P*-value
Colon	7.8	5	3.4, 6.5	<0.001	7.9	7.3	4.5, 10.2	<0.001
Rectum	5.1	2.8	1.2, 4.5	<0.01	4.8	6.1	2.4, 9.8	<0.01
Liver	4.2	−2.04	−4.0, −0.1	0.04	2.8	−3.28	−9.8, 3.7	0.31
Stomach	2.9	−2	−3.5, −0.4	0.02	2.8	0.2	−6.8, 7.7	0.9
Kidney	2.6	3.2	1.2, 5.1	<0.1	1.7	4.1	−2.0, 10.6	0.1
Hodgkin's lymphoma	2.6	2.2	1.1, 3.4	0.001	3.1	1.9	−3.2, 7.3	0.4
Pancreas	2.5	2.9	1.2, 4.6	<0.01	1.9	6.8	−1.5, 15.8	0.1
Thyroid	2.5	4.42	2.3, 4.5	<0.001	3.1	1.3	−4.1, 7.0	0.6
Other and unspecified	1.7	−5.01	−7.0, −2.9	<0.001	0.7	−9.8	−16.5, −2.5	0.01
Gall Bladder	1.2	3.4	1.3, 5.4	<0.01	1.2	**		
Testis	1.1	4.7	2.9, 6.5	<0.001	0.8	−0.7	−7.9, 7.1	0.8
Esophagus	1.1	−1.7	−3.5, 0.1	0.056	1	−5.1	−9.8, −0.1	0.04
Bone	0.9	2.6	0.9, 4.4	<0.01	1.1	8.3	0.6, 16.6	0.03
Breast	0.6	3.2	0.1, 6.3	0.04	0.8	**		

**Empty cells due to the presence of zero values of ASR. ASR: Age-standardized rate per 100.000 females, APC: Annual percentage changes from 2002 to 2016, CI: Confidence interval

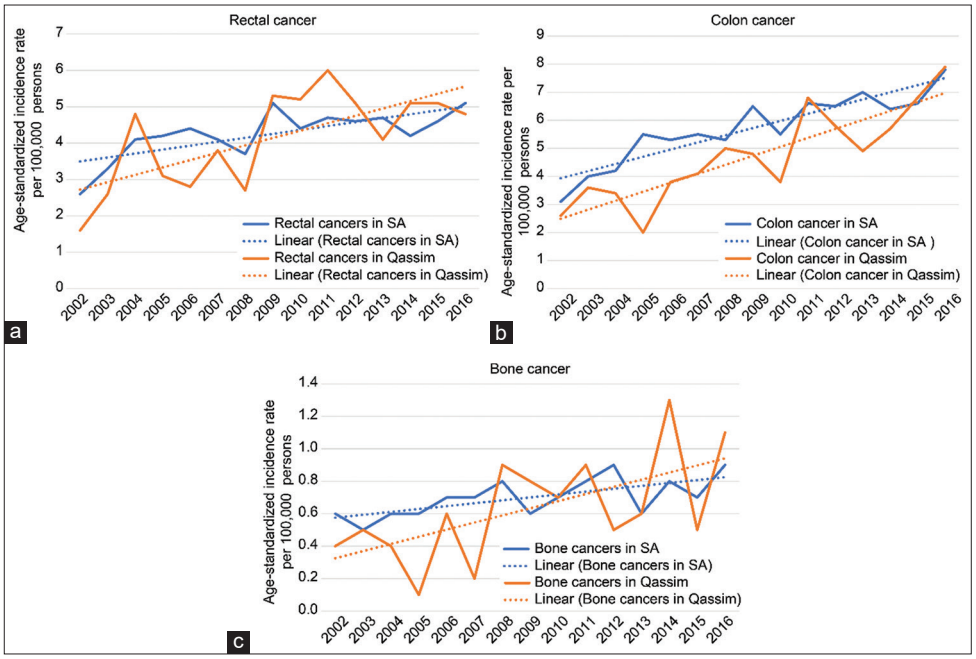

Figure 3: The trends of cancers in males that had significant increases in incidence rate in Qassim; rectal cancer (a), colon cancer (b), and bone cancer (c) from 2002 to 2016

In comparison to SA, the APC of ASR was higher in Qassim for breast, colon, kidney, and bone cancers. The ASR of uterine cancer showed a significant increase in both Qassim and SA, with the rate of increase being higher in

Table 6: The cancer sites in females that had significant annual percentage changes (APC) in ASR from 2002 to 2016

Cancer site	Saudi Arabia				Qassim			
	ASR (2016)	APC (%)	95% CI	*P*-value	ASR (2016)	APC (%)	95% CI	*P*-value
Breast	27.2	4.8	3.4, 6.2	<0.001	31.7	6.0	2.6, 9.5	<0.01
Thyroid	8.9	4.3	3.3, 5.4	<0.001	5.5	3.2	−1.7, 8.4	0.2
Uterus	6.6	13.6	4.6, 23.5	<0.01	6.1	10.1	2.5, 18.2	0.01
Colon	6.1	4.4	2.7, 6.1	<0.001	6.2	7.2	3.7, 10.7	0.001
Rectum	3.4	2.4	0.9, 4.0	<0.01	2.4	−3.2	−.8.3, 2.3	0.2
Hodgkin's lymphoma	2.9	3.9	2.2, 5.6	<0.001	3.9	7.5	−3.1, 19.3	0.15
Ovary	2.7	1.8	0.1, 3.5	0.03	1.2	6.3	−.03, 13.6	0.07
Skin (non-melanoma)	2.1	−2.5	−4.2, −0.8	<0.01	0.9	−8.1	−14.9, −0.7	0.03
Liver	1.9	−1.4	−3.9, 1.2	0.2	1.2	−6.6	−17.4, 5.6	0.2
Kidney	1.8	1.8	0.1, 3.6	0.04	1.1	15.3	4.2, 27.5	<0.01
Myeloid leukemia	1.7	0.8	−1.4, 3.0	0.5	0.5	−14.2	−20.5, −7.5	0.001
Other and unspecified	1.5	−4.73	−6.7, −5.0	<0.001	2	−2.4	−6.6, 2.1	0.3
Pancreas	1.5	3.45	0.6, 6.3	0.02	1.5	**		
Lymphoid Leukemia	1.2	2.4	0.4, 4.4	0.02	0.2	−7.3	−16.5, 2.9	0.1
Cervix	0.8	−2.1	−3.5, −0.6	<0.01	0.8	0.02	−10.9, 12.2	0.9
Esophagus	0.7	−4.8	−6.5, −3.1	<0.001	0.6	−3.9	1.1, −1.7	0.1
Nasopharynx	0.7	−2.7	−4.5, −0.9	<0.01	1.5	2.14	2.1, 10.6	0.6
Multiple myeloma	0.6	4.8	1.3, 8.4	0.01		**		
Bone	0.5	3.4	0.9, 5.8	0.01	0.8	8.1	0.5, 16.2	0.03

**Empty cells due to presence of zero values of ASR, ASR: Age-standardized rate per 100.000 females, APC: Annual percentage changes from 2002 to 2016, CI: Confidence interval

SA. Figure 4 illustrates the annual ASR of these cancers from 2002 to 2016.

The incidence of liver cancer decreased from 2002 to 2016 in Qassim: APC: −3.3% (95% CI: −9.8–3.7, $P = 0.31$) in males, and APC: −6.6% (95% CI: −17.4–5.6, $P = 0.2$) in females. However, in males from 2008 to 2016, the APC was −17%, 95% CI: −24–−8.5, $P < 0.01$). Figure 5 illustrates the annual ASR for liver cancer from 2002 to 2016.

APC of prostate cancer ASR was trending up, however, no statistical significance was detected; in SA, APC was 1.4% (95% CI: −0.2–3, $P = 0.08$). In Qassim, the APC of prostate cancer was 2.2% (95% CI: −1.4–5.9, $P = 0.2$). Figure 6 illustrates the annual ASR for prostate cancer from 2002 to 2016.

APC of cervical cancer ASR was trending down, in SA APC −2.1%, 95% CI: −3.5–0.6, $P < 0.01$; however, this was not statistically significant in Qassim APC 0.02% (95% CI: −10.9–12.2, $P = 0.9$). Figure 7 illustrates the annual ASR for liver cancer from 2002 to 2016.

APC of thyroid cancers ASR was significant only in SA; males had an APC of 4.42% (95% CI: 2.3–4.5, $P < 0.001$), and females had an APC of 4.3% (95% CI: 3.3–5.4, $P < 0.001$). Figure 8 illustrates the annual ASR for thyroid cancer from 2002 to 2016.

Discussion

This study provides a comprehensive descriptive analysis of cancer incidence in Qassim and SA from 2002 to 2016. However, the overall cancer incidence increased; APC did not reach statistical significance. Females consistently had a higher ASR of cancer than males during the study period. In Qassim, the most frequently reported cancers in men were colorectal cancer (14.3%) (colon cancer [7.8%] and rectal cancer [6.5%]), followed by NHL (8.6%), liver cancer (6.5%), HL (6.4%), and NPC and stomach cancer (4.9%) each. However, in the last calendar period (2014–2016), colorectal cancer increased to (22.1%) (colon cancer [12.7%] and rectal cancer [9.4%]), followed by NHL (7.7%), prostate (6.3%), HL (5.6%), and NPC (5.2%). The most frequent cancer in females was breast cancer (28.3%), followed by colorectal cancer (11.2%) (colon cancer [6.6%] and rectal cancer [4.6%]), thyroid cancer (9%), and NHL (4.8%). In the last calendar period (2014–2016), breast cancer frequency was 34%, followed by colorectal cancer (12%), thyroid (8.5%), and uterine cancer (5.8%). The incidence rates of three cancers (NPC, esophageal cancer, and HL) were higher in Qassim than in SA. Significant increases in APC were detected in three cancer sites in males; rectal (6.1%), colon (7.3%), and bone cancer (8.3%), and five in females; breast (6.0%), colon (7.2%), uterine (10.1%), kidney (15.3%), and bone cancer (8.1%). Moreover, except for uterine cancer, the magnitude of increase was higher in Qassim than in SA in all of these cancers. The trend of esophageal cancer incidence decreased; however, it was significant only in men.

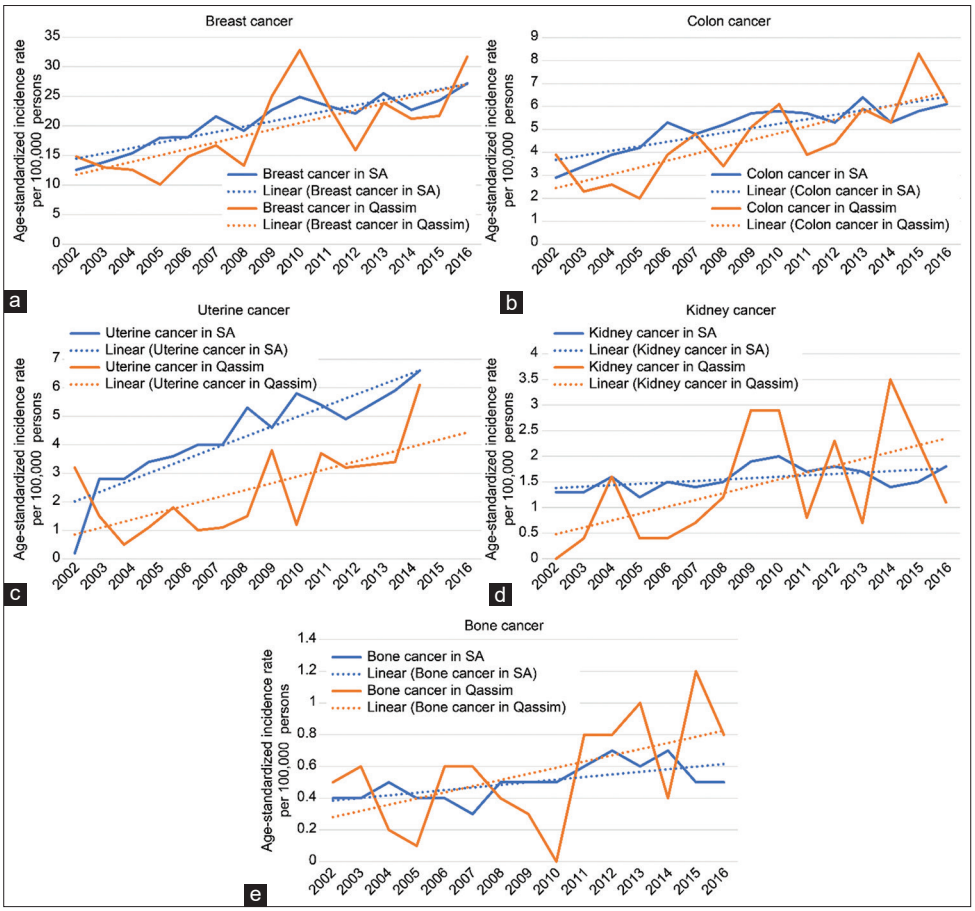

Figure 4: The trends of cancers in females that had significant increases in incidence rate in Qassim; breast cancer (a), colon cancer (b), uterine cancer (c), kidney cancer (d), and bone cancer (e) from 2002 to 2016

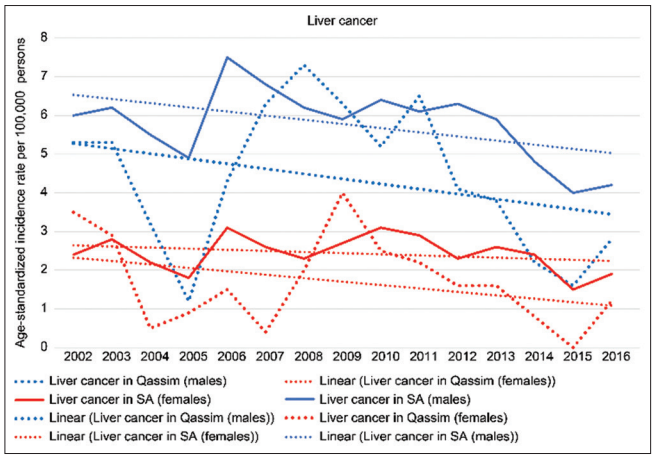

Figure 5: Liver cancer trends in Qassim and Saudi Arabia from 2002 to 2016

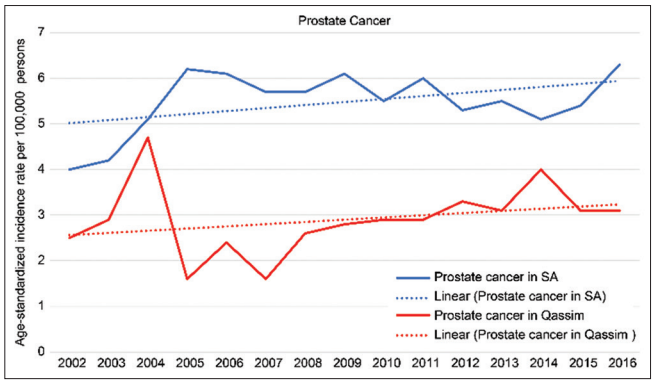

Figure 6: Prostate cancer trends in Qassim and Saudi Arabia from 2002 to 2016

The liver and cervical cancer rates also decreased but did not reach statistical significance.

Cancer incidence is increasing worldwide,[14] which is consistent with the global cancer transition theory, which attributes this increase to the rapid and substantial changes in risk factors of cancers, including environmental carcinogens, tobacco, obesity, chronic inflammation, infectious agents, radiation, diet, immunosuppression, hormones, and increases in life expectancy.[4] However, the increase in cancer incidence in SA is not yet statistically significant and is far lower than the global ASR per 100,000 persons (males: 89 vs. 222, and females: 111.9 vs. 186).[15,16]

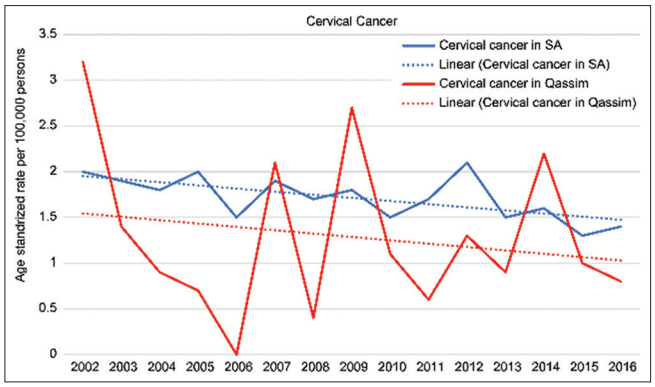

Figure 7: Cervical cancer trends in Qassim and Saudi Arabia from 2002 to 2016

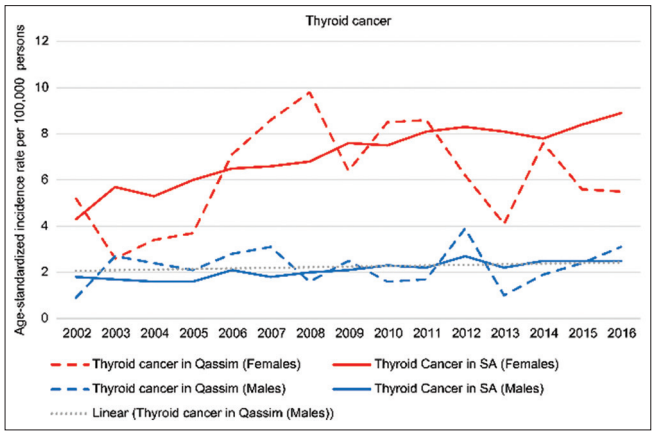

Figure 8: Thyroid cancer trends in Qassim and Saudi Arabia from 2002 to 2016

The higher incidence of cancer in women [Figure 2] in our population differs from that in most of the world's regions, where the incidence rate is higher in men.[16] The inversion of this global trend could be due to the prevalence of the most common cancers among men worldwide (i.e., prostate and lung cancer), which are less prevalent in SA; the ASR of prostate cancer in SA is 7 vs. 30.7 worldwide, and ASR of lung cancer in SA is 6.2 vs. 31.5 worldwide.[15] Moreover, in Saudi women, the burden of the thyroid (ASR; 12.9 vs. 10.1) and uterine (ASR; 10.9 vs. 8.7) cancers exceeded global rates.[15]

The cancer incidence in Qassim was higher in women than in men; the female-to-male ratio was 1.19:1. This contrasts with the 1:1.38 female-to-male ratio reported in Qassim.[11] A previous study reported the absolute number of cases rather than the ASR per 100,000 population. For example, in 2020, the predicted total number of cancer cases in SA was higher in males (14,253 vs. 13,632), while the predicted ASR per 100,000 was higher in females (89 vs. 111.9 per 100,000 persons)[15] as the male proportion of the population is higher than that of females (20.1 million males vs. 14.6 million females).[17]

The current study showed that the APC of ASR was statistically significant in the Asir region among men and women and in Hail, Jouf, Riyadh, and the Eastern region among women. The ASR of cancers exceeded the national ASR in Riyadh and the Eastern regions over the 15-year study period [Table 1]. This may reflect the prevalence of cancer-predisposing factors in these areas, the most economically developed regions in SA.

Over 15 years, the ASR of breast cancer increased by two folds in Qassim and SA [Figure 4a], with an APC of 6% and 4.8%, respectively, and it was the most common cancer among women in Qassim (28.3%). However, despite the ASR in SA being far less than the global figure (27.7 vs. 47.8),[16] the sharp rise in breast cancer incidence and mortality is concerning.[2,3] Breast cancer risk factors include obesity, westernized nutritional habits, physical inactivity, early menarche, late marriage, and a reduced number of pregnancies.[1,18-20]

Similarly, the ASR of colon cancer for both sexes showed a significant increase (two-fold) regionally and nationally, with APC of 7.2% and 4.4%, respectively, perhaps due to the prevailing risk factors, which include an increase in consumption of red or processed meat, obesity, low rates of screening, and an increase in life expectancy.[21-24] Compared to Western countries, colorectal cancer in SA is diagnosed at a younger age and in more advanced stages.[25] Therefore, screening for colorectal cancer has been recommended by the Saudi Center for Evidence-Based Healthcare Panel for asymptomatic 45-year-olds with an average risk of colorectal cancer.[26]

Thyroid cancer is the third most common cancer in women in Qassim and SA, after breast and colorectal cancers. The rising APC of thyroid cancer ASR per 100,000 individuals was significant in SA (APC 4.3%, $P < 0.001$). In a previous study, the Qassim region showed the highest increase in thyroid cancer incidence between 2001 and 2008.[27] This analysis showed no statistically significant increase in the incidence rate ($P = 0.2$). That because the highest increase was during the third calendar period (2008–2010), in which the ASR rose from 3.7 to 8.2 per 100,000 persons; the ASR of thyroid cancer in the last two calendar periods (2011–2013) and (2014–2016) decreased to 6.3 and 6.2 per 100,000 women, respectively. Worldwide, thyroid cancer is the ninth most common cancer among females (ASR 10.1), which is lower than the rate in SA, which is 12.9 per 100,000 persons. The risk factors for the increased incidence of thyroid cancer include increased detection, radiation exposure, increased age, increased life expectancy, dietary factors, body weight, and physical inactivity.[28-30]

Gynecological malignancies account for 8.4% and 11% of all cancers in Qassim and SA. The distribution of gynecological malignancies is shown in Figure 9.

The Qassim region has been reported to have one of the lowest uterine cancer incidence rates.[31] However, from 2002 to 2016, the ASR increased three-fold in Qassim and SA [Figure 4c].

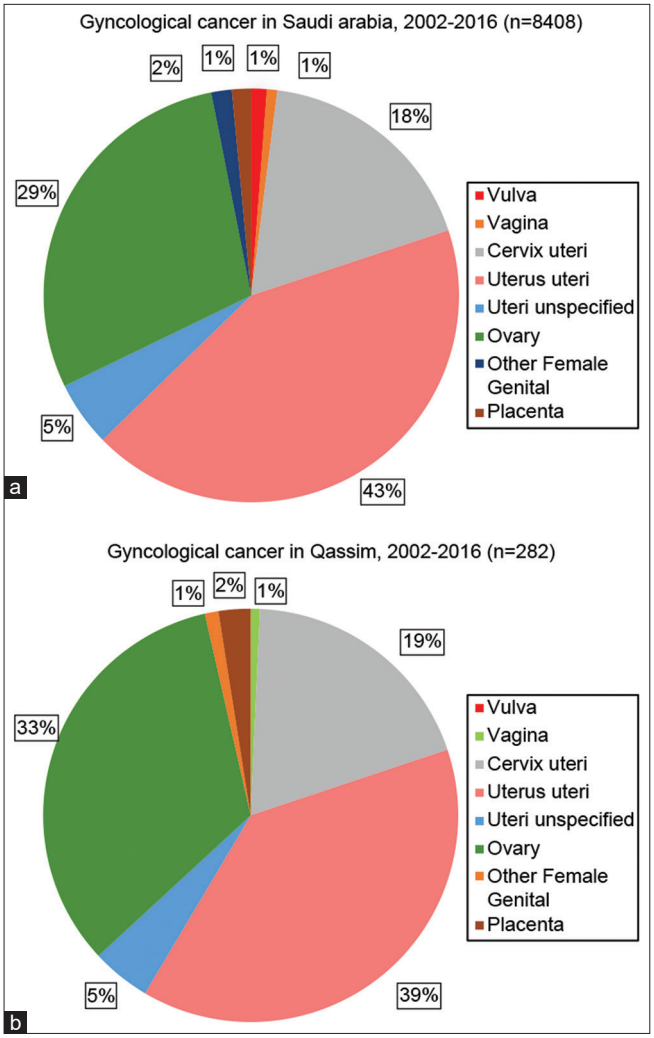

Figure 9: The frequency of gynecological cancers in Saudi Arabia (a) and Qassim (b) from 2002-to 2016

The APC of uterine cancer ASR per 100,000 women in SA is 13.6% and in Qassim is 10.1%. The uterine cancer incidence rate is higher in SA (ASR: 10.9) than the global rate (ASR: 8.7) and is expected to increase further.[15] The incidence of uterine cancer increases with increased BMI, hormonal replacement therapy, diabetes mellitus, and decreased parity.[32,33] Ovarian cancer also showed significant increases in SA (APC 1.8%), but it did not reach statistical significance in Qassim (APC 6.6%, $P = 0.07$). ASRs of ovarian (3.8 vs. 6.6 per 100,000 women) and cervical (2.8 vs. 13.3 per 100,000 women) cancers in SA are much lower than the worldwide ASR.[15] The significant differences in cervical cancer reflect the lower rate of the leading risk factors, particularly human papillomavirus.[34] No significant changes were observed in other gynecological malignancies.

The ASR of esophageal cancer in the Qassim region was higher than the national figure; however, the incidence rate in Qassim decreased by 40% from the first to the last calendar period, and the APC was −5.1%. In addition, the incidence rate of esophageal cancer in the SA decreased, although the difference was not statistically significant. Worldwide, the incidence rate of esophageal cancer is increasing; however, it is decreasing in some parts of the words, such as in the United States, where the APC is −1.5% since 1986.[35] Esophageal cancer incidence rates have significant geographical and racial variations. Risk factors for esophageal cancer include obesity, alcohol consumption, tobacco use, esophageal reflux, and diet. A 1990 report linked the high rate of esophageal cancer in Qassim to drinking water.[36] Improved drinking water quality is an effective measure for esophageal cancer prevention and control.[37,38] Drinking water quality has improved in our population in the last decades; however, it has not yet been proven to be the reason for our population's decreasing esophageal cancer incidence rate. Further studies are warranted to investigate the variation between the incidence rates of esophageal cancer histological subtypes among the region of SA (e.g., squamous vs. adenocarcinoma).

This report highlights the high incidence of NPC in Qassim. NPC is known to vary geographically.[39] NPC in SA was not among the 20 most common cancers, while in Qassim, it was ranked 6th–9th among men and 14th to 20th among women between 2002 and 2016. The reason for this is unknown and has not yet been investigated. The risk factors for NPC include Epstein–Barr virus activation, smoking, a high rate of consanguineous marriage, and a diet with high nitrate.[40-42] The non-keratinizing histological subtype is the predominant subtype in SA; however, there are no data on EBV prevalence in Qassim. Interestingly, the incidence of another EBV-related cancer, HL, was higher in Qassim nationally throughout the 15 years studied (2002–2016). One study compared samples from SA and Swiss HL patients under the same conditions and found no statistically significant difference in EBV-positive rate.[43] However, the risk of HL increases 2–4 times among first-degree relatives.[44,45] Further research is required to determine whether the Qassim region has a higher rate of these risk factors. However, essential preventive measures include control of tobacco smoking, reduction in salted and preserved food intake, and reduction of carcinogen exposure in occupational settings.[46]

Liver cancers were more common in men than in women and showed a statistically significant decrease in the incidence rate in SA (APC −2.04%) only. In Qassim, (APC −3.28%, $P = 0.3$; however, the 3-year ASR average decreased threefold from 2008-2010 to 2014-2016 in males and females [Tables 2 and 3]. These findings may reflect the interventions that the Ministry of Health has implemented in SA to manage hepatitis B virus and hepatitis C virus.[47,48] The mandatory premarital screening program introduced in the country in 2004 for hepatitis could have indirectly led to the timely detection of hepatitis and, ultimately, a decrease in the national burden of liver cancer.

The ASR of other and non-specified cancers significantly decreased from 2002 to 2016, most likely reflecting the

improvement in the tumor classification. However, further specification is needed for rare tumors and their histological subtypes.

SA has one of the most rapidly growing populations globally.[49] The population is projected to grow at an annual rate of 1.02–2.65% and is expected to reach more than 45.1–72.2 million by 2050.[50] In 1975, life expectancy in SA was 58 years, which increased to 75 years by 2018.[24] With the current steady increase in the incidence of some cancers, the burden of cancer will grow faster than the population growth. These data necessitate maximizing efforts to mitigate the current trend and prepare the health-care system. Effective primary preventive interventions can decrease the cancer burden.[4] In high-income countries, 33–40% of new cancer cases can be prevented by reducing exposure to known lifestyle and environmental risk factors.[39]

The strength of this study lies in its comprehensive evaluation of cancer incidence in SA, focusing on the Qassim region over 15 years, using high-quality data generated by the national population-based registry that encompasses the entire population of SA. The current analysis was limited by the unavailability of details on cancer characteristics, risk factors, and survival data in the SCR database. However, these findings are helpful for researchers to study the risk factors for significant changes in cancer incidence and for policymakers to mitigate the expected demand on the health-care system in the region, resulting in a reduced burden of cancer.

Conclusions

The ASR of cancer was higher in females throughout the study period in Qassim and SA. Overall, the ASR of cancer in Qassim was lower than in SA. However, NPC, esophageal, and HL incidence rates were consistently higher in Qassim than in SA. Rectal, colon, breast, kidney, and bone cancers had a higher APC in Qassim than in SA. Additional studies examining risk factors and preventive measures are warranted.

Authors' Declaration Statements

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013). The data used for this project were retrieved from annual reports (2002-2016) of the SCR. SCR is a population-based registry that is available online (https://nhic.gov.sa/en/eServices/Pages/TumorRegistration.aspx). Therefore, ethical approval was not required for this study.

Availability of data and materials

All data generated or analyzed in this study are included in this published article. The data are available online at the Department of National Health Registries, Saudi Cancer Registry Annual Reports**,** https://nhic.gov.sa/en/eServices/Pages/TumorRegistration.aspx.

Competing interests

None.

Funding

None.

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