وزارة الصحة
Ministry of Health

المركز الوطني للسرطان
National Cancer Center

المجلس الصحي السعودي
Saudi Health Council

Cancer Survival Report Saudi Arabia

2005-2019

Dr. Nahar M. Al-Azemi

Secretary General of the Saudi Health Council

In the Name of Allah, the Most Gracious, the Most Merciful

The National Cancer Center (NCC) of the Saudi Health Council presents, for the first time, the National Cancer Survival report (2005 – 2019), outlining the recent achievements of the registry head office.

The Saudi Cancer Registry (SCR) reports support the efforts made in Saudi Cancer Control program. They provide those in charge of cancer healthcare and education with the accurate information that reflects on the situational analysis of cancer survival in Saudi Arabia.

This report compiles data on patterns and trends in cancer survival in the Kingdom, focusing on various demographics, including gender and age. This data is vital for assessing the effectiveness of ongoing cancer control programs. Furthermore, this report supports policymakers in planning and developing targeted cancer healthcare programs and interventions aligned with national health strategies.

The survival report allows decision-makers to plan the development of cancer healthcare and health promotion programs to control cancer, aligned with the national strategies and healthcare objectives. Inspired by Vision 2030 to achieve the goals of the ambitious leadership, and the expectations of beneficiaries, healthcare coordination and integration are the prime goals of the Saudi Health Council that strengthen healthcare provision.

The progress witnessed in our beloved country's healthcare sector is a blessing from Allah the Almighty, bolstered by the ambitious leadership of the Custodian of the Two Holy Mosques and the Royal Highness, the Crown Prince, may Allah protect them. This advancement is also the result of the close follow-up by His Excellency the Chairman and the members of the Saudi Health Council.

I would like to express my sincere gratitude to my colleagues at the National Cancer Center (NCC), National health information center and and ministry of health national data office for their diligent work and continuous efforts in preparing this report and achieving the mission and objectives of the Saudi Cancer Registry.

Furthermore, I would also like to extend my appreciations to all healthcare staff, organizations, institutions, and charity involved in healthcare provision and raising awareness to alleviate cancer burden in Saudi Arabia and improving survival outcomes for patients.

Professor Mushabbab Ali Al-Asiri

General Director of The National Cancer Center, Saudi Health Council

Praise be to Allah, the Lord of the Worlds, and blessings and peace be upon His prophet and messenger Mohammad.

Cancer survival is the most accurate indicator for the quality of cancer care at all levels. It reflects the outcomes of easy health care access , early detection programs and well-established screening programs, and it will highlight the successful interventions for patients with cancer.

We knew for a long time, in Saudi Arabia that we had excellent tertiary care services, but that feeling was not supported with an evidence-based measurement.
The National Cancer Center (NCC) at the Saudi Health Council plays a crucial role in compiling and analysing incidence data for the last thirty years. However, we failed to analyse the survival data in the Kingdom of Saudi Arabia for several reasons that became enjoyable short stories to tell young scientists. It took us around twenty years of failure until we reached this achievement. Currently, I am extremely happy to witness the release of the 1st national cancer survival report before my retirement.

This initiative ensures the validity of survival statistics through the collaborative efforts of both government and private health sector in the Kingdom. By gathering comprehensive data on cancer patient outcomes, the NCC aims to enhance understanding of patterns and trends in cancer survival and improve future cancer care and treatment strategies in Saudi Arabia.

This survival report aims to highlight the progress made in cancer treatment and the effectiveness of our national programs. It provides insights that will further enhance the quality of cancer care in the future.

We extend our sincere gratitude to the local and international consultants who helped us to review this report, to the data managers in national health information center , to the data mangers in the Data office of ministry of health, to the technical team responsible for the preparation and implementation of this report, as well as to our colleagues at the NCC and cancer registrars across all health sectors for their invaluable contributions. Special thanks are also due to the members of the Scientific Committee and the reviewers of this report for their unwavering commitment to the Saudi Cancer Registry, which serves to benefit both citizens and residents alike.

Eng. Saad Abdulatif Alhezami

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In the Name of Allah, the Most Gracious, the Most Merciful

As part of our ongoing efforts to evolve and improve the healthcare system, understanding the patterns of cancer survival in Saudi Arabia has become increasingly important. Over the past decade, advancements in data collection and artificial intelligence (AI) have played a key role in helping us gain deeper insights into these patterns, enabling more informed decisions for the future of cancer care.

Saudi Health Council has been at the forefront of leading the development of this cancer survival registry, collaborating with key partners. Their efforts have ensured that the registry is built on a foundation of high-quality, reliable data, setting a new standard for cancer research and healthcare in the Kingdom. This initiative has strengthened our ability to track cancer survival rates, identify trends, and implement evidence-based strategies to enhance cancer care across Saudi Arabia .

The integration of AI and data analytics in this initiative has not only transformed how we approach patient care but has also made it possible to build valuable resources like the cancer survival registry. With this data, we are better equipped to guide treatment strategies, optimize healthcare policies, and ultimately improve the overall experience for patients.

This registry is a crucial step toward enhancing the quality of cancer care in Saudi Arabia, enabling earlier diagnosis, more personalized treatment options, and a stronger support system for those affected by cancer. By using this data effectively, we can ensure that patients receive the care they need, at the right time, in the most efficient way possible.

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Introduction

The Saudi Cancer Registry (SCR) operates under the National Cancer Center of the Saudi Health Council. It is a population-based registry with national coverage, which started recording incident cancer cases in 1994. Personal and tumour details are abstracted by trained registrars from patient medical records. These include name (first, father, grandfather and family name according to official documents), nationality, ID number, date of birth, sex, marital status, address, telephone number, full date of diagnosis defined as date of confirmation on pathology report, primary site, histology, behaviour, grade, stage, laterality and basis of diagnosis). Date of last contact, vital status, and cause of death if dead (cancer or other) are recorded based on information available at the time of abstraction and are later updated if other sources for the same patient become available, including records from other hospitals, death notifications or death certificates.

The registry publishes annual cancer incidence reports describing age, sex and regional distribution of cancer diagnosed in each calendar year for citizens and residents. This is crucial in identifying changing risk factors and planning preventive programs and treatment services.

Population-based cancer survival is an important metric to further assess the burden of cancer. Monitoring survival trends enables the evaluation of progress in the healthcare system in terms of timely diagnosis and referral, and adequate management of cancer. Furthermore, comparison of survival by stage at diagnosis can shed light on the underlying causes for variations in survival over time or between geographies or population groups and evaluate the efficacy of stage-specific treatment on a population-level. Together, cancer incidence, mortality and survival provide a complementary and more comprehensive understanding of the cancer burden, and how it can be managed.(1)

This report provides 1- and 5-year net survival estimates for 20 cancers in Saudi Arabia over fifteen years, divided into three 5-year periods (2005-2009, 2010-2014, 2015-2019). Survival is also explored by stage for the five most common cancers during this period, (excluding lymphoma due to different staging system): breast cancer in women, and cancers of the colon, thyroid, liver and lung.

Methodology

Survival analysis is a time-to-event analysis, where each subject is followed up longitudinally from the time they become at risk (e.g., date of diagnosis) until an event of interest (e.g. death). If an individual is known to have survived until a certain point in time, but whose survival past that point is unknown, they then only contribute their follow-up time to that point, i.e., their survival time is censored. They are also censored if they experience a competing event that prevents the event of interest from occurring, or do not experience the event of interest by the end of the follow-up time. Methods for survival analysis allow for rates of the outcome (hazard rate) to change over time, as the risk of death from many conditions, including the cancer itself, may change after the cancer has been diagnosed. The survivor function (usually denoted S(t)) is the probability that an individual will survive up to and including time t. As a summary statistic, survival is reported as the proportion surviving for a defined duration (usually 1 or 5 years for cancer).

In population-based cancer survival, assigning death due to the cancer of interest as an event requires accurate attribution of cause of death by the reporting physician and correct coding of the underlying cause of death. Determining the underlying cause of death is challenging as not all cancer patients die as a direct result of their cancer. Moreover, dying from other causes precludes dying of cancer, which introduces "informative censoring". This informative censoring increases in older age. In order to monitor survival trends over time and compare survival between different settings, independent of the background risk of death in the various populations, it is of interest to isolate the hazard of death due to cancer. This is achieved by comparing the survival observed in the cancer patients to the survival that would have been expected if they had had the same risk of death as persons of the same age and sex in the general population (i.e., observed versus expected survival). The background mortality is derived from life tables of all-cause death rates in the general population, usually stratified by single year of age, sex, and calendar year. These are usually obtained from government census and vital registration data. They are regularly published for all countries by the United Nations Population Division (UNPD) World Population Prospects as well as The Institute of Health Metrics and Evaluation (IHME).(2, 3) These use various data sources and methods to check for consistency and adjust for under-enumeration of population and death counts where appropriate. For the current analysis, life tables for the Saudi Arabian population were obtained from the UNPD.

Net survival is a type of relative survival. It is calculated using the Pohar-Perme estimator which is a non-parametric estimator that gives an unbiased estimate by correcting for the increasing competing risk of death from other causes in older age. This is achieved by assigning weights to each failure and censoring time that are the inverse of the expected probability of surviving up to this time.(4)

When net survival is estimated with the appropriate life tables to correct for background mortality by age and sex, and for changes in background mortality over time, it enables monitoring of trends over time within a country and comparison of survival trends between countries where background mortality may well be very different. Such comparisons have important implications for assessing the effectiveness of the health system in managing cancer.

Data preparation

National ID numbers for all individuals with a registered cancer from 2005 to 2019 were submitted to the National Information Center (NIC) of the Ministry of Interior to ascertain their vital status and obtain the date of death if dead. Records were linked on 24 July 2023. The received database was merged with the cancer registry database based on matching ID numbers using the many to one merge command in STATA IC 18 to account for patients with multiple primary tumours. Dates of birth were not used for verification as there was a considerable inconsistency between the officially recorded dates of birth and those obtained from hospital records, but an examination of a sample of records showed a high consistency between the two databases. The last known vital status and date of last known vital status were updated preferentially with the date from the NIC. For the 14.6% of records without a valid ID number (i.e., missing, incomplete or failing to match with an ID number in the NIC), we used the vital status and the date of last known vital status available in the cancer registry record. This allowed us to retain records for which at least partial follow-up was available, thus reducing the risk of bias if those records had all been dropped. Updating the vital status and the date of last known vital status with the NIC records produced a substantial increase in the quality of the data for survival analysis. The total person-time of cancer patients that could be included in the analyses increased from 177,906 person-years if we had only used the cancer registry data to 780,897 person-years. The proportion of patients who were censored within five years of diagnosis or before the closing date of the study was reduced from 30.4% to 11.3%. The completeness of ascertainment of deaths among the cancer patients also increased, such that the proportion known to have died rose from 20.8% to 33.9%.

Because non-nationals are often working on limited contracts, the availability of data on their vital status from the NIC for the included period was only 67%, compared to 85% for Saudis, and was lower than 50% for the years before 2008. Including non-national would therefore reduce the overall accuracy of cancer survival estimates. In addition, obtaining accurate life table data for this population is challenging given their unsteady in- and out-migration. Therefore, survival analysis was limited to nationals.

The cancers included in the analyses were defined with codes in the 10th revision of the International Classification of Diseases (ICD-10) (Table 1). We excluded 6,830 (4.7%) records with incomplete or incorrect essential data items (n=907) or were otherwise ineligible for inclusion in survival analyses (n=5,923) In total, 137,683 records (99.3% of those eligible) were included in the survival analyses (Figure 1). Follow-up was censored at the date of record linkage (24 July 2023) for those for whom complete 5-year follow-up was not observed and were still alive at that date, and at the date of last contact for those who only had follow-up information available from the registry.

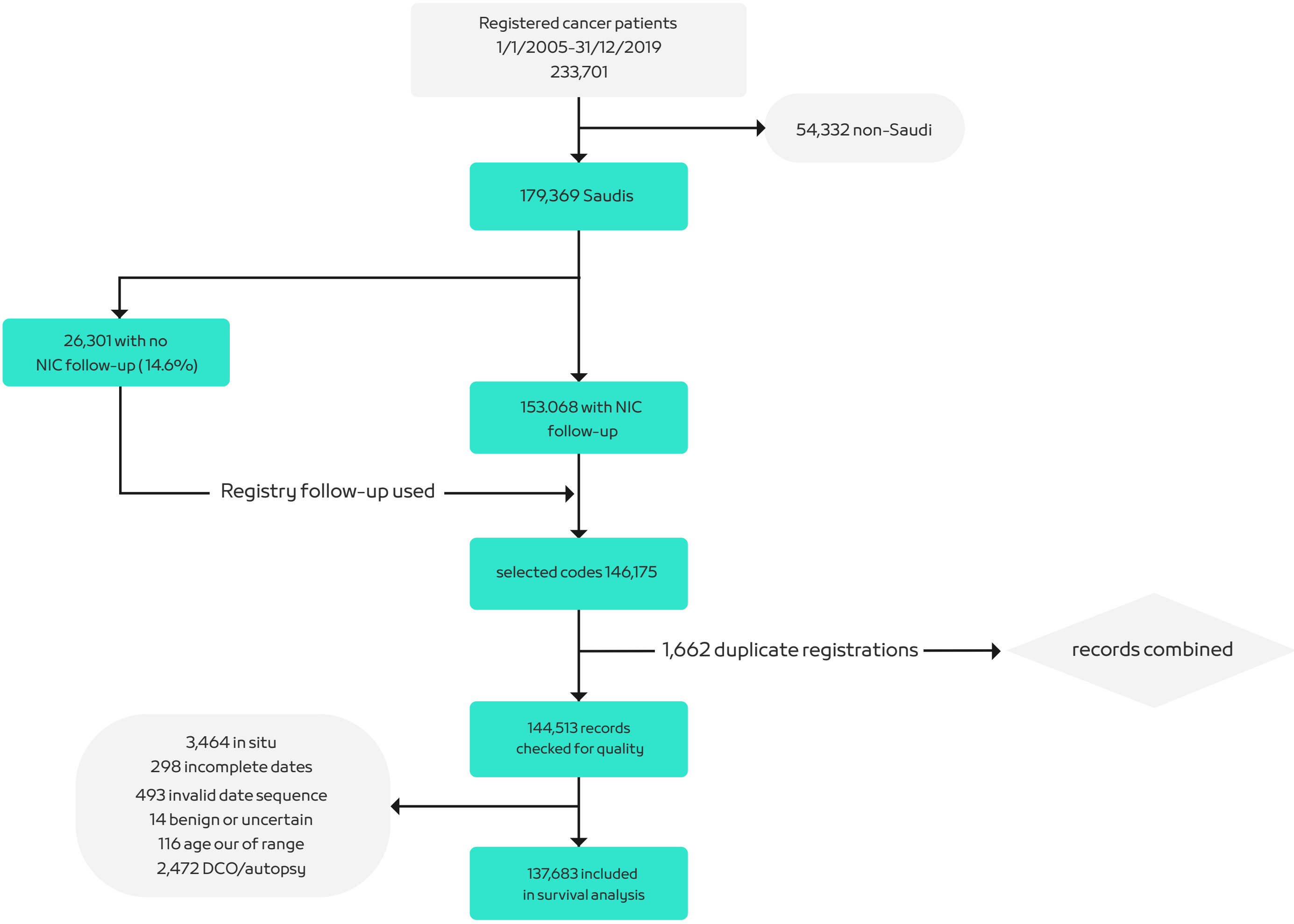

Figure 1: Records included in the survival analysis.

Table 1: :Cancers included in the analyses: ICD 10 codes and the numbers of patients by sex and calendar period of diagnosis.

Cancer		ICD-10 codes	sex	All periods	2005-09	2010-14	2015-19
1	Lip and oral	C000-C006, C008-C009, C019, C020-C024, C028-C029, C030-C031, C039, C040-C041, C048-C049, C050-C052, C058-C059, C060-C062, C068-C069	Male	1,543	403	513	627
			Female	1,383	392	496	495
			Persons	2,926	795	1,009	1,122
2	Oesophagus	C150-C155; C158-C159	Male	994	295	350	349
			Female	802	270	263	269
			Persons	1,796	565	613	618
3	Stomach	C160-C166; C168-C169	Male	2,637	846	893	898
			Female	1,788	519	598	671
			Persons	4,425	1,365	1,491	1,569
4	Colon	C180-C189; C199	Male	7,809	1,743	2,572	3,494
			Female	6,756	1,565	2,249	2,942
			Persons	14,565	3,308	4,821	6,436
5	Rectum	C209; C210-C212; C218	Male	2,960	730	941	1,289
			Female	2,076	499	695	882
			Persons	5,036	1,229	1,636	2,171
6	Liver	C220-C221	Male	4,283	1,358	1,570	1,355
			Female	1,837	549	690	598
			Persons	6,120	1,907	2,260	1,953
7	Gallbladder	C239	Male	370	94	136	140
			Female	874	246	279	349
			Persons	1,244	340	415	489
8	Pancreas	C250-C254; C257-C259	Male	2,092	511	692	889
			Female	1,304	304	429	571
			Persons	3,396	815	1,121	1,460
9	Lung	C340-C343; C348-C349	Male	4,624	1,331	1,624	1,669
			Female	1,615	419	538	658
			Persons	6,239	1,750	2,162	2,327
10	Ovary	C480-C482; C488; C569; C570-C574; C577-C579	Male	-	-	-	-
			Female	3,207	809	1,061	1,337
			Persons	3,360	842	1,105	1,413

	Cancer	ICD-10 codes	sex	All periods	2005-09	2010-14	2015-19
11	Breast	C500-C506; C508-C509	Male	423	92	131	200
			Female	25,933	5,636	8,521	11,776
			Persons	26,356	5,728	8,652	11,976
12	Cervix	C530-C531; C538-C539	Male	-	-	-	-
			Female	1,653	459	559	635
			Persons	1,653	459	559	635
13	Uterus	C540-C543; C548-C549; C559	Male	-	-	-	-
			Female	5,496	1,051	1,774	2,671
			Persons	5,496	1,051	1,774	2,671
14	Prostate	C619	Male	4,839	1,320	1,490	2,029
			Female	-	-	-	-
			Persons	4,839	1,320	1,490	2,029
15	Kidney	C649, C659, C669	Male	2,665	653	893	1,119
			Female	1,534	378	516	640
			Persons	4,199	1,031	1,409	1,759
16	Bladder	C670-C679	Male	3,179	864	1,022	1,293
			Female	738	188	251	299
			Persons	3,917	1,052	1,273	1,592
17	Brain	C710-C719	Male	1,876	476	615	785
			Female	1,265	335	399	531
			Persons	3,141	811	1,014	1,316
18	Thyroid	C739	Male	2,735	619	900	1,216
			Female	10,047	2,312	3,378	4,357
			Persons	12,782	2,931	4,278	5,573
19	Lymphoid	9590, 9591, 9596, 9650-9655,9659, 9662-9667, 9670, 9671, 9673, 9675, 9678- 9680, 9684, 9687, 9689-9691, 9695, 9698-9702, 9705, 9708, 9709, 9714, 9716-9719, 9727-9729, 9731, 9732-9734, 9760, 9761, 9820, 9823, 9826, 9827, 9832-9837, 9940, 9948*	Male	11,345	3,151	3,751	4,443
			Female	8,086	2,218	2,753	3,115
			Persons	19,431	5,369	6,504	7,558
20	Myeloid	9741, 9800, 9801, 9805, 9840, 9860, 9861, 9863, 9866, 9867, 9871, 9872, 9873-9876, 9891, 9895-9897, 9910, 9920, 9930, 9931, 9945, 9946, 9950, 9960-9964, 9980, 9982-9987, 9989*	Male	2,726	700	930	1,096
			Female	2,428	628	821	979
			Persons	5,154	1,328	1,751	2,075
	ALL		Male	58,454	15,577	19,462	23,415
			Female	79,229	18,893	26,406	33,930
			Persons	137,683	34,470	45,868	57,345

*According to Haemacare Manual for Coding and Reporting Haematological Malignancies.(5)

Statistical analysis

Data were STSET to prepare for survival analysis, with follow-up time starting at date of diagnosis and ending at the date of last known status (date of death if dead or the date the patient was last known to be alive if alive). Death due to any cause was considered an event and survival time was censored on the date individuals were last known to be alive to the registry if only registry follow-up was available. One- and 5-year net survival probabilities and their 95% confidence intervals (CIs) were estimated for males, females and both sexes combined for individuals diagnosed during the three periods 2005–2009, 2010–2014, and 2015-2019 with the Pohar-Perme estimator(4) using the STNS package in STATA IC 18. Life tables of all-cause mortality rates in the Saudi Arabian population were used to correct for background mortality. For the period 2015–2019, a complete approach was used, where individuals diagnosed in years for which a full 5 years of follow-up were not available (2018–2019) were censored at the closing date (date of record linkage, 24 July 2023) if they were alive on that day.

five-year net survival was also estimated by stage at diagnosis for the five most common cancers (breast cancer in women, colon, thyroid, liver and lung).

Age-standardised net survival was derived using the International Cancer Survival Standard (ICSS) weights, which assigns weights to each of five age groups (15–44, 45–54, 55–64, 65–74, and 75–99 years). Weights vary by type of cancer and are divided into three groups: cancers for which incidence increases with age, cancers for which incidence is fairly constant with age, and cancers for which incidence decreases with age.(6) Age-specific estimates were produced and then multiplied by the appropriate weights. The resulting weighted estimates were then summed to produce age-standardised estimates. If fewer than 10 patients were at risk for a single age group, they were combined with those in the adjacent age group and the resulting survival estimate was assigned to both age groups, which were then used for age standardisation. Survival estimates were not age-standardised if fewer than 50 patients were at risk in an analysis stratum or fewer than 10 patients were at risk in two or more age groups. This was done to obtain robust survival estimates according to experience from the CONCORD programme for the global surveillance of trends in cancer survival.(7)

Results

137,683 records were included in the analysis with a total of 780,897 years of follow-up. The proportion of individuals who died within 5 years of diagnosis increased slightly over the three calendar periods. The proportion of records for which survival time was censored within 5 years or before the closing date decreased from 17.5% in 2005-2009 to only 7.2% in 2015-2019, indicating an improvement in completeness of follow-up (Table 1).

Table 1: Number and proportion that have died or were lost to follow-up for each period of diagnosis.

Period	N	Died*		Censored	
		N	%	N	%
2005-09	34,470	11,307	32.8	6,042	17.53
2010-14	45,868	15,475	33.7	5,392	11.76
2015-19	57,345	19,934	34.8	4,113	7.17
All	137,683	46,716	33.9	15,547	11.29

*within 5 years
Censored: censored alive within 5 years of diagnosis or before 24 July 2023 (the closing date) for patients diagnosed in 2018 and 2019.

1-year age-standardised net survival was highest for breast, thyroid and prostate cancer, exceeding 90% for all periods; and lowest for pancreatic cancer, followed by lung, liver and gallbladder cancer. Survival was consistently higher among women for most cancers and periods except for bladder and gallbladder cancer (Table 2, Figure 1). 1-year survival declined slightly during the last period for cancers of the gastrointestinal tract, breast, uterus, prostate and ovary, and increased slightly for myeloid, kidney and bladder cancers, while it remained unchanged or with no trend pattern for the remaining cancers. The confidence intervals of the estimates however overlapped between periods for all cancers.

Table 2: Age-standardised 1-year net survival (%), with 95% confidence intervals, for the 20 most common cancers in adults.

		Men		Women		Persons	
Cancer	**Period**	**NS**	**95% CI**	**NS**	**95% CI**	**NS**	**95% CI**
Breast	**2005-2009**	89.3	81.4 - 97.2	95.9	95.0 - 96.9	95.9	94.9 - 96.8
	2010-2014	86.6	79.7 - 93.5	95.9	95.3 - 96.6	95.8	95.2 - 96.5
	2015-2019	95.6	92.4 - 98.8	94.6	94.0 - 95.2	94.6	94.0 - 95.2
Lymphoid	**2005-2009**	78.2	76.5 - 79.9	84.9	83.2 - 86.7	81.2	80.0 - 82.5
	2010-2014	79.4	78.0 - 80.9	86.0	84.5 - 87.5	82.3	81.2 - 83.4
	2015-2019	80.9	79.6 - 82.2	83.3	81.8 - 84.8	82.1	81.1 - 83.1
Colon	**2005-2009**	84.3	82.3 - 86.2	87.1	85.2 - 89.1	85.8	84.4 - 87.2
	2010-2014	84.4	82.8 - 86.0	88.2	86.6 - 89.8	86.3	85.2 - 87.4
	2015-2019	84.2	82.9 - 85.5	84.1	82.6 - 85.6	84.3	83.3 - 85.3
Thyroid	**2005-2009**	90.5	87.2 - 93.8	93.8	91.6 - 96.0	93.2	91.4 - 95.1
	2010-2014	89.8	87.0 - 92.7	94.5	92.7 - 96.3	93.3	91.8 - 94.9
	2015-2019	89.6	87.3 - 92.0	95.2	93.8 - 96.7	93.6	92.3 - 94.8
Lung	**2005-2009**	43.8	40.2 - 47.5	62.8	57.5 - 68.0	49.0	46.0 - 52.0
	2010-2014	46.9	43.7 - 50.0	69.2	64.8 - 73.5	53.0	50.4 - 55.6
	2015-2019	47.6	44.5 - 50.7	63.7	59.7 - 67.6	52.4	50.0 - 54.8
Liver	**2005-2009**	47.8	43.4 - 52.1	61.1	56.1 - 66.1	52.5	49.3 - 55.8
	2010-2014	49.0	44.7 - 53.3	59.4	54.5 - 64.4	52.7	49.5 - 56.0
	2015-2019	49.8	45.7 - 53.9	54.3	49.2 - 59.4	51.3	48.0 - 54.5
Uterus	**2005-2009**			92.6	90.6 94.7	92.6	90.6 94.7
	2010-2014			91.6	89.9 93.3	91.6	89.9 93.3
	2015-2019			87.6	86.1 89.2	87.6	86.1 89.2
Myeloid	**2005-2009**	70.9	66.9 - 75.0	78.5	74.4 - 82.6	74.9	72.0 - 77.8
	2010-2014	71.2	68.0 - 74.4	76.9	73.4 - 80.3	73.9	71.5 - 76.2
	2015-2019	75.1	72.1 - 78.2	77.7	74.4 - 81.0	76.6	74.3 - 78.8
Rectum	**2005-2009**	89.1	86.5 - 91.6	84.2	80.4 - 88.1	87.6	85.4 - 89.8
	2010-2014	86.1	83.6 - 88.6	89.5	86.8 - 92.2	87.8	86.0 - 89.7
	2015-2019	85.5	83.3 - 87.6	87.4	84.9 - 90.0	86.5	84.8 - 88.1
Prostate	**2005-2009**	92.8	88.3 - 97.2			92.8	88.3 - 97.2
	2010-2014	96.1	93.5 - 98.7			96.1	93.5 - 98.7
	2015-2019	90.2	84.7 - 95.8			90.2	84.7 - 95.8

		Men		Women		Persons	
Cancer	**Period**	**NS**	**95% CI**	**NS**	**95% CI**	**NS**	**95% CI**
Stomach	**2005-2009**	55.5	51.1 - 59.9	65.1	60.5 - 69.6	59.4	56.3 - 62.5
	2010-2014	58.0	54.1 - 61.9	64.7	60.5 - 68.9	60.4	57.6 - 63.3
	2015-2019	57.0	53.4 - 60.5	56.7	52.8 - 60.6	56.8	54.1 - 59.4
Kidney	**2005-2009**	83.4	80.4 - 86.5	91.1	87.7 - 94.5	86.3	83.9 - 88.7
	2010-2014	85.8	83.3 - 88.2	89.5	86.4 - 92.6	87.4	85.4 - 89.3
	2015-2019	86.6	84.5 - 88.8	88.7	86.0 - 91.5	87.7	86.0 - 89.4
Bladder	**2005-2009**	83.9	81.0 - 86.8	85.8	79.7 - 92.0	84.3	81.5 - 87.0
	2010-2014	84.2	81.7 - 86.8	82.0	76.0 - 87.9	84.2	81.8 - 86.6
	2015-2019	85.5	83.2 - 87.7	82.4	77.2 - 87.5	85.3	83.2 - 87.4
Pancreas	**2005-2009**	40.7	35.6 - 45.7	54.3	47.8 - 60.8	45.8	41.7 - 49.9
	2010-2014	42.3	37.9 - 46.8	55.6	50.4 - 60.8	47.6	44.2 - 51.1
	2015-2019	40.0	35.9 - 44.0	48.4	43.7 - 53.1	43.5	40.4 - 46.6
Ovary	**2005-2009**			81.6	78.5 - 84.6	81.6	78.5 - 84.6
	2010-2014			85.5	83.1 - 87.8	85.5	83.1 - 87.8
	2015-2019			79.2	76.9 - 81.6	79.2	76.9 - 81.6
Brain	**2005-2009**	60.2	55.4 - 65.1	69.2	63.2 - 75.2	63.6	59.8 - 67.5
	2010-2014	63.5	59.4 - 67.6	61.6	55.7 - 67.4	62.6	59.3 - 66.0
	2015-2019	62.9	59.1 - 66.6	62.2	57.7 - 66.7	63.2	60.2 - 66.2
Lip and oral	**2005-2009**	81.1	76.8 85.4	83.4	79.1 87.7	82.4	79.3 85.5
	2010-2014	79.9	76.2 83.6	86.7	83.4 90.1	83.5	81.0 86.1
	2015-2019	75.6	72.0 79.1	78.5	74.6 82.5	77.2	74.5 79.8
Oesophagus	**2005-2009**	51.8	42.7 - 60.9	68.5	61.2 - 75.8	60.0	54.1 - 65.9
	2010-2014	63.6	57.3 - 69.9	63.2	56.2 - 70.2	62.9	58.1 - 67.7
	2015-2019	57.6	51.1 - 64.1	53.9	47.3 - 60.4	56.3	51.7 - 60.8
Cervix	**2005-2009**			85.1	81.1 - 89.1	85.1	81.1 - 89.1
	2010-2014			81.7	77.9 - 85.5	81.7	77.9 - 85.5
	2015-2019			83.6	80.3 - 86.8	83.6	80.3 - 86.8
Gallbladder	**2005-2009**	72.4	50.3 - 94.4	57.9	50.2 - 65.5	53.9	47.4 - 60.5
	2010-2014	47.5	36.2 - 58.8	59.9	52.0 - 67.7	55.3	48.6 - 62.0
	2015-2019	67.6	52.9 - 82.3	47.4	39.5 - 55.3	46.4	39.9 - 52.9

NS: net survival; 95% CI: 95% confidence interval.

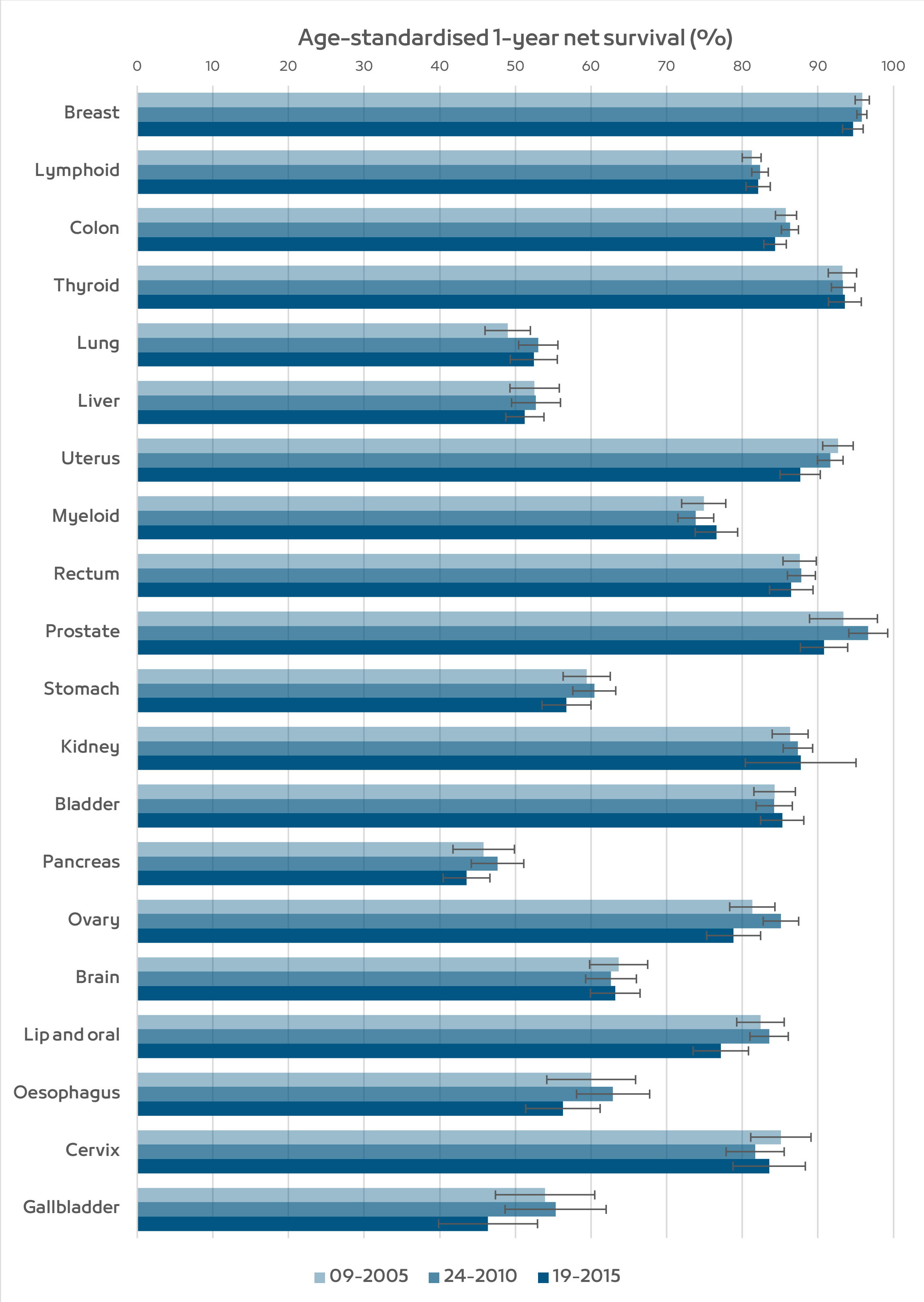

Figure 1: Age-standardised 1-year net survival and 95% confidence intervals for the 20 most common cancers in adults (both sexes).

5-year age-standardised net survival was highest for thyroid cancer, which exceeded 90% throughout the 15 years 2005-2019 for all sexes, followed by breast and kidney cancer where survival exceeded 80% over the three periods. The lowest was for pancreatic cancer, which was below 40% over the three periods. There was a declining trend in 5-year survival for several cancers, most notably cancers of the gastrointestinal tract, lung and uterus. For ovary and prostate, a decline was only seen in the last period. For the remaining cancers there was no change or no pattern of trend (Table 3, Figure 2).

The decline in 5-year survival for those diagnosed in 2015-2019 may be due to the restriction in access to diagnostic and treatment services or fear of infection during the COVID-19 pandemic, as 5-years of follow-up for those diagnosed in 2015 onwards coincides for the majority of these patients with the timing of the pandemic. 1-year survival, for which only those diagnosed in 2019 would have been exposed to the effects of the pandemic, does not show a consistent pattern of reduced survival. However, other factors may have contributed to the lack of improvement or decline in survival estimates: Death-certificate-only (DCO) cases made up only 0.7% in the last period, 2005-2019, compared to over 2% in the first two periods. This may indicate an improved traceback of death certificate-initiated (DCI) case findings. Because DCI cases are a subset of the cancer population with worse prognosis since they died of their cancer, an increased proportion of DCIs where an earlier diagnosis is found allows for including these in the survival analysis when they previously would have been excluded, and thus might reduce the survival estimate.(8) In addition, The proportion of patients whose survival time was censored within five years or before the closing date was 7.2% for the period 2015-2019, compared to 17.5 and 11.8 % for 2005-2009 and 2010-2014, respectively. This is also reflected in a higher proportion of patients with valid ID numbers that enabled more complete follow-up (76.2%, 85.7%, 91.9% for 2005-2009, 2010-2014, and 2015-2019, respectively). The improvement in follow-up provides more complete ascertainment of deaths which may consequentially result in lower survival estimates. It is also possible that death reporting to the department of civil status has become more timely and complete as stricter regulations including fines for late reporting were implemented since 2015. Electronic death reporting by the physician who has diagnosed the death has also been implemented since 2020, replacing the earlier requirement of patient families to report the death. This is expected to lead to more complete and timely reporting. This alternative explanation might at least partially justify some of the decline in survival as this is seen in the period 2010 -2014 which was not affected by the COVID-19 pandemic.

Five-year net survival estimates were similar to those seen in several countries in Europe and higher-income countries in Asia and the Americas during 2005-2014 for cancers with high survival (e.g. Austria, Türkiye, Taiwan, and Argentina for breast cancer); and to estimates from high-income European countries such as Austria, Belgium and France, as well as Canada and Singapore for cancers with medium survival such as cervical and rectal cancer. But estimates were substantially higher than expected for lymphoid malignancies and for cancers that typically carry a poor prognosis (stomach, pancreas, liver, oesophagus and gallbladder).(7) This may indicate incomplete death ascertainment, either resulting from missing ID numbers or delayed or missed reporting of deaths. Misclassification of a given proportion of dead patients as alive leads to larger overestimation of survival in cancers with poor survival, compared to those with high survival.(9)

Table 3: Age-standardised 5-year net survival (%), with 95% confidence intervals, for the 20 most common cancers in adults.

		Men		Women		Persons	
Cancer	**Period**	**NS**	**95% CI**	**NS**	**95% CI**	**NS**	**95% CI**
Breast	**2005-2009**	74.5	62.3 - 86.8	83.2	81.3 - 85.0	83.0	81.2 - 84.8
	2010-2014	73.9	64.0 - 83.8	84.0	82.6 - 85.4	83.9	82.5 - 85.4
	2015-2019	82.7	75.9 - 89.4	82.1	80.7 - 83.5	82.4	81.0 - 83.7
Lymphoid	**2005-2009**	69.7	67.3 - 72.1	77.8	75.2 - 80.3	74.7	72.8 - 76.5
	2010-2014	71.4	69.2 - 73.6	79.6	77.4 - 81.7	76.8	75.1 - 78.5
	2015-2019	68.7	66.9 - 70.6	78.0	75.8 - 80.3	73.1	71.7 - 74.6
Colon	**2005-2009**	69.5	66.4 - 72.5	73.2	70.3 - 76.2	71.6	69.4 - 73.7
	2010-2014	67.8	65.2 - 70.4	72.5	70.0 - 75.0	71.0	69.1 - 72.8
	2015-2019	63.6	61.5 - 65.7	67.4	65.0 - 69.7	67.1	65.5 - 68.7
Thyroid	**2005-2009**	90.2	84.5 - 95.9	93.4	89.9 - 96.8	93.5	90.4 - 96.5
	2010-2014	84.7	80.4 - 89.0	95.2	92.6 - 97.8	93.3	90.9 - 95.7
	2015-2019	85.4	81.8 - 88.9	95.5	93.2 - 97.8	94.5	92.4 - 96.7
Lung	**2005-2009**	31.1	27.5 - 34.6	46.1	40.6 - 51.6	39.3	36.0 - 42.6
	2010-2014	27.2	24.2 - 30.3	48.1	42.8 - 53.5	34.7	31.9 - 37.5
	2015-2019	26.9	23.8 - 29.9	43.0	38.4 - 47.6	31.7	29.2 - 34.2
Liver	**2005-2009**	32.3	28.1 - 36.4	47.1	41.5 - 52.6	38.2	34.8 - 41.6
	2010-2014	32.2	28.0 - 36.4	47.1	41.7 - 52.4	38.7	35.3 - 42.1
	2015-2019	28.4	24.5 - 32.3	35.0	29.7 - 40.2	37.5	33.9 - 41.1
Uterus	**2005-2009**			86.4	83.0 89.8	86.4	83.0 89.8
	2010-2014			83.7	81.0 86.4	83.7	81.0 86.4
	2015-2019			78.9	76.2 81.5	78.9	76.2 81.5
Myeloid	**2005-2009**	57.2	52.2 - 62.3	74.0	67.9 - 80.0	67.9	63.7 - 72.2
	2010-2014	55.5	51.3 - 59.7	68.7	63.9 - 73.6	66.3	62.4 - 70.1
	2015-2019	60.1	56.2 - 64.0	69.5	64.9 - 74.1	64.7	61.7 - 67.8
Rectum	**2005-2009**	66.0	61.3 - 70.7	67.4	61.7 - 73.2	68.0	64.3 - 71.8
	2010-2014	65.9	61.6 - 70.2	68.3	63.9 - 72.7	70.0	66.7 - 73.2
	2015-2019	55.4	52.1 - 58.8	67.2	62.5 - 72.0	60.6	57.5 - 63.8
Prostate	**2005-2009**	65.9	57.5 - 74.3			65.9	57.5 - 74.3
	2010-2014	89.9	83.8 - 96.0			89.9	83.8 - 96.0
	2015-2019	71.7	64.4 - 79.0			71.7	64.4 - 79.0

		Male		Female		Total	
Cancer	Period	NS	95% CI	NS	95% CI	NS	95% CI
Stomach	**2005-2009**	39.5	35.0 - 44.0	53.0	48.0 - 58.1	47.4	43.9 - 50.9
	2010-2014	36.8	32.7 - 40.9	49.9	45.1 - 54.8	46.8	43.3 - 50.3
	2015-2019	32.4	28.8 - 36.1	38.3	34.1 - 42.5	34.7	31.9 - 37.5
Kidney	**2005-2009**	76.5	72.3 - 80.8	83.0	77.4 - 88.5	80.3	76.7 - 83.9
	2010-2014	76.9	73.0 - 80.7	82.6	78.3 - 86.9	81.2	78.1 - 84.3
	2015-2019	77.8	74.4 - 81.2	81.3	77.0 - 85.7	82.9	79.9 - 85.9
Bladder	**2005-2009**	70.7	66.3 - 75.1	74.4	66.1 - 82.8	71.9	68.0 - 75.9
	2010-2014	72.2	68.4 - 76.0	77.5	70.6 - 84.4	75.4	72.0 - 78.8
	2015-2019	72.6	69.3 - 76.0	71.7	64.5 - 78.8	76.8	73.5 - 80.0
Pancreas	**2005-2009**	30.6	25.5 - 35.6	45.2	38.3 - 52.1	37.3	33.0 - 41.6
	2010-2014	25.0	20.9 - 29.2	37.1	31.5 - 42.7	37.9	33.6 - 42.2
	2015-2019	18.2	14.7 - 21.7	34.8	29.5 - 40.0	25.9	22.7 - 29.1
Ovary	**2005-2009**			67.0	62.7 - 71.3	67.0	62.7 - 71.3
	2010-2014			69.5	65.8 - 73.1	69.5	65.8 - 73.1
	2015-2019			62.3	58.6 - 66.0	62.3	58.6 - 66.0
Brain	**2005-2009**	36.1	31.3 - 40.9	53.8	47.1 - 60.4	43.7	39.6 - 47.8
	2010-2014	34.0	29.8 - 38.2	42.9	37.0 - 48.9	37.7	34.2 - 41.3
	2015-2019	33.9	29.9 - 37.8	41.7	36.8 - 46.6	37.4	34.1 - 40.6
Lip and oral	**2005-2009**	67.7	61.3 74.0	74.5	69.1 80.0	72.2	67.9 76.4
	2010-2014	62.0	56.6 67.4	73.3	68.3 78.2	68.9	65.1 72.6
	2015-2019	55.7	50.9 60.5	64.0	58.7 69.2	62.1	58.3 65.9
Oesophagus	**2005-2009**	40.0	30.9 - 49.0	52.8	45.1 - 60.6	46.6	40.5 - 52.7
	2010-2014	36.3	29.4 - 43.3	40.6	33.4 - 47.9	40.0	34.7 - 45.2
	2015-2019	29.0	22.9 - 35.2	39.1	32.2 - 46.0	36.6	31.6 - 41.5
Cervix	**2005-2009**			68.8	63.3 - 74.3	68.8	63.3 - 74.3
	2010-2014			64.5	59.6 - 69.5	64.5	59.5 - 69.5
	2015-2019			67.6	62.6 - 72.5	67.6	62.6 - 72.5
Gallbladder	**2005-2009**	68.5	46.0 - 91.0	44.4	36.6 - 52.3	43.9	37.0 - 50.9
	2010-2014	27.5	17.5 - 37.5	47.3	38.8 - 55.8	40.5	33.5 - 47.4
	2015-2019	53.8	16.0 - 91.6	32.3	24.4 - 40.1	32.3	25.6 - 39.0

NS: net survival; 95% CI: 95% confidence interval

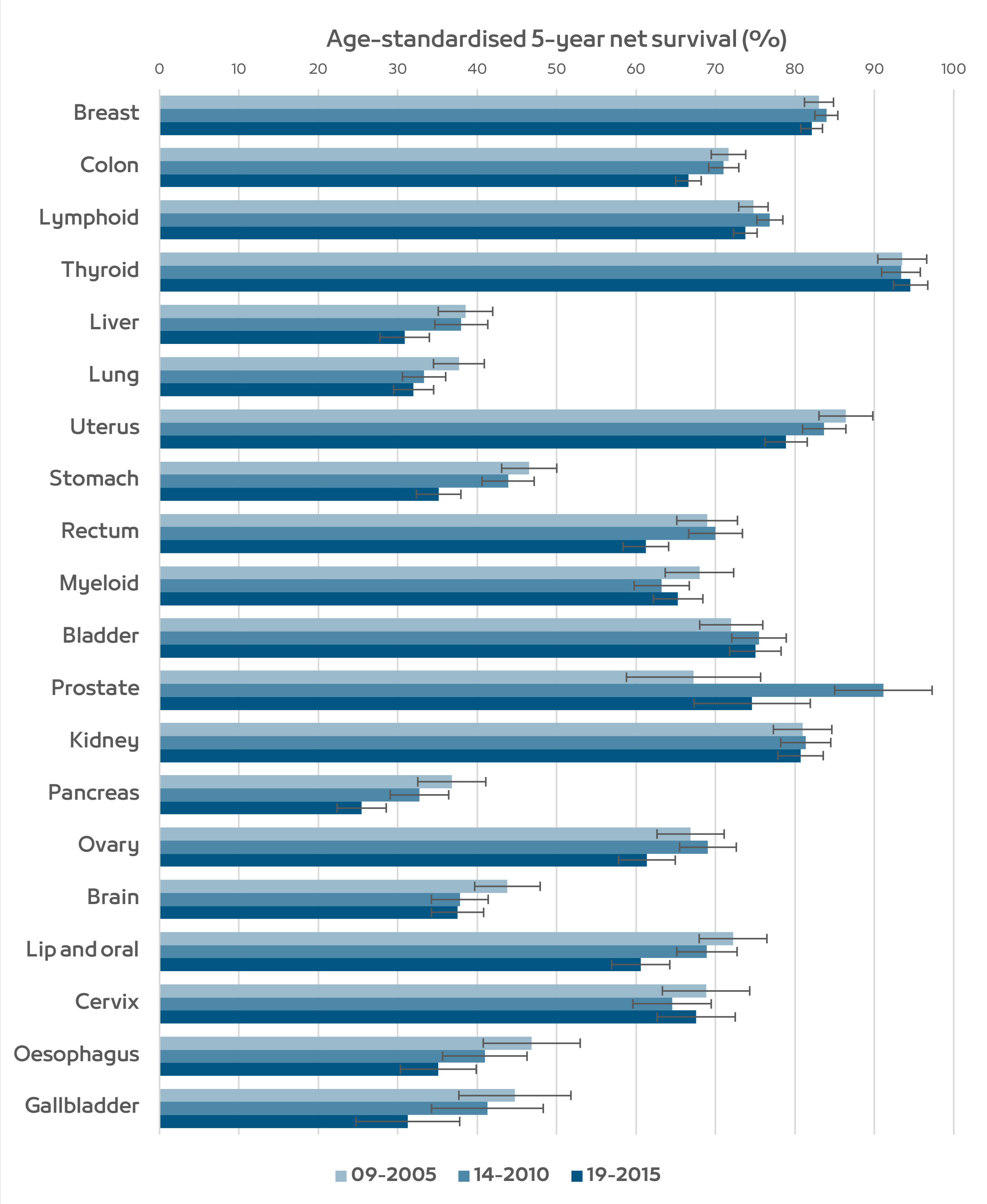

Figure 2: Age-standardised 5-year net survival and 95% confidence intervals for the 20 most common cancers in adults (both sexes).

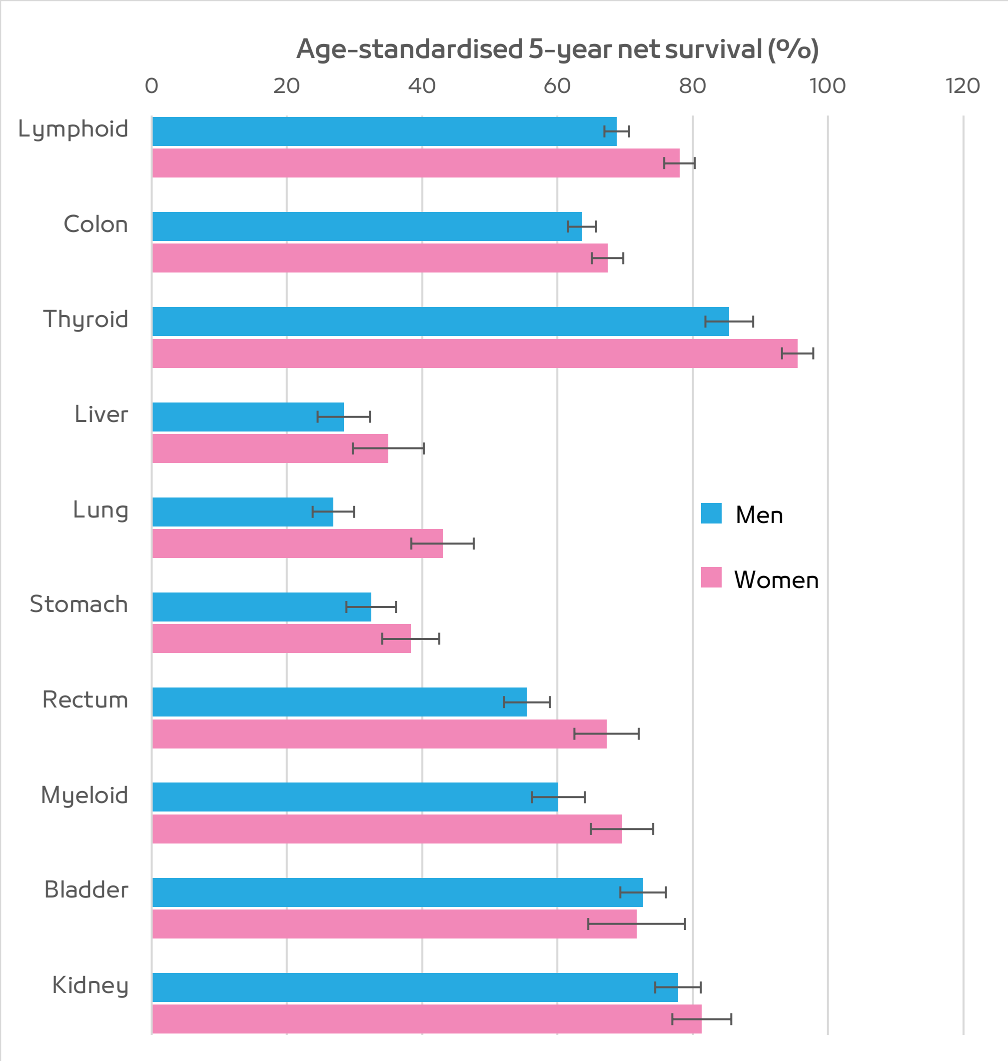

Figure 3: age-standardised 5-year net survival and 95% confidence intervals for the 10 most common cancers diagnosed during 2015-2019 (excluding breast and sex-specific cancers) in women and men.

Women had higher 5-year survival for the most common cancers that occur in both sexes, except for bladder cancer, for which survival is slightly lower among women. Lower survival from bladder cancer has been observed in many settings but may not hold true for long-term survival. (10, 11)

Survival by stage

Similar to survival for all stages combined, stage-specific 5-year net survival mostly shows little change or some decline in the period 2015-2019, despite a trend towards a more favourable stage distribution over the 15 years 2005-2019 (Figure 5). The decline in survival was especially consistent for patients diagnosed at a distant stage (Table 4, Figure 4). This may support the explanation that there has been better finding of cases with the worst prognosis in more recent years, but may also reflect the more immediate impact of the COVID-19 pandemic.

5-year net survival for localised stage is lower than that reported from England for several cancers, while it is higher for distant stage.(12) This again points to under-ascertainment of deaths, which has a higher impact on survival estimates for subgroups with poor outcomes. However, the case mix of those with unknown stage may include some of those with the worst and best survival, who were more likely to have died before staging or been treated without the need for staging, respectively. This may also lead to lower survival in individuals with localised stage and higher survival in those with distant stage. The reduction in the proportion of patients with unknown stage over time may change the case mix for each stage and lead to more accurate stage-specific estimates (Figure 5).

Table 4: Age-standardised 5-year net survival (%), with 95% confidence intervals, by stage at diagnosis for the 10 most common cancers in adults.

	Stage												
Calendar period		Localized			Regional			Distant			Unknown		
	Period	N	NS	95% CI	N	NS	95% CI	N	NS	95% CI	N	NS	95% CI
Breast	2005-2009	9,866	94.8	92.2 - 97.3	8,948	86.8	84.3 - 89.3	10,592	54.9	49.4 - 60.5	5,064	79.8	73.8 - 85.8
	2010-2014	15,285	93.5	92.2 - 95.6	11,578	87.1	84.8 - 89.4	14,435	56.9	52.9 - 60.8	4,570	86.1	81.6 - 90.6
	2015-2019	23,549	91.1	91.4 - 92.9	13,772	83.7	81.4 - 86.1	16,801	46.4	43 - 49.7	3,223	77.4	71.8 - 83.1
Colon	2005-2009	852	86.9	78 - 90.7	828	80.1	77 - 83.3	2,805	45.2	41.2 - 49.1	884	64.9	56.6 - 73.2
	2010-2014	1,385	87.5	83 - 90.5	847	81.2	78.4 - 84.1	3,598	40.1	36.9 - 43.4	674	71.4	64.5 - 78.4
	2015-2019	2,149	81.2	84.4 - 83.9	924	78.8	76.3 - 81.3	4,024	33.2	30.5 - 35.9	461	73.6	66.3 - 81
Thyroid	2005-2009	729	99.3	78.5 - 100	828	93.7	88.5 - 98.9	901	71.9	64.1 - 79.6	285	92.2	84.7 - 99.8
	2010-2014	1,201	98.8	95.9 - 100	847	92	87.8 - 96.2	1,372	69.4	61.4 - 77.4	355	90.8	84.8 - 96.8
	2015-2019	1,813	99.2	95.6 - 100	924	92.4	88.4 - 96.3	1,784	62.3	55.7 - 69	317	91	83.5 - 98.5
Lung	2005-2009	1,478	56.9	96.7 - 67.8	854	36.5	29.3 - 43.6	209	28.1	24.6 - 31.7	390	41.1	32.8 - 49.4
	2010-2014	2,420	61.4	45.9 - 67.9	1,143	41.7	34.1 - 49.4	229	23.7	20.7 - 26.6	486	40.4	30.9 - 50
	2015-2019	3,596	55.8	54.9 - 61.6	1,445	43.3	36.3 - 50.4	220	22.3	19.5 - 25.2	312	34.6	24.6 - 44.6
Liver	2005-2009	189	44.5	50.0 50.4	245	29.3	21.7 36.9	1,002	34.8	27.9 41.7	314	36.4	29.6 43.2
	2010-2014	293	52.9	38.5 58	261	28.9	21.5 36.2	1,382	22.3	17.9 26.8	226	28.5	21.6 35.5
	2015-2019	435	44.2	47.8 49.8	306	20.2	15.6 24.8	1,475	15.4	11.1 19.7	111	32.2	23.9 40.6

N: number of records analysed; NS: net survival; 95% CI: 95% confidence interval

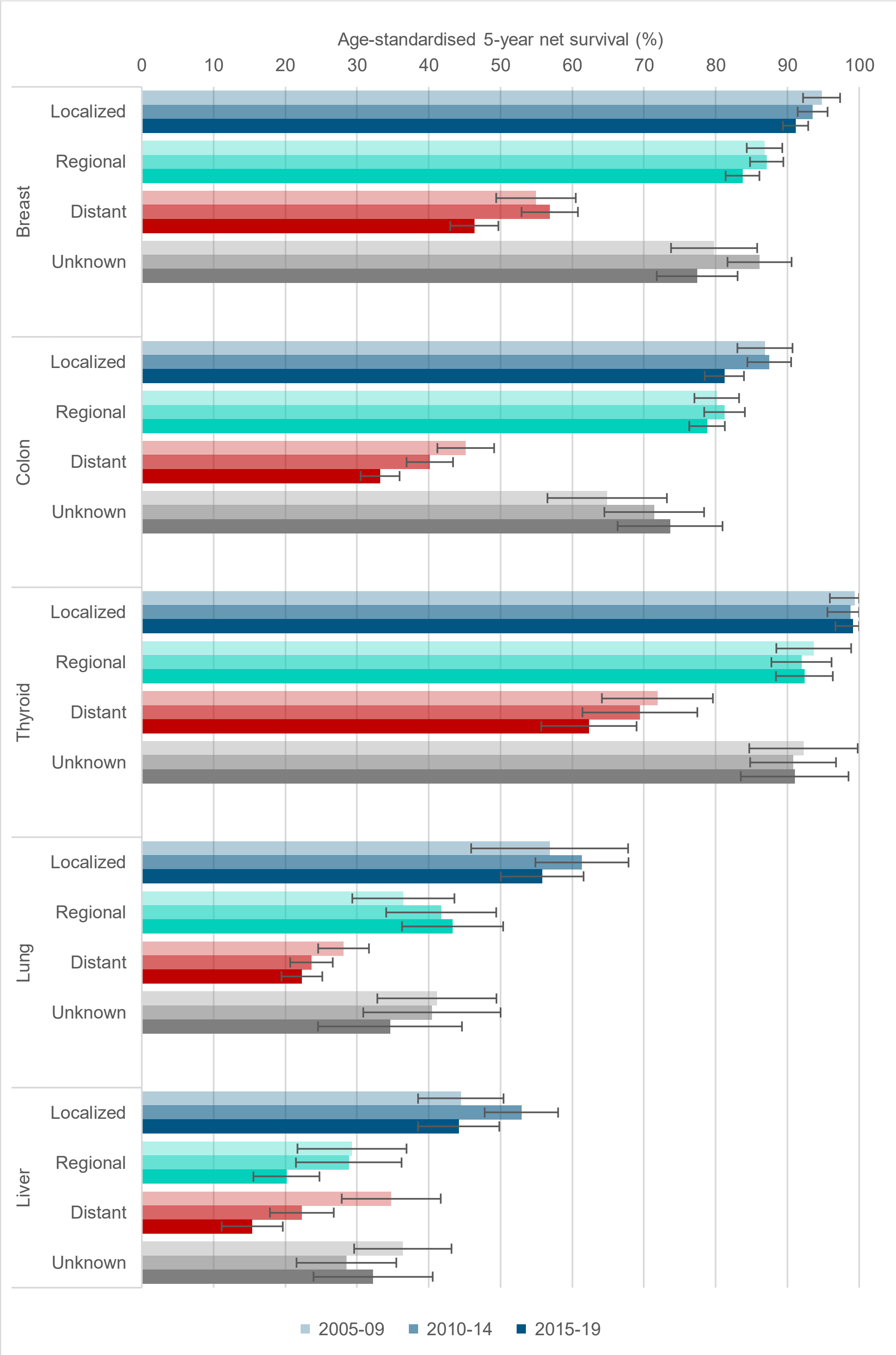

Figure 4: Age-standardised 5-year net survival and 95% confidence intervals by stage at diagnosis for the 10 most common cancers diagnosed during 2005-2019 (all sexes)

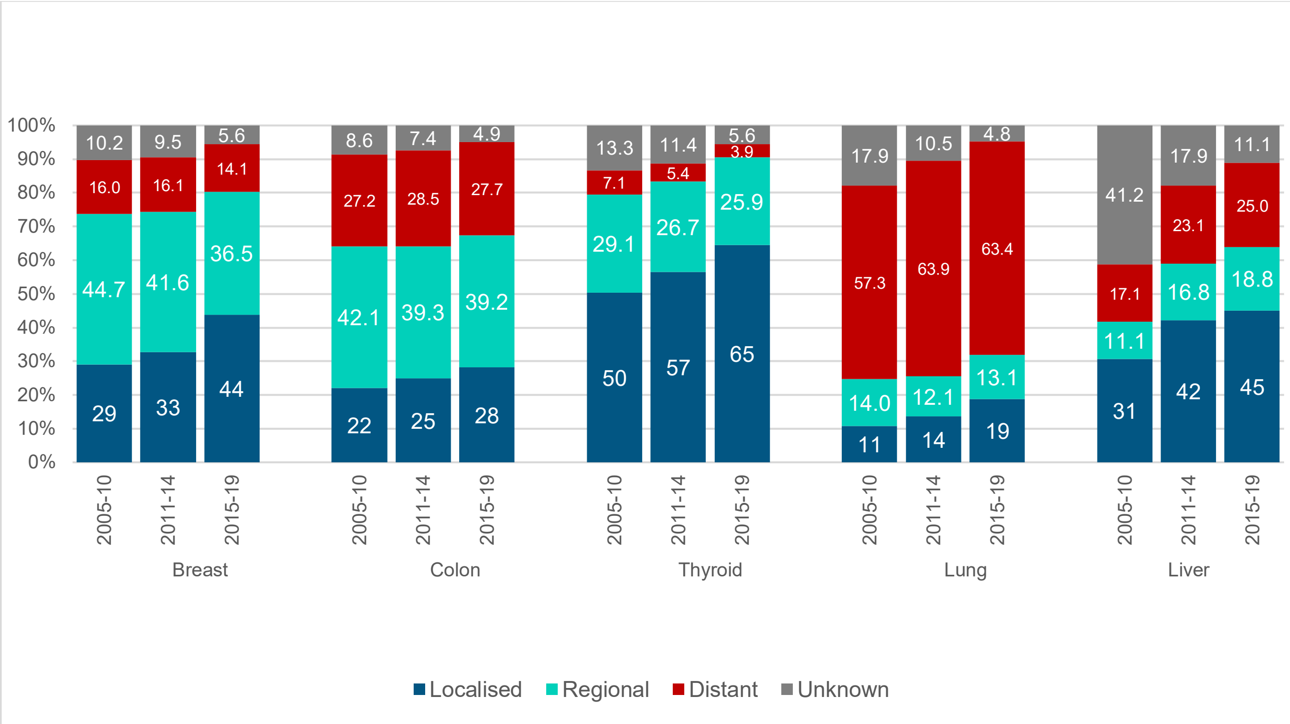

Figure 5: Stage distribution for the 10 most common cancers (columns from left to right: 2005-10, 2011-2014, 2015-2019).

Conclusion

Monitoring of population-based cancer survival over time will enable the assessment of the impact of changes in healthcare policy and in the management of cancer in a "real world" settings. It will also help to identify priorities for cancer control, such as improving early diagnosis, reducing time to treatment, and improving the completion of treatment. Together with trends in incidence and mortality, assessing the burden of cancer will impact policies that could ultimately lead to better outcomes for cancer patients in Saudi Arabia. Further efforts are also warranted to improve the completeness and quality of cancer registration, and the completeness and accuracy of reporting all death in the Kingdom. To reduce delays in reporting cancer survival, it will be necessary to enable continues linkage between records of cancer patients in the Saudi Cancer Registry and the deaths of all registered cancer patients.

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