Government of **Western Australia**
Department of **Health**

The Cancer Effect

An "Exploring Cancer" Series
Western Australia

All Cancers Survival 2010–2014

No: 2017/01

Western Australia Cancer Registry
WA Department of Health

Recent releases

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2017/02 Breast Cancer Survival 2010-2014
2017/03 Colorectal Cancer Survival 2010-2014
2017/04 Prostate Cancer Survival 2010-2014
2017/05 Melanoma Cancer Survival 2010-2014
2017/06 Lymphoma Cancer Survival 2010-2014
2017/07 Lung cancer Survival 2010-2014

WA Cancer Registry

The WA Cancer Registry is part of the Department of Health (WA). The Registry records all cancer notifications (i.e. cancer diagnoses) for WA residents. The notification (reporting) of cancers, by pathologists and radiation oncologists (amongst others), to the Department of Health has been a legal requirement under the *Health Act* since 1981.

Abbreviations

ABS Australian Bureau of Statistics

Acknowledgements

The Epidemiology Branch of the Department of Health WA designed the analysis tools used in this relative survival analysis study as well as conducting the analysis process. The Epidemiology Branch also provided the WA Cancer Registry with feedback on the report.

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Contents

Tables

Figures

1.0 Introduction

The Cancer Effect: An Exploring Cancer Series documents key cancer facts, beginning with this first publication that reviews five-year relative survival outcomes, and changes in relative survival over time, in Western Australia.

Information on relative survival from cancer provides an indication of cancer prognosis and the effectiveness of treatments available. A range of factors influence survival from cancer, including the demographic characteristics of the patient (e.g. age, sex and genetics), the nature of the tumour (e.g. site, stage at diagnosis and histology type) and the health care system (e.g. the availability of health-care services, screening, diagnostic and treatment facilities, and follow-up services) [1].

Section 2 provides information about how relative survival is determined. This information will only be presented in this release for all cancers, subsequent relative survival statistics for specific cancers will refer to this information (i.e. it will not be reproduced in every release).

This release provides broad indications of relative survival across all cancers in Section 3. Subsequent releases will provide specific information for specific cancers (e.g. breast, prostate, etc.).

2.0 Understanding how relative survival statistics are determined

There are several methods for calculating and presenting relative survival. This publication presents a technique recommended by the WA Epidemiology Branch and this section of the report details how the relative survival is determined.

2.1 What is 'relative survival'?

Relative survival is generally considered to be a robust statistic for reviewing the likely effect of cancer over a period of time, typically five years, after the original diagnosis is made.

Relative survival refers to the probability of ***being alive for a given amount of time*** after diagnosis compared with the general population [1].

2.2 Why is it different from general cancer mortality information?

The conventional cancer mortality statistic (not reported in this publication) refers only to the actual number or rate of deaths caused by different cancer types over a given period of time. These mortality statistics are usually presented along with incidence statistics for each distinct cancer type.

2.3 How is relative survival calculated?

Relative survival is the standard approach used by population-based cancer registries to produce population-level relative survival statistics as it does not require information on cause of death.

Two information sources are used to estimate relative survival (see also 2.5 Sources of data):

- observed survival— the proportion of people alive for a given amount of time after a diagnosis of cancer; it is calculated from population-based cancer data [1].

  Note: If a person has more than one primary tumour then there will be more than one count for both incidence and death as appropriate.

- expected survival— the proportion of people in the general population alive for a given amount of time [2]. These are derived from life-tables for the Western Australian general population which includes deaths from all causes, including cancer.

Relative survival is calculated by dividing observed survival by the expected survival for the general population. All survival estimates in this study are relative survival estimates.

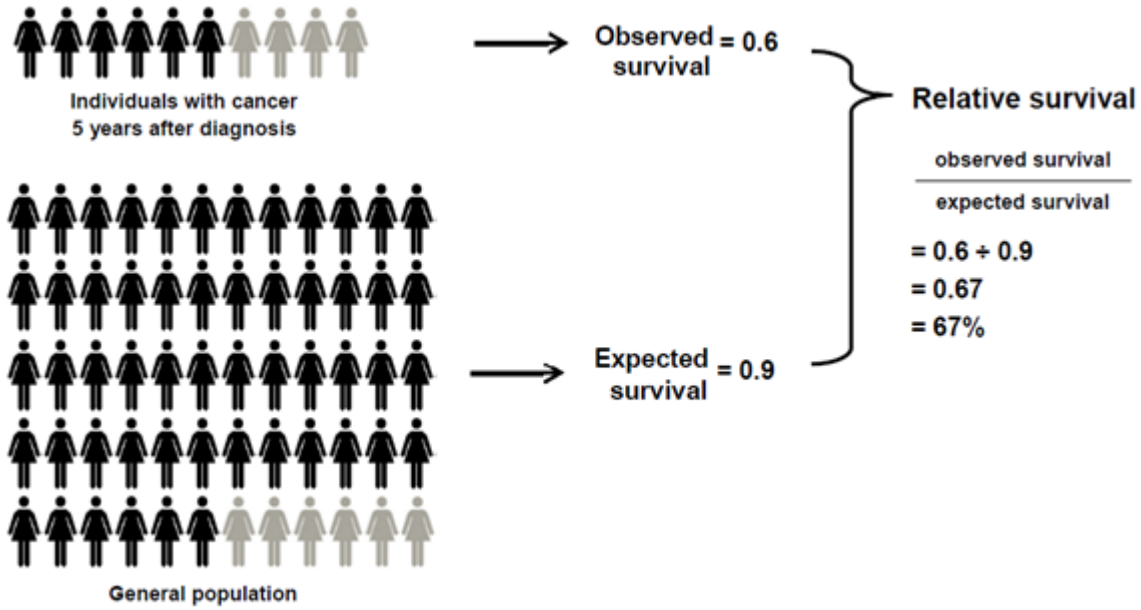
2.4 Understanding the relative survival outcome percentages

Results are presented as a per cent relative survival.

For example, if the observed five-year survival of a particular cohort of persons diagnosed with cancer was 0.60 (i.e. 60 per cent of them remain alive five years after diagnosis) and their expected survival, based on West Australian life-tables, was 0.9 (i.e. 90 per cent of West Australians with the same age and sex as the cohort would be expected to be alive five years later) then the five-year relative survival for that particular cohort of persons would be 0.6/0.9 = 0.67.

This can then be interpreted to mean that each person in the particular cancer cohort has a 67 per cent chance of being alive five years after diagnosis. A visual example of how relative survival is interpreted using the above values of observed and expected survival is provided in Figure 1.

Figure 1 Simplified example of how relative survival is calculated and interpreted



Source: [2, p6]

2.5 Advantage of using this method

The main advantage of calculating relative survival this way is that both ***cohort-based*** estimates as well as ***period estimates*** of patient survival can be obtained.

- Cohort—a group of persons who share a defining characteristic (e.g. cancer diagnosis) and following these persons over time.
- Period—focuses on the survival experience of a group of persons in a recent time period.

While period analysis is thought to provide more accurate predictions of newly diagnosed patients, recent relative survival analysis conducted by the Australian Institute of Health and Welfare (AIHW) for the period 2006-2010 showed that results from period analysis and cohort analysis were very similar [2].

Relative survival estimates for cancer have traditionally been calculated using the cohort method, and to facilitate comparisons with other reports this is the primary method used for this analysis [3, 4].

The cohort method focuses on a group of people diagnosed with cancer within a designated 5-year time period, and follows these people over five years. The group of people diagnosed with cancer are grouped according to age and sex. The cohort method as described by Paul Dickman [5, 6], a well-established and widely used method for relative survival analysis, was used for this analysis (see 2.9 for a summary of the Dickman method).

2.6 Data Sources used for this report

Observed survival—individual-level cancer data

First primary incident cancers diagnosed in persons residing in WA for the thirty years between 1 January 1985 and 31 December 2014 (divided into six five-year periods) were selected from the WA Cancer Registry. Data extracted on participants included: cancer type and behaviour; and date of birth, diagnosis and death (if applicable). Persons with more than one tumour type had a separate record for each primary cancer.

Deaths for all persons in the cohort described above were also recorded up to 31 December 2015 using information recorded by the WA Cancer Registry. The WA Cancer Registry records deaths of persons diagnosed with cancer from two sources. The WA Registrar General's Death Notifications for WA residents who have died in WA and the National Death Index (NDI) which provides information about persons who were diagnosed with cancer while resident in WA but who have died in another Australian state or territory.

Exclusions

Several criteria were used to determine the eligibility of each cancer case for inclusion in the relative survival analysis, based on criteria used by other reports, in particular those of the AIHW [2].

The following were excluded from the analysis:

- Patients for whom the tumour record was based only on a death notification, for which no independent confirmation could be obtained.
- Any person's cancer notification that had missing or 'questionable' date information, for example, missing date of birth, generic dates (e.g. 01/01/1900) or persons of excessive recorded age (e.g. 115 years old).

Expected survival—expected probabilities of death for a comparable general population

Lifetable estimates for the Western Australian population, by one year age groups (up to age 100), sex and year (up to 2014), were sourced from the Australian Bureau of Statistics (ABS) [7].

Yearly lifetable estimates by Indigenous status are not available and so analysis was limited to the whole Western Australian population.

Survival probabilities for the year 2015 were not available from the ABS so linear regression was used on the previous 23 years of data to extrapolate estimates for 2015. These extrapolated values were compared to 2014 values, with only very small differences noted (the largest difference was 0.0377years). For years prior to 2003, data were extrapolated to calculate ages 100+ using linear regression based on values from ages 90-99.

2.7 How the analysis was done

The method used for the analysis is the Dickman method—see section 2.8 for more information.

To investigate changes in relative survival over time, six cohorts of interest were identified within the full set of data available. The cohorts were defined as patients diagnosed with cancer between: 1985-1989; 1990-1994; 1995-1999; 2000-2004; 2005-2009 and 2010-2014 with five-year ***follow-up*** or until death or the 31 December 2015.

- Follow-up—a further examination or observations of a patient in order to either monitor the condition or the success of earlier treatment(s). For relative survival it is about determining whether the patient is alive or dead within the specified time period from diagnosis (i.e. up to five years).

Each cohort was grouped by age and sex according to the type of analysis performed. Age groups were categorised as follows: 0-14 years; 15-39 years; 40-64 years and 65+ years.

This release provides a summary across all cancers. Subsequent releases will relate to specific cancers (e.g. breast, prostate, etc.).

The years of diagnosis and follow-up are illustrated in Table 1 for five-year relative survival based on the years of data available at the time of analysis. The entries in the table cells indicate the number of years of follow-up for a person with a given combination of diagnosis and follow-up calendar years. For example, a person diagnosed with cancer in 1989 and followed up in 1989 would be undergoing their first year of follow-up, while a person diagnosed with cancer in 1989 and followed up in 1990 would be undergoing their first or second year of follow-up during this time; dependent upon which part of the year the diagnosis and follow-up took place.

Table 1 Diagram to illustrate follow-up time for each cohort by year of diagnosis

Year of diagnosis	Years after diagnosis									
1985-1989	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1985	1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9	9/10
1986		1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
1987			1	1/2	2/3	3/4	4/5	5/6	6/7	7/8
1988				1	1/2	2/3	3/4	4/5	5/6	6/7
1989					1	1/2	2/3	3/4	4/5	5/6
1990-1994	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
1990	1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9	9/10
1991		1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
1992			1	1/2	2/3	3/4	4/5	5/6	6/7	7/8
1993				1	1/2	2/3	3/4	4/5	5/6	6/7
1994					1	1/2	2/3	3/4	4/5	5/6
1995-1999	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1995	1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9	9/10
1996		1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
1997			1	1/2	2/3	3/4	4/5	5/6	6/7	7/8
1998				1	1/2	2/3	3/4	4/5	5/6	6/7
1999					1	1/2	2/3	3/4	4/5	5/6
2000-2004	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
2000	1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9	9/10
2001		1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
2002			1	1/2	2/3	3/4	4/5	5/6	6/7	7/8
2003				1	1/2	2/3	3/4	4/5	5/6	6/7
2004					1	1/2	2/3	3/4	4/5	5/6
2005-2009	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
2005	1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9	9/10
2006		1	1/2	2/3	3/4	4/5	5/6	6/7	7/8	8/9
2007			1	1/2	2/3	3/4	4/5	5/6	6/7	7/8
2008				1	1/2	2/3	3/4	4/5	5/6	6/7
2009					1	1/2	2/3	3/4	4/5	5/6
2010-2014	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	*2016*	*2017*	*2018*	*2019*
2010	1	1/2	2/3	3/4	4/5	5/6				
2011		1	1/2	2/3	3/4	4/5				
2012			1	1/2	2/3	3/4				
2013				1	1/2	2/3				
2014					1	1/2				

In the case of the most recent five-year cohort period of 2010-2014, there is only follow-up to the 31 December 2015. The Dickman method (see section 2.8) takes limited follow-up into account as individuals only contribute to those lifetable intervals where they are at risk. For example, where a person is diagnosed with cancer in 2014 and survives until the end of follow-up (i.e. 31 December 2015), that person will contribute to just the first two intervals. They would be ***censored*** during the second interval. Alternatively, a person diagnosed in 2014 who dies in February 2015 will contribute to just the first interval (as they have died).

- Censored/censoring—be excluded from consideration in determining relative survival rates.

The individual-level and lifetable estimate data were matched for sex, age and calendar year to produce sex, age and cohort specific relative survival estimates. Survival time was calculated using the date of diagnosis and date of death or the 31 December 2015.

It is important to note that as persons with more than one primary tumour have a record for each primary cancer, they may appear in more than one analysis.

The practical implication of this is that a person with more than one tumour type may be included in several analyses. While a person's relative survival may clearly be influenced by one or more tumour types, or two tumours of similar type, the adjustment of the analyses to account for this is beyond the scope of this report [8].

2.8 The Dickman method of determining relative survival

The Dickman method was used throughout the analysis to estimate and model the relative survival of persons diagnosed with cancer. Below is a summary of the steps involved in the Dickman method. For a more detailed explanation see [5, 6]:

- Split the observation time for each individual cancer case into multiple observations; one for each interval of follow-up time.
- Match expected probabilities of surviving each interval to the corresponding observation interval per case.
- For each observation, create indicator variables for death and censoring.
- Create lifetables for each desired combination of covariates by collapsing over relevant records. For example, all observations that refer to the first interval of follow up for a class of patients are collapsed into a single observation. The number of observations collapsed to form this single observation is equal to the number first at risk in the interval. Summing the death and censoring indicator variables gives the total number of deaths and censorings occurring during the interval. The average of the subject-specific expected survival probabilities gives the Ederer II estimate of expected survival for the interval.
- Calculate interval-specific and cumulative observed and expected relative survival with corresponding confidence intervals, for each lifetable interval [5].

2.9 References

1. Australian Institute of Health and Welfare, *Cancer in Australia 2017*. 2017: Cancer Series no. 101. Cat. no. CAN 100. Canberra: AIHW.
2. Australian Institute of Health and Welfare, *Cancer survival and prevalence in Australia: period estimates from 1982 to 2010*. 2012: Cancer series no. 69. Cat. no. CAN 65. Canberra: AIHW.
3. Australian Institute of Health and Welfare and Australasian Association of Cancer Registries, *Cancer in Australia: an overview, 2010. Cancer series no. 60. Cat. no. CAN 56*. 2010, Australian Institute of Health and Welfare: Canberra.
4. AIHW, CA, and AACR, *Cancer survival and prevalence in Australia: cancers diagnosed from 1982 to 2004*. 2008: Cancer Series no. 42 Cat. no. CAN 38. Canberra: AIHW.
5. Dickman, P. *Estimating and modelling relative survival using SAS*. 2004.
6. Dickman, P., et al., *Regression models for relative survival.* Statistics in Medicine, 2004. **23**: p. 51-64.
7. Australian Bureau of Statistics, *Life tables, States, Territories and Australia 2012-2014*. 2015: Cat. 3302.0.55.001, 12 November 2015.
8. Threlfall TJ, Brameld K. Cancer survival in Western Australian residents, 1982-1997. Health Department of Western Australia, Perth, 2000. Statistical series number 60.

3.0 Relative Survival after diagnosis—All cancers

3.1 Relative survival and number of cancer notifications

Figure 2 The relationship between relative survival and number of cancer notifications (2010-2014)

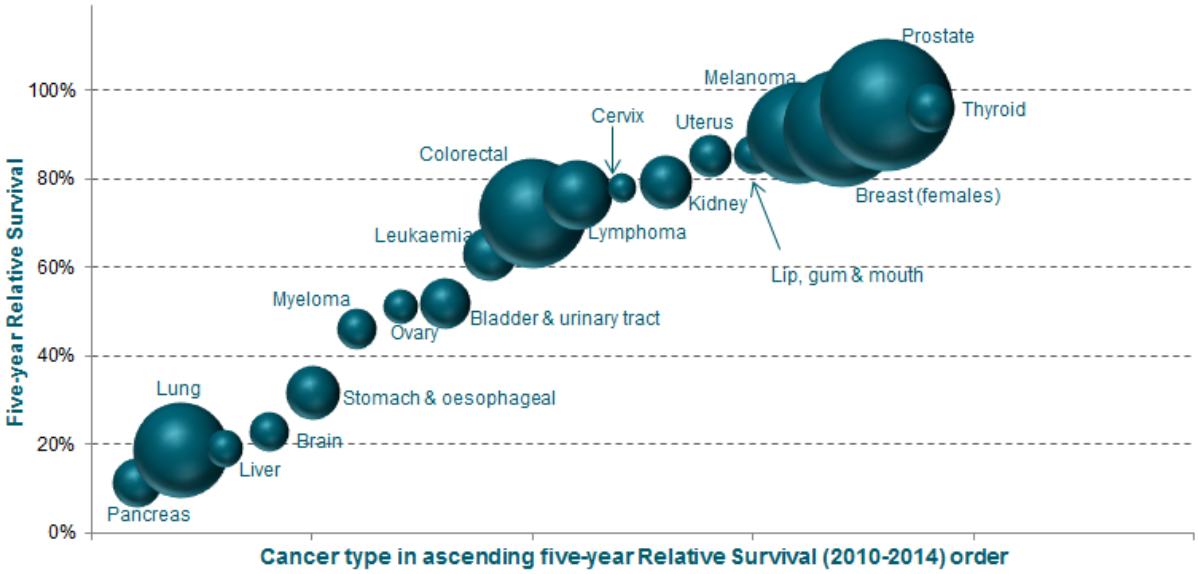


Figure 2 shows the relationship between five year relative survival and the incidence of cancer diagnoses over the period from 2010 to 2014 (for males and females combined).

Interpreting Figure 2:

- the height of the “bubble”, as measured on the vertical axis, is an indication of relative survival rate (i.e. the higher the “bubble” the greater the relative survival rate).
- the size (diameter) of the “bubble” is an indication of incidence (i.e. the larger the “bubble” the more cancer notifications identified—incidence).

Of the more common cancers:

- prostate and breast cancers have a comparatively high relative survival rate.
- whereas lung cancer has a low relative survival rate.

For less common cancers:

- pancreatic and liver cancers have a low relative survival rate.
- whereas thyroid cancer has a high relative survival rate.

Some information about the determinants of relative survival for specific cancers will be included in the cancer specific releases.

As with all statistics, these relative survival percentages require careful interpretation.

For example, all cancers can be '***staged***' at the time of diagnosis. Although this has not been done for this analysis as the information is not available, it would be expected that each sub-group of similarly staged cancers would have their own relative survival percentage. Other survival reports typically show ***significant differences*** between Stage 3 and 4 tumours, compared to those with a Stage 1 or Stage 2 diagnosis. Hence, while the cancer type relative survival totals for the most common groups are accurate, they will not be correct for those individuals diagnosed with more aggressive pathology.

- Staging—is a measure of the clinical progression of a diagnosed cancer that reflects the attributes of that cancer in terms of size, lymph mode involvement and metastasis.

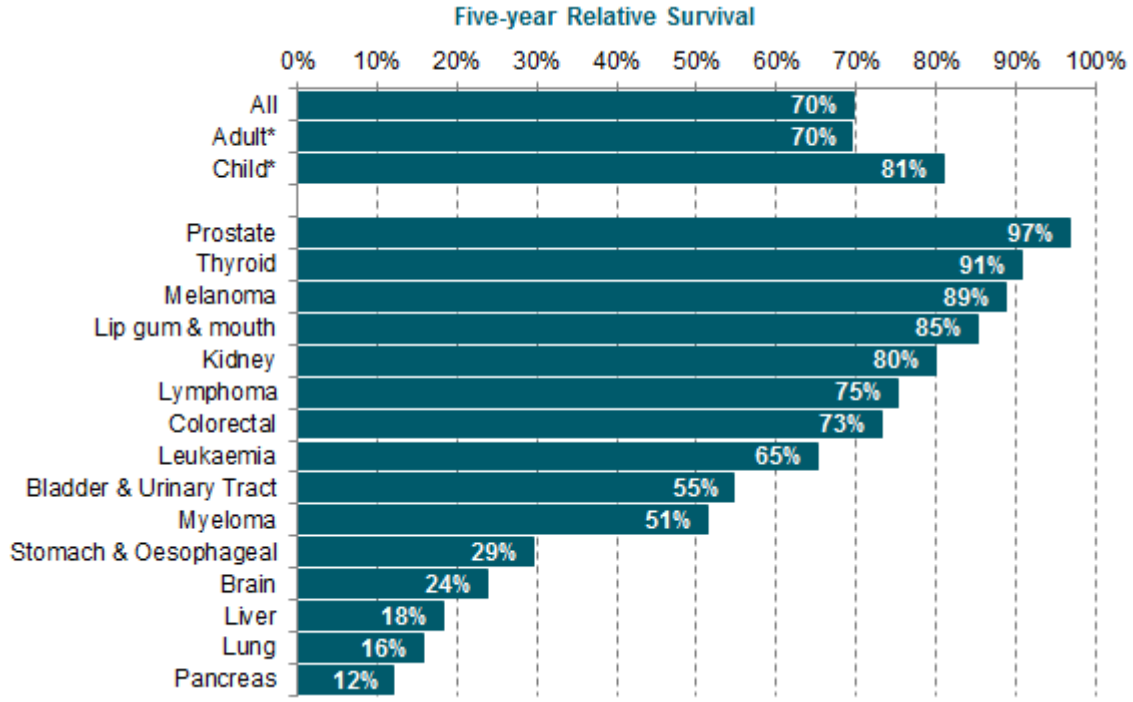
The WA Cancer Registry is currently working on a national collaborative project with Cancer Australia to retrospectively stage five different cancer types for 2011 cancer notifications. Once this project is completed it will be possible to calculate relative survival for the key sub-groups by stage.

3.2 Relative survival by type of cancer and gender

This section contains information about relative survival analysed by type of cancer and gender.

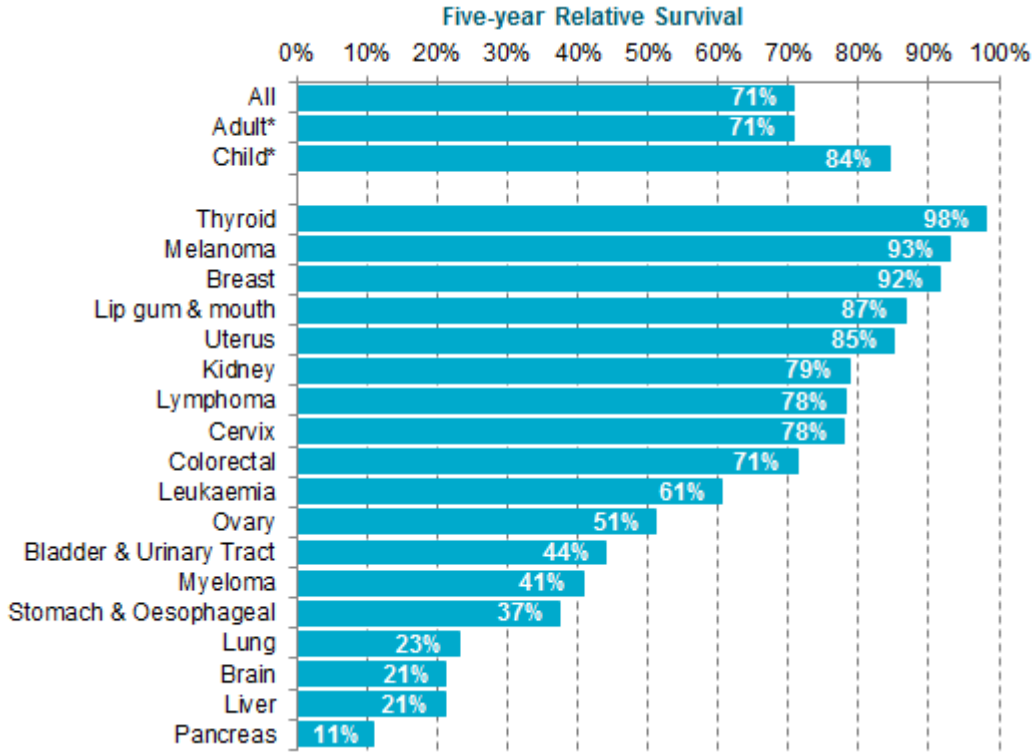
Figures 3A and 3B (Male and Female respectively) show gender specific information similar to that contained in the Bubble Diagram (Figure 2).

Figure 3A Most recent five-year relative survival (2010-2014) for most common cancer types, Male, WA



* Child = 0-14 years; Adult = 15+ years

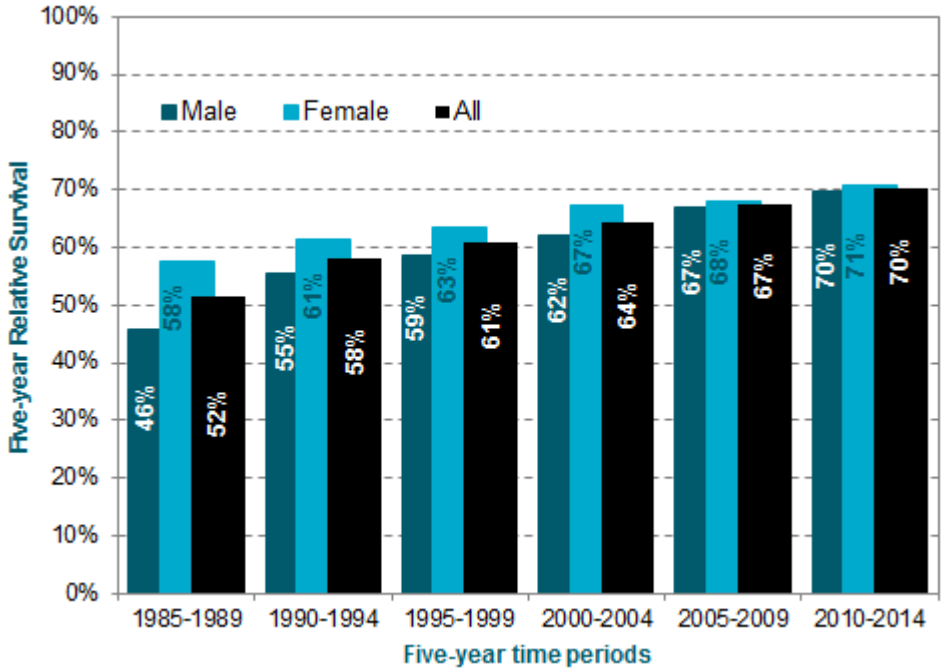
Figure 3B Most recent five-year relative survival (2010-2014) for most common cancer types, Female, WA



* Child = 0-14 years; Adult = 15+ years

3.3 Trends in relative survival

Figure 4 Trends in relative survival for all cancers, five-year relative survival for each of the five-year time periods from 1985-1989 to 2010-2014; Male, Female, All; WA



The change in relative survival from cancer over time is of significant interest.

Figure 4 shows that there has been an overall increase in relative survival for all Western Australian cancers from 52 per cent between 1985-1989 compared to 70 per cent in the most recent period 2010-2014. This nearly 20 per cent increase in in the relative survival rate over the six five-year periods is largely attributable to:

- earlier detection of cancer via national screening programs (e.g. breast, colorectal) [1].
- greater education about and awareness of possible cancer–related signs and symptoms.
- advances in medical treatments.

It is also relevant to note that the difference in relative survival percentages between males and females has also decreased (12 per cent in 1985-1989 compared to 1 per cent in 2010-2014).

3.4 Number of primary tumours identified and number of deaths from any cause by age group

Another method of reviewing relative survival is by age group. The four age groups profiled in Table 2 show different percentages between Males and Females for people diagnosed with cancer between 2010 and 2014.

Table 2 Number of primary tumours identified, number of deaths from any cause and relative survival, All cancers by age group, 2010-2014; Male and Female, WA

	Primary tumours	Deaths	Relative Survival
Male			
Total	**33,743**	**11,071**	**70%**
Adult*	33,515	11,037	70%
Child*	228	34	81%
0-14	228	34	81%
15-39	1,357	157	87%
40-64	12,704	2,665	78%
65+	19,454	8,215	62%
Female			
Total	**25,997**	**7,629**	**71%**
Adult*	25,821	7,605	71%
Child*	176	24	84%
0-14	176	24	84%
15-39	1,839	144	90%
40-64	11,107	1,848	81%
65+	12,875	5,613	58%

* Child = 0-14 years; Adult = 15+ years

Reviewing the proportions presented in Table 2, the commonly reported comment that younger people diagnosed with cancer in the first three age groups (0-14, 15-39 and 40-64) tend to survive better when compared to older people (65+) is supported.

Females tend to have a slightly better relative survival than males in the younger age groups, and this outcome may be related to the more recent changes in gender-specific high incidence cancer types such as in breast cancer.

When comparing the reduced relative survival outcomes for males and females in the 65+ age group, males have better five year relative survival than females (62 per cent compared to 58 per cent). This result is a statistically significant difference.

Figure 5 Relative Survival by years after diagnosis by age groups, 2010-2014, All cancers, Comparing Male and Female, WA

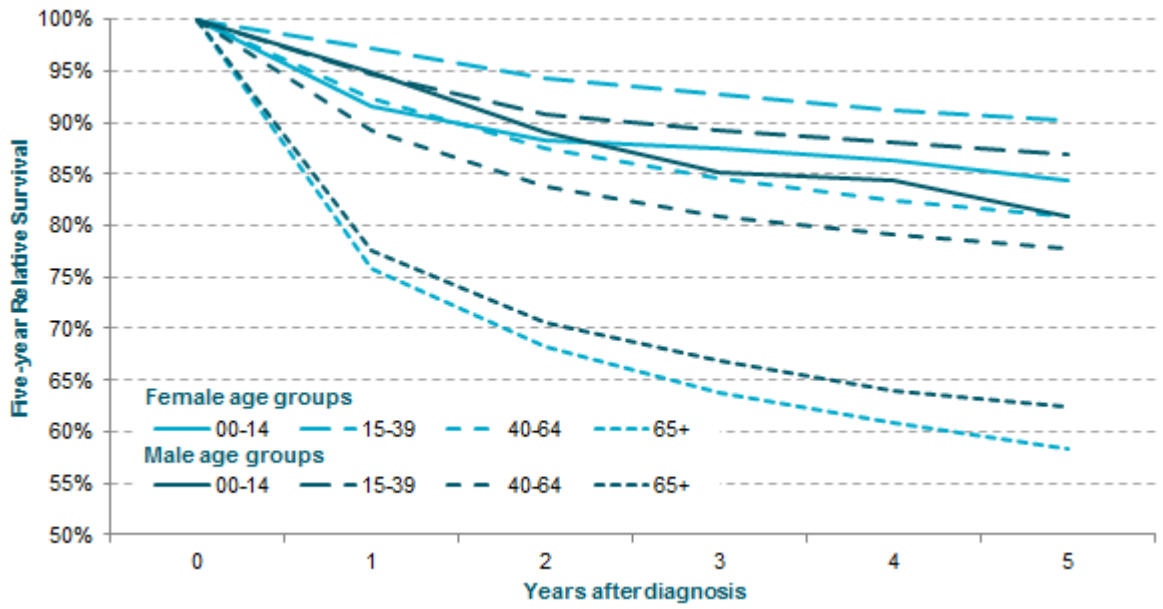


Figure 5 is a useful graphical comparison of this gender difference between both younger age groups relative survival (0-14, 15-39 and 40-64) compared to the 65+ groups.

3.5 Relative Survival by years after diagnosis

Continuing on from the original comparisons of improvement in relative survival shown in Figure 4, another way to review this information is by separating the gender changes over the six groups of five year relative survival measures.

Figure 6 Relative Survival by years after diagnosis by selected five-year time periods, All cancers, Comparing Male and Female, WA

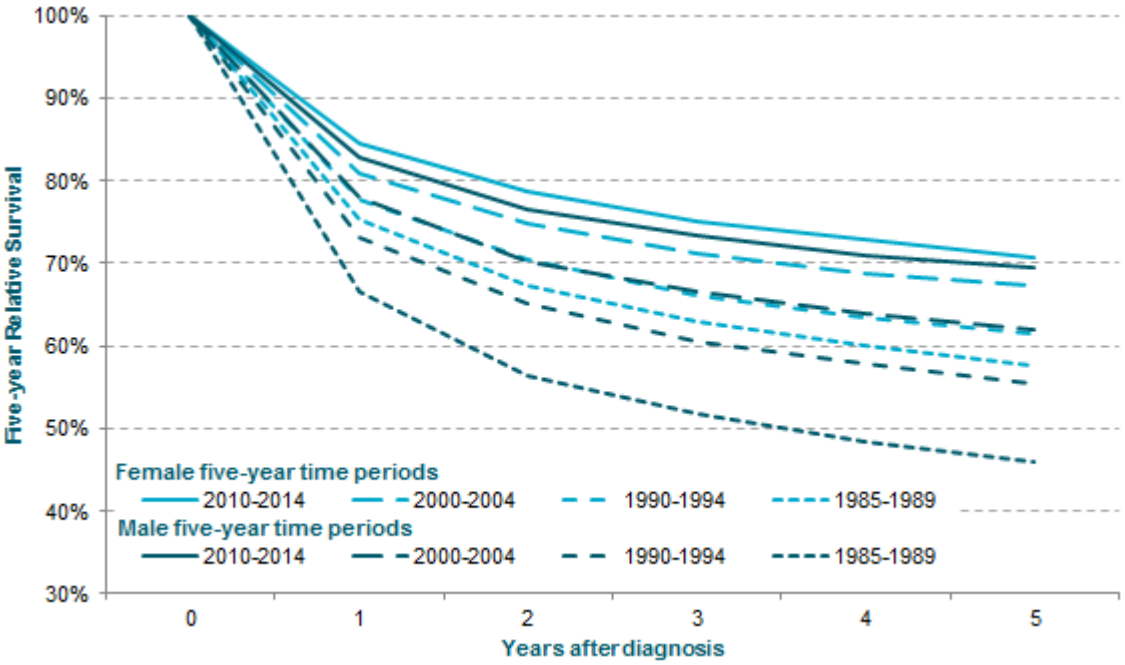


Figure 6 shows that male relative survival has significantly improved over the last two and a half decades (24%) compared to females (13%). Care should be taken in understanding this result as specific incidence of cancer types involved and patient age greatly influence this population-wide outcome.

Importantly, the current relative survival is now similar for both males and females.

This document can be made available in alternative formats on request for a person with disability.

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