Breast cancer survival in Australian women 1982–1994

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The Australasian Association of Cancer Registries (AACR) is a collaborative body representing State and Territory cancer registries in Australia and New Zealand. Most are members of the International Association of Cancer Registries (IACR). The AACR was formed in November 1982, with the backing of the IACR, to provide a formal mechanism for promoting uniformity of collection, classification and collation of cancer data.

The purposes of the AACR are:

- to provide a continuing framework for the development of population-based cancer registration in Australia and New Zealand;
- to facilitate exchange of scientific and technical information between cancer registries and to promote standardisation in the collection and classification of cancer data;
- to facilitate cancer research both nationally and internationally; and
- to facilitate the dissemination of cancer information.

The Australian Institute of Health and Welfare has joined with the AACR to produce national cancer statistics through the establishment of the National Cancer Statistics Clearing House.

The National Breast Cancer Centre (NBCC) works in partnership with women, health professionals, cancer organisations, researchers and governments to improve breast cancer outcomes for women. It was established to improve breast cancer control by:

- analysing research and making it readily available to women and health professionals;
- developing, disseminating and encouraging the adoption of clinical guidelines to improve the diagnosis, treatment and support of women with breast cancer; providing accurate and accessible information to well women, women with breast cancer, primary care providers and breast cancer specialists; and developing a national monitoring system to provide information about all aspects of breast cancer.

Goals of the Centre

- Ensuring that all women and health professionals have a balanced understanding of the incidence of and risk factors for breast cancer;
- Ensuring that all women with breast cancer are diagnosed as early as possible;
- Ensuring that all women diagnosed with breast cancer receive 'state of the art' treatment;
- Ensuring that all women diagnosed with breast cancer and their families receive adequate psychosocial, physical and practical support;
- Developing networks and infrastructure to increase breast cancer control; and
- Developing a national monitoring system for breast cancer outcomes.

CANCER SERIES

Number 9

Breast cancer survival in Australian women 1982–1994

December 1998

Australian Institute of Health and Welfare

Australasian Association of Cancer Registries

NHMRC National Breast Cancer Centre

Canberra

AIHW Cat. No. CAN 4

This is the ninth publication of the Australian Institute of Health and Welfare's Cancer Series. A complete list of the Institute's publications is available from the Publications Unit, Australian Institute of Health and Welfare, GPO Box 570, Canberra ACT 2601, or via the Institute's web site at http://www.aihw.gov.au.

ISSN 1307-3307
ISBN 0 642 24786 2

Suggested citation

Australian Institute of Health and Welfare, Australasian Association of Cancer Registries and NHMRC National Breast Cancer Centre 1998. Breast cancer survival in Australian women 1982–1994. AIHW cat. no. CAN 4. Canberra: Australian Institute of Health and Welfare (Cancer Series No. 9).

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Published by Australian Institute of Health and Welfare

Printed by Pirie Printers

Contents

List of tables

Appendix A

Appendix B

List of figures

Summary

- Breast cancer is an important disease in the female population of Australia, with 1 in 11 women expected to be diagnosed with it before the age of 75.
- In 1996, 9,556 new cases of breast cancer were diagnosed in Australia.
- In 1996, there were 2,623 deaths attributed to breast cancer.
- Relative survival in this report is calculated as the ratio of survival in women diagnosed with breast cancer to survival of women with similar characteristics such as age.
- An analysis of relative survival patterns for women diagnosed with breast cancer in the period 1982–1994 showed that the relative survival proportion was 90.9% 2 years after diagnosis, 76.8% 5 years after and 63.1% 10 years after.
- The relative survival proportions increased over time, with those diagnosed in the 1990s showing better relative survival proportions than those diagnosed in the 1980s.
- Women diagnosed with breast cancer while aged in their 40s had a better relative survival proportion than any other age group, while those aged in their 80s and 90s showed the worst relative survival proportions.
- Relative survival proportions in each of the States were similar (within 4%). Survival proportions for the Australian Capital Territory (higher) and the Northern Territory (lower) showed more substantial variation from the national average. This difference probably reflects the small and unusual populations of the two Territories.
- There was very little difference in the 2- or 5-year relative survival proportions for urban and rural areas and both areas showed improved relative survival proportions over time.
- Breast cancer relative survival proportions in Australia for women diagnosed in the 1980s are lower than those for white women in the United States but are comparable with those for women in the Scandinavian countries. Other European countries such as England, Spain and Scotland all show lower survival proportions than those in Australia.

Contributors

This report has been sponsored by the National Health and Medical Research Council's National Breast Cancer Centre and produced by the Australian Institute of Health and Welfare and the member registries of the Australasian Association of Cancer Registries.

This report would not have been possible without the cooperation and effort of those who direct the operation, promotion and development of the State and Territory cancer registries and the Australian Institute of Health and Welfare staff responsible for the operation of the National Cancer Statistics Clearing House. These people, listed below, worked together to produce the national breast cancer survival statistics in this publication. In particular, we acknowledge Rajah Supramaniam, who assisted us in the use of the software used to undertake the relative survival analysis. We also thank Professor Bruce Armstrong, Professor Annette Dobson, Professor Bob Gibberd, Dr David Roder, Dr John Boyages and Dr Richard Taylor who commented on early drafts of the report, and Dr Michael Adena who reviewed the final draft.

Cancer incidence information is received predominantly from hospitals, pathologists and departments of radiation oncology, with supplementary information provided by medical practitioners in private practice. The major contributors of cancer deaths information are the State and Territory Registrars of Births, Deaths and Marriages, and the Australian Bureau of Statistics. The authors thank them all for their efforts.

Funding and support for cancer registries in Australia are provided by State and Territory governments and various charity bodies. We acknowledge the support of the State and Territory governments, the New South Wales Cancer Council, the Anti-Cancer Council of Victoria, the Queensland Cancer Fund, the Cancer Foundation of Western Australia, the Northern Territory Anti-Cancer Foundation and the Australian Cancer Society. Finally, the contributions of the staff and volunteers who work with the State and Territory cancer registries are acknowledged.

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National Breast Cancer Centre—Dr Anne Kricker

New South Wales—Professor Bruce Armstrong, Mr Rajah Supramaniam, Mrs Marylon Coates, Mrs Noreen Panos, Mrs Maria Arcorace

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1 Introduction

Breast cancer is an important disease in the female population of Australia and, based on the current risks, 1 in 11 women are expected to be diagnosed with it before the age of 75. In 1996, it is estimated that 9,556 new cases of breast cancer were diagnosed in Australia. In the same year there were 2,623 deaths attributed to this cause. Breast cancer ranks as the most common cancer in women, after the less serious but more numerous non-melanocytic skin cancers. Breast cancer represents around 29% of all cancers diagnosed in women (excluding non-melanocytic skin cancers) and 18.6% of all cancer deaths; and it results in approximately 31,000 person-years of life lost. Its impact is predominantly in women aged above 50, however it is an important concern for women of all ages, and particularly so for women with a family history of the disease. Breast cancer incidence has increased steadily between 1982 and 1990, rising more sharply to a peak in 1995 and then falling in 1996. While this fall in incidence is welcomed, the present state of knowledge offers little for the primary prevention of breast cancer, and consequently a large number of women will be affected, as will their families and the community. Despite this, breast cancer's impact, in terms of morbidity and mortality, can be significantly reduced if the disease is detected at an early stage in its development.

Most interventions to detect and control breast cancer are directed at (a) extending the length of survival following diagnosis (through either cure or remission) and (b) maximising the quality of life during that survival period. A third level of control is through palliative care where treatment is not primarily targeted at extending life. Given the importance placed on survival from breast cancer, it has long been recognised that it should be a key measure that is examined regularly at both a population level and a clinical level to monitor the effectiveness of the various interventions. This recognition has recently been given by the National Health Priority Areas report on cancer (DHFS & AIHW 1998) and by the National Cancer Control Initiative (NCCI 1998), both stating that survival measurements are among the key indicators for measuring the health system performance in reducing the impact of cancer.

This report addresses this issue and focuses on reporting survival patterns in Australia on a population level. It follows the publication of survival measures in South Australia (SAHC 1997), New South Wales (Taylor et al. 1994, Supramaniam et al. 1998) and Victoria (in press) and anticipates those in Western Australia and Tasmania. In order to conduct a national survival analysis three elements must exist:

(a) a comprehensive national cancer registration system;

(b) a comprehensive national mortality database; and

(c) the technical ability and social environment that allows for the drawing together of confidential information for the public good under ethical guidance and regulatory controls.

The cancer registry incidence information was made available at a national level by combining State and Territory cancer registry data into a national database, the National Cancer Statistics Clearing House, located at the Australian Institute of Health and Welfare (AIHW). Deaths data, provided by the Registrars of Births, Deaths and Marriages via the cancer registries, were combined with the National Death Index (also at the AIHW) to provide a mechanism for identifying which women diagnosed with breast cancer from 1982 onwards were:

(a) still alive in each calendar year up until the end of 1994; or

(b) had died of breast cancer or other causes.

The probabilistic record linkage to bring the incidence and mortality data together was undertaken by the AIHW, after ethical review, with cases confirmed by the cancer registries according to local registry practice. These processes are described further in Chapter 2 and Appendix A.

It should be noted that at the closing date for inclusion of data in this report, Queensland data on breast cancer incidence and deaths was incomplete and hence not suitable for survival analysis. Therefore, Queensland data have been excluded from all analyses. It is anticipated that future versions of this report will include Queensland survival estimates.

It is important to note the differences between the survival estimates at a population level and those at a clinical level. Survival estimates at a population level are an average of all the outcomes of women diagnosed with breast cancer (good and bad) and also take into account the underlying risk of competing causes of death (e.g. cardiovascular disease). While the 5-year relative survival proportion for Australia is estimated at 76.8%, it cannot be inferred that all women will experience this survival proportion as an individual woman's survival time is dependent on many factors. These factors include age at diagnosis, stage of disease, family history, access to and use of treatment and further monitoring services, general health, and other complicating conditions. These factors are relevant to the clinical management and survival of women diagnosed with breast cancer. The tables and graphs in this report show the variation in survival in relation to some of these factors.

One major factor in survival that is not accounted for in this report, but is available in survival analyses in other countries, is stage at diagnosis. Three States currently collect staging information. News South Wales collects and stages all breast cancers to a broad staging system—local, regional and distant (Taylor et al. 1994, Supramaniam et al. 1998). South Australia collects staging information for all breast cancers collected through the hospital-based cancer registry system and codes them to the tumour, nodes and metastases (TNM) staging system. Victoria has been staging all breast cancers over the last several years to the TNM system. The National Breast Cancer Centre recently initiated and commissioned the development of a protocol for recording the size, grade and nodal status of breast cancers. It was developed by the cancer registries and published by the National Breast Cancer Centre (Marr et al. 1998). This protocol should be implemented in most States and Territories in collections beginning in 1999, which will enable future versions of this report to include analyses by stage at diagnosis. Nevertheless, it is known that the survival of women diagnosed with advanced cancers is significantly worse than the survival of those with cancer detected at an early stage (Taylor et al. 1994, Supramaniam et al. 1998).

The information contained in this report is expected to be used by agencies guiding policy and activities related to cancer treatment services, research and health promotion (e.g. governments, hospitals and other treatment centres, clinicians and cancer councils). The information is also expected to be useful for women diagnosed with breast cancer and for well women considering taking up the screening services.

Report structure

The remainder of this report is structured as follows:

- Chapter 2: Methods summary—a brief summary of the methods used;
- Chapter 3: Relative survival analysis results—a description and discussion of the patterns;
- Appendix A—a detailed description of the materials and methods used; and
- Appendix B—a description of incidence and mortality patterns for the breast cancer cohort.

The report is available on the Institute’s web site (www.aihw.gov.au) and on the National Breast Cancer Centre’s web site (www.nbcc.org.au).

2 Methods summary

The objective of this report is to estimate relative survival proportions for women with breast cancer in Australia. The women included in this analysis were those diagnosed with breast cancer from 1982 to 1994 inclusive with survival follow-up to 31 December 1994. The analysis examines relative survival estimates, taking into account the year of diagnosis, age at diagnosis, State or Territory of usual residence, and urban or rural area of usual residence.

To achieve this objective four key elements are required:

- data relating to women diagnosed with breast cancer and their vital status;
- population-based lifetables;
- relative survival analysis software to combine the first two elements; and
- staff with knowledge of the data systems, their linkage and survival analysis.

The methods used to combine these elements are described briefly here and in more detail in Appendix A.

Preparation of breast cancer data and lifetables

Breast cancer incidence data were derived from the National Cancer Statistics Clearing House (NCSCH) database (Table 1). As at February 1998, the NCSCH contained identifiable information relating to new breast cancer cases and deaths between 1982 and 1994. This group of women is referred to throughout the report as the breast cancer 'cohort'. Queensland cancer incidence and mortality data were not complete at the time of analysis and were therefore excluded.

Table 1: Summary of breast cancer data initially extracted from the NCSCH, 1982–1994

State/Territory	New cases (cohort)	Per cent of new cases (cohort)	Total deaths (cohort)	Per cent of total deaths (cohort)
New South Wales	31,792	42.2	9,992	42.1
Victoria	23,696	31.4	7,623	32.1
Western Australia	8,089	10.7	2,533	10.7
South Australia	8,038	10.7	2,476	10.4
Tasmania	2,293	3.0	765	3.2
Australian Capital Territory	1,212	1.6	263	1.1
Northern Territory	278	0.4	83	0.3
Australia[(a)]	**75,398**	**100.0**	**23,735**	**100.0**

(a) Excludes Queensland data.

A death clearance of all breast cancer incident cases was undertaken using probabilistic linkage between the NCSCH and the National Death Index (NDI), which contains data on all deaths in Australia from 1980. State and Territory cancer registries validated this death clearance by following up proposed matches through a range of sources, e.g. hospitals, pathology laboratories, other cancer registries and treating doctors. A deduplication probabilistic linkage on the final database ensured that cases were not counted in more than one State or Territory. Quality assurance procedures were used to ensure consistency of data within the project and with previously published work. In handling the breast cancer data, strict confidentiality protocols (required under the Australian Institute of Health and Welfare Act 1987) were adhered to, with no identifiable information passed beyond the NCSCH or the State and Territory cancer registries. No identifying information was included on the final data analysis file.

Lifetables were derived for Australia, each State and Territory, and urban and rural populations using deaths data and estimates of resident population. Queensland data were excluded from each of these lifetables as the data were not included in the survival analysis.

Relative survival analysis

Relative survival is defined as the ratio of the observed survival rate for a given cohort of patients to the expected survival rate (Ederer et al. 1961). The expected survival rate is that which the patient group should have experienced based on the lifetable of the general population from which they were diagnosed (Estève et al. 1990). A relative survival of less than 100% implies that the cohort survived for less time than would be expected for the general population. A relative survival of 100% implies that survival in the cohort is no different from that in the general population.

The relative survival analysis was undertaken using the RELSURV (v2.0) software, which was written by Guy Hédelin of Louis Pasteur University, Strasbourg, France (Hédelin 1995). The program calculates expected survival using the lifetable method and estimates relative survival using a Cox proportional hazards regression model.

In undertaking the relative survival analysis some key assumptions were made which are important in the interpretation of the results:

1. Records with the following characteristics were excluded from the survival analysis (see Appendix A):
   - any woman whose age at diagnosis was not known or was missing;
   - any woman aged 100 years or over at diagnosis;
   - all cases diagnosed in Queensland;
   - any woman whose diagnosis or death date could not be resolved;
   - death certificate only cases (i.e. cases diagnosed at death);
   - any woman who died within a month of diagnosis; and
   - any woman diagnosed in December 1994.
2. After excluding 8,088 records with the characteristics described in (1), the data file contained 73,827 records. However the software was not able to handle files larger than 65,535 records. To compensate for this in the analysis the following strategies were used.
   (a) To estimate relative survival at the 'Australia, all ages, 1982–1994' level, a sample of 65,500 records (88.7% of all records) was systematically selected and used.
   (b) To estimate relative survival at all other levels, the data file was split according to the level of analysis being undertaken. For example, for analysis by State and Territory, the data file was split into two files, one containing all records for New South Wales and Victoria, and the other containing all records for the remaining

States and Territories. The former file was used to estimate relative survival for New South Wales and Victoria and the latter file was used for all other States and Territories.

3. All cases were followed up to 31 December 1994, which was the censoring date. Unless a woman diagnosed with breast cancer was known to have died before 31 December 1994, it was assumed that she was still alive (i.e. censored). The impact of this censoring date, combined with the modeling methods used, is that survival proportions can be estimated for women for a number of years following their diagnosis: women diagnosed between 1982 and 1987, up to 10 years; those diagnosed 1988 to 1992, up to 7 years; and those diagnosed 1993 to 1994, up to 2 years.

3 Relative survival analysis results

Survival time

Length of survival is an important measure in assessing the broad impacts of screening and treatment on women diagnosed with breast cancer. The convention is to focus on survival proportions at 1 ,2 or 3 years and at 5 and 10 years after diagnosis (Supramaniam et al. 1998, NCI 1998, Bonnett et al. 1992), however single-year proportions are also routinely reported. These periods reflect different stages of management during the life of women diagnosed with breast cancer. Relative survival proportions one year after diagnosis reflect the success or otherwise of interventions on the immediately detectable cancer, encompassing issues such as stage of disease, surgical success and post-operative issues (e.g. breast reconstruction, infection), and comorbid conditions. The relative survival proportions at the second and third year reflect situations where (a) the disease has not reappeared and no further management of the disease is required; or (b) the disease has not progressed rapidly, treatment is ongoing but some metastases may have been found and require treatment. The relative survival proportions at 5 and 10 years are strong indicators of successful breast cancer management, through either periods of remission or cure, however metastases are sometimes detected after long periods.

The single-year relative survival proportions (Table 2, Figure 1) showed a steady decline each year following diagnosis. The greatest falls in relative survival proportions occurred in the first 5 years after diagnosis, with the decline in proportions slowing over the next 5 years. This general pattern was consistent across the two periods 1982–1987 and 1988–1992. The differences between the relative survival curves for each period increased with increasing survival time.

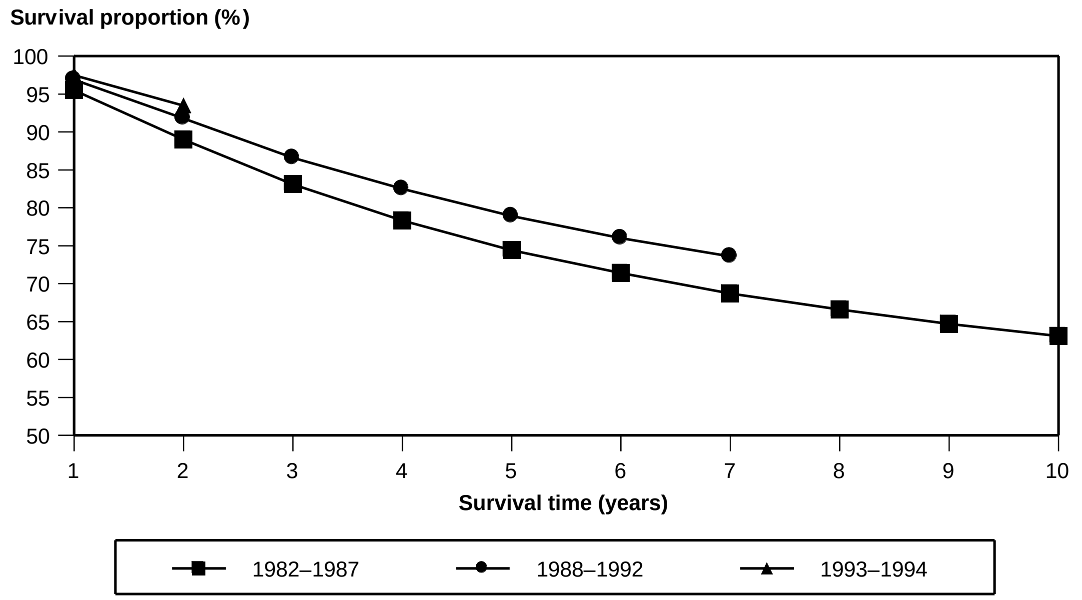
Table 2: Breast cancer relative survival proportions (%) by survival time and period of diagnosis, Australia[(a)(b)]

	1982–1994[(c)]		1982–1987		1988–1992		1993–1994	
Survival time (years)	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
1	96.5	96.4–96.7	95.5	95.2–95.8	96.9	96.7–97.1	97.5	97.2–97.8
2	90.9	90.6–91.1	89.0	88.6–89.4	91.8	91.5–92.1	93.5	92.7–94.2
3	85.2	84.8–85.5	83.1	82.6–83.6	86.6	86.1–87.0		
4	80.7	80.3–81.1	78.3	77.7–78.8	82.5	82.0–83.0		
5	76.8	76.4–77.3	74.4	73.8–75.0	78.9	78.3–79.5		
6	73.6	73.1–74.1	71.4	70.8–72.0	76.0	75.4–76.7		
7	70.9	70.4–71.4	68.7	68.1–69.4	73.6	72.8–74.4		
8	68.7	68.2–69.3	66.6	66.0–67.3				
9	66.7	66.1–67.3	64.7	64.0–65.3				
10	65.0	64.3–65.7	63.1	62.4–63.8				

(a) Excludes Queensland.

(b) Ages 0–99 years.

(c) Results for period of diagnosis 1982–1994 based on a sample of 65,500 records (88.7% of all records).



(a) Excludes Queensland.

Figure 1: Breast cancer relative survival proportions by survival time and period of diagnosis, Australia[(a)]

Year of diagnosis

The year of diagnosis is an important indicator for the availability of screening or breast cancer management options and therefore has an indirect relationship to survival. The trends over time can indicate the successes of the public health system in dealing with breast cancer. Since 1984, the 1-, 3-, 5- and 10-year breast cancer relative survival proportions have increased with each successive year of diagnosis (Table 3, Figure 2). It is noticeable that the rate of increase in relative survival was somewhat greater in the period 1984–1987.

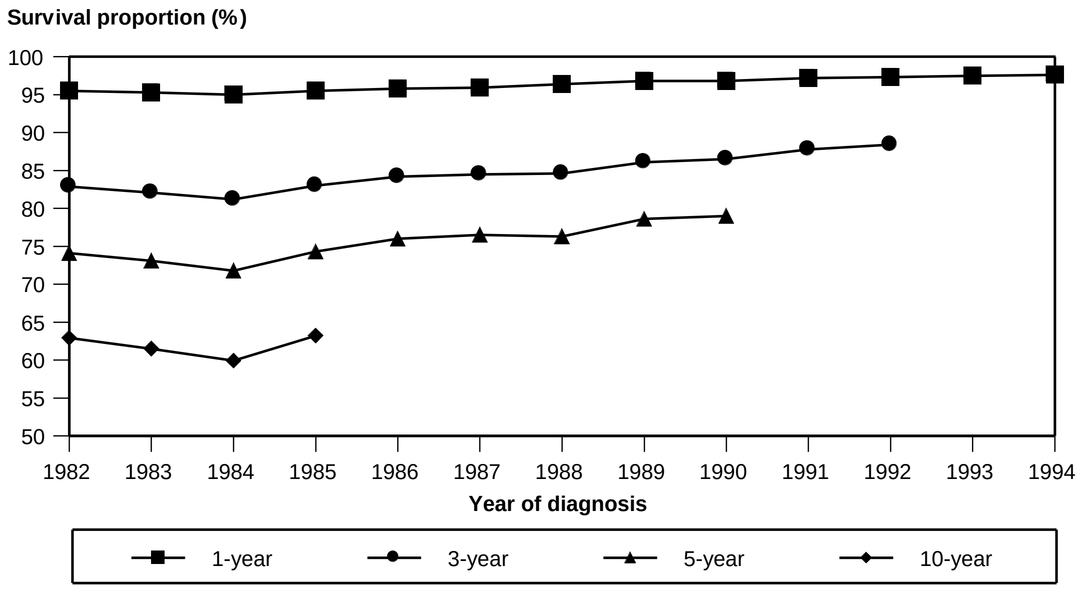
Proportions for all survival intervals from 1- to 10-years are given in Table 4.

Table 3: Breast cancer 1-, 3-, 5- and 10-year relative survival proportions (%) in Australia[(a)(b)] by year of diagnosis

			1-year		3-year		5-year		10-year	
Year of diagnosis	New cases	Deaths	%	95% CI	%	95% CI	%	95% CI	%	95% CI
1982	4,310	2,407	95.5	95.1–95.8	82.9	81.9–83.8	74.1	72.8–75.5	62.9	61.2–64.6
1983	4,370	2,420	95.3	94.9–95.6	82.1	81.1–83.1	73.1	71.7–74.4	61.5	59.8–63.2
1984	4,748	2,573	95.0	94.6–95.4	81.2	80.3–82.2	71.8	70.5–73.1	59.9	58.2–61.5
1985	4,900	2,422	95.5	95.2–95.9	83.0	82.1–83.9	74.3	73.1–75.6	63.2	61.5–64.8
1986	4,992	2,236	95.8	95.5–96.2	84.2	83.3–85.1	76.0	74.8–77.3		
1987	5,493	2,241	95.9	95.6–96.3	84.5	83.7–85.4	76.5	75.3–77.7		
1988	5,568	2,112	96.4	96.1–96.7	84.6	83.8–85.5	76.3	75.1–77.6		
1989	5,931	1,871	96.8	96.5–97.0	86.1	85.3–87.0	78.6	77.4–79.7		
1990	6,028	1,612	96.8	96.6–97.1	86.5	85.6–87.3	79.0	77.8–80.3		
1991	6,535	1,332	97.2	96.9–97.4	87.8	86.9–88.7				
1992	6,557	907	97.3	97.1–97.6	88.4	87.4–89.5				
1993	7,109	549	97.5	97.2–97.9						
1994	7,286	170	97.6	96.9–98.2						

(a) Excludes Queensland.

(b) Ages 0–99 years.



(a) Excludes Queensland.

Figure 2: Breast cancer survival proportions by year of diagnosis and survival time, Australia[(a)], 1982–1994

Table 4: Breast cancer relative survival proportions (%) in Australia[(a)(b)] by time since diagnosis and year of diagnosis

Time since diagnosis	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1 year	95.5	95.3	95.0	95.5	95.8	95.9	96.4	96.8	96.8	97.2	97.3	97.5	97.6
2 years	88.9	88.4	87.8	89.0	89.8	90.0	90.5	91.5	91.7	92.5	92.9	93.4	
3 years	82.9	82.1	81.2	83.0	84.2	84.5	84.6	86.1	86.5	87.8	88.4		
4 years	78.0	77.1	76.0	78.2	79.7	80.1	80.1	82.0	82.4	84.1			
5 years	74.1	73.1	71.8	74.3	76.0	76.5	76.3	78.6	79.0				
6 years	71.1	69.9	68.6	71.3	73.2	73.7	73.3	75.7					
7 years	68.4	67.1	65.7	68.6	70.6	71.2	70.7						
8 years	66.3	65.0	63.5	66.6	68.7	69.3							
9 years	64.4	63.0	61.4	64.6	66.8								
10 years	62.9	61.5	59.9	63.2									

(a) Excludes Queensland.

(b) Ages 0–99 years.

Age at diagnosis

The 5-year relative survival proportions varied by age group across all periods of analysis (Table 5, Figure 3). The highest relative survival proportion (79%) was observed in women diagnosed in the age range 40–49 years, an age group that comprises 19% of all breast cancers. The lowest relative survival proportion (72%) was observed for women in the oldest age group 90–99 years, comprising 1.2% of all breast cancers. With the exception of women aged 80–89 years, 5-year relative survival proportions improved from 1982–1987 to 1988–1992 for all age groups. The most striking of these improvements (8%) was in women diagnosed in the 50–59 year age range.

The overall 5-year relative survival proportion increased from 74% in 1982–1987 to 79% in 1988–1992.

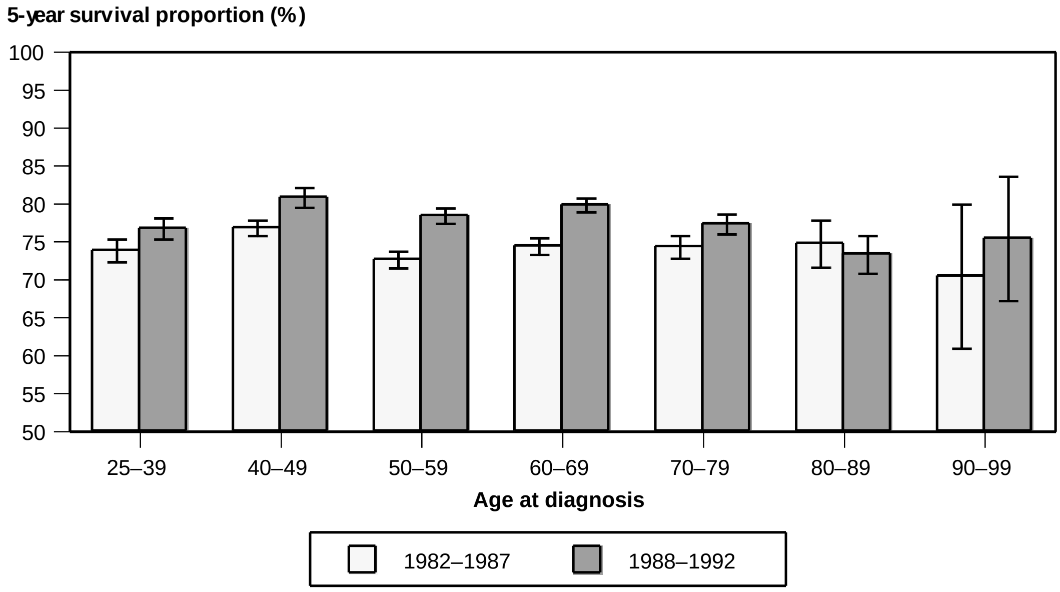
Table 5: Breast cancer 5-year relative survival proportions (%) by age at diagnosis and period of diagnosis, Australia[(a)]

	1982–1994			1982–1987		1988–1992	
Age at diagnosis	**New cases**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
25–39 years	5,860	74.8	73.7–76.0	73.8	72.3–75.3	76.7	75.3–78.1
40–49 years	14,211	78.8	78.0–79.5	76.8	75.8–77.9	80.8	79.5–81.7
50–59 years	15,403	75.6	74.8–76.4	72.6	71.5–73.7	78.4	77.4–79.3
60–69 years	17,358	77.9	77.1–78.7	74.4	73.3–75.4	79.8	78.9–80.8
70–79 years	13,749	75.9	74.9–77.0	74.3	72.8–75.7	77.3	76.0–78.6
80–89 years	6,253	72.6	70.4–74.8	74.7	71.6–77.9	73.3	70.8–75.8
90–99 years	922	71.9	63.2–80.6	70.4	60.9–79.8	75.4	67.2–83.5
All ages[(b)(c)]	65,500	76.8	76.4–77.3	74.4	73.8–75.0	78.9	78.3–79.5

(a) Excludes Queensland.

(b) All ages for period of diagnosis 1982–1994 results based on a sample of 65,500 records (88.7% of all records).

(c) Ages 0–99 years.



(a) With 95% confidence intervals.
(b) Excludes Queensland.

Figure 3: Breast cancer 5-year relative survival proportions[(a)] by age at diagnosis and period of diagnosis, Australia[(b)]

The 2-year relative survival estimates showed increases in all age groups across the three diagnosis periods, although, as for the 5-year estimates, the trend varied between age groups (Table 6, Figure 4). In 1993–1994, the highest relative survival proportion (94.0%) was observed in women diagnosed in the age range 40–49 years while the lowest relative survival proportion (91.4%) was observed for women in the 80–89 year age group.

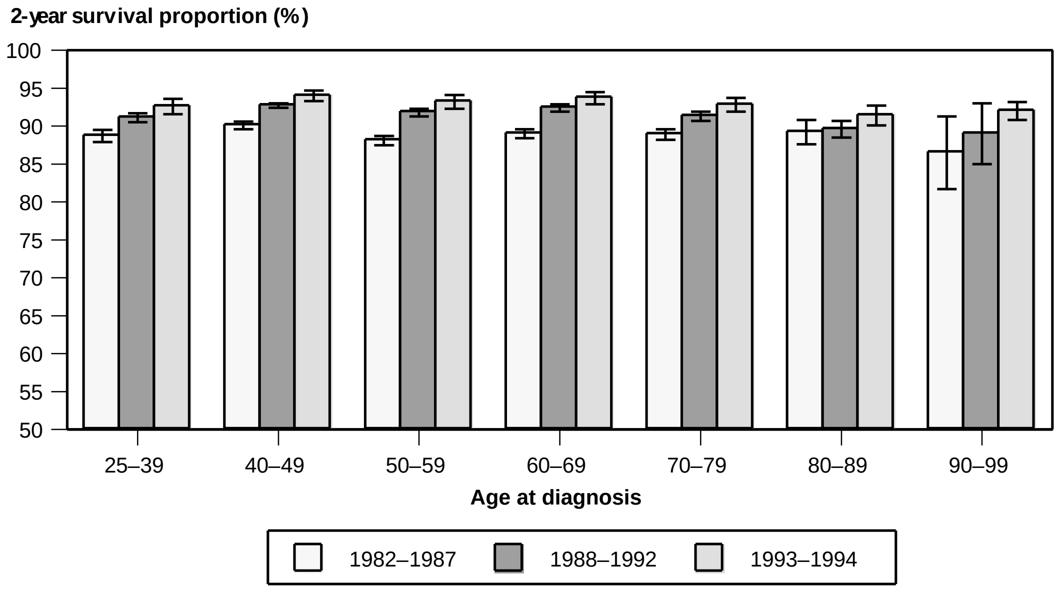
Table 6: Breast cancer 2-year relative survival proportions (%) by age at diagnosis and period of diagnosis, Australia[(a)]

	1982–1994		1982–1987		1988–1992		1993–1994	
Age at diagnosis	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
25–39 years	90.7	90.2–91.3	88.7	87.9–89.5	91.1	90.5–91.7	92.6	91.6–93.6
40–49 years	92.3	91.9–92.7	90.1	89.6–90.7	92.7	92.4–93.1	94.0	93.3–94.7
50–59 years	91.1	90.7–91.5	88.1	87.5–88.7	91.8	91.3–92.2	93.2	92.3–94.0
60–69 years	90.4	90.0–90.9	89.0	88.4–89.6	92.4	91.9–92.8	93.7	92.9–94.5
70–79 years	89.5	88.9–90.1	88.9	88.2–89.7	91.3	90.7–91.9	92.8	91.9–93.7
80–89 years	87.9	86.8–89.0	89.2	87.6–90.7	89.6	88.5–90.7	91.4	90.1–92.8
90–99 years	87.5	83.3–91.8	86.5	81.7–91.3	89.0	85.0–93.0	92.0	90.8–93.1
All ages[(b)(c)]	90.9	90.6–91.1	89.0	88.6–89.4	91.8	91.5–92.1	93.5	92.7–94.2

(a) Excludes Queensland.

(b) All ages for period of diagnosis 1982–1994 results based on a sample of 65,500 records (88.7% of all records).

(c) Ages 0–99 years.



(a) With 95% confidence intervals.

(b) Excludes Queensland.

Figure 4: Breast cancer 2-year relative survival proportions[(a)] by age at diagnosis and period of diagnosis, Australia[(b)]

State and Territory of usual residence

The 5-year relative survival proportion for all States and Territories combined (excluding Queensland) was 76.8% (Table 7) for the period 1982–1994. The proportions by State and Territory varied by 11.5%, from 83.2% in the Australian Capital Territory to 71.7% in the Northern Territory. These variations may reflect real differences between the populations or health services (and their quality) in the States and Territories and are probably contributed to by the greater statistical variability of the estimates for the less populous Territories. These issues could be further explored in the future. If the Territories are excluded, the difference in 5-year relative survival proportions between the States narrows to 4.2%.

The Australian Capital Territory followed by Western Australia, showed consistently higher 2- and 5-year relative survival proportions than the other States and the Northern Territory. It is noteworthy that all States and Territories showed improvements in their 5-year relative survival proportions across the two analysis periods (Figure 5). The largest improvements in relative survival proportions were in the Northern Territory (10.1%) and Tasmania (8.8%).

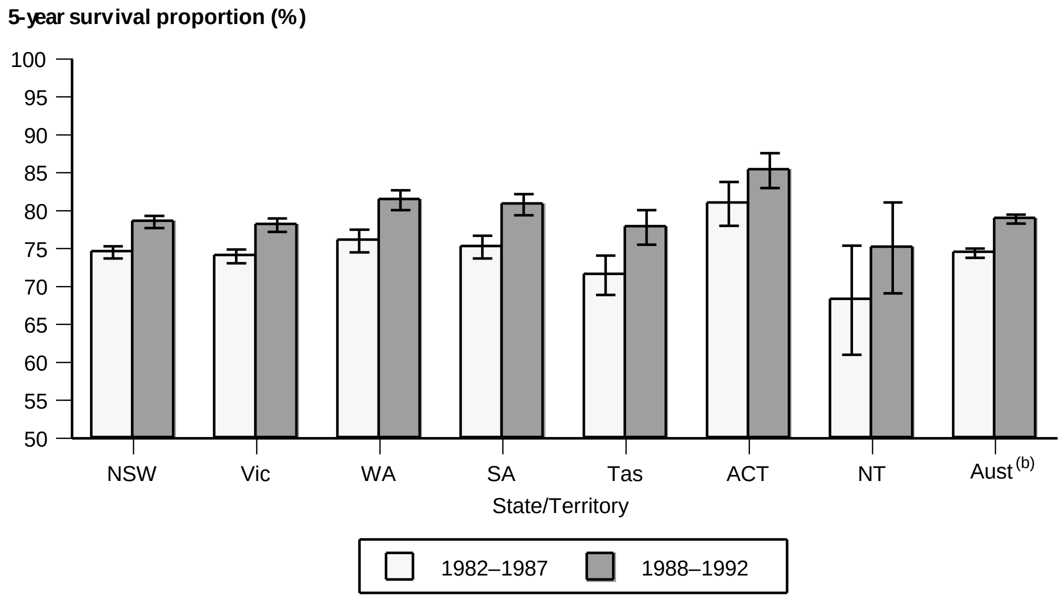
Table 7: Breast cancer 5-year relative survival proportions (%) by State or Territory[(a)] of usual residence and period of diagnosis

	1982–1994		1982–1987		1988–1992	
State/Territory	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
NSW	76.6	76.0–77.2	74.5	73.7–75.3	78.5	77.7–79.3
Vic	76.0	75.3–76.7	74.0	73.1–74.8	78.1	77.2–78.9
WA	78.7	77.6–79.9	76.0	74.5–77.4	81.4	80.1–82.7
SA	77.9	76.7–79.1	75.2	73.7–76.6	80.8	79.4–82.1
Tas	74.5	72.2–76.9	71.5	68.9–74.1	77.8	75.5–80.1
ACT	83.2	80.6–85.7	80.9	78.0–83.8	85.3	83.0–87.7
NT	71.7	65.2–78.3	68.2	61.0–75.4	75.1	69.1–81.1
Australia[(b)(c)]	76.8	76.4–77.3	74.4	73.8–75.0	78.9	78.3–79.5

(a) Ages 0–99 years.

(b) Excludes Queensland.

(c) Australian results based on a sample of 65,500 records (88.7% of all records).



(a) With 95% confidence intervals.

(b) Excludes Queensland.

Figure 5: Breast cancer 5-year relative survival proportions[(a)] by period of diagnosis, States and Territories compared with Australia[(b)]

In a comparison of the 2-year relative survival proportions (Table 8, Figure 6), for the three diagnosis periods, the proportions also showed a consistent upward trend in all States and Territories. They reached a peak in the 1993–1994 diagnosis period where all jurisdictions have relative survival proportions above 91%. The greatest increases occurred in the Northern Territory, New South Wales and Victoria, although these increases were only marginally greater than in the other States and Territories.

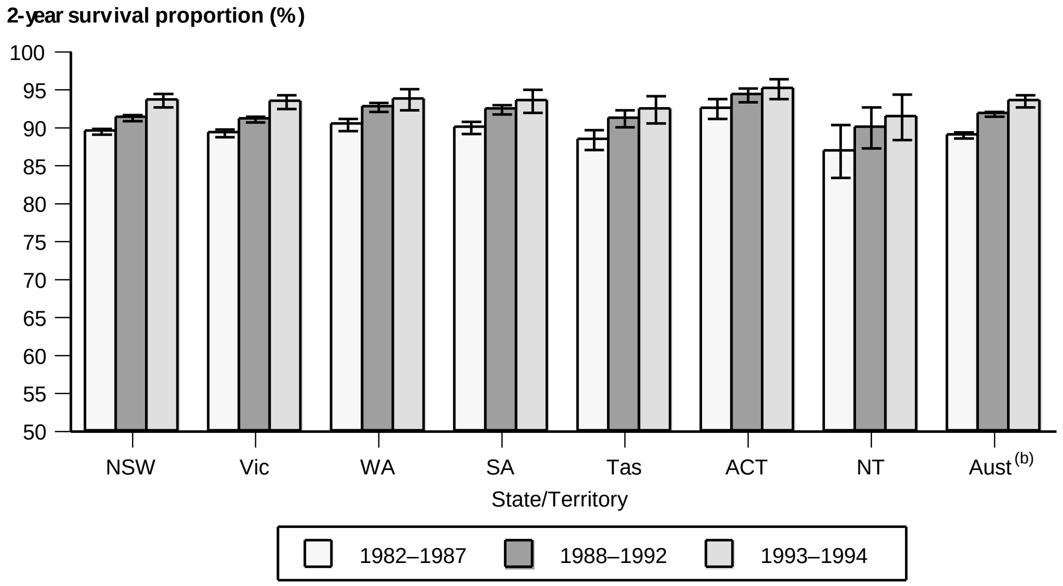
Table 8: Breast cancer 2-year relative survival proportions (%) by State and Territory[(a)] of usual residence and period of diagnosis

	1982–1994		1982–1987		1988–1992		1993–1994	
State/Territory	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
NSW	90.7	90.4–91.1	89.5	89.1–90.0	91.3	90.9–91.7	93.6	92.7–94.5
Vic	90.5	90.1–90.9	89.3	88.8–89.8	91.1	90.7–91.5	93.4	92.5–94.4
WA	91.9	91.3–92.5	90.4	89.6–91.2	92.7	92.1–93.3	93.7	92.3–95.2
SA	91.5	90.9–92.1	90.0	89.2–90.8	92.4	91.8–93.1	93.5	92.0–95.0
Tas	90.1	89.0–91.2	88.4	87.1–89.7	91.2	90.1–92.2	92.4	90.6–94.2
ACT	93.7	92.6–94.7	92.5	91.2–93.8	94.3	93.4–95.3	95.1	93.8–96.5
NT	88.9	86.0–91.8	86.9	83.4–90.3	90.0	87.3–92.7	91.4	88.4–94.3
Australia[(b)(c)]	90.9	90.6–91.1	89.0	88.6–89.4	91.8	91.5–92.1	93.5	92.7–94.2

(a) Ages 0–99 years.

(b) Excludes Queensland.

(c) Australian results based on a sample of 65,500 records (88.7% of all records).



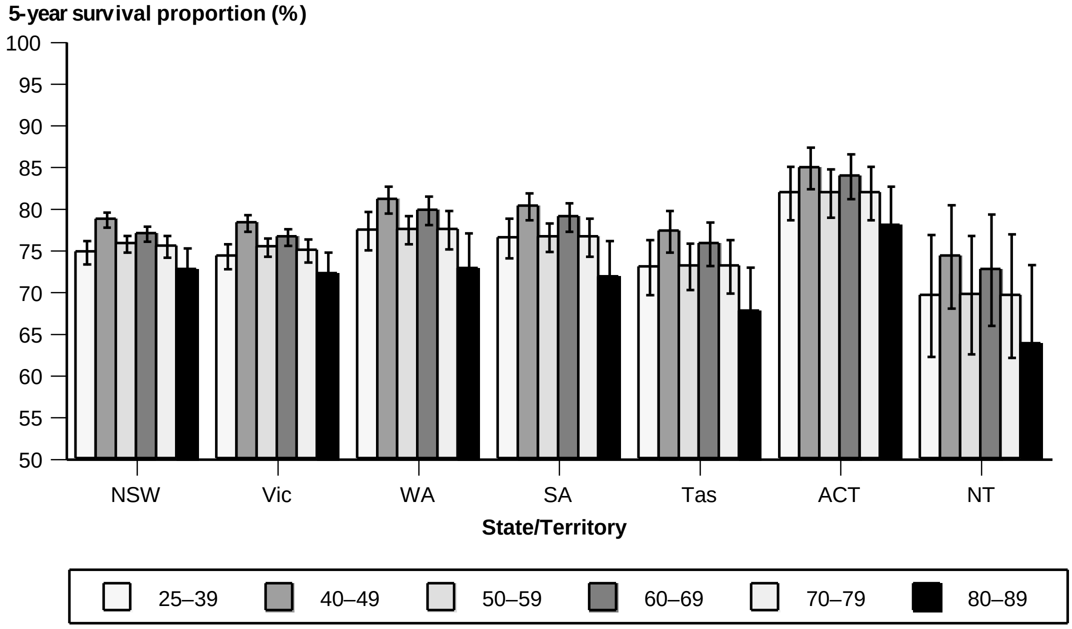
(a) With 95% confidence intervals.
(b) Excludes Queensland.

Figure 6: Breast cancer 2-year relative survival proportions[(a)] by period of diagnosis, States and Territories compared with Australia[(b)]

Table 9: Breast cancer 5-year relative survival proportions (%) by State and Territory and age at diagnosis, 1982–1994

	State/Territory						
Age at diagnosis	NSW	Vic	WA	SA	Tas	ACT	NT
25–39 years	74.8	74.3	77.4	76.5	73.0	81.9	69.6
40–49 years	78.7	78.3	81.1	80.3	77.3	84.9	74.3
50–59 years	75.8	75.4	77.5	76.6	73.1	81.9	69.7
60–69 years	77.0	76.6	79.8	79.0	75.8	83.9	72.7
70–79 years	75.5	75.0	77.5	76.6	73.1	81.9	69.6
80–89 years	72.7	72.2	72.8	71.8	67.7	78.0	63.8
All ages[(a)]	76.6	76.0	78.7	77.9	74.5	83.2	71.7

(a) Ages 0–99 years.



(a) With 95% confidence intervals.

Figure 7: Breast cancer 5-year relative survival proportions[(a)] by State and Territory and age at diagnosis, 1982–1994

An examination of the age-specific relative survival proportions in each State and Territory (Table 9, Figure 7) showed consistency in the age distribution (i.e. higher in the 40–49 and 60–69 year age groups and lower in the 80–89 year age group). There was also similarity in the magnitude of the relative survival proportions in New South Wales, Victoria and Tasmania. The Australian Capital Territory, Western Australia and South Australia showed slightly higher relative survival proportions for each age group, while in the Northern Territory the proportions were substantially lower. The age group 90–99 years was excluded from the analysis due to the small numbers of cases in each State and Territory.

Urban and rural areas of usual residence

The differential between the 5-year relative survival proportions in urban and rural locations (see Appendix A for classification of these locations) was small, at just under 2% (Table 10). In both diagnosis periods (1982–1987 and 1988–1992) relative survival proportions were higher in urban areas than in rural areas (Figure 8). The upward trend in relative survival proportions over time observed for the States and Territories, and across age groups, was also reflected in this geographic split.

Table 10: Breast cancer 5-year relative survival proportions (%) in Australia[(a)(b)] by geographic area of usual residence and period of diagnosis

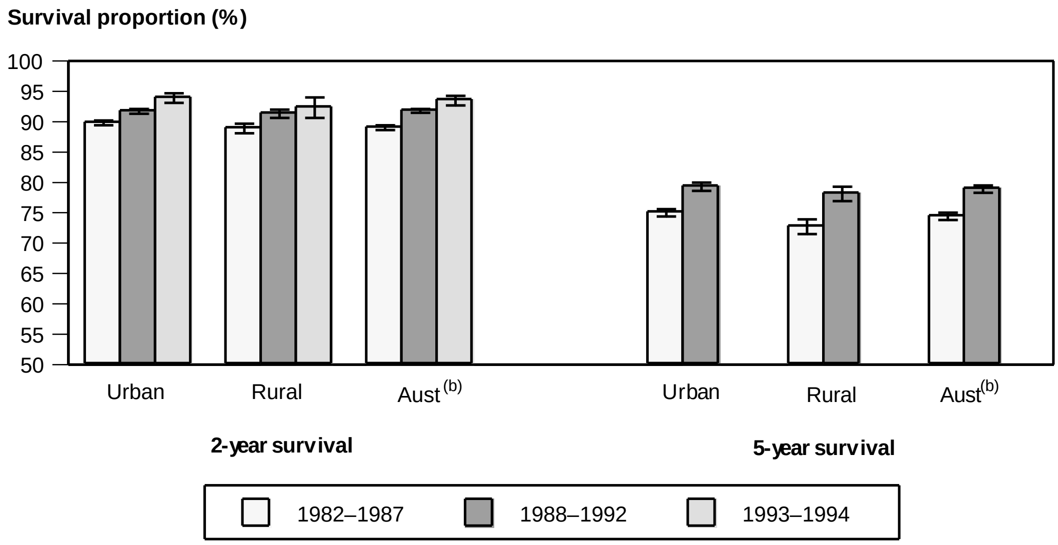
	1982–1994		1982–1987		1988–1992	
Area	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Urban	77.2	76.8–77.7	75.0	74.4–75.7	79.3	78.6–80.0
Rural	75.3	74.5–76.2	72.7	71.5–73.9	78.1	76.9–79.3
Australia[(c)(d)]	76.8	76.4–77.3	74.4	73.8–75.0	78.9	78.3–79.5

(a) Excludes Queensland.

(b) Ages 0–98 years.

(c) Australian results for 0–98 year olds from the sample of 65,500 records (88.7% of all records).

(d) 616 cases missing geographical locators were excluded from the urban and rural estimates but included in the Australian estimate.



(a) With 95% confidence intervals.

(b) Excludes Queensland.

Figure 8: Breast cancer 2-year and 5-year survival proportions[(a)] by period of diagnosis, urban and rural areas of usual residence compared with Australia[(b)]

Two-year relative survival proportions in urban and rural locations showed a pattern similar to 5-year relative survival proportions (Table 11) in their upward trend over time. Further, 2-year relative survival proportions were higher in urban areas than in rural areas in all three diagnosis periods (1982–1987, 1988–1992 and 1993–1994).

Table 11: Breast cancer 2-year relative survival proportions (%) in Australia[(a)(b)] by geographical area and period of diagnosis

	1982–1994		1982–1987		1988–1992		1993–1994	
Area	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**
Urban	91.0	90.8–91.3	89.8	89.4–90.2	91.7	91.3–92.0	93.9	93.1–94.8
Rural	90.3	89.8–90.9	88.9	88.1–89.6	91.3	90.6–91.9	92.3	90.6–94.1
Australia[(c)(d)]	90.9	90.6–91.1	89.0	88.6–89.4	91.8	91.5–92.1	93.5	92.7–94.2

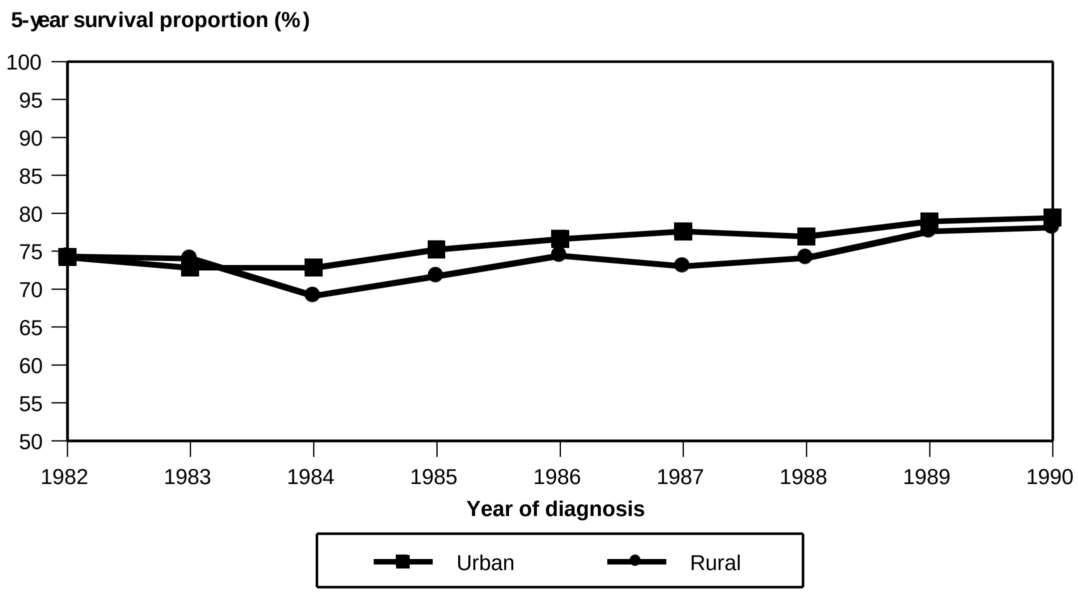
(a) Excludes Queensland.

(b) Ages 0–98 years.

(c) Australian results for 0–98 year olds from the sample of 65,500 records (88.7% of all records).

(d) 616 cases missing geographical locators were excluded from the urban and rural estimates but included in the Australian estimate.

From 1984, 5-year relative survival proportions by single year of diagnosis in urban and rural locations increased over time (Figure 9). In urban areas, the 5-year relative survival proportions rose quickly between 1984 and 1987 and then increased more slowly to 1990. In rural areas, there were sharp increases in proportions between 1984 and 1986 and between 1988 and 1989. The greatest difference in proportions between urban and rural locations occurred in 1987, when the relative survival proportion in urban areas was 3.6% higher than that in rural areas (Table 12). Two-year relative survival proportions showed a similar pattern to 5-year proportions (Table 13).



(a) Excludes Queensland.

Figure 9: Breast cancer 5-year relative survival proportions by urban and rural areas of usual residence and year of diagnosis[(a)], 1982–1990

Table 12: Breast cancer 5-year relative survival proportions (%) in Australia[(a)(b)] by year of diagnosis and geographical area

	Urban			Rural			Unknown area
Year of diagnosis	New cases	5-year %	95% CI	New cases	5-year %	95% CI	New cases
1982	3,308	74.2	72.7–75.7	991	74.3	71.5–77.1	19
1983	3,279	72.8	71.2–74.3	1,070	74.0	71.3–76.7	31
1984	3,568	72.8	71.3–74.3	1,154	69.1	66.4–71.8	57
1985	3,704	75.2	73.7–76.6	1,159	71.7	69.0–74.3	75
1986	3,813	76.6	75.2–78.0	1,160	74.4	71.8–77.0	47
1987	4,063	77.6	76.3–79.0	1,376	73.0	70.5–75.5	84
1988	4,180	76.9	75.5–78.2	1,344	74.1	71.5–76.6	79
1989	4,495	78.9	77.5–80.2	1,401	77.6	75.1–80.1	38
1990	4,534	79.4	77.9–80.8	1,467	78.1	75.6–80.7	33

(a) Excludes Queensland.

(b) Ages 0–98 years.

Table 13: Breast cancer 2-year relative survival proportions (%) in Australia[(a)(b)] by year of diagnosis and geographical area

	Urban			Rural			Unknown area
Year of diagnosis	New cases	2-year %	95% CI	New cases	2-year %	95% CI	New cases
1982	3,308	89.3	88.5–90.0	991	89.4	88.1–90.8	19
1983	3,279	88.6	87.9–89.4	1,070	89.3	88.0–90.6	31
1984	3,568	88.6	87.9–89.4	1,154	87.0	85.6–88.4	57
1985	3,704	89.7	89.0–90.4	1,159	88.2	86.9–89.6	75
1986	3,813	90.4	89.7–91.0	1,160	89.5	88.2–90.8	47
1987	4,063	90.8	90.2–91.5	1,376	88.8	87.6–90.1	84
1988	4,180	90.5	89.8–91.2	1,344	89.3	88.1–90.6	79
1989	4,495	91.4	90.8–92.0	1,401	90.9	89.7–92.1	38
1990	4,534	91.6	90.9–92.3	1,467	91.1	90.0–92.3	33
1991	4,881	92.4	91.7–93.0	1,630	92.5	91.4–93.7	57
1992	4,893	92.9	92.2–93.6	1,650	92.8	91.5–94.1	40
1993	5,350	93.8	92.8–94.7	1,751	92.6	90.8–94.5	25

(a) Excludes Queensland.

(b) Ages 0–98 years.

International comparisons

Table 14: Breast cancer 5-year relative survival proportions internationally[(a)] by period of diagnosis

Period	Location	Number of cancers	Relative survival (%)
1978–1984	Poland, Cracow	362	57
1978–1982	Scotland	11,261	62
1978–1984	Germany, Saarland	3,359	68
1978–1985	France	1,510	73
1980–1984	Canada	—	74
1982–1989	India, Bangalore	1,514	46
1982–1989	India, Madras	1,747	51
1982–1987	**Australia—1**	**29,193**	**74**
1983–1985	Estonia	742	63
1983–1985	Spain	691	63
1983–1985	England	19,840	64
1983–1987	Denmark	13,138	69
1983–1985	Italy	1,730	73
1983–1985	Finland	3,494	75
1983–1985	Switzerland	868	77
1985–1992	Thailand, Khon Kaen	423	48
1986–1993	United States (black)	7,891	70
1986–1993	United States (white)	89,336	86
1987–1992	Netherlands	—	76
1988–1992	Lithuania	1,649	57
1988–1992	*Northern Territory*	*118*	*75*
1988–1992	Norway	9,403	78
1988–1992	*Victoria*	*9,552*	*78*
1988–1992	*Tasmania*	*871*	*78*
1988–1992	**Australia—2**	**30,975**	**79**
1988–1992	*New South Wales*	*13,126*	*79*
1988–1992	*South Australia*	*3,344*	*81*
1988–1992	*Western Australia*	*3,462*	*81*
1988–1992	*Australian Capital Territory*	*502*	*85*

(a) Table is split into studies with follow-up before and after 1990 and ordered from lowest relative survival proportion to highest.

Note: Entries in italics denote results from this report.

Sources: Supramaniam et al. (1998) and results from this report.

Five-year breast cancer relative survival proportions in women diagnosed in Australia in the 1980s and early 1990s are lower than those in white women in the United States (Table 14). However, Australian proportions are similar to those in the Scandinavian countries and higher than those in other European countries such as England, Spain and Scotland.

In a comparison of 2- and 10-year Australian and United States relative survival proportions, the Australian proportions were consistently lower regardless of the period of diagnosis (NCI 1998). However, it should be noted that the United States relative survival proportions are based on data from 9 SEER (Surveillance, Epidemiology and End Results) Program geographic areas.

Appendix A: Methods

Objective

The objective was to estimate the relative survival proportions for women with breast cancer in Australia.

The women included in this analysis were those diagnosed with breast cancer from 1982 to 1994 inclusive, with survival follow-up to 31 December 1994. The analysis provides survival estimates taking into account year and period of diagnosis, age at diagnosis, State or Territory of usual residence, and urban or rural area of usual residence.

Data sources

National Cancer Statistics Clearing House

Each year the National Cancer Statistics Clearing House (NCSCH) receives from the eight State and Territory cancer registries data on cancer diagnosed in residents of Australia. This commenced with cases first diagnosed in 1982. The data provided to the NCSCH enable record linkage to be performed and the analysis of cancer by site and behaviour.

National Death Index

The National Death Index (NDI) is a database maintained by the Australian Institute of Health and Welfare (AIHW). It contains data on all deaths that have occurred in Australia since 1980 and is current to mid-1998. The data contained in the NDI come from State and Territory Registrars of Births, Deaths and Marriages.

As part of normal NCSCH operating practices, the NCSCH is regularly linked to the NDI. This linkage is undertaken to assist State and Territory cancer registries to identify deaths occurring interstate or that were not notified to the cancer register for some reason (i.e. death clearance).

It should be noted that although the NDI is current to mid-1998, follow-up for the breast cancer survival analysis finished at 31 December 1994.

Confidentiality

Strict confidentiality and privacy provisions apply to the NCSCH and the NDI. Restrictions on the use and release of information are included in State and Territory legislation controlling the operation of the Registries of Births, Deaths and Marriages and the cancer registries. Within the Australian Institute of Health and Welfare the data are protected under the *Australian Institute of Health and Welfare Act 1987*. The *Privacy Act 1988*, the Australian Public Service Regulations and the *Commonwealth Crimes Act 1914* also control the release of information by Institute staff. Further, the Institute maintains a secure physical and computer environment.

Applications to access either the NCSCH or the NDI must have ethics committee approval and strict controls are applied to the information provided to researchers due to the personal and confidential nature of the data. Ethics approval was sought and obtained for the survival analysis reported here.

Breast cancer incidence and mortality data

Initially, breast cancer incidence and mortality data, from 1982 to the most recent completed year of processing by the State and Territory cancer registries, were extracted from the NCSCH for all States and Territories. However, Queensland incidence and mortality data were not complete and were subsequently excluded from the survival analysis.

Preliminary analysis of the data extracted from the NCSCH indicated that the incidence information was relatively complete. However, the information relating to death, from breast cancer or any other cause, was incomplete. Discussions with cancer registries indicated that death information on the NCSCH could be incomplete for the following reasons.

- At the time of providing data to the NCSCH, a State or Territory cancer registry may not have been notified of all deaths that have occurred in people on the register (e.g. deaths occurring interstate).
- At the time of providing data to the NCSCH, a State or Territory cancer registry may not have been able to process and update all deaths information available to it.

To establish a comprehensive data collection for breast cancer incidence and mortality, cancer registries were asked to:

(a) provide updated incidence and mortality files where possible; and

(b) examine proposed deaths information provided by the Institute in its matching of breast cancer cases held in the NCSCH with all death information held in the NDI (see below).

NCSCH and NDI matching

The Institute used probabilistic matching to identify potential deaths from any cause among women diagnosed with breast cancer within the State or Territory of diagnosis or in another State or Territory. It did this by using the identifiable information held in the NDI and the NCSCH. For all States and Territories, except New South Wales, the same matching algorithms were used. In the case of New South Wales, due to the large file size, a modified algorithm was used to control the number of marginally plausible matches and to be consistent with the matching algorithm used by the New South Wales Cancer Registry for other death matching.

The matching algorithms allocated scores to each matching pair, with higher scores reflecting a greater probability of a correct match and lower scores a less likely match. Output files containing potential matches and their scores were sent to State and Territory cancer registries, via a secure means, for review. The information on these files related to the woman’s name, date of birth, age at diagnosis, date of diagnosis, date of death, State or Territory of death, cancer incidence and death registration numbers, a matching score, and cause of death.

Inevitably there were variations in case details on the output files, e.g. missing middle names, variation in name spelling, and date of birth differences. Further, date of birth was not always available on the NDI as this information was not collected by the Registrars of Births, Deaths and Marriages in some jurisdictions over specific periods (Table A1). In this situation an estimated year of birth, based on a computation of the difference between the age at death and the year of death, was available. This calculation could, however, result in the estimated year of birth being up to one year out in either direction. This lack of precision for some jurisdictions reduces the certainty of the match between cancer and death records. Nationally, date of birth information was available from 1996; however most States and Territories had complete date of birth information by the early 1990s.

Table A1: National Death Index: availability of date of birth data by State and Territory

State/Territory	Date of birth not available	Date of birth available
New South Wales	1980–1991	1992–1997
Victoria	1980–1988	1989–1997
Western Australia	Nil[(a)]	1980–1997
South Australia	Nil[(a)]	1980–1997
Tasmania	1980–1994	1995–1997
Australian Capital Territory	1980–1992	1993–1997
Northern Territory	1982–1990	1991–1997

(a) There are a few death registrations where date of birth was unavailable. These are spread across the whole period.

Each State and Territory cancer registry resolved possible matches according to local rules for accepting a cancer death notification. These rules are described in detail below. In general, cancer registries undertook validation checks on potential matches. These validation checks included checking their own database for the case, reviewing case file notes, and contacting hospitals, pathologists and specialists. Of the proposed matches sent to the State and Territory cancer registries for resolution, the majority (approximately 70%) were found to be valid.

The number of potential matches that were eventually accepted as matches varied by State and Territory (Table A2). This variation was partly due to:

- the number of women with breast cancer in each State or Territory;
- the length of time since the State or Territory cancer registry last updated its register with deaths information;
- the length of time since the NCSCH data were last linked to the NDI to assist the cancer registries with death clearance; and
- the differing local rules for case resolution.

Table A2: Results of breast cancer matching process by State and Territory

State/Territory	Years	Matched cases
New South Wales	1982–1994	3,955
Victoria	1982–1994	1,758
Western Australia	1982–1994	158
South Australia	1982–1994	30
Tasmania	1982–1994	39
Australian Capital Territory	1982–1994	40
Northern Territory	1982–1994	70

Some of the deaths identified by matching the NCSCH data to the NDI were already known to the cancer registries but had not been reported to the NCSCH. These deaths were subsequently added to the NCSCH. Other deaths were unknown to the cancer registries and were subsequently added to the relevant cancer registry's records and incorporated in the NCSCH. In some instances, cancer registries exchanged information about cases diagnosed in one jurisdiction and dying in another.

Cancer registries' practices in resolving matches between the NCSCH and the NDI

Each cancer registry appointed an experienced officer(s) to resolve proposed matches of NDI deaths with breast cancer cases. While there were some local variations to this practice the essential elements of the matching criteria are summarised here.

Officers either electronically or manually examined the breast cancer cases and the proposed NDI deaths, comparing them for:

- similarity of name, name combinations and name rarity;
- plausibility of death linkage e.g. diagnosis date or follow-up date later than death date;
- similarity of dates of birth, incidence and death, checking multiple reporting sources; and
- similarity of cause of death and the breast cancer diagnosis.

It was recognised that some latitude was required in handling these proposed matches as the recording of information from all cancer registry and death notification sources is not consistent and not always accurate, although the use of multiple checking sources helped to alleviate this problem. It was noted that there was a tendency to accept matches more readily where complete date of birth details were available from the cancer registry file and the NDI rather than an estimated year of birth.

Cancer registry officers applied the matching criteria described above and validated the linkage by:

- comparing the proposed NDI death with full case details on the cancer registry database;
- comparing the proposed NDI death with electoral roll details;
- comparing the proposed NDI death with hospital records;
- following up the proposed NDI death and case details with treating doctors; and
- comparing the case and proposed NDI death with details from other cancer registries.

Often more than one of these validation strategies was used to undertake the death clearance process. In circumstances where these strategies failed to confirm or reject the linkage clearly, the case, for the purposes of this analysis, was treated as being alive until further evidence was obtained. Cases registered in the Australian Capital Territory were handled mainly by the New South Wales Registry staff, while the South Australian Registry handled a large proportion of the Northern Territory cases, both situations being covered under existing contractual arrangements.

NCSCH internal matching

To ensure that incident cases were not counted more than once when they had recorded diagnoses in more than one State or Territory, a deduplication probabilistic linkage was undertaken on the final database. Where positive matches were found, these were referred to the cancer registries for resolution using standard registration rules based on personal identification, date of diagnosis, histological comparisons (to check for multiple primaries) and place of usual residence at time of diagnosis. Where cancer registries were not able to resolve the cases in the available time the Institute made an allocation based on the available information. Only the most definite matches were accepted in this last phase, otherwise the matched pairs were treated as separate new cases.

Classification to urban and rural areas of usual residence

The survival analysis included an examination of differences in relative survival proportions by urban and rural areas of usual residence. To undertake this analysis it was necessary to allocate, to each breast cancer case, a code indicating whether the woman's geographic area of usual residence was urban or rural.

The Rural, Remote and Metropolitan Areas (RRMA) classification (DPIE & DHSH 1994) classifies each State and Territory into three groups—metropolitan areas, rural zones and remote zones—using information from the 1991 Census. Metropolitan areas are allocated according to total population. Rural and remote zones are allocated according to their index of remoteness, which is based on population density and distance to large population centres.

Electronic files converting postcodes and statistical local areas (SLAs) to the RRMA classification were used to classify each breast cancer case to either:

- an urban area of usual residence (i.e. a RRMA metropolitan area); or
- a rural area of usual residence (i.e. a RRMA rural or remote zone).

However, there was a small proportion of cases where postcode and SLA were missing or were not recognised by the RRMA conversion system. Each of these cases was manually reviewed and, where possible, allocated to an urban or rural area of usual residence. Less than 1% of all cases could not be allocated to an urban or rural area (Table A3).

Table A3: Per cent of breast cancer cases missing urban or rural status

State/Territory	Years	New cases	Per cent of cases missing urban or rural area of usual residence
New South Wales	1982–1994	31,792	0.75
Victoria	1982–1994	23,696	0.09
Western Australia	1982–1994	8,089	0.82
South Australia	1982–1994	8,038	<0.01
Tasmania	1982–1994	2,293	0
Australian Capital Territory	1982–1994	1,212	0.25
Northern Territory	1982–1994	278	2.52
Australia	1982–1994	90,090	0.69

Data validation

Quality assurance in data and in procedures was an important focus of this project. Cases were subjected to internal data consistency checks and external checks. A series of tables (see Appendix B) was used to assess the distribution of the incidence and mortality data for the cohort by year, State and Territory, age group, and geographic area of usual residence. Many of these tables were compared with data published by the cancer registries and mortality data extracted from the national mortality database.

Further investigation of the data was undertaken by calculating age-standardised incidence rates for most of the validation tables. These rates were compared with those published in previous cancer registry publications.

Relative survival analysis

Cause-specific survival and relative survival are two methods used to estimate the probability of surviving a specific disease (Estève et al. 1994). Cause-specific survival is used when cause of death is known with certainty. However, cause of death is not always easy to determine. Further, for most cancer patients, the risk of dying from other causes is not negligible and should be adjusted for when analysing their survival experience (Ederer et al. 1961). In contrast to cause-specific survival, relative survival does not require knowledge of the cause of death. For this national breast cancer survival project, not all causes of death were known with certainty, although the fact of death was known and therefore relative survival methods were appropriate.

Relative survival is defined as the ratio of the observed survival rate for a given cohort of patients to the expected survival rate (Ederer et al. 1961). The expected survival rate is that which the patient group should have experienced based on the lifetable of the general population from which they were diagnosed (Estève et al. 1990).

A relative survival of less than 100% implies that the patient group survived for less time than would be expected for a similar group from the general population. A relative survival of 100% implies that survival in the patient group is no different from that in the general population.

The relative survival analysis for this report was undertaken using the software program RELSURV (v2.0), which was written in 1995 by Guy Hédelin of Louis Pasteur University, Strasbourg, France (Hédelin 1995). The program calculates expected survival using the lifetable method and estimates relative survival using a Cox proportional hazards regression model.

Life tables

Lifetables by single-year ages (0–99 years) were derived for Australia and each State and Territory for each year from 1982 to 1994 using deaths data and estimates of resident population. Queensland data were excluded from each of these lifetables.

The derivation of lifetables for Australia by urban and rural areas of usual residence (excluding Queensland) was problematic and the following methods and assumptions were used to derive lifetables by single-year ages (0–98 years) for each year from 1982 to 1994.

Deaths data by urban and rural areas of usual residence

1. Deaths data were available by single-year ages and statistical local areas (SLAs) from 1985 onwards. For each year from 1985 to 1994, every death record was mapped to the RRMA classification using electronic SLA-to-RRMA concordance files. Deaths by RRMA were then aggregated to two levels:
   - urban areas of usual residence (consisting of RRMA metropolitan codes M1 and M2); and
   - rural areas of usual residence (consisting of RRMA rural codes R1, R2 and R3, and remote codes Rem1 and Rem 2).
2. Deaths data for each of the years 1982 to 1984 do not include SLA information and therefore could not be mapped to the RRMA classification. It was assumed that the number of deaths for each of the years 1982 to 1984, by single-year ages for urban and rural areas of usual residence, was the same as that in 1985.

Estimated resident population data by urban and rural areas of usual residence

1. Estimated resident population (ERP) data were available by SLA only for 5-year age groups from 1986 onwards, with the exception of 1991 for which ERP data by single-year ages from 0 to 98 years were available. For each year from 1986 to 1990 and from 1992 to 1994, ERP data by 5-year age group were mapped to the RRMA classification using electronic SLA-to-RRMA concordance files. The ERPs by 5-year age group and RRMA were then aggregated to two levels:
   - urban areas of usual residence (consisting of RRMA metropolitan codes M1 and M2); and
   - rural areas of usual residence (consisting of RRMA rural codes R1, R2, R3 and remote codes Rem1, Rem 2).
2. For 1991, ERP data by single-year ages (0–98 years) were mapped to the RRMA classification using electronic SLA-to-RRMA concordance files. The ERPs were then aggregated to urban and rural areas of usual residence. The single-year age ERPs were then further aggregated to 5-year age groups so that the distribution of single-year ages within each 5-year age group could be determined. For example, for the age group 0–4 years, the proportions of 0-year-olds, 1-year-olds, 2-year-olds, 3-year-olds and 4-year-olds were calculated. The distribution of single-year ages within each 5-year age group for 1991 was then applied to the ERP data for each of the years 1986 to 1990 and 1992 to 1994. This enabled the estimation of ERPs for these years by single-year ages (0–98) for urban and rural areas of usual residence.
3. ERP data for the years 1982 to 1985 were not available by SLA and therefore could not be mapped to the RRMA classification. It was assumed that the ERP for each of the years 1982 to 1985, by single-year ages for urban and rural areas of usual residence, was the same as that in 1986.

Lifetables by urban and rural areas of usual residence

The deaths data and estimated resident population data by urban and rural areas of usual residence described above were used to construct lifetables for each of the years 1986 to 1994. A lifetable for 1985 was constructed using ERP data for 1986. Lifetables for each of the years 1982 to 1984 were assumed to be the same as the lifetable for 1985.

Relative survival analysis methods

The RELSURV program required the input of two data files. The first contained hazard rates by birth cohort for each of the years 1982 to 1994 stratified by age and any other main variables included in the model. The second file contained the characteristics of each woman diagnosed with breast cancer between 1 January 1982 and 31 December 1994; this file contained the main variables and covariables included in the model.

Data files are provided to the RELSURV program in a specific format. The software is able to run interactively or in batch mode, the latter approach being adopted for this project. RELSURV returns a range of relative survival estimates, their confidence intervals and tests for differences between these estimates. Chapter 3 summarises these results.

Hazard rates

As discussed, the RELSURV software program requires hazard rates by single-year ages for each year of follow-up. These hazard rates, l_x, were calculated from lifetable information using the formula:

$$l_x = -\ln(1 - q_x)$$

where q_x is the probability of dying between exact ages x and x+1 and is calculated using the following standard approximation:

$$q_x = \frac{M_x}{(1 + M_x(1 - a_x))}$$

where M_x is the age-specific death rate of persons aged x; and

a_x is the assumed fraction of a year lived by those who die during the year.

The following assumptions were made for a_x:

- a_0 = 0.9 because deaths among the very young in Australia tend to be concentrated early in the first year of life; and
- $a_1 - a_{99}$ = 0.5 because those who die in the year will live, on average, half of a year during that year.

Records excluded from the analysis

Records with the following characteristics were excluded from the survival analysis (Table A4):

- any woman whose age at diagnosis was not known or was missing;
- any woman aged 100 years or over at diagnosis. This was due to the lack of precision in the hazard rates for women older than 99 years, the atypical nature of survival in this cohort, and the relatively few cases available for analysis when compared with younger women;
- all cases diagnosed in Queensland. This was due to the fact that survival status was incomplete for cases diagnosed in Queensland;
- any woman for whom there was ambiguity surrounding their exact date of diagnosis or death;

- death certificate-only cases (i.e. cases diagnosed at death) because the survival methods used by the RELSURV program do not allow for a survival time of zero;
- any woman who died within one month of diagnosis. This was because the calculation of survival time used only month and year of diagnosis and death (as day of diagnosis is unreliable) and therefore survival time was calculated as zero for these women;
- any woman who was diagnosed in December 1994 because these women had a follow-up time of less than one month and therefore survival time was calculated as zero;
- cases that could not be allocated to an urban or rural area of usual residence for analyses by area of usual residence.

Table A4: Characteristics of records excluded from survival analysis

Characteristic	Number of cases
Unknown/missing age at diagnosis	2
Women aged = 100 years of age at diagnosis	24
Cases diagnosed in Queensland	14,693
Death certificate-only cases	565
Women whose date of diagnosis or death could not be resolved	60
Women surviving less than one month or diagnosed in December 1994	475
Women diagnosed in December 1994	836
Unknown area of usual residence[(a)]	619
Total records excluded[(b)]	16,263

(a) These cases were excluded only from analyses by area of usual residence.

(b) The total is less than the sum of components because some records may have been excluded for more than one reason.

Key assumptions

1. One limitation of the RELSURV program is that it is not able to handle data files that are larger than 65,535 records. After excluding records with the characteristics described above, the breast cancer data file contained 73,827 records. Therefore it was not possible to use the whole file when undertaking the analysis at the 'Australia, all ages, 1982–1994' level. To account for this, a sample of 65,500 records (88.7% of all records) was systematically selected. Before selecting the sample, the whole file of 73,827 records was sorted by State or Territory of usual residence, geographic area of usual residence, diagnosis year, and age at diagnosis. Frequency tables by diagnosis year, age at diagnosis, survival time (in months), State or Territory of usual residence, and geographic area of usual residence were used to compare the distribution of records in the sample file with that in the whole file. The distribution of each variable in the sample file was almost always identical to that in the whole file. Where the distribution was not completely identical, it was different by only 0.1%. This indicated that the sample file was representative of the whole file and that use of the sample file for analysis at the 'Australia, all ages, 1982–1994' level would not introduce bias.
2. To estimate relative survival at all other levels (i.e. by age at diagnosis, period or year of diagnosis, State or Territory of usual residence, and urban or rural area of usual residence), the whole data file was split into files that were analysed separately. For example, to estimate relative survival by age at diagnosis, the whole file was split into two files:

- File A—all women aged 25–59 years at diagnosis; and
- File B—all women aged 60–99 years at diagnosis.

File A was used to estimate relative survival proportions for women aged 25–39 years, 40–49 years and 50–59 years. File B was used to estimate relative survival for women aged 60–69 years, 70–79 years, 80–89 years and 90–99 years.

3. All cases were followed up to 31 December 1994, which was the censoring date. Unless a woman diagnosed with breast cancer was known to have died before 31 December 1994, it was assumed that she was still alive (i.e. censored).

Variables included in the relative survival analysis

Survival time (in months) and vital status were always included in the survival model.

Survival time

For women known to have died before 31 December 1994, survival time in months was calculated as:

(year of death – year of diagnosis)*12 + (month of death – month of diagnosis)

For women still believed to be alive at 31 December 1994 (i.e. censored), survival time in months was calculated as:

(1994 – year of diagnosis)*12 + (12 – month of diagnosis)

Vital status

Vital status = 0 if believed to be still alive at 31 December 1994 (i.e. censored)
1 if dead

The following variables were included as necessary:

- year of diagnosis;
- State or Territory of usual residence at diagnosis;
- urban or rural area of usual residence at diagnosis;
- age at 1982 (this was required instead of age at diagnosis because of the way that RELSURV looks up the hazard rates when files by birth cohort are used).

To adjust for confounding variables, the following covariables were included in the survival models as necessary:

- age group at diagnosis (25–39, 40–49, 50–59, 60–69, 70–79, 80–89);
- period of diagnosis (1982–1987, 1988–1992, 1993–1994);
- State or Territory of usual residence at diagnosis.

Appendix B: Descriptive data analysis

Table B1: Breast cancer cohort: age-standardised incidence rates[(a)] by period of diagnosis, Australia[(b)]

	1982–1994		1982–1987		1988–1992		1993–1994	
Age group	**New cases**	**Rate**	**New cases**	**Rate**	**New cases**	**Rate**	**New cases**	**Rate**
25–39	5,909	27.7	2,528	27.3	2,397	28.2	984	27.8
40–49	14,407	131.4	5,262	120.4	6,168	136.0	2,977	144.6
50–59	15,648	188.2	6,104	162.0	6,202	194.3	3,342	245.0
60–69	17,672	236.0	6,851	208.1	7,181	239.3	3,640	304.9
70–79	14,139	273.0	5,519	250.9	5,774	277.8	2,846	315.7
80+	7,549	296.9	2,897	284.3	3,228	310.1	1,424	295.2
25+	75,324	131.1	29,161	118.7	30,950	134.4	15,213	154.8
All ages	**75,395**	**81.5**	**29,193**	**73.8**	**30,975**	**83.6**	**15,227**	**96.3**

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

Table B2: Breast cancer cohort: age-standardised death rates[(a)] for deaths from all causes by period of death, Australia[(b)]

	1982–1994		1982–1987		1988–1992		1993–1994	
Age group	**Deaths**	**Rate**	**Deaths**	**Rate**	**Deaths**	**Rate**	**Deaths**	**Rate**
25–39	945	4.4	301	3.3	460	5.4	184	5.2
40–49	2,576	23.5	692	15.8	1,318	29.1	566	27.4
50–59	3,710	44.5	1,119	29.5	1,778	55.7	813	59.6
60–69	4,747	63.4	1,400	42.6	2,326	77.5	1,021	85.4
70–79	5,566	107.5	1,467	66.9	2,746	131.6	1,353	150.4
80+	6,170	238.9	1,330	129.0	3,098	292.8	1,742	354.2
25+	23,714	39.1	6,309	24.8	11,726	48.1	5,679	53.1
All ages	**23,724**	**24.3**	**6,313**	**15.4**	**11,730**	**29.9**	**5,681**	**33.0**

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

Table B3: Breast cancer cohort: age-standardised incidence rates[(a)] by State and Territory and period of diagnosis

	1982–1994		1982–1987		1988–1992		1993–1994	
State	New cases	Rate	New cases	Rate	New cases	Rate	New cases	Rate
NSW	31,791	81.4	12,302	73.3	13,126	84.1	6,363	95.9
Vic	23,696	81.7	9,363	74.9	9,552	82.5	4,781	97.0
WA	8,087	86.4	3,016	78.7	3,462	90.2	1,609	95.7
SA	8,038	79.8	3,089	71.0	3,344	83.5	1,605	94.7
Tas	2,293	75.1	895	68.4	871	71.1	527	102.2
ACT	1,212	87.9	433	78.4	502	88.1	277	107.4
NT	278	52.7	95	44.6	118	56.6	65	58.8
Australia[(b)]	**75,395**	**81.5**	**29,193**	**73.8**	**30,975**	**83.6**	**15,227**	**96.3**

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

Table B4: Breast cancer cohort: age-standardised death rates[(a)] for deaths from all causes by State and Territory and period of death

	1982–1994		1982–1987		1988–1992		1993–1994	
State	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate
NSW	9,992	24.2	2,593	14.8	4,992	30.0	2,407	33.2
Vic	7,623	24.8	1,991	15.3	3,806	31.0	1,826	33.9
WA	2,532	26.3	747	19.3	1,216	30.7	569	31.9
SA	2,476	22.8	645	14.0	1,206	27.8	625	32.6
Tas	765	23.6	236	17.5	349	26.6	180	31.7
ACT	253	20.4	78	15.9	119	22.9	56	23.8
NT	83	20.9	23	14.3	42	25.0	18	24.6
Australia[(b)]	**23,724**	**24.3**	**6,313**	**15.4**	**11,730**	**29.9**	**5,681**	**33.0**

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

Table B5: Breast cancer cohort: age-standardised incidence rates[(a)] by urban and rural area of usual residence[(b)] and year of diagnosis

	Urban		Rural	
Year of diagnosis	New cases	Rate	New cases	Rate
1982	3,326	(c)	1,004	(c)
1983	3,303	(c)	1,081	(c)
1984	3,582	(c)	1,161	(c)
1985	4,274	(c)	1,184	(c)
1986	3,893	76.7	1,177	67.5
1987	4,119	79.5	1,407	79.4
1988	4,258	80.5	1,362	75.1
1989	4,557	84.5	1,421	76.3
1990	4,578	83.5	1,478	77.0
1991	4,930	88.1	1,650	83.8
1992	4,936	86.5	1,663	82.2
1993	5,387	93.3	1,777	86.1
1994	6,044	103.0	1,997	94.7

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

(c) Rate could not be calculated because the base population data were not available.

Table B6: Breast cancer cohort: age-standardised death rates[(a)] for deaths from all causes by urban and rural area of usual residence[(b)] and year of diagnosis

	Urban		Rural	
Year of diagnosis	Deaths	Rate	Deaths	Rate
1982	141	(c)	37	(c)
1983	417	(c)	131	(c)
1984	681	(c)	237	(c)
1985	991	(c)	345	(c)
1986	1,141	21.6	353	19.8
1987	1,369	25.2	441	23.8
1988	1,531	27.4	545	28.4
1989	1,701	30.0	538	27.5
1990	1,697	29.2	595	29.8
1991	1,898	31.9	629	30.4
1992	1,880	30.9	643	29.8
1993	2,037	32.5	685	30.8
1994	2,131	33.3	800	34.1

(a) Rates are expressed per 100,000 population and age-standardised to the total 1991 Australian population.

(b) Excludes Queensland.

(c) Rate could not be calculated because the base population data were not available.

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