



Australian Government
Cancer Australia

**Study of breast cancer screening characteristics
and breast cancer survival in Aboriginal and
Torres Strait Islander women of Australia**

May 2012

Study of breast cancer screening characteristics and breast cancer survival in Aboriginal and Torres Strait Islander women of Australia
was prepared and produced by:

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© Cancer Australia (2012)
ISBN Online: 978-1-74127-185-0

Recommended citation

Cancer Australia. Study of breast cancer screening characteristics and breast cancer survival in Aboriginal and Torres Strait Islander women of Australia Cancer Australia, Surry Hills, NSW, (2012).

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Copies of Study of breast cancer screening characteristics and breast cancer survival in Aboriginal and Torres Strait Islander women of Australia can be downloaded from the Cancer Australia website: www.canceraustralia.gov.au or ordered by telephone: 1800 624 973.

Foreword

This study provides a national overview of breast cancer screening and survival in Aboriginal and Torres Strait Islander women of Australia. Cancer Australia (formerly National Breast and Ovarian Cancer Centre*) undertook this study in response to the clear evidence of disadvantage among Aboriginal and Torres Strait Islander peoples compared with other Australians, and the lack of high quality, national breast cancer data available for Aboriginal and Torres Strait Islander women.

The data in this report, collected through state and territory BreastScreen programs and population-based cancer registries, identifies significant areas for future work to ultimately improve breast cancer outcomes for Aboriginal and Torres Strait Islander women. The value of data is its relevance to outcomes and its capacity to impact on change. This report will provide benchmarks for future monitoring, and will help to inform health policy, health promotion and health service planning for Aboriginal and Torres Strait Islander women.

Cancer Australia is grateful to the Aboriginal and Torres Strait Islander women who had input into the study and resulting report to help ensure its relevance. This report also represents the contribution of state and territory BreastScreen programs and cancer registries in making the data available to the Australian Institute of Health and Welfare for analysis. We anticipate that the information contained in this report will be used to improve the outcomes of Aboriginal and Torres Strait Islander women diagnosed with breast cancer.

Dr Helen Zorbas

Chief Executive Officer

**On 30 June 2011, National Breast and Ovarian Cancer Centre (NBOCC) and Cancer Australia amalgamated to form a single national agency, Cancer Australia, to provide leadership in cancer control and improve outcomes for Australians affected by cancer.*

Contents

Foreword	i
Acknowledgments.....	vi
Executive summary	ix
1 Background	1
2 Study 1: BreastScreen evaluation data	3
2.1 Overview	3
2.2 Introduction	9
2.3 Methods	10
2.4 Results	11
2.5 Discussion	16
2.6 Conclusions.....	20
3 Study 2: Linked BreastScreen and cancer registry data.....	23
3.1 Overview	23
3.2 Introduction	26
3.3 Methods	27
3.4 Results	28
3.5 Discussion	31
3.6 Conclusions.....	33
Appendix A Contributors.....	63
Abbreviations	64
References.....	65

Tables

Table 1:	Socio-demographic differences for 50-69 year old women by Aboriginal and Torres Strait Islander status: BreastScreen Australia, 1996-2005	34
Table 2:	Screening characteristics of 50-69 year old women by Aboriginal and Torres Strait Islander status: BreastScreen Australia, 1996-2005	35
Table 3:	Relative odds of screened women being rescreened within 27 months by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	36
Table 4:	Relative odds of rescreened women being rescreened within 27 months by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis.....	37
Table 5:	Relative odds of presenting to screening with symptoms by socio-demographic characteristics: BreastScreen Australia, 1996-2005* - Regression analysis	38
Table 6:	Relative odds of screened women being recalled to assessment by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	39
Table 7:	Relative odds of assessed women being assessed within 28 days by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	40
Table 8:	Relative odds of screened women having a biopsy by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	41
Table 9:	Relative odds of recalled women having a biopsy by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	42
Table 10:	Relative odds of screened women having invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	43
Table 11:	Relative odds of recalled women having invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	44
Table 12:	Relative odds of screened women having DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis.....	45
Table 13:	Relative odds of recalled women having DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis.....	46
Table 14:	Relative odds of screened women having invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	47
Table 15:	Relative odds of recalled women having invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	48
Table 16:	Relative odds of invasive cancer compared with DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	49

Table 17:	Relative odds of large (> 15mm) compared with smaller invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	50
Table 18:	Relative odds of large (> 15mm) compared with smaller invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	51
Table 19:	Relative odds of mastectomy compared with complete local excision for invasive breast cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis.....	52
Table 20:	Relative odds of mastectomy compared with complete local excision for invasive breast or DCIS cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005 - Regression analysis	53
Table 21:	Characteristics of women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status	54
Table 22:	Invasive breast cancer characteristics for women diagnosed in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status	55
Table 23:	Percentage 5-year crude survivals (95% confidence limits) for invasive breast cancers for women diagnosed in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status.....	56
Table 24:	Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia - Proportional hazards regression analysis	57
Table 25:	Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 30,852 women with recorded tumour size and nodal status) - Proportional hazards regression analysis.....	58
Table 26:	Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 28,073 women with recorded tumour size and nodal status) - Proportional hazards regression analysis.....	59
Table 27:	Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia - Proportional hazards regression analysis.....	60
Table 28:	Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 30,852 women with recorded tumour size and nodal status) - Proportional hazards regression analysis	61
Table 29:	Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 28,073 women with recorded tumour size and nodal status) - Proportional hazards regression analysis	62

Figures

Figure 1: Relative odds of Aboriginal and Torres Strait Islander compared with other women having specified breast screening experiences: 50-69 year old women screened through BreastScreen, 1996-2005 - Screening and assessment experiences.....	6
Figure 2: Relative odds of Aboriginal and Torres Strait Islander compared with other women having specified breast screening experiences: 50-69 year old women screened through BreastScreen, 1996-2005 - Screening outcomes	8

Acknowledgments

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Cancer Australia also acknowledges staff at the Cancer and Palliative Care Branch of the Department of Health and Ageing for their input into the study and resulting report.

Cancer Australia Aboriginal and Torres Strait Islander Advisory Network

Cancer Australia would like to sincerely thank the members of the Cancer Australia Aboriginal and Torres Strait Islander Advisory Network for their important contribution to the detail of the study and development of this report.

Research ethics committees

Ethics approval to undertake this study was provided by the following research ethics committees from across Australia:

- Australian Institute of Health and Welfare Ethics Committee
- NSW Population & Health Service Ethics Committee
- Aboriginal Health & Medical Research Ethics Committee (NSW)
- ACT Health Human Research Ethics Committee
- SA Health Human Research Ethics Committee
- Aboriginal Health Research Ethics Committee (SA)
- Human Research Ethics Committee of the Northern Territory Department of Health and Families and Menzies School of Health Research
- Queensland Health Human Research Ethics Committee
- WA Aboriginal Health Information & Ethics Committee

Approval to undertake this study was also provided by the Victorian Cancer Registry and Tasmanian Cancer Registry.

Australian Institute of Health and Welfare

The analysis for the study was undertaken by staff at the Cancer and Screening Unit of the Australian Institute of Health and Welfare, whose contribution we are grateful.

Jurisdictions

This report would not have been possible without the significant contribution of the state and territory BreastScreen programs and cancer registries in making the data available to the Australian Institute of Health and Welfare for analysis. Key contributors involved in the data extraction and linkage are outlined in Appendix A.

Executive summary

Aboriginal and Torres Strait Islander people represent about 2.5% of the Australian population (ABS 2008; AIHW 2008; Cunningham et al 2008). They more frequently live in remote and very remote areas than other Australians and their health is often affected adversely by severe socio-economic disadvantage, cultural marginalisation and remoteness (Cunningham et al 2008).

Studies have shown survivals of Aboriginal and Torres Strait Islander women with breast cancer to be lower than for other women with breast cancer and their breast cancers to be generally detected at a more advanced stage of progression (AIHW 2008; AIHW & NBOCC 2009; Roder & Currow 2009; Condon et al 2005c, 2005d). Increased participation of Aboriginal and Torres Strait Islander women in breast screening is therefore considered important to increase prospects for improved survival.

The present investigation comprises two studies (study 1 and study 2). In study 1, 1996-2005 BreastScreen screening data provided by the states and territories to the Australian Institute of Health and Welfare (AIHW) were used to compare screening, assessment and outcomes of 50-69 year old women (the breast screening target age range) by Aboriginal and Torres Strait Islander status. Analyses included adjustment for socio-demographic differences (i.e., differences in age, socio-economic status, and remoteness) and screening period, in order to determine whether less favourable outcomes in Aboriginal and Torres Strait Islander women were explained by these differences.

Results of study 1 indicated that compared with other women, Aboriginal and Torres Strait Islander women:

- Participate less frequently in breast screening and rescreening and that this was not fully explained by their socio-demographic characteristics and likely would have contributed to the larger sizes of their breast cancers at diagnosis and their poorer survivals.
- Were less likely to be assessed within the recommended 28 days from screening, when recalled for assessment.
- Had a lower detection of invasive breast cancers, which is consistent with their lower population-based incidence. Results indicated, however, that this lower detection rate was more a function of socio-demographic correlates than of factors specific to Aboriginal and Torres Strait Islander status.
- Had elevated ductal carcinoma in situ (DCIS) detection rates after adjusting for socio-demographic factors and difference in calendar year period. The reasons for this are not known and require further study.
- Had larger invasive cancer at diagnosis than other women after adjusting for socio-demographic correlates and difference in calendar year period. This would contribute to higher case fatality.

- Were more likely than other women to receive a mastectomy than complete local excision of their breast cancers. Further research is needed to determine the extent to which this difference is due to choice, larger tumour sizes, lower access to radiotherapy services or other factors.

In study 2, invasive breast cancer survivals were compared by Aboriginal and Torres Strait Islander status within the cohort of women with a history of participation in the BreastScreen Australia Program. The study was regarded as complementary to study 1 in exploring whether longer term inequalities existed that needed further attention.

Invasive breast cancer data for 1991-2006 diagnoses from Australian cancer registries and corresponding BreastScreen record data were linked at a jurisdictional level. This process excluded the Australian Capital Territory where data were not available within the time of the study. The effect of this exclusion would have been negligible as only about 0.8% of Aboriginal and Torres Strait Islander people reside in the Australian Capital Territory. De-identified linked data were sent to the AIHW for analysis.

Results of these analyses indicated that compared with other women with breast cancer, Aboriginal and Torres Strait Islander women:

- Had a lower five-year survival from death from all causes (81% compared with 90%), although these survivals were higher than those previously estimated for Aboriginal and Torres Strait Islander and other women in Australia, many of whom would not have been screened.
- Were generally younger than other women and more likely to live in remote locations and areas of greater socio-economic disadvantage.
- Had on average taken up participation in BreastScreen more recently, such that a higher proportion of their breast cancers were diagnosed in more recent time periods. These data are consistent with screening participation data that show a decreasing gap between participation rates for Aboriginal and Torres Strait Islander and other women.
- Had larger breast cancers with more evidence of nodal spread at diagnosis.
- Had, after adjusting for diagnostic period and socio-demographic factors, a risk of death from all causes 84% higher than for other women with breast cancer.
- Had, after adjusting for diagnostic period and socio-demographic factors, a risk of death from breast cancer 68% higher than other women with breast cancer.

When analyses were repeated for sub-groups of women, adjusting in addition for tumour size, nodal spread, and whether diagnosis occurred within four months of prior screening (note: in sub-groups with recorded tumour size, nodal spread and time from prior screening), the risk of death from any cause was 122% higher in Aboriginal and Torres Strait Islander than other women and a corresponding 96% elevation in risk of death from breast cancer was observed.

The reasons for excess deaths in Aboriginal and Torres Strait Islander women after adjusting for socio-demographic and tumour characteristics are not known, but from

previous study results, they probably include higher levels of co-morbidity and potentially less complete cancer treatment due to geographic remoteness and cultural factors.

1 Background

Aboriginal and Torres Strait Islander people represent about 2.5% of the Australian population (ABS 2008; AIHW 2008; Cunningham et al 2008). They more frequently live in remote and very remote areas than other Australians and their health is often affected adversely by severe socio-economic disadvantage, cultural marginalisation and remoteness (Cunningham et al 2008). Studies have shown lower survivals from breast cancer among Aboriginal and Torres Strait Islander women than other women (AIHW & NBOCC 2009; Chong & Roder 2010). They also have more advanced stages of breast cancers at diagnosis which would predispose to their poorer survival outcomes (Condon et al 2005c, 2005d).

Breast cancer incidence was estimated to be about a third lower in Aboriginal and Torres Strait Islander than other Australian females during 2002-2006 after standardising by age (AIHW & NBOCC 2009). Some studies have indicated much lower breast cancer incidence rates in Aboriginal and Torres Strait Islander women, including rates as low as half that seen in other women (AIHW 2008; AIHW & NBOCC 2009; Condon et al 2005a; Cottrell et al 2007; Roder & Currow 2009). A recent Queensland study, while also indicating a lower incidence in Aboriginal and Torres Strait Islander women, found a difference of smaller magnitude of about 18% (Moore et al 2010). Despite lower incidence figures in Aboriginal and Torres Strait Islander women, breast cancer mortality rates appear to be at least as high as in other Australian women, reflecting lower case survivals (AIHW 2008; AIHW & NBOCC 2009; Roder & Currow 2009). Five-year survivals of breast cancer patients from all causes of death combined were found to be 65% for Aboriginal and Torres Strait Islander women and 82% for other Australian women in 2002-2006; whereas data from South Australia indicated five-year disease-specific survivals from breast cancer of about 60% for Aboriginal and Torres Strait Islander and 80% for other women (AIHW & NBOCC 2009; Chong & Roder 2010).

As for other cancers, more advanced stages at diagnosis are likely contributors to poorer survivals from breast cancer in Aboriginal and Torres Strait Islander women. Previous studies have shown more advanced stages in the former, including a Northern Territory investigation where 55% of invasive breast cancers in Aboriginal and Torres Strait Islander women were found at diagnosis to have spread to regional nodes or more distant organ sites compared with a corresponding 38% of invasive breast cancers in other women (Condon et al 2005c, 2005d).

Incomplete recording of Aboriginal and Torres Strait Islander status has been a major limitation in Australian health statistics collections, including cancer registries which obtain this information from secondary sources such as hospital and death records (AIHW & ABS 2006). Nonetheless, data from multiple sources show a similar cancer picture (AIHW 2008; Condon et al 2004, 2005a, 2005b, 2006a; Coory et al 2000; Cottrell et al 2007; Cunningham et al 2008; Moore et al 2010; Roder 2005; Roder & Currow 2009; SACR 1997; Supramaniam et al 2006). While cancer incidence for all cancers combined appears to be similar or slightly lower in Aboriginal and Torres Strait Islander people than other Australians (excluding basal and squamous cell carcinomas of the skin), cancer death rates are about 50% higher in Aboriginal and Torres Strait Islander people, making cancer the third leading cause of death in males and the second leading cause of

death in females (AIHW 2008). Partly this is due to an elevation in case fatality among Aboriginal and Torres Strait Islander patients that is attributable to an excess of the more lethal cancer types, but there are also more advanced stages of cancer progression at diagnosis in these patients, and evidence that other factors are contributing, including higher levels of co-morbidity and less complete treatment (AIHW 2008; Cunningham 2002; Condon et al 2005a, 2005b, 2005c, 2006a, 2006b; Coory et al 2000; Coory et al 2008; Cottrell et al 2007; Fisher & Weeramanthri 2002; Hall et al 2004; Hunt & Geia 2002; Lowenthal et al 2005; Roder 2005; Roder & Currow 2009; SACR 1997; Shaw & Elston 2003; Valery et al 2006).

BreastScreen Australia provides screening mammography to detect unsuspected breast cancer to enable earlier treatment and reduce mortality. BreastScreen Australia data for 1996-2005 showed a lower two-year participation in screening by Aboriginal and Torres Strait Islander (32%) than other women (55%) in the 50-69 year screening target age range (AG 2009). This lower participation is likely to have contributed to the more advanced stages at diagnosis seen among Aboriginal and Torres Strait Islander women at a population level.

Comprising two studies, this research investigates the screening experiences and outcomes among Aboriginal and Torres Strait Islander and other Australian women; and determines the differences in survival from breast cancer among Aboriginal and Torres Strait Islander and other Australian women.

Using BreastScreen Australia data from 1996-2005, study 1 compares screening and assessment activity and screening outcomes by Aboriginal and Torres Strait Islander status among 50-69 year old Australian women. The purpose was to identify and quantify inequalities as a benchmark for ongoing monitoring and evaluation.

Study 2 analyses BreastScreen Australia data linked with state and territory cancer registry data to examine survivals of women with invasive breast cancer by Aboriginal and Torres Strait Islander status. This is undertaken within the cohort of women with a history of screening through BreastScreen Australia.

These studies provide a broad national overview. As the Aboriginal and Torres Strait Islander population is socio-demographically and culturally diverse, it was expected that results would not apply to all sections of this population. A benefit of this study was the availability of data on Aboriginal and Torres Strait Islander status from BreastScreen Australia, which was thought to be a more accurate information source.

2 Study 1: BreastScreen evaluation data

2.1 Overview

Introduction

In this study, screening and assessment activity and screening outcomes were compared by Aboriginal and Torres Strait Islander status in 50-69 year old Australian women to identify and quantify inequalities as a benchmark for ongoing monitoring and evaluation. By restricting the study to screening participants, it is recognised that differences in breast cancer characteristics by Aboriginal and Torres Strait Islander status are likely to have been smaller than would apply for the population more generally. This could occur for example if there was a self-selection of the more health conscious for BreastScreen Australia participation, irrespective of Aboriginal and Torres Strait Islander status. Inequalities found within the screening cohort would still be important, however, and potentially more amenable to change, given engagement of these women with BreastScreen Australia.

Methods

Two comparisons were undertaken using 1996-2005 screening data originally provided by the states and territories to the AIHW for broader evaluation of BreastScreen Australia (AG 2009). The comparisons were as follows:

- *Comparison 1* – A comparison of screening, assessment and outcomes by Aboriginal and Torres Strait Islander status, without adjusting for differences in socio-demographic profile (i.e., age, socio-economic status, and remoteness) and screening period.
- *Comparison 2* – A comparison of screening, assessment and outcomes by Aboriginal and Torres Strait Islander status, with adjustment for differences in socio-demographic profile and screening period. Results were interpreted as showing differences that were more likely to relate to specific Aboriginal and Torres Strait Islander factors than these socio-demographic correlates.

Where applicable, results were adjusted in both comparisons for screening round (initial versus subsequent) to avoid confounding from this factor.

Cross tabulations were used in Comparison 1, adjusting for screening round using the Mantel-Haenszel procedure (Armitage & Berry 1987). Regression modelling was employed in Comparison 2, as described in the Methods section of the main report, to adjust for socio-demographic factors, period of screening and screening round (Armitage & Berry 1987). The regression model produced relative odds (synonymous with odds ratios) of specified outcomes for Aboriginal and Torres Strait Islander compared with other women. For consistency, this same metric was used to describe results of Comparison 1. Ninety-five per cent confidence limits were provided in both comparisons to assist interpretation. They are regarded as indicative rather than definitive, due to the potential for a lack of independence of some observations.

Relative odds were the odds of a specified screening activity or outcome occurring in Aboriginal and Torres Strait Islander women, divided by the odds of this activity or outcome occurring in other screened women. If the odds were the same in Aboriginal and Torres Strait Islander women as in other screened women, the relative odds would be 1.00. Relative odds were interpreted as follows: those with lower 95% confidence limits above 1.00 indicated a greater probability of that experience or outcome occurring in Aboriginal and Torres Strait Islander than other screened women; whereas those with upper 95% confidence limits below 1.00 indicated that the probability was lower in Aboriginal and Torres Strait Islander than other screened women.

When presenting crude percentages of women with specified screening characteristics, the results for initial and subsequent screening rounds were weighted equally to avoid confounding.

Results

Results are presented under the headings of "Screening and assessment activity" and "Screening outcomes" respectively.

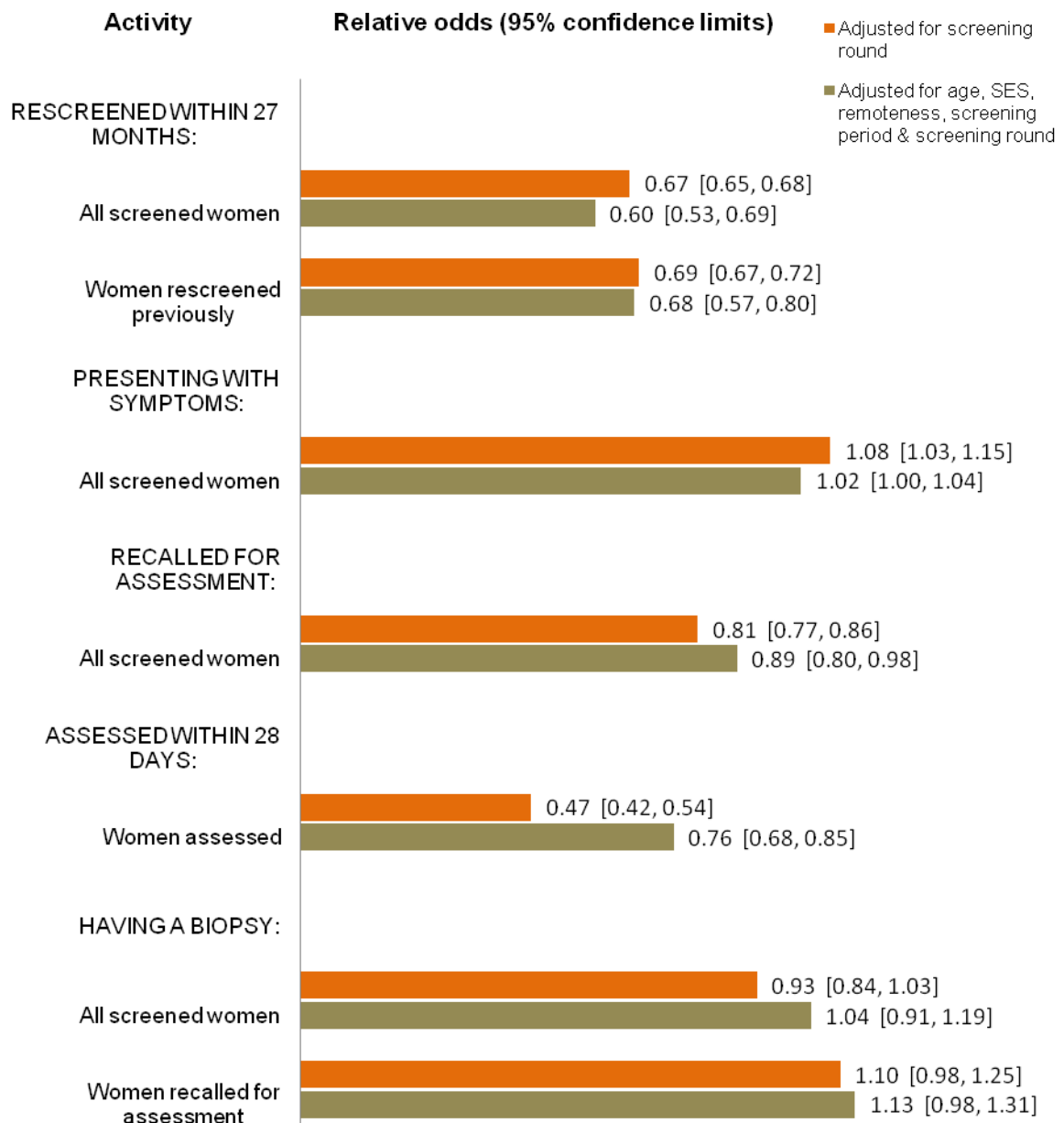
Screening and assessment activity (Figure 1)

- *Screening participation* - Aboriginal and Torres Strait Islander women had a lower two-year participation rate (36.3% Vs 57.5%). Less than half the difference in relative odds was attributable to socio-demographic factors and calendar year period, indicating a likely contribution of factors that were specific to Aboriginal and Torres Strait Islander women.
- *Rescreening participation* - Aboriginal and Torres Strait Islander women were less likely to participate in rescreening (60.1% Vs 70.4% rescreened following all screens; 80.2% Vs 85.6% rescreened following subsequent screens). These differences were not explained by socio-demographic correlates and calendar year period, again indicating the likely involvement of factors that were specific to Aboriginal and Torres Strait Islander women.
- *Symptom reporting* - The frequency with which symptoms were reported at screening was marginally higher for Aboriginal and Torres Strait Islander women (3.6% Vs 3.5%) and the difference decreased further when adjusting for socio-demographic correlates, although the 95% confidence interval of the relative odds suggested that the difference may not have been eliminated entirely. If real, it may reflect a greater tendency of Aboriginal and Torres Strait Islander than other women to use BreastScreen for symptomatic purposes rather than less accessible diagnostic services.
- *Recall to assessment* - Fewer Aboriginal and Torres Strait Islander women were recalled for assessment (4.7% Vs 5.8%) which was not explained by socio-demographic correlates and calendar year period. Among women attending assessment clinics, fewer Aboriginal and Torres Strait Islander women were assessed within the recommended period of 28 days (71.8% Vs 84.1%). This was partly explained by socio-demographic correlates and differences in calendar year period, but not fully. The greater distances to travel to assessment in very remote areas is an issue for many Aboriginal and Torres Strait Islander women,

and may have contributed to this difference, despite the attempts made to adjust statistically for remoteness.

- *Biopsy* – There was little difference in biopsy rates by Aboriginal and Torres Strait Islander status in all screened women (1.4% Vs 1.5%) and in women recalled for assessment (25.6% Vs 23.8%), with 95% confidence intervals of relative odds encompassing 1.00. Similar rates applied after adjusting for socio-demographic and secular factors, suggesting that these factors had little or no bearing on the results.

Figure 1: Relative odds of Aboriginal and Torres Strait Islander compared with other women having specified breast screening experiences: 50-69 year old women screened through BreastScreen, 1996-2005 - Screening and assessment experiences*

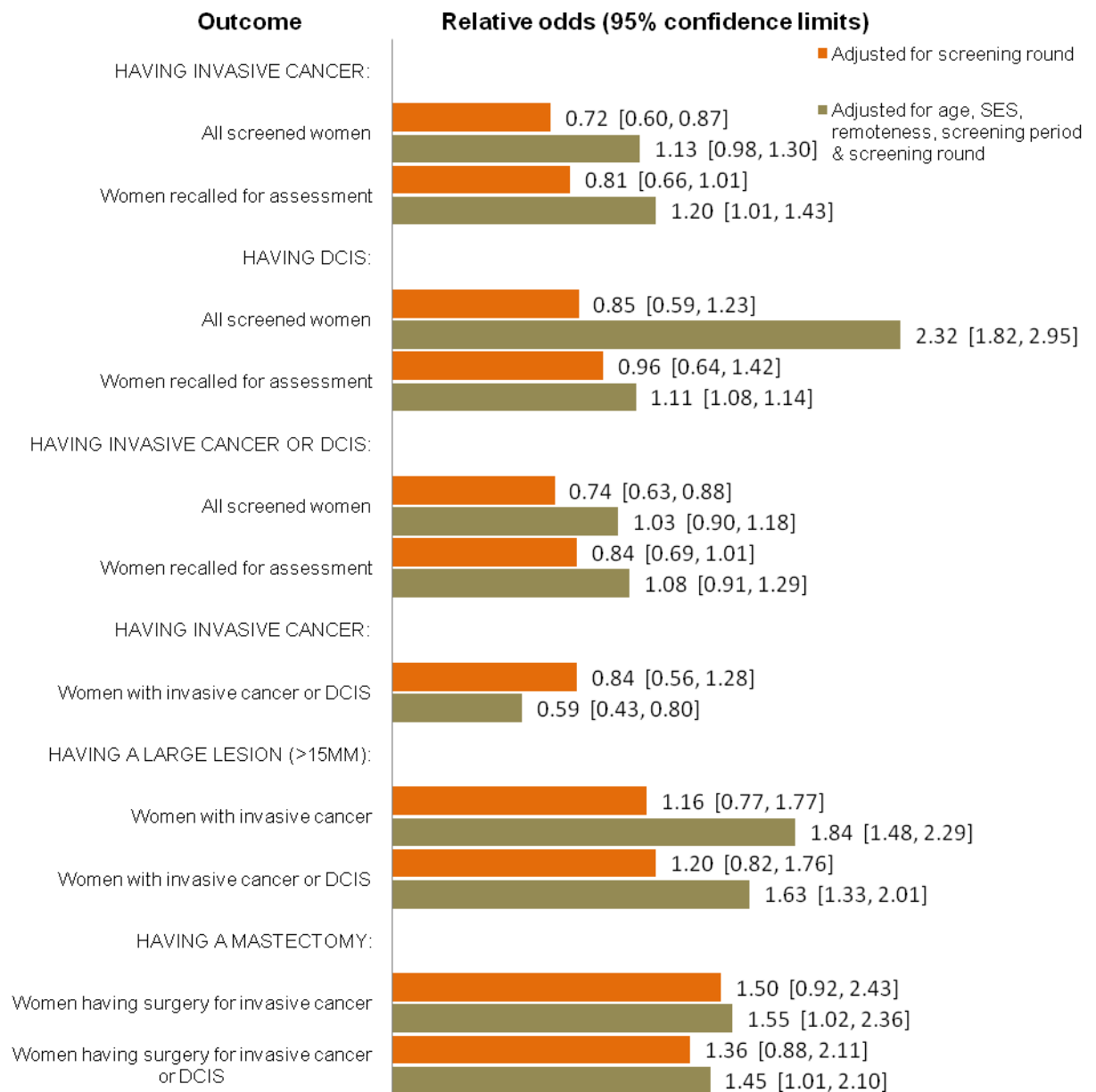


Screening outcomes (Figure 2)

- Invasive breast cancer** – The detection rate for invasive cancer was lower in Aboriginal and Torres Strait Islander women than other screened women (0.3% Vs 0.5%), but this was explained by socio-demographic correlates and calendar year period. By comparison, the invasive cancer detection rate was elevated in Aboriginal and Torres Strait Islander women compared with other women recalled for assessment after adjusting for socio-demographic differences and calendar year period. This indicates that the process of selecting Aboriginal and Torres Strait Islander women for assessment selected strongly for women at elevated risk of invasive cancer.

- *Ductal carcinoma in situ (DCIS)* – Detection rates for DCIS did not vary by Aboriginal and Torres Strait Islander status, either for all women (0.1% Vs 0.1%) or those recalled for assessment (2.0% Vs 2.0%). Rates were higher in Aboriginal and Torres Strait Islander than other screened women however, after adjusting for socio-demographic correlates and calendar year period. This is a novel observation requiring confirmation and further investigation. It raises the question of why Aboriginal and Torres Strait Islander women would be at higher risk of DCIS detection.
- *Invasive Vs DCIS lesions* – There was a lower proportion of invasive lesions among invasive and DCIS lesions collectively in Aboriginal and Torres Strait Islander than other screened women (75.7% Vs 81.3%) which became more evident after adjusting for socio-demographic correlates and calendar year period. This indicated that there was a greater likelihood for lesions to be found at a pre-invasive stage in Aboriginal and Torres Strait Islander than other women.
- *Large lesions* – The proportion of invasive and DCIS lesions classified as large (>15 mm diameter) was larger in Aboriginal and Torres Strait Islander than other women (43.4% Vs 38.5%) and this difference increased after adjusting for socio-demographic correlates and calendar year period. That is, Aboriginal and Torres Strait Islander women had larger lesions than other screened women of similar socio-demographic profile.
- *Surgery type* – Aboriginal and Torres Strait Islander women were more likely than other screened women to have a mastectomy rather than complete local excision, both for invasive cancers and combined invasive cancers and DCIS. The difference was not explained by socio-demographic correlates, suggesting that factors specific to Aboriginal and Torres Strait Islander status were involved.

Figure 2: Relative odds of Aboriginal and Torres Strait Islander compared with other women having specified breast screening experiences: 50-69 year old women screened through BreastScreen, 1996-2005 - Screening outcomes*



Discussion

Aspects suggesting disadvantage in Aboriginal and Torres Strait Islander women include lower screening participation, lower rescreening participation, possibly higher symptom rates, longer time to assessment among recalled women, larger invasive and combined invasive and DCIS lesions than experienced by other screened women of similar socio-demographic profile, and a greater likelihood than other women of having a mastectomy rather than a complete local excision. Desirable features may include a higher ratio of DCIS to (more lethal) invasive cancers, due to an elevated rate of DCIS. This observation requires confirmation and raises aetiological questions.

2.2 Introduction

BreastScreen Australia provides screening mammography to detect unsuspected breast cancer at an early stage, increase benefit from early treatment, and reduce illness and mortality from breast cancer. BreastScreen Australia services are available to well women aged 50-69 years, although women aged 40-49 and over 70 years may also attend. The Screening and Assessment Services provide services from initial mammogram to any follow up diagnostic procedures needed.

BreastScreen Australia data for 1996-2005 showed a lower two-year participation in screening by Aboriginal and Torres Strait Islander (32%) than other women (55%) in the 50-69 year screening target age range (AG 2009). This lower participation is likely to have contributed to the more advanced stages at diagnosis seen among Aboriginal and Torres Strait Islander women at a population level.

The aim of study 1 was to identify and quantify differences in Aboriginal and Torres Strait Islander screening coverage, screening and assessment experiences, and screening outcomes, and to investigate whether these differences are explained by geographic remoteness, lower socio-economic status, and differences in age distribution and screening period. The screening measures used in this study were selected from BreastScreen Australia National Accreditation Standards (AG 2009; BSA 2008; CAUS 2005). Results are used to indicate which differences are explained by socio-demographic correlates of Aboriginal and Torres Strait Islander status and differences in calendar year period, and which are not explained by these factors and may be due to more specific characteristics of this sector of the population (e.g., cultural differences and poorer general health status). Results will provide benchmarks for assessing effects of endeavours to reduce inequalities.

Participation of Aboriginal and Torres Strait Islander women in BreastScreen Australia screening and rescreening was examined and compared with participation of other women, both without and with adjustment for differences in socio-demographic characteristics and period of screening. Screening and assessment experiences examined and compared included: (1) proportion reporting symptoms at screening; (2) proportion recalled for assessment and the proportion of recalled women assessed within 28 days; and (3) proportion receiving a biopsy. Meanwhile screening outcomes and surgical management practices were compared including: (1) proportion found to have an invasive cancer and/or DCIS; (2) proportion of invasive cancers among invasive cancers and DCIS lesions; (3) proportion of women with large (>15mm

diameter) invasive cancers and large invasive cancers plus DCIS lesions; and (4) proportion of invasive cancers and invasive cancers plus DCIS lesions treated by mastectomy as opposed to complete local excision.

It should be noted that the study aim was to provide a broad national overview for national policy consideration. Aboriginal and Torres Strait Islander people live in many different geographic and cultural settings. It is likely that these national data, while useful as an overview, would not apply to many sub-groups around Australia.

Apart from investigating screening and assessment experiences, and screening outcomes by Aboriginal and Torres Strait Islander status, an ancillary aim of the study was to compare screening experiences and outcomes by other socio-demographic factors, including age, socio-economic status, and remoteness, and by calendar year period, for broader policy consideration.

2.3 Methods

Analyses were undertaken using unit record data for 50-69 year old BreastScreen participants held at the AIHW. The data related to the 1996-2005 screening period and were originally provided by state and territory screening services for national BreastScreen evaluation (AG 2009). Initially percentages of women with specified screening characteristics were analysed by Aboriginal and Torres Strait Islander status, where applicable, weighting the results equally for initial and subsequent screening rounds.

Cross tabulations were then undertaken to produce relative odds (synonymous with odds ratios) for each screening characteristic for Aboriginal and Torres Strait Islander compared with other screened women (Armitage & Berry 1987). Where applicable the data were analysed by screening round (initial versus subsequent) and pooled using the Mantel-Haenszel procedure to adjust for screening round (Armitage & Berry 1987). Ninety-five per cent confidence limits were calculated, although regarded as indicative rather than exact due to potential for lack of independence of some observations.

Relative odds were the odds of a specified screening experience or outcome occurring in Aboriginal and Torres Strait Islander women, divided by the odds of this activity or outcome occurring in other screened women. If the odds were the same in Aboriginal and Torres Strait Islander women as in other screened women, the relative odds would be 1.00. Relative odds were interpreted as follows: those with lower 95% confidence limits above 1.00 indicated a greater probability of that experience or outcome occurring in Aboriginal and Torres Strait Islander than other screened women, whereas those with upper 95% confidence limits lower than 1.00 indicated that the probability was lower in Aboriginal and Torres Strait Islander than other screened women.

Breast cancer incidence is known to increase with age and to be lower in more remote and lower socio-economic areas (AIHW & NBOCC 2009). Detection rates are known to be higher at initial than subsequent screens and there is evidence that they were higher in 2001-2005 than 1996-2000 (AG 2009). Screening participation and experiences have also been found to vary by socio-demographic characteristics and calendar year. For example, higher screening participation has been observed in inner and outer regional

areas than in more remote areas and major cities; and increases have applied over time in rates of recall to assessment and in invasive cancer detection (AG 2009).

Regression analyses (log-linear) were therefore used to model associations of Aboriginal and Torres Strait Islander status with each screening characteristic (Davis et al 2001, Davis et al 2002), adjusting for age (60-64 and 65-69 versus 50-59 years), remoteness of residential area (Australian Standard Geographical Classification expressed as inner regional, outer regional and more remote versus major city), socio-economic disadvantage of residential area (SEIFA Index of Relative Socio-economic Disadvantage, using the lowest quintile as the reference category), screening time period (generally expressed in the report as calendar year, but constituting 2001-2005 versus 1996-2000), and screening round (subsequent versus initial) (AIHW, CA & AACR 2008; Armitage & Berry 1987).

In the modelling process, each cross classification of explanatory variables was a data point for modelling the logit of the yes/no response for the specified characteristic (the response variable). The modelling used a linear function of values of the explanatory variables. Parameter estimation was based on weighted least square regression where regression weights were set equal to the observed rounds in the cross classification. The SAS module PROC REG was employed.

The model produced relative odds (95% confidence limits) for each screening characteristic among Aboriginal and Torres Strait Islander compared with other women. Again, confidence limits were regarded as indicative rather than exact due to the potential for a lack of independence of some observations.

2.4 Results

2.4.1 Socio-demographic differences

(Table 1)

Differences were evident between Aboriginal and Torres Strait Islander women and other screened women in: (1) age distribution ($p < 0.001$) with 32.3% of the former being under 60 years compared with 29.4% of other women; (2) remoteness of place of residence ($p < 0.001$) with 52.2% of the former living in outer regional or more remote areas compared with 13.1% of other women; (3) level of socio-economic disadvantage of place of residence ($p < 0.001$) with 67.9% of Aboriginal and Torres Strait Islander compared with 39.8% of other women living in the bottom two socio-economic quintiles; and (4) screening period ($p < 0.001$) with 59.1% of Aboriginal and Torres Strait Islander screens occurring in 2001-2005 compared with 55.1% of screens of other women (Table 1). In addition, more of the screening rounds for Aboriginal and Torres Strait Islander women (22.3%) were initial screens than for other women (17.2%) ($p < 0.001$).

2.4.2 Screening characteristics by Aboriginal and Torres Strait Islander status

(Table 2)

2.4.2.1 24-month screening participation

The 24-month BreastScreen participation rate in 1996-2005 was lower in Aboriginal and Torres Strait Islander than other women at 36.3% compared with 57.5%. Compared with other screened women, the unadjusted relative odds of screening participation (95% confidence limits) were 0.55 (0.54, 0.56) for Aboriginal and Torres Strait Islander women, but the relative odds increased from 0.55 to 0.73 after adjusting in the regression model for differences in age, remoteness, level of socio-economic disadvantage, and screening period. This indicated that around 40% of the reduction in relative odds for Aboriginal and Torres Strait Islander compared with other screened women could be attributed to socio-demographic differences and difference in calendar year period and the rest to factors that were more specific for Aboriginal and Torres Strait Islander women.

2.4.2.2 Rescreening within 27 months

(Note: analyses in this section only included screens occurring 27 months or more before the end of the study, to allow time for this rescreening to occur)

All screened women:

Aboriginal and Torres Strait Islander women were less likely than other women to be rescreened. For all screens combined, the proportion rescreened within 27 month was 60.1% for Aboriginal and Torres Strait Islander women compared with 70.4% for other women.

The relative odds of rescreening within 27 months was 0.67 (0.65, 0.68) (Mantel-Haenszel) among Aboriginal and Torres Strait Islander women and 0.60 (0.53, 0.69) after adjusting in the regression for socio-demographic correlates and differences in calendar year period. Characteristics associated in the regression model with lower rescreening rates included Aboriginal and Torres Strait Islander status, being aged 65-69 years and (less so) 50-59 years compared with 60-64 years, living in a major city, living in residential areas categorised in the bottom two quintiles of socio-economic disadvantage, being screened in 2001-2005 compared with 1996-2000, and rescreening after initial compared with subsequent screening rounds (Table 3).

Rescreened women:

Among rescreened women, Aboriginal and Torres Strait Islander women were less likely than other women to be rescreened within 27 months (80.2% compared with 85.6%). The relative odds were similarly low at 0.69 (0.67, 0.72) (Mantel-Haenszel) and 0.68 (0.57, 0.80) in the regression model after adjusting for socio-demographic differences and difference in calendar year period. Characteristics associated with lower rescreening within 27 months included Aboriginal and Torres Strait Islander status, younger age, living in a major city or inner regional area, living in an area ranked in the bottom two quintiles

of socio-economic disadvantage, being screened in 1996-2000 compared with 2001-2005, and rescreening after initial compared with subsequent screening round (Table 4).

2.4.2.3 *Symptomatic status*

The percentage of women reporting symptoms at screening was low irrespective of Aboriginal and Torres Strait Islander status, at around 3.5%. This figure was higher for initial screens at 4.1% than the 3.0% for subsequent screens. Overall, the relative odds were slightly elevated in Aboriginal and Torres Strait Islander women at 1.08 (1.03, 1.15) (Mantel-Haenszel) but were lower at 1.02 (1.00, 1.04) after adjusting for socio-demographic differences and difference in calendar year period. Characteristics associated with higher frequency of symptom reporting included Aboriginal and Torres Strait Islander status (only potentially so, in that the lower 95% confidence limit was not above 1.00), younger age, living in a major city and in areas of less socio-economic disadvantage, and initial rather than subsequent screening round (Table 5).

2.4.2.4 *Recall to assessment*

All screened women

Aboriginal and Torres Strait Islander women were less likely than other women to be recalled to assessment (4.7% compared with 5.8%). The relative odds was 0.81 (0.77, 0.86) (Mantel-Haenszel), increasing to 0.89 (0.80, 0.98) after adjusting for socio-demographic differences and difference in calendar year period. Apart from Aboriginal and Torres Strait Islander status, characteristics associated with lower rates of recall included older age, living in outer regional or more remote areas, living in lower socio-economic areas, subsequent compared with initial screen, and being screened in 1996-2000 rather than 2001-2005 (Table 6).

Women recalled to assessment

The probability of women being assessed within 28 days was lower for Aboriginal and Torres Strait Islander (71.8%) than other women (84.1%). The relative odds for Aboriginal and Torres Strait Islander women remained low but increased from 0.47 (0.42, 0.54) (Mantel-Haenszel) to 0.76 (0.68, 0.85) after adjusting for socio-demographic differences and difference in calendar year period. Apart from Aboriginal and Torres Strait Islander status, characteristics associated with lower assessment rate within 28 days among recalled women included older age, living more remotely from a major city, living in low socio-economic areas, and subsequent compared with initial screening round (Table 7).

2.4.2.5 *Having a biopsy (including fine needle aspiration and core biopsies but not open biopsies)*

There was little difference in biopsy rate by Aboriginal and Torres Strait Islander status, either among all screened women, where about 1.5% had a biopsy, or among recalled women where about 24% to 26% were biopsied. Characteristics found to be predictive of a biopsy among all screened women were older age, increased remoteness from a major city, higher socio-economic status of residential area, being screened in 2001-2005 compared with 1996-2000, and initial compared with subsequent screening round

(Table 8). Similar predictive characteristics applied among women recalled for assessment (Table 9).

2.4.2.6 Detection of invasive breast cancer

All screened women

Aboriginal and Torres Strait Islander women were less likely than other screened women to have an invasive cancer detected (0.3% compared with 0.5%). The relative odds were 0.72 (0.60, 0.87) (Mantel-Haenszel) but this increased to 1.13 (0.98, 1.30) after adjusting for socio-demographic differences and difference in calendar year period. Characteristics predictive of invasive cancer detection included older age, higher socio-economic status, and initial compared with subsequent screening round (Table 10).

Women recalled to assessment

There was a lower proportion of Aboriginal and Torres Strait Islander women (6.5%) than other women (8.1%) found to have invasive breast cancer among women recalled for assessment. The relative odds were not significantly reduced, however, at 0.81 (0.66, 1.01) (Mantel-Haenszel) and became significantly elevated at 1.20 (1.01, 1.43) after adjusting for socio-demographic differences and difference in calendar year period. Among recalled women, predictors of invasive cancer detection included Aboriginal and Torres Strait Islander status, older age, residence in a major city and (more so) an outer regional and more remote than inner regional area, a higher socio-economic status, and subsequent rather than initial screening round (Table 11).

2.4.2.7 Detection of DCIS

All screened women

There was not a statistically significant difference in detection rate for DCIS in screened women irrespective of Aboriginal and Torres Strait Islander status (rates equalling 0.1%), with a relative odds of 0.85 (0.59, 1.23) (Mantel-Haenszel) for Aboriginal and Torres Strait Islander women. The relative odds became elevated at 2.32 (1.82, 2.95), for these women, however, after adjusting for socio-demographic correlates and difference in calendar year period. The model indicated that characteristics associated with higher DCIS detection included Aboriginal and Torres Strait Islander status, being over 60 years of age, residing in a higher socio-economic area, being screened in 2001-2005 compared with 1996-2000, and having an initial compared with subsequent screen (Table 12).

Women recalled to assessment

There was also a similar detection rate for DCIS in recalled women irrespective of Aboriginal and Torres Strait Islander status (rates equalling 2.0%), with a relative odds of 0.96 (0.64, 1.42) (Mantel-Haenszel) for Aboriginal and Torres Strait Islander women. The relative odds became elevated at 1.11 (1.08, 1.14), however, after adjusting in the regression model for socio-demographic differences and difference in calendar year period. Characteristics associated with higher DCIS detection in recalled women were Aboriginal and Torres Strait Islander status, being over 60 years of age, a remote residential area, a higher socio-economic status, being screened in 2001-2005 rather

than 1996-2000, and having a subsequent compared with initial screening round (Table 13).

2.4.2.8 *Detection of invasive cancers and DCIS*

All screened women

The rate of detection of invasive cancers and DCIS lesions collectively was lower in Aboriginal and Torres Strait Islander women at 0.4% compared with 0.6% for other women, giving a relative odds of 0.74 (0.63, 0.88) (Mantel-Haenszel). This was explained by socio-demographic differences and difference in calendar year period, such that adjusting for these characteristics gave relative odds of 1.03 (0.90, 1.18). Characteristics associated with a higher detection rate included older age over 60 years, higher socio-economic status, initial rather than subsequent screening round, and potentially, being screened in 2001-2005 rather than 1996-2000 (Table 14).

Women recalled to assessment

The rate of detection of invasive cancers and DCIS was lower among recalled Aboriginal and Torres Strait Islander than other women (8.4% Vs 10.0%), but not to a statistically significant extent with relative odds of 0.84(0.69, 1.01) (Mantel-Haenszel). Again the relative odds increased after adjusting for socio-demographic differences and difference in calendar year period, becoming 1.08 (0.91, 1.29). Characteristics associated with a higher detection rate were older age over 60 years, living in outer regional or more remote areas, higher socio-economic status, and subsequent compared with initial screening round (Table 15).

2.4.2.9 *Detection of invasive cancers compared with DCIS*

While the proportion of lesions detected as invasive cancers compared with DCIS was lower at 75.7% for Aboriginal and Torres Strait Islander than 81.3% for other women, the 95% confidence interval of the relative odds included encompassed 1.00, indicating the potential for this to have occurred by chance. More specifically the relative odds for Aboriginal and Torres Strait Islander women was 0.84 (0.56, 1.28) (Mantel-Haenszel). After adjusting for socio-demographic differences and difference in calendar year period, however, the relative odds for Aboriginal and Torres Strait Islander women reduced to 0.59 (0.43, 0.80), which was unlikely to be due to chance. Predictors of lower relative odds of invasive cancers compared with DCIS included Aboriginal and Torres Strait Islander status, aged less than 60 years, and being screened in 2001-2005 compared with 1996-2000 (Table 16).

2.4.2.10 *Detection of a large (>15mm) compared with smaller lesion*

Invasive cancer

There was little difference in the proportions of invasive cancers that were large among Aboriginal and Torres Strait Islander (39.8%) and other screened women (37.7%). The relative odds for Aboriginal and Torres Strait Islander women were 1.16 (0.77, 1.77) (Mantel-Haenszel), but this increased to 1.84 (1.48, 2.29) after adjusting for socio-demographic differences and difference in calendar year period. Predictors of a higher proportion of large than smaller invasive cancers included Aboriginal and Torres Strait

Islander status, older age over 60 years, a higher socio-economic status, being screened in 2001-2005, and initial compared with subsequent screening round (Table 17).

Invasive cancers and DCIS

Large lesions among invasive cancers and DCIS lesions collectively were more common in Aboriginal and Torres Strait Islander (43.4%) than other women (38.5%). The relative odds for Aboriginal and Torres Strait Islander women were 1.20 (0.82, 1.76) (Mantel-Haenszel), with this increasing to 1.63 (1.33, 2.01) after adjusting for socio-demographic differences and difference in calendar year period. Characteristics associated with a higher ratio of larger to smaller lesions in the regression model included Aboriginal and Torres Strait Islander status, older age over 60 years, higher socio-economic status, being screened in 2001-2005 rather than 1996-2000, and initial compared with subsequent screening round (Table 18).

2.4.2.11 Surgical management

Invasive cancer

The proportion of cancers treated by mastectomy rather than complete local excision was higher for Aboriginal and Torres Strait Islander (34.8%) than other screened women (28.2%). This gave a relative odds of 1.50 (0.92, 2.43) (Mantel-Haenszel) and 1.55 (1.02, 2.36) after adjusting for socio-demographic correlates and difference in calendar year period. Predictors of a higher proportion of mastectomies among surgical cases included Aboriginal and Torres Strait Islander status, living outside a major city, being screened in 1996-2000 rather than 2001-2005, and initial compared with subsequent screening round. The proportion was also higher for areas classified in the third and fourth lowest socio-economic quintiles than in the lowest or higher quintiles (Table 19).

Invasive cancers and DCIS

Again, the proportion of women treated by mastectomy compared with complete local excision was higher for Aboriginal and Torres Strait Islander women (31.0%) than other screened women (27.3%). The relative odds were 1.36 (0.88, 2.11) (Mantel-Haenszel) and 1.45 (1.01, 2.10) after adjusting for socio-demographic differences and difference in calendar year period. Predictors of a higher proportion of mastectomies in surgical cases included Aboriginal and Torres Strait Islander status, living outside a major city and more particularly in outer regional or more remote areas, being screened in 1996-2000 rather than 2001-2005, and initial compared with subsequent screening round. The proportion was also higher for areas classified in the third and fourth lowest socio-economic quintiles than in the lowest or higher quintiles (Table 20).

2.5 Discussion

2.5.1 Participation

Aboriginal and Torres Strait Islander women were less likely than other women to participate in biennial BreastScreen Australia screening during 1996-2005 (36% Vs 58%). This was partly explained by socio-demographic differences and difference in calendar year period, but only partly, suggesting a role for factors that were more specific for

Aboriginal and Torres Strait Islander women. Rescreening participation was also lower in Aboriginal and Torres Strait Islander than other women, and among rescreened women, Aboriginal and Torres Strait Islander women were less likely than other women to be screened within 27 months. Again, these differences were not explained by socio-demographic differences and difference in calendar year period, suggesting a contribution from specific Aboriginal and Torres Strait Islander factors.

Previous research has shown Aboriginal and Torres Strait Islander women with breast cancer to be diagnosed at more advanced stages and to have higher case fatality rates (AIHW & NBOCC 2009; Chong & Roder 2010; Condon et al 2005c, 2005d). It is particularly important therefore to address sub-optimal levels of participation of these women in breast screening. Opportunities to increase participation by increasing service accessibility and cultural appropriateness may exist, both in relation to screening and follow-up assessment services, although it is clear that work has already been done to address this gap (AG 2009; BSQLD; BSWA; McLean & Condon 1999; McMichael et al 2000). In some areas for example, four-wheel drive screening vans have been used to bring services to very remote populations to increase screening participation. Ongoing provision of education on the benefits of earlier detection should also be maintained, including providing educational materials tailored to Aboriginal and Torres Strait Islander populations. It is reassuring that the gap in screening participation between Aboriginal and Torres Strait Islander and other women has narrowed, with a higher proportion of screens relating to Aboriginal and Torres Strait Islander women in more recent years.

Likelihood of rescreening is generally higher among all women (i.e., Aboriginal and Torres Strait Islander and other women collectively) residing in more remote areas. This may seem counter-intuitive. It could be due to a heightened awareness of screening services in those areas, as might occur for example when mobile services are moved to relatively small towns. Potentially there are other social and community factors that may be involved, but they are ill defined. These factors warrant investigation and consideration as to whether and how they might be used to enhance screening and rescreening participation in Aboriginal and Torres Strait Islander women. Results indicate that areas of greater socio-economic disadvantage generally had lower rescreening participation. This may be due to poorer levels of education and competing priorities. Again, further investigation of associated barriers, and how they might be overcome, should be undertaken.

2.5.2 Symptoms

BreastScreen Australia is directed at the screening of asymptomatic women. As a result it was predictable that the frequency of reported symptoms was low at time of screening. Irrespective of Aboriginal and Torres Strait Islander status, this frequency approximated 3.5%, although it was slightly higher in Aboriginal and Torres Strait Islander women. The difference decreased in scale and was marginal but potentially still in existence after adjusting for socio-demographic and secular differences. Higher frequency of symptom reporting was evident in younger women (all women collectively) and in areas of higher socio-economic status and major cities. A higher prevalence of symptoms was also reported at initial compared with subsequent screening rounds.

Reasons for a higher frequency of reported symptoms in Aboriginal and Torres Strait Islander women at screening (if real) are speculative, although one possibility is that these women are more likely than others to use BreastScreen in preference to less accessible diagnostic services when experiencing symptoms. Aboriginal and Torres Strait Islander women often have community as well as family needs which may lead them to delay mammography until they have symptoms. For Aboriginal and Torres Strait Islander women feelings of fear and embarrassment and different views to health professionals of the relationship between symptoms and the presence of illness may also have an impact on presenting to local health professionals with breast cancer symptoms (McMichael et al 2000 and WHGNE, 2010). Also it is possible that the larger sizes of their cancers at diagnosis predisposed to symptoms.

Meanwhile the higher prevalence of symptoms reported in older women, and those from higher socio-economic areas, is consistent with differences in breast cancer incidence which may have contributed (AIHW & NBOCC 2009). It is not surprising that women who had been screened previously reported fewer symptoms, in that repeat screens would be more common among women participating in regular screening than in those attending for symptomatic reasons.

2.5.3 Recall to assessment

Aboriginal and Torres Strait Islander women were less likely than other women to be recalled for assessment. This is consistent with their lower incidence of breast cancer and presumably of associated mammographic abnormalities (AIHW & NBOCC 2009). When recalled, these women were less likely to be assessed within 28 days. This may be due to increased times to read films in advance of assessment for many of these women, as may occur for example when obtaining film reading for mobile units (in the pre-digital era). Potentially other factors may have been involved as well, including differences in cultural appropriateness of services. Opportunities to better support and coordinate assessment through liaison with Aboriginal Health Workers could be investigated. Other factors associated with lower rates of recall to assessment included older age over 60 years. The reasons for this are not known. It may be that older women had less dense breasts leading to more definitive mammographic findings and fewer uncertainties requiring assessment. Lower recalls to assessment in more remote and lower socio-economic areas could have been influenced by the lower incidence of breast cancer in those areas (AIHW & NBOCC 2009).

Meanwhile the higher recall rates following initial rather than subsequent screens accord with expectations. This is a well known feature of breast screening programs that is reflected in screening performance standards (AG 2009; BSA 2008). The increased rate of recall over time has also been observed elsewhere (AG 2009).

Of women recalled for assessment, assessment within 28 days was less likely: (1) among older women, possibly due to their lower mobility; (2) in more remote areas, potentially due to prolonged time for film reading and perhaps greater distances to travel; and (3) in low socioeconomic areas, where adherence to recommendations may have been influenced by lower levels of education and competing priorities.

2.5.4 Biopsy

Biopsy rates were not found to differ by Aboriginal and Torres Strait Islander status, either among all screened women or those recalled for assessment. Rates tended to be higher in older women and upper socio-economic areas, which is consistent with variations in breast cancer incidence (AIHW & NBOCC 2009). The lower biopsy rates for subsequent than initial screens are also consistent with well-established patterns of cancer detection (AG 2009; BSA 2008). Reasons for the secular increase in biopsy rate are not clear, however, although again, increased wariness of false negative findings may have played a role. The higher biopsy rates outside major cities, and for recalled women, outside major cities and inner regional areas, are also unexplained.

2.5.5 Invasive cancer

Although Aboriginal and Torres Strait Islander women had a lower detection of invasive breast cancer, as observed in population-based studies (AIHW & NBOCC 2009), this did not apply after adjusting for socio-demographic differences and difference in calendar year period. In other words, the lower detection rate appeared not to be a function of factors specific to Aboriginal and Torres Strait Islander status so much as a reflection of socio-demographic correlates. Indeed among recalled women, Aboriginal and Torres Strait Islander women had a higher detection rate than other women of invasive cancer, after adjusting for socio-demographic and secular differences.

The detection of invasive breast cancer in screened women paralleled that seen in population-based statistics in that it was higher in older women and in upper socio-economic areas (AIHW & NBOCC 2009). The lower detection rates for subsequent than initial screens accord with well-recognised screening patterns that are taken into account in BreastScreen performance standards (BSA 2008). The reason for the relatively high detection rate among the sub-set of women recalled to assessment following subsequent screens is not clear, however, nor is the reason for higher detection among women recalled in remote areas.

2.5.6 DCIS

There was little difference in DCIS rates by Aboriginal and Torres Strait Islander status prior to adjustment by socio-demographic differences and difference in calendar year period. After this adjustment, higher DCIS detection rates were found in Aboriginal and Torres Strait Islander than other screened women.

These rates were elevated in older age groups, upper socio-economic areas, and for initial rather than subsequent screens, which accords with population-based trends. The reason for the elevated rate in Aboriginal and Torres Strait Islander women after socio-demographic and secular adjustment is not known and requires confirmation in additional studies. Meanwhile the secular increase in DCIS detection accords with the separately reported incidence trends seen in population-based studies (Luke et al 2006).

2.5.7 Detection of invasive as opposed to DCIS lesion

This proportion of invasive cancers among invasive plus DCIS lesions was lower in Aboriginal and Torres Strait Islander women after adjusting for socio-demographic secular factors and difference in calendar year period, due to elevated rates of DCIS. The reason for this higher DCIS rate in Aboriginal and Torres Strait Islander women is not known. It seems that risk factors for DCIS and invasive cancers may not be identical in these women or that their effects differ between invasive and DCIS lesions. Further investigation is needed to confirm and seek explanation for this observation.

2.5.8 Size of invasive cancer

The evidence for larger cancers in Aboriginal and Torres Strait Islander than other screened women, after adjusting for socio-demographic factors and difference in calendar year period, is consistent with population-based statistics showing more advanced stages at diagnosis and likely would predispose to the poorer survivals experienced by these women (Condon et al 2005c, 2005d). Predictably smaller sizes applied for subsequent compared to initial screening rounds, indicating the importance of continuing screening beyond the initial round. This observation requires further investigation using the more detailed data available in screening services on size than was available for this study.

2.5.9 Surgery for invasive cancer

The relative odds of mastectomy compared with complete local excision were elevated in Aboriginal and Torres Strait Islander women compared with other screened women after adjusting for socio-demographic factors and difference in calendar year period. This may reflect a more limited access to radiotherapy services for many Aboriginal and Torres Strait Islander women, leading to a preference for mastectomy where adjunctive radiotherapy may be less important (NHMRC National Breast Cancer Centre 2001). In addition, the larger sizes of cancers in Aboriginal and Torres Strait Islander women may have predisposed to mastectomy.

Other predictors of mastectomy, after adjusting for socio-demographic factors and difference in calendar year period, included a greater remoteness from major cities (and hence from radiotherapy services). The lower frequency of mastectomies in the later years is thought to reflect a more general trend towards breast conserving surgeries rather than mastectomy in the treatment of breast cancer (Wang et al 2008). Meanwhile the lower frequency of mastectomies for subsequent than initial screens is consistent with the higher frequency of smaller cancers found at subsequent screens that may have been more conducive to local excision.

2.6 Conclusions

The collection of data on Aboriginal and Torres Strait Islander status has been inconsistent in most administrative health statistics collections, but is likely to have been of higher quality in BreastScreen Australia due to the use of these data in ongoing

monitoring for accreditation and other purposes and the support given to data collection through BreastScreen Australia data dictionary definitions. From the results of this study, it can be concluded that:

- Aboriginal and Torres Strait Islander women participate less frequently in breast screening and rescreening and this is not fully explained by their socio-demographic characteristics. It is likely to contribute to the larger sizes of their breast cancers at diagnosis and their poorer survivals at a population level. Opportunities to further increase screening participation by enhancements to screening accessibility and cultural appropriateness may exist, although there is much that has been done already and there is evidence that the gap is closing.
- Aboriginal and Torres Strait Islander women may have a slightly higher prevalence of symptoms at screening than other women, which is largely but potentially not entirely explained by socio-demographic differences and difference in calendar year period. If real, the explanation may be that these women are more likely than others to use BreastScreen for symptomatic purposes in preference to less accessible diagnostic services. Another explanation may be that the larger cancers in Aboriginal and Torres Strait Islander women were more likely to be symptomatic.
- Opportunities to increase access to appropriate diagnostic services should be investigated and all women with symptoms should be encouraged to attend diagnostic as opposed to screening services. It is recognised that there would be substantial impediments, however, due to geographic remoteness.
- While Aboriginal and Torres Strait Islander women were less likely than other women to be recalled for assessment, those who were recalled were less likely to be assessed within the recommended 28 days. Again, this may be due to the time taken to obtain film reading, as for mobile services for example, in the pre-digital era, plus the longer travelling distances for assessment. Opportunities to reduce barriers through the provision of transport services and ongoing education should be explored, although it is recognised that there are difficulties inherent in geographic remoteness and that much has already been done.
- The lower detection of invasive breast cancers in Aboriginal and Torres Strait Islander women is consistent with recognised differences in population-based incidence. It appears to be more a function of socio-demographic correlates than of factors specific to Aboriginal and Torres Strait Islander status.
- Aboriginal and Torres Strait Islander women had elevated DCIS detection rates after adjusting for socio-demographic factors and difference in calendar year period. This led to a lower ratio of invasive to DCIS lesions among these women. The reasons for this are not known. Possibly socio-demographic factors responsible for lower invasive cancer detection in Aboriginal and Torres Strait Islander women, potentially including differences in fertility rates, age at first full-term pregnancy, and use of hormone replacement therapy, did not have an equivalent effect on DCIS.
- Sizes of invasive cancer at diagnosis were larger in Aboriginal and Torres Strait Islander than other women after adjusting for socio-demographic correlates and difference in calendar year period, and likely would be contributing to higher case

fatality. This underscores the need to optimise regular screening participation in this high-risk group of women.

- Aboriginal and Torres Strait Islander women were more likely than other women to have a mastectomy than complete local excision of their breast cancers. This may be due to choice, larger tumour sizes or lower access to radiotherapy services. Further research is needed to determine reasons for higher mastectomy rates in Aboriginal and Torres Strait Islander women.

These conclusions are broad national statements that should be interpreted in a national context and should not be regarded as necessarily applicable to individual local settings.

3 Study 2: Linked BreastScreen and cancer registry data

3.1 Overview

Introduction

In study 1, screening and assessment activity and outcomes were compared by Aboriginal and Torres Strait Islander status in 50-69 year old Australian women using BreastScreen Australia data for 1996-2005. The purpose was to identify and quantify inequalities as a benchmark for ongoing monitoring and evaluation. Study 1 data provided a broad national overview. As the Aboriginal and Torres Strait Islander population is socio-demographically and culturally diverse, it was expected that results would not apply to all sections of this population. Nonetheless study 1 data were useful in providing a broad national overview for benchmarking purposes.

Using linked data from BreastScreen Australia and state and territory cancer registries in study 2, invasive breast cancer survivals were compared by Aboriginal and Torres Strait Islander status within the cohort of women aged 50-69 with a history of participation in the BreastScreen Australia program. It was anticipated that results would indicate whether there were any remaining longer term inequalities that would need further attention.

Methods

Invasive breast cancer data for 1991-2006 diagnoses from Australian cancer registries and corresponding BreastScreen record data were linked at a jurisdictional level. All jurisdictions were included except the Australian Capital Territory where data were not available within the study time frame. The effect of this exclusion would have been negligible as only about 0.8% of Aboriginal and Torres Strait Islander people in Australia reside in the Australian Capital Territory (ABS 2008).

Data items included in the resulting linked dataset included: (1) from BreastScreen - Aboriginal and Torres Strait Islander status; and date of last screen; and (2) from cancer registries - date of birth, date of breast cancer diagnosis, date of death, cause of death, tumour morphology, tumour diameter and nodal status at diagnosis. Many registry records did not include diameter and nodal status information, but these data items were included in analyses of the sub-sets of records that had this information. A decision was taken not to substitute BreastScreen data in place of missing cancer registry data for these items to avoid statistical bias.

De-identified linked data were sent to the AIHW for analysis. Bivariate analyses of associations of socio-demographic and cancer characteristics with Aboriginal and Torres Strait Islander status first were undertaken using the Mann-Whitney U test for ordinal and continuous variables and the Pearson chi-square test for nominal variables (Armitage & Berry 1987). Characteristics analysed included age at diagnosis, remoteness of residence, socio-economic status of area, diagnostic period (i.e., 1991-

1994, 1995-1999, and 2000-2006), whether or not the cancer diagnosis occurred within four months following the last screen (used as a marker of screen detection), cancer morphology type, diameter, and nodal status.

Crude survivals were used because life tables for Aboriginal and Torres Strait Islander people were not available for the period of study for relative survival analysis. Multivariable Cox proportional hazards regression was also employed to indicate relative risks of death (i.e., hazards ratios) according to Aboriginal and Torres Strait Islander status after adjusting for other predictor variables in the model (i.e., age, remoteness, socio-economic status, diagnostic period, and in sub-set analyses, cancer size, nodal status and whether diagnosis occurred within four months of the last screen) (Armitage & Berry 1987). Parallel analyses were performed of relative risks of breast cancer death by Aboriginal and Torres Strait Islander status. Censoring of follow-up was at December 31st 2006 or date of death, whichever occurred first.

Results

Bivariate analyses

Aboriginal and Torres Strait Islander women diagnosed with breast cancer generally were of a lower age than other women with breast cancer and more likely to live in remote or very remote locations and in lower socio-economic areas (Table 21).

Compared with other women, a higher proportion of Aboriginal and Torres Strait Islander women were diagnosed in more recent periods. Cancers in Aboriginal and Torres Strait Islander women tended to be larger and a higher proportion had nodal spread at diagnosis (Table 22). Differences were not found by morphology type or whether breast cancer diagnosis had occurred within four months of the last screen. Slightly fewer deaths were attributed to breast cancer in Aboriginal and Torres Strait Islander than other women, but the difference was not statistically significant (Table 22).

Crude five-year survivals were lower for Aboriginal and Torres Strait Islander than other women at 81% compared with 90%. Aboriginal and Torres Strait Islander women had lower survivals in each age category and irrespective of remoteness of residential location (Table 23). Differences in survival were not consistent by socio-economic status and diagnostic period.

Multivariable proportional hazards regression

Deaths from any cause

After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women had an 84% higher risk of death from any cause compared with other women (Table 24). After adjusting in addition for tumour size and nodal status in the sub-group of women where this information was available, Aboriginal and Torres Strait Islander women had a 117% higher risk of death than other women (Table 25). When in addition, adjustment was made for duration from last screen to diagnosis (i.e., whether it was within four months) in the sub-group where this information was available, Aboriginal and Torres Strait Islander women presented a 122% higher risk of death than other women (Table 26).

Deaths from breast cancer

After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women had a 68% higher risk of breast cancer death than other women (Table 27). After adjusting in addition for tumour size and nodal status in the sub-group with these data, Aboriginal and Torres Strait Islander women had an 81% higher risk of breast cancer death than other women (Table 28). When in addition, adjustment was made for duration from last screen to diagnosis (i.e., whether it was within four months) in the sub-group with these data, Aboriginal and Torres Strait Islander women had a 96% higher risk of breast cancer death than other women (Table 29).

Discussion

The crude five-year survivals in this study of 81% for Aboriginal and Torres Strait Islander women diagnosed with breast cancer, and 90% for other women, were higher than the corresponding survivals of 65% and 82% respectively which were estimated previously for four Australian states and territories where Aboriginal and Torres Strait Islander descriptors were considered adequate for survival comparison (AIHW & NBOCC 2009). This is understandable, given prior participation of all women in the present study in the BreastScreen Australia program.

Results show that Aboriginal and Torres Strait Islander women diagnosed with breast cancer were generally younger, more likely to live in remote locations and areas of greater socio-economic disadvantage, and more likely to have their breast cancers diagnosed in more recent diagnostic periods. These results accord with the BreastScreen data presented in study 1.

Results show that breast cancers in Aboriginal and Torres Strait Islander women were more likely to be larger and with nodal spread at diagnosis, which also accords with the study 1 BreastScreen data on tumour size after adjusting for socio-demographic correlates, screening period and screening round.

Multivariable analyses showed that after adjusting for diagnostic period and socio-demographic factors, the risk of death (any cause) was 84% higher in Aboriginal and Torres Strait Islander women and that there was a corresponding 68% elevation in risk of death from breast cancer.

When adjustment was also made in a sub-group analysis for tumour size, nodal spread, and whether diagnosis occurred within four months of prior screening, the risk of death (any cause) was 122% higher in Aboriginal and Torres Strait Islander women and there was a corresponding 96% elevation in risk of death from breast cancer.

The reasons for excess deaths in Aboriginal and Torres Strait Islander women after adjusting for socio-demographic and tumour characteristics are not known. However, it can be inferred from the results of previous studies that they are likely to include higher levels of co-morbidity in Aboriginal and Torres Strait Islander patients and potentially less complete cancer treatment due to geographic remoteness and cultural factors (AIHW 2008). These cultural factors may include differences in perceived value of treatment, for example cancer is seen as a 'deadly disease' and treatment is seen as mostly futile, and giving precedence to family and community needs above individual needs (Prior

2006; McMichael et al 2000). It has been reported that a perceived lack of acknowledgment of cultural differences from health professionals to Aboriginal women can also influence uptake of cancer treatment (Prior 2005; Shahid et al 2009).

Although remoteness of residence generally was not predictive of survival in the present analyses, it is likely from earlier research that small population sub-groups would still exist who were seriously disadvantaged by distance. For example, lower cancer survivals have been found in Aboriginal and Torres Strait Islander patients in very remote locations of Australia, but not in other patients from equivalent locations (Chong & Roder 2010).

3.2 Introduction

As noted previously in this report, Aboriginal and Torres Strait Islander people account for close to 2.5% of the Australian population (ABS 2008; AIHW 2008; Cunningham et al 2008). Compared with other Australians, they more frequently live in remote areas and their health is often affected adversely by socio-economic deprivation and cultural marginalisation (Cunningham et al 2008). Survivals from breast cancer are lower among Aboriginal and Torres Strait Islander than other women (AIHW & NBOCC 2009; Chong & Roder 2010) and their breast cancers are on average more advanced at diagnosis, which would predispose to poorer survivals (Condon et al 2005a, 2005b).

Study 1 compared screening and assessment activity and outcomes by Aboriginal and Torres Strait Islander status in 50-69 year old Australian women using BreastScreen Australia data for 1996-2006. The purpose was to identify and quantify inequalities as a benchmark for ongoing monitoring and evaluation. By restricting the study to screening participants, it was recognised that differences in breast cancer characteristics by Aboriginal and Torres Strait Islander status are likely to have been smaller than would have applied for the population more generally. This could occur for example if there was a self-selection of more health conscious women for BreastScreen Australia participation, irrespective of Aboriginal and Torres Strait Islander status. Nonetheless it was considered that inequalities found within the screening cohort would still be important and potentially more amenable to change, given engagement of these women with BreastScreen Australia.

In study 2, data on survivals of women with invasive breast cancer are compared by Aboriginal and Torres Strait Islander status. This is undertaken within the cohort of women with a history of screening through BreastScreen Australia. It was expected that differences in survival by Aboriginal and Torres Strait Islander status would be less in this cohort than in the population more generally due to self-selection of women into the BreastScreen Australia program and as a result of this screening. Any differences in survival would still be important, however, in indicating the longer term experience of screened women and their needs for ongoing attention.

Cancer registries have obtained information on Aboriginal and Torres Strait Islander status from other administrative datasets as secondary sources. Often the data have been incomplete and of uncertain accuracy (AIHW & ABS 2006). A benefit of the present study was the availability of data on Aboriginal and Torres Strait Islander status

from BreastScreen Australia, which was thought to be a more accurate information source.

3.3 Methods

Invasive breast cancer data from Australian cancer registries and BreastScreen record data were linked at a jurisdictional level, with relevant administrative and research ethics committee approvals. Approval was also obtained from relevant Aboriginal and Torres Strait Islander health and medical research administrations and associated Aboriginal and Torres Strait Islander health research ethics committees. All jurisdictions of Australia were included except the Australian Capital Territory where due to logistical difficulties, data were not available within the study time frame. The effect of this exclusion on study size and representativeness would have been negligible, given that only about 0.8% of Aboriginal and Torres Strait Islander people of Australia reside in the Australian Capital Territory (ABS 2008) (note: preliminary analyses indicated that no breast cancers were diagnosed among previously screened Aboriginal and Torres Strait Islander women in the Australian Capital Territory for the study period).

BreastScreen data for 1991-2006 and corresponding breast cancer data from cancer registries were linked using probabilistic matching of names, birth dates and places of residence. The process was similar to the one routinely employed by screening programs to detect interval cancers for quality monitoring and program accreditation (BSA 2008). It was therefore a well-practised process where technical arrangements were in place.

Data items included in the resulting linked dataset included: (1) from BreastScreen - Aboriginal and Torres Strait Islander status and date of last screen; and (2) from cancer registries - date of birth, date of breast cancer diagnosis, date of death, cause of death, morphology type, tumour diameter and nodal status at diagnosis. Many records did not include tumour diameter and nodal status information but sub-sets with these data items were included for analysis. A decision was taken not to substitute BreastScreen data in place of missing cancer registry data to avoid statistical bias.

These de-identified data were forwarded to the AIHW for analysis. Bivariate analyses of associations of socio-demographic and cancer characteristics with Aboriginal and Torres Strait Islander status were first undertaken using the Mann-Whitney U test for ordinal and continuous variables and the Pearson chi-square test for nominal variables (Armitage & Berry 1987). Characteristics analysed included: age at diagnosis (i.e., under 50, 50-59, 60-69, and 70 years or more); remoteness of residence (i.e., major city, inner regional, outer regional or remote or very remote area, obtained by applying the Australian Standard Geographical Classification (ASGC) to residential Statistical Local Areas (SLAs)) (AIHW,CA & AACR 2008); socio-economic status of area (i.e., five quintiles of the Socio-economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage, which was applied to SLAs) (AIHW,CA & AACR 2008); diagnostic period (i.e., 1991-1994, 1995-1999, and 2000-2006); whether or not cancer diagnosis occurred within four months following the last screen (used as a marker of screen detection); morphology type (i.e., ductal, lobular or other); cancer diameter (in mm categories); and nodal status (i.e., positive or negative). Categorisation by diagnostic period was

arranged to enable comparison of outcomes for the early and late 1990s, with pooling of data for 2000-2006 to enable sufficient follow-up time for survival analysis.

Relative survivals could not be calculated due to the absence of life tables for Aboriginal and Torres Strait Islander people for the period of study. Instead crude survivals were determined from date of diagnosis of breast cancer to date of death from any cause, as in prior analyses of survivals of breast cancer patients by Aboriginal and Torres Strait Islander status in Australia (AIHW & NBOCC 2009).

The Cox proportional hazards technique was used to estimate relative risks of death (i.e., hazards ratios) according to Aboriginal and Torres Strait Islander status. A multiple linear regression model was used to control for the confounding effects of other predictor variables in the models (i.e., age at diagnosis, remoteness of residence, socioeconomic status of area, and diagnostic period, and for some analyses, cancer size, nodal status and whether diagnosis occurred within four months following the last screen) (Armitage & Berry 1987). When estimating this model the only censoring criterion was survival until the end of the observation period, December 31st 2006. This approach was also used to estimate relative risks of death from breast cancer by Aboriginal and Torres Strait Islander status after adjusting for these predictor variables. In this case, deaths from other causes and survival to the end of the observation period were both regarded as censoring events. Statistical assumptions of proportionality and absence of co-linearity were checked and found to be met.

3.4 Results

Bivariate analyses

3.4.1 Socio-demographic characteristics

(Table 21)

The age distribution of Aboriginal and Torres Strait Islander women was lower than for other women with breast cancer ($p < 0.001$) (e.g., 20.6% Vs 11.7% under 50 years; 13.0% Vs 20.1% aged 70 years or more). Geographic distribution of place of residence also varied ($p < 0.001$), with fewer Aboriginal and Torres Strait Islander than other women living in major cities (36.5% Vs 68.5%) and more Aboriginal and Torres Strait Islander women living in remote or very remote areas (20.4% Vs 1.5%). Meanwhile, Aboriginal and Torres Strait Islander women were more likely than other women to live in lower socio-economic areas ($p < 0.001$) (e.g., 41.1% Vs 20.2% in the lowest quintile; 6.2% Vs 22.1% in the highest quintile).

3.4.2 Cancer characteristics

(Table 22)

A larger proportion of cancers among Aboriginal and Torres Strait Islander women was diagnosed in more recent time periods than was so for cancers among other women ($p < 0.001$), the proportion diagnosed in 2000-2006 being 74.5% and 63.2% respectively.

Aboriginal and Torres Strait Islander women had on average larger cancers ($p=0.003$), the proportion exceeding 15mm being 51.6% compared with 43.8% for other women. Meanwhile, the proportion of cancers that were node positive was 54.9% for Aboriginal and Torres Strait Islander women compared with the 43.6% for other women ($p<0.001$). Statistically significant differences were not found by Aboriginal and Torres Strait Islander status for morphology type ($p=0.212$) or whether breast cancer diagnosis had occurred within four months of the last screen ($p=0.961$).

3.4.3 Causes of death

(Table 22)

Slightly fewer deaths were attributed to breast cancer in Aboriginal and Torres Strait Islander women (49.1%) than for other women with cancer (52.8%), but the difference did not approach statistical significance ($p=0.432$).

3.4.4 Crude five-year survivals

(Table 23)

Crude five-year case survivals were lower for Aboriginal and Torres Strait Islander than other women at 80.8% compared with 89.6%. Aboriginal and Torres Strait Islander women had lower survivals in each age category and irrespective of remoteness of residential location. Differences in survival by Aboriginal and Torres Strait Islander status were not consistent, however, by socio-economic status or diagnostic period.

Multivariable proportional hazards regression

3.4.5 Deaths from any cause

After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women had an 84% higher risk of death from any cause than other women (Table 24). Risk of death increased with increasing age for all women collectively and was elevated in the lower socio-economic quintiles. An elevated risk also applied for residents of outer regional areas. Compared with 1991-94, risks of death were higher in cohorts of women diagnosed with breast cancer in 1995-1999 and 2000-2006; however, it will be shown that this did not apply after adjusting for tumour characteristics and time between last screen and diagnosis.

After adjusting in addition for tumour size and nodal status (note: in the sub-group of women with data available on size and nodal status), Aboriginal and Torres Strait Islander women had a 117% higher risk of death than other women (Table 25). Differences by age, socio-economic status and remoteness of residence were broadly consistent for all women collectively with differences observed in the previous analysis (Table 24), but a difference was not found by diagnostic period. Predictably risk of death was higher in women with larger cancers and positive nodal status.

When in addition, adjustment was made for duration from last screen to diagnosis (i.e., whether it was within four months) (note: in the subgroup of women with data available on tumour size, nodal status and duration from last screen), Aboriginal and Torres Strait Islander women presented a 122% higher risk of death than other women (Table 26). Differences by age, socio-economic status, remoteness and tumour size were broadly the same as found for all women collectively in the prior analysis (Table 25), but the difference by nodal status was smaller and not statistically significant. Notably a positive trend emerged by diagnostic period, in that the risk of death became lower in the more recent diagnostic periods (Table 26). Predictably the risk of death was lower when the duration from last screen to diagnosis was within four months (used as a marker of screen detection).

3.4.6 Deaths from breast cancer

After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women had a 68% higher risk of breast cancer death than other women (Table 27). Risk of breast cancer death for all women collectively was higher in women aged 70 years or more than for the reference category less than 50 years. Little difference was evident by remoteness of residence but women from the highest socio-economic quintile were at lower risk of breast cancer death than those in the lowest quintile. As for deaths from any cause, risk of breast cancer death was higher in cohorts of women diagnosed with breast cancer in 1995-1999 and 2000-2006, as compared with 1991-1994. Again, it will be shown that this did not apply after adjusting for tumour characteristics and time between last screen and diagnosis.

After adjusting in addition for tumour size and nodal status (note: in the sub-group of women with data available on size and nodal status), Aboriginal and Torres Strait Islander women had an 81% higher risk of breast cancer death than other women (Table 28). The difference by age for all women collectively was broadly consistent with the difference observed in the previous analysis (Table 27), but a difference was not found by socio-economic status or diagnostic period. Predictably risk of breast cancer death was higher in women with larger cancers and positive nodes.

When in addition, adjustment was made for duration from last screen to diagnosis (i.e., whether it was within four months) (note: in the subgroup of women with data available on tumour size, nodal status and duration from last screen), Aboriginal and Torres Strait Islander women had a 96% higher risk of breast cancer death than other women (Table 29). Differences by age and tumour size were broadly the same for all women collectively as in the previous analysis and women with a positive nodal status had a higher risk of breast cancer death. No differences were evident by remoteness of residence or socio-economic status. As for deaths from any cause, a positive trend emerged by diagnostic period, in that the risk of death was lower in more recent diagnostic years (Table 29). Predictably, the risk of death was lower when the duration from last screen to diagnosis was within four months.

3.5 Discussion

The five-year survivals of breast cancer cases in this study of 81% for Aboriginal and Torres Strait Islander women and 90% for other women were higher than the corresponding survivals of 65% and 82% respectively which were estimated previously for four Australian states and territories where Aboriginal and Torres Strait Islander descriptors were considered adequate for survival comparison (AIHW & NBOCC 2009).

The present survival data correspond with five-year case fatalities of 19% for Aboriginal and Torres Strait Islander women and 10% for other women in this study (i.e., 100-81 and 100-90 respectively). This compares with case fatalities of 35% and 18% respectively in the previous study (AIHW & NBOCC 2009). The higher survivals in the present study accord with expectations, given prior participation of all women in this study in the BreastScreen Australia program. Most breast cancers (i.e., 56% for Aboriginal and Torres Strait Islander women and 61% for other women) were diagnosed within four months of the last BreastScreen Australia screen. This indicated a higher level of screen detection than the corresponding 34% reported for all female breast cancers at a population level in a 2001-04 study (BSSA 2010).

The present results show that Aboriginal and Torres Strait Islander women diagnosed with breast cancer were generally younger than other women with breast cancer. This corresponds with differences observed in BreastScreen participation by Aboriginal and Torres Strait Islander status. Although participation still appears to be a little lower in Aboriginal and Torres Strait Islander than other women in the 40-49 year old age range, the difference is much smaller than seen in the screening target age range of 50-69 years (AIHW, 2010).

Aboriginal and Torres Strait Islander women diagnosed with breast cancer were more likely to live in remote locations and areas of greater socio-economic disadvantage. They appeared to have taken up participation in BreastScreen more recently, leading to a higher proportion of their breast cancers being diagnosed in more recent diagnostic periods. These results accord with BreastScreen participation data from study 1 which showed that screened Aboriginal and Torres Strait Islander women were younger, more likely to live in remote locations and areas of greater socio-economic disadvantage, and to account for a higher proportion of screens in the more recent years. The data are consistent with screening participation data that have shown a decreasing gap between participation rates for Aboriginal and Torres Strait Islander women compared with other women in more recent years (AIHW, 2006; AIHW, 2010).

The present results also show that breast cancers in Aboriginal and Torres Strait Islander women were more likely to have been larger and with nodal spread at diagnosis. This also accords with study 1 data that showed larger invasive cancers found through BreastScreen among Aboriginal and Torres Strait Islander than other women after adjusting for age, remoteness of residence, socio-economic status, screening period and screening round.

Multivariable analysis of the present study 2 data showed that after adjusting for diagnostic period and socio-demographic factors (i.e., age, remoteness of residence, and socio-economic status), the risk of death (any cause) was 84% higher in Aboriginal and Torres Strait Islander than other women. A corresponding 68% elevation in risk of death from breast cancer was also observed in a parallel model. This indicates that the

higher risks of death observed in Aboriginal and Torres Strait Islander women were not explained by socio-demographic factors.

When multivariable analyses were repeated, adjusting for tumour size, nodal spread, and whether diagnosis occurred within four months of prior screening (note: in a subgroup of women with recorded tumour size, nodal spread and time from prior screening), in addition to diagnostic period and socio-demographic factors, the risk of death (any cause) was 122% higher in Aboriginal and Torres Strait Islander than other women. A corresponding 96% elevation in risk of death from breast cancer also was observed in a parallel model.

The reasons for excess deaths in Aboriginal and Torres Strait Islander women after adjusting for socio-demographic and tumour characteristics are not known, but it is inferred from results of previous studies that they would reflect higher levels of comorbidity in the Aboriginal and Torres Strait Islander population (e.g., diabetes and respiratory, cardiovascular and renal diseases) and potentially less complete cancer treatment due to geographic remoteness and cultural factors (AIHW 2008). These cultural factors may include differences in perceived value of treatment, for example cancer is seen as a 'deadly disease' and treatment is seen as mostly futile, and giving precedence to family and community needs above individual needs (Prior 2006; McMichael et al 2000). It has been reported that a perceived lack of acknowledgment of cultural differences from health professionals to Aboriginal women can also influence uptake of cancer treatment (Prior 2005; Shahid et al 2009).

Other observations include the higher risk of death from any cause, and from breast cancer specifically, among older women overall (i.e., Aboriginal and Torres Strait Islander and other women collectively), women from lower socio-economic areas, and predictably in women with larger breast cancers and more evidence of nodal involvement at diagnosis. Survivals were higher for cancers diagnosed within four months of last screen than other cancers, even after adjusting for tumour size and nodal spread, which is consistent with previous study results showing mammographic detection to be an independent prognostic indicator (Gill et al 2004, Shen et al 2005).

In general, remoteness of residence was not predictive of survival in the multivariable analyses. This does not preclude the possibility that distance may be an important factor for some sub-groups. For example, a previous study indicated lower cancer survivals for Aboriginal and Torres Strait Islander women in very remote compared with major city locations, which did not apply to non-Aboriginal and non-Torres Strait Islander patients in equivalent locations (Chong & Roder 2010). Further research is needed to explore the effects of distance more closely.

When adjusting only for socio-demographic factors in the present study, risk of death from any cause and from breast cancer was higher for all women collectively in 1995-1999 and 2000-2006 than 1991-1994. This would reflect the increased proportion of the cancers in the later diagnostic periods that had been diagnosed as symptomatic lesions in the years after women discontinued screening. When adjustment was also made in the analysis for tumour size, nodal spread, and whether or not diagnosis occurred within four months of the last screen, risk of death from any cause and from breast cancer was found to be lower in the more recent diagnostic periods.

3.6 Conclusions

The collection of data on Aboriginal and Torres Strait Islander status has been inconsistent in most administrative health statistics collections, but is likely to have been of higher quality in BreastScreen Australia due to the use of these data in ongoing monitoring for accreditation and the support given to data collection through BreastScreen Australia data dictionary definitions. Linking BreastScreen Australia data on Aboriginal and Torres Strait Islander status to Australian population-based cancer registry data has enabled a comparison of invasive breast cancer characteristics and survival outcomes by Aboriginal and Torres Strait Islander status among women with a prior history of mammography screening. From the results of this study, it is concluded that:

- Aboriginal and Torres Strait Islander women with breast cancer had on average lower ages than other women with breast cancer and there were differences in geographic distribution of place of residence with fewer Aboriginal and Torres Strait Islander than other women living in major cities and more living in remote or very remote locations and in lower socio-economic areas.
- A larger proportion of cancers among Aboriginal and Torres Strait Islander women were diagnosed in more recent time periods than was so for cancers among other women, which reflects their more recent participation in the BreastScreen Australia Program.
- Aboriginal and Torres Strait Islander women had on average larger cancers and a higher proportion of cancers that were node positive at diagnosis.
- Five-year case survivals from deaths from any cause were lower for Aboriginal and Torres Strait Islander than other women with breast cancer at about 81% compared with 90%. Aboriginal and Torres Strait Islander women had lower survivals in each age category and irrespective of remoteness of residential location.
- After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women with breast cancer had an 84% higher risk of death from any cause than other women with breast cancer. After adjusting in addition for tumour size, nodal status and duration from last screen to diagnosis (i.e., whether it was within four months) in sub-groups of women with data on these characteristics, Aboriginal and Torres Strait Islander women had a 122% elevation in risk of death from any cause.
- After adjusting for age at diagnosis, remoteness of residence, socio-economic status and diagnostic period, Aboriginal and Torres Strait Islander women had a 68% higher risk of death from breast cancer than other women with this cancer. After adjusting in addition for tumour size, nodal status and duration from last screen to diagnosis in sub-groups of women with data on these characteristics, Torres Strait Islander women had a 96% higher risk of breast cancer death than other women with this cancer.
- Even within a cohort of women with a breast screening history, Aboriginal and Torres Strait Islander women with breast cancer had poorer survival outcomes.

Apart from differences in cancer stage, factors contributing to these poorer outcomes may have included higher levels of comorbidity and more limited access to specialist treatment services.

Table 1: Socio-demographic differences for 50-69 year old women by Aboriginal and Torres Strait Islander status: BreastScreen Australia, 1996-2005

Characteristic	Aboriginal	Other	P Value*
Age (yrs.):	[n=36,204]	[n=5,330,779]	
50-54 [n=1,674,712]	35.9%	31.2%	
55-59 [n=1,474,009]	28.7%	27.5%	
60-64 [n=1,205,179]	20.8%	22.5%	MWp<0.001
65-69 [n=1,013,083]	14.6%	18.9%	
Total [n=5,366,983]	100%	100%	
Residence (ASGC):	[n=36,023]	[n=5,315,103]	
Major city [n=3,375,046]	28.2%	63.3%	
Inner regional [n=1,259,184]	19.6%	23.6%	
Outer regional [n=609,000]	26.5%	11.3%	MWp<0.001
Remote [n=80,886]	10.8%	1.4%	
Very remote [n=27,012]	14.9%	0.4%	
Total [n=5,351,128]	100%	100%	
Area socio-economic disadvantage (SEIFA):	[n=35,672]	[n=5,294,424]	
1 (lowest SES) [n=1,019,048]	41.3%	19.0%	
2 [n=1,112,482]	26.6%	20.8%	
3 [n=1,080,156]	17.8%	20.3%	MWp<0.001
4 [n=1,019,301]	10.1%	19.2%	
5 (highest SES) [n=1,099,109]	4.2%	20.7%	
Total [n=5,330,096]	100%	100%	
Screening period:	[n=36,204]	[n=5,330,779]	
1996-2000 [n=2,406,712]	40.9%	44.9%	
2001-2005 [n=2,960,271]	59.1%	55.1%	X2[1]p<0.001
Total [n=5,366,983]	100%	100%	

*MW: Mann-Whitney U test (see text)

X2[1]: Pearson chi-square test (1 degree of freedom) (see text)

Table 2: Screening characteristics of 50-69 year old women by Aboriginal and Torres Strait Islander status: BreastScreen Australia, 1996-2005

Characteristic	Aborig/TSI	Other	Relative odds (95% CIs) (Relative odds of characteristic in Aboriginal & Torres Strait Vs Other)	
			RO1	RO2
1 Rescreened within 27 months				
- Among screened women	60.1%	70.4%	0.67 [0.65, 0.68]	0.60 [0.53, 0.69]
- Among rescreened women	80.2%	85.6%	0.69 [0.67, 0.72]	0.68 [0.57, 0.80]
2 Presenting with symptoms	3.6%	3.5%	1.08 [1.03, 1.15]	1.02 [1.00, 1.04]
3 Recalled to assessment	4.7%	5.8%	0.81 [0.77, 0.86]	0.89 [0.80, 0.98]
4 Assessed women assessed < 28 days	71.8%	84.1%	0.47 [0.42, 0.54]	0.76 [0.68, 0.85]
5 Having a biopsy				
- Among screened women	1.4%	1.5%	0.93 [0.84, 1.03]	1.04 [0.91, 1.19]
- Among recalled women	25.6%	23.8%	1.10 [0.98, 1.25]	1.13 [0.98, 1.31]
6 Having invasive cancer				
- Among screened women	0.3%	0.5%	0.72 [0.60, 0.87]	1.13 [0.98, 1.30]
- Among recalled women	6.5%	8.1%	0.81 [0.66, 1.01]	1.20 [1.01, 1.43]
7 Having DCIS				
- Among screened women	0.1%	0.1%	0.85 [0.59, 1.23]	2.32 [1.82, 2.95]
- Among recalled women	2.0%	2.0%	0.96 [0.64, 1.42]	1.11 [1.08, 1.14]
8 Having invasive cancer or DCIS				
- Among screened women	0.4%	0.6%	0.74 [0.63, 0.88]	1.03 [0.90, 1.18]
- Among recalled women	8.4%	10.0%	0.84 [0.69, 1.01]	1.08 [0.91, 1.29]
9 Having invasive cancer in those with invasive cancer or DCIS	75.7%	81.3%	0.84 [0.56, 1.28]	0.59 [0.43, 0.80]
10 Large (>15mm) Vs smaller				
- Invasive cancers	39.8%	37.7%	1.16 [0.77, 1.77]	1.84 [1.48, 2.29]
- Invasive cancers or DCIS	43.4%	38.5%	1.20 [0.82, 1.76]	1.63 [1.33, 2.01]
11 Mastectomy Vs complete local excision				
- Invasive cancers	34.8%	28.2%	1.50 [0.92, 2.43]	1.55 [1.02, 2.36]
- Invasive cancers or DCIS	31.0%	27.3%	1.36 [0.88, 2.11]	1.45 [1.01, 2.10]

* Initial and Subsequent screening round data weighted equally

RO1: adjusted for Initial Vs Subsequent round using Mantel-Haenszel procedure (see text).

RO2: adjusted for age, ASGC, socio-economic disadvantage (SEIFA), screening period and Initial Vs Subsequent round using regression (see text).

**Table 3: Relative odds of screened women being rescreened within 27 months by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=4,061,111]	1.00
Yes [n=26,830]	0.60 [0.53, 0.69]
Age (yrs.):	
50-59 [n=2,398,865]	1.00
60-64 [n=916,244]	1.17 [1.14, 1.20]
65-69 [n=772, 832]	0.28 [0.27, 0.28]
Residence (ASGC):	
Major city [n=2,612,753]	1.00
Inner regional [n=966,598]	1.06 [1.03, 1.09]
Outer regional [n=437,734]	1.20 [1.16, 1.25]
More remote [n=70,856]	1.09 [1.00, 1.19]
Socio-economic status (SEIFA):	
5 (lowest) [n=786,642]	1.00
4 [n=856,185]	1.02 [0.98, 1.05]
3 [n=828,740]	1.08 [1.05, 1.12]
2 [n=775,699]	1.11 [1.07, 1.15]
1 (highest) [n=840,675]	1.08 [1.04, 1.12]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=1,699,921]	0.89 [0.87, 0.91]
Screening round:	
Initial [n=772,514]	1.00
Subsequent [n=3,315,427]	2.05 [2.00, 2.11]

* Excludes women without time to rescreen within 27 months of end of study. Weighted log-linear regression (see text).

**Table 4: Relative odds of rescreened women being rescreened within 27 months by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=3,406,445]	1.00
Yes [n=20,861]	0.68 [0.57, 0.80]
Age (yrs.):	
50-59 [n=2,162,195]	1.00
60-64 [n=833,508]	1.28 [1.24, 1.32]
65-69 [n=431,603]	1.98 [1.90, 2.06]
Residence (ASGC):	
Major city [n=2,183,933]	1.00
Inner regional [n=811,945]	1.01 [0.98, 1.04]
Outer regional [n=372,591]	1.21 [1.15, 1.26]
More remote [n=58,837]	1.34 [1.21, 1.49]
Socio-economic status (SEIFA):	
5 (lowest) [n=651,273]	1.00
4 [n=714,605]	0.99 [0.95, 1.03]
3 [n=696,332]	1.10 [1.05, 1.15]
2 [n=656,238]	1.08 [1.04, 1.13]
1 (highest) [n=708,858]	1.10 [1.05, 1.14]
Screening period:	
1996-2000 [n=2,016,894]	1.00
2001-2005 [n=1,410,412]	1.06 [1.03, 1.09]
Screening round:	
Initial [n=610,140]	1.00
Subsequent [n=2,817,166]	1.80 [1.74, 1.86]

*Weighted log-linear regression (see text).

Table 5: Relative odds of presenting to screening with symptoms by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	1.02 [1.00, 1.04]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	0.78 [0.75, 0.81]
65-69 [n=1,007,326]	0.67 [0.64, 0.70]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	0.64 [0.61, 0.66]
Outer regional [n=569,069]	0.69 [0.66, 0.73]
More remote [n=91,072]	0.61 [0.54, 0.69]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.04 [0.99, 1.09]
3 [n=1,080,156]	1.33 [1.27, 1.40]
2 [n=1,019,301]	1.34 [1.28, 1.41]
1 (highest) [n=1,099,109]	1.48 [1.41, 1.56]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.03 [0.99, 1.06]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.74 [0.71, 0.77]

*Weighted log-linear regression (see text).

**Table 6: Relative odds of screened women being recalled to assessment by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	0.89 [0.80, 0.98]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	0.95 [0.93, 0.97]
65-69 [n=1,007,326]	0.91 [0.89, 0.93]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	1.01 [0.98, 1.03]
Outer regional [n=569,069]	0.93 [0.91, 0.96]
More remote [n=91,072]	0.75 [0.71, 0.80]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.06 [1.04, 1.09]
3 [n=1,080,156]	1.09 [1.06, 1.12]
2 [n=1,019,301]	1.10 [1.07, 1.13]
1 (highest) [n=1,099,109]	1.14 [1.11, 1.17]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.08 [1.06, 1.09]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.48 [0.47, 0.49]

*Weighted log-linear regression (see text).

**Table 7: Relative odds of assessed women being assessed within 28 days by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=225,932]	1.00
Yes [n=1,293]	0.76 [0.68, 0.85]
Age (yrs.):	
50-59 [n=142,832]	1.00
60-64 [n=46,994]	0.94 [0.92, 0.96]
65-69 [n=37,399]	0.90 [0.87, 0.92]
Residence (ASGC):	
Major city [n=148,695]	1.00
Inner regional [n=52,617]	0.95 [0.92, 0.97]
Outer regional [n=22,907]	0.88 [0.85, 0.91]
More remote [n=3,006]	0.75 [0.69, 0.80]
Socio-economic status (SEIFA):	
5 (lowest) [n=38,831]	1.00
4 [n=44,498]	1.04 [1.01, 1.07]
3 [n=46,173]	1.17 [1.14, 1.20]
2 [n=45,892]	1.25 [1.21, 1.29]
1 (highest) [n=51,831]	1.22 [1.18, 1.26]
Screening period:	
1996-2000 [n=100,498]	1.00
2001-2005 [n=126,727]	0.99 [0.97, 1.01]
Screening round:	
Initial [n=68,401]	1.00
Subsequent [n=158,824]	0.48 [0.46, 0.49]

*Weighted log-linear regression (see text).

**Table 8: Relative odds of screened women having a biopsy by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CLs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	1.04 [0.91, 1.19]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	1.06 [1.04, 1.09]
65-69 [n=1,007,326]	1.08 [1.05, 1.11]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	1.04 [1.02, 1.07]
Outer regional [n=569,069]	1.05 [1.01, 1.09]
More remote [n=91,072]	1.05 [0.97, 1.15]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.09 [1.05, 1.12]
3 [n=1,080,156]	1.10 [1.07, 1.14]
2 [n=1,019,301]	1.28 [1.24, 1.33]
1 (highest) [n=1,099,109]	1.25 [1.20, 1.29]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.20 [1.18, 1.23]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.45 [0.43, 0.46]

*Weighted log-linear regression (see text).

**Table 9: Relative odds of recalled women having a biopsy by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=236,942]	1.00
Yes [n=1,376]	1.13 [0.98, 1.31]
Age (yrs.):	
50-59 [n=149,356]	1.00
60-64 [n=49,420]	1.18 [1.15, 1.22]
65-69 [n=39,542]	1.28 [1.24, 1.32]
Residence (ASGC):	
Major city [n=155,980]	1.00
Inner regional [n=56,203]	1.00 [0.97, 1.03]
Outer regional [n=23,120]	1.11 [1.07, 1.16]
More remote [n=3,015]	1.36 [1.23, 1.50]
Socio-economic status (SEIFA):	
5 (lowest) [n=42,096]	1.00
4 [n=48,519]	1.02 [0.98, 1.06]
3 [n=48,481]	0.99 [0.96, 1.03]
2 [n=46,960]	1.18 [1.14, 1.23]
1 (highest) [n=52,262]	1.14 [1.10, 1.18]
Screening period:	
1996-2000 [n=106,296]	1.00
2001-2005 [n=132,022]	1.13 [1.11, 1.16]
Screening round:	
Initial [n=71,056]	1.00
Subsequent [n=167,262]	0.87 [0.85, 0.89]

*Weighted log-linear regression (see text).

Table 10: Relative odds of screened women having invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	1.13 [0.98, 1.30]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	1.36 [1.32, 1.40]
65-69 [n=1,007,326]	1.50 [1.45, 1.55]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	0.98 [0.95, 1.01]
Outer regional [n=569,069]	0.98 [0.94, 1.02]
More remote [n=91,072]	0.95 [0.87, 1.05]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.09 [1.05, 1.13]
3 [n=1,080,156]	1.17 [1.12, 1.21]
2 [n=1,019,301]	1.33 [1.28, 1.38]
1 (highest) [n=1,099,109]	1.38 [1.33, 1.44]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.00 [0.98, 1.02]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.67 [0.65, 0.69]

*Weighted log-linear regression (see text).

**Table 11: Relative odds of recalled women having invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=236,942]	1.00
Yes [n=1,376]	1.20 [1.01, 1.43]
Age (yrs.):	
50-59 [n=149,356]	1.00
60-64 [n=49,420]	1.58 [1.52, 1.63]
65-69 [n=39,542]	1.88 [1.81, 1.95]
Residence (ASGC):	
Major city [n=155,980]	1.00
Inner regional [n=56,203]	0.94 [0.91, 0.98]
Outer regional [n=23,120]	1.06 [1.01, 1.11]
More remote [n=3,015]	1.27 [1.12, 1.44]
Socio-economic status (SEIFA):	
5 (lowest) [n=42,096]	1.00
4 [n=48,519]	1.03 [0.99, 1.08]
3 [n=48,481]	1.05 [1.00, 1.09]
2 [n=46,960]	1.16 [1.10, 1.21]
1 (highest) [n=52,262]	1.18 [1.12, 1.23]
Screening period:	
1996-2000 [n=106,296]	1.00
2001-2005 [n=132,022]	0.98 [0.95, 1.01]
Screening round:	
Initial [n=71,056]	1.00
Subsequent [n=167,262]	1.35 [1.31, 1.39]

*Weighted log-linear regression (see text).

**Table 12: Relative odds of screened women having DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	2.32 [1.82, 2.95]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	1.21 [1.15, 1.27]
65-69 [n=1,007,326]	1.24 [1.18, 1.31]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	1.01 [0.96, 1.06]
Outer regional [n=569,069]	1.06 [0.99, 1.13]
More remote [n=91,072]	1.14 [0.97, 1.32]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.04 [0.98, 1.10]
3 [n=1,080,156]	1.13 [1.06, 1.20]
2 [n=1,019,301]	1.41 [1.32, 1.50]
1 (highest) [n=1,099,109]	1.45 [1.36, 1.54]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.16 [1.11, 1.20]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.63 [0.59, 0.66]

*Weighted log-linear regression (see text).

**Table 13: Relative odds of recalled women having DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=236,942]	1.00
Yes [n=1,376]	1.11 [1.08, 1.14]
Age (yrs.):	
50-59 [n=149,356]	1.00
60-64 [n=49,420]	1.31 [1.24, 1.39]
65-69 [n=39,542]	1.39 [1.31, 1.48]
Residence (ASGC):	
Major city [n=155,980]	1.00
Inner regional [n=56,203]	0.96 [0.90, 1.01]
Outer regional [n=23,120]	1.07 [0.99, 1.16]
More remote [n=3,015]	1.43 [1.17, 1.74]
Socio-economic status (SEIFA):	
5 (lowest) [n=42,096]	1.00
4 [n=48,519]	1.00 [0.93, 1.07]
3 [n=48,481]	1.04 [0.96, 1.11]
2 [n=46,960]	1.25 [1.16, 1.35]
1 (highest) [n=52,262]	1.24 [1.15, 1.33]
Screening period:	
1996-2000 [n=106,296]	1.00
2001-2005 [n=132,022]	1.07 [1.02, 1.12]
Screening round:	
Initial [n=71,056]	1.00
Subsequent [n=167,262]	1.25 [1.19, 1.32]

*Weighted log-linear regression (see text).

**Table 14: Relative odds of screened women having invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=5,294,424]	1.00
Yes [n=35,672]	1.03 [0.90, 1.18]
Age (yrs.):	
50-59 [n=3,125,725]	1.00
60-64 [n=1,197,045]	1.33 [1.30, 1.37]
65-69 [n=1,007,326]	1.45 [1.41, 1.49]
Residence (ASGC):	
Major city [n=3,407,229]	1.00
Inner regional [n=1,262,726]	0.98 [0.96, 1.01]
Outer regional [n=569,069]	0.99 [0.95, 1.03]
More remote [n=91,072]	0.98 [0.90, 1.08]
Socio-economic status (SEIFA):	
5 (lowest) [n=1,019,048]	1.00
4 [n=1,112,482]	1.09 [1.05, 1.13]
3 [n=1,080,156]	1.16 [1.12, 1.20]
2 [n=1,019,301]	1.34 [1.30, 1.39]
1 (highest) [n=1,099,109]	1.40 [1.34, 1.45]
Screening period:	
1996-2000 [n=2,388,020]	1.00
2001-2005 [n=2,942,076]	1.03 [1.00, 1.05]
Screening round:	
Initial [n=917,689]	1.00
Subsequent [n=4,412,407]	0.66 [0.64, 0.68]

*Weighted log-linear regression (see text).

**Table 15: Relative odds of recalled women having invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=236,942]	1.00
Yes [n=1,376]	1.08 [0.91, 1.29]
Age (yrs.):	
50-59 [n=149,356]	1.00
60-64 [n=49,420]	1.54 [1.49, 1.60]
65-69 [n=39,542]	1.81 [1.74, 1.88]
Residence (ASGC):	
Major city [n=155,980]	1.00
Inner regional [n=56,203]	0.94 [0.91, 0.98]
Outer regional [n=23,120]	1.06 [1.01, 1.11]
More remote [n=3,015]	1.30 [1.15, 1.47]
Socio-economic status (SEIFA):	
5 (lowest) [n=42,096]	1.00
4 [n=48,519]	1.03 [0.98, 1.08]
3 [n=48,481]	1.05 [1.00, 1.10]
2 [n=46,960]	1.18 [1.13, 1.24]
1 (highest) [n=52,262]	1.20 [1.14, 1.25]
Screening period:	
1996-2000 [n=106,296]	1.00
2001-2005 [n=132,022]	1.00 [0.97, 1.03]
Screening round:	
Initial [n=71,056]	1.00
Subsequent [n=167,262]	1.34 [1.30, 1.38]

*Weighted log-linear regression (see text).

Table 16: Relative odds of invasive cancer compared with DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=28,130]	1.00
Yes [n=146]	0.59 [0.43, 0.80]
Age (yrs.):	
50-59 [n=14,698]	1.00
60-64 [n=7,111]	1.13 [1.06, 1.21]
65-69 [n=6,467]	1.21 [1.13, 1.30]
Residence (ASGC):	
Major city [n=18,736]	1.00
Inner regional [n=6,355]	0.97 [0.90, 1.04]
Outer regional [n=2,768]	0.94 [0.85, 1.03]
More remote [n=417]	0.85 [0.68, 1.05]
Socio-economic status (SEIFA):	
5 (lowest) [n=4,563]	1.00
4 [n=5,408]	1.06 [0.97, 1.17]
3 [n=5,524]	1.04 [0.95, 1.14]
2 [n=6,033]	0.96 [0.87, 1.05]
1 (highest) [n=6,748]	0.96 [0.88, 1.06]
Screening period:	
1996-2000 [n=12,811]	1.00
2001-2005 [n=15,465]	0.86 [0.82, 0.91]
Screening round:	
Initial [n=6,450]	1.00
Subsequent [n=21,826]	1.06 [0.99, 1.13]

*Weighted log-linear regression (see text).

Table 17: Relative odds of large (> 15mm) compared with smaller invasive cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=20,836]	1.00
Yes [n=103]	1.84 [1.48, 2.29]
Age (yrs.):	
50-59 [n=10,564]	1.00
60-64 [n=5,385]	1.33 [1.27, 1.39]
65-69 [n=4,990]	1.39 [1.33, 1.46]
Residence (ASGC):	
Major city [n=13,738]	1.00
Inner regional [n=4,774]	1.00 [0.96, 1.05]
Outer regional [n=2,108]	0.95 [0.89, 1.00]
More remote [n=319]	1.01 [0.88, 1.15]
Socio-economic status (SEIFA):	
5 (lowest) [n=3,446]	1.00
4 [n=4,157]	1.15 [1.09, 1.22]
3 [n=4,143]	1.22 [1.15, 1.29]
2 [n=4,388]	1.33 [1.26, 1.41]
1 (highest) [n=4,805]	1.29 [1.22, 1.37]
Screening period:	
1996-2000 [n=9,106]	1.00
2001-2005 [n=11,833]	1.21 [1.17, 1.26]
Screening round:	
Initial [n=4,766]	1.00
Subsequent [n=16,173]	0.51 [0.49, 0.54]

*Weighted log-linear regression (see text).

**Table 18: Relative odds of large (> 15mm) compared with smaller invasive cancer or DCIS by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis**

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=23,607]	1.00
Yes [n=120]	1.63 [1.33, 2.01]
Age (yrs.):	
50-59 [n=12,080]	1.00
60-64 [n=6,077]	1.31 [1.26, 1.37]
65-69 [n=5,570]	1.37 [1.31, 1.44]
Residence (ASGC):	
Major city [n=15,567]	1.00
Inner regional [n=5,419]	0.98 [0.94, 1.02]
Outer regional [n=2,368]	0.94 [0.89, 1.00]
More remote [n=373]	1.06 [0.93, 1.21]
Socio-economic status (SEIFA):	
5 (lowest) [n=3,893]	1.00
4 [n=4,731]	1.17 [1.11, 1.24]
3 [n=4,729]	1.22 [1.16, 1.29]
2 [n=5,047]	1.37 [1.29, 1.44]
1 (highest) [n=5,327]	1.26 [1.19, 1.34]
Screening period:	
1996-2000 [n=10,116]	1.00
2001-2005 [n=13,611]	1.25 [1.21, 1.30]
Screening round:	
Initial [n=5,433]	1.00
Subsequent [n=18,294]	0.52 [0.50, 0.55]

*Weighted log-linear regression (see text).

Table 19: Relative odds of mastectomy compared with complete local excision for invasive breast cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds ratio (95% CLs)
Aboriginal or Torres Strait Islander:	
No [n=16,178]	1.00
Yes [n=81]	1.55 [1.02, 2.36]
Age (yrs.):	
50-59 [n=8,167]	1.00
60-64 [n=4,220]	1.03 [0.94, 1.12]
65-69 [n=3,872]	0.99 [0.90, 1.09]
Residence (ASGC):	
Major city [n=10,491]	1.00
Inner regional [n=4,038]	1.42 [1.29, 1.56]
Outer regional [n=1,518]	1.85 [1.62, 2.12]
More remote [n=212]	1.70 [1.26, 2.31]
Socio-economic status (SEIFA):	
5 (lowest) [n=2,559]	1.00
4 [n=3,220]	1.24 [1.09, 1.40]
3 [n=3,196]	1.26 [1.11, 1.42]
2 [n=3,404]	0.86 [0.76, 0.97]
1 (highest) [n=3,880]	1.00 [0.88, 1.13]
Screening period:	
1996-2000 [n=6,826]	1.00
2001-2005 [n=9,433]	0.80 [0.74, 0.87]
Screening round:	
Initial [n=3,724]	1.00
Subsequent [n=12,535]	0.71 [0.65, 0.77]

*Weighted log-linear regression (see text).

Table 20: Relative odds of mastectomy compared with complete local excision for invasive breast or DCIS cancer by socio-demographic characteristics: BreastScreen Australia, 1996-2005*
- Regression analysis

	Relative odds (95% CIs)
Aboriginal or Torres Strait Islander:	
No [n=19,904]	1.00
Yes [n=103]	1.45 [1.01, 2.10]
Age (yrs.):	
50-59 [n=10,222]	1.00
60-64 [n=5,143]	1.05 [0.97, 1.13]
65-69 [n=4,642]	1.00 [0.92, 1.09]
Residence (ASGC):	
Major city [n=12,920]	1.00
Inner regional [n=4,954]	1.38 [1.27, 1.50]
Outer regional [n=1,858]	1.80 [1.60, 2.03]
More remote [n=275]	1.85 [1.42, 2.41]
Socio-economic status (SEIFA):	
5 (lowest) [n=3,155]	1.00
4 [n=3,925]	1.25 [1.12, 1.39]
3 [n=3,905]	1.23 [1.11, 1.38]
2 [n=4,218]	0.85 [0.76, 0.95]
1 (highest) [n=4,804]	1.07 [0.96, 1.19]
Screening period:	
1996-2000 [n=8,238]	1.00
2001-2005 [n=11,769]	0.79 [0.74, 0.85]
Screening round:	
Initial [n=4,632]	1.00
Subsequent [n=15,375]	0.74 [0.69, 0.80]

*Weighted log-linear regression (see text).

Table 21: Characteristics of women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status

Characteristics	Aboriginal and Torres Strait Islander status		P Value*
	Yes	No	
Age at diagnosis (yrs.):	[n=446]	[n=61,636]	
Under 50 [n=7,313]	20.6%	11.7%	MW p<0.001
50-59 [n=22,024]	38.1%	35.5%	
60-69 [n=20,327]	28.3%	32.8%	
70+ [n=12,418]	13.0%	20.1%	
Total [n=62,082]	100%	100%	
Residence (ASGC):	[n=422]	[n=61,826]	
Major city [n=42,487]	36.5%	68.5%	X ² (3) p<0.001
Inner regional [n=13,307]	21.1%	21.4%	
Outer regional [n=5,450]	22.0%	8.7%	
Remote & very remote [n=1,004]	20.4%	1.5%	
Total [n=62,248]	100%	100%	
Area socio-economic (SEIFA):	[n=421]	[n=61,734]	
1 (lowest SES) [n=12,611]	41.1%	20.2%	MW p<0.001
2 [n=13,846]	21.4%	22.3%	
3 [n=11,558]	19.0%	18.6%	
4 [n=10,498]	12.4%	16.9%	
5 (highest SES) [n=13,642]	6.2%	22.1%	
Total [n=62,155]	100%	100%	

* MW: Mann-Whitney U test (see text).

X²(3): Pearson chi-square test (3 degrees of freedom) (see text).

Table 22: Invasive breast cancer characteristics for women diagnosed in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status

Characteristics	Aboriginal and Torres Strait Islander status		P Value*
	Yes	No	
Diagnosis period**:	[n=454]	[n=63,287]	
1991-94 [n=4,688]	6.0%	7.4%	MW p<0.001
1995-99 [n=18,711]	19.6%	29.4%	
2000-06 [n=40,342]	74.5%	63.2%	
Total [n=63,741]	100%	100%	
Time from screen (months):	[n=356]	[n=56,201]	
Within 4 [n=34,548]	56.2%	61.1%	X ² (1) p=0.961
Outside 4 [n=22,009]	43.8%	38.9%	
Total [n=56,557]	100%	100%	
Morphology type:	[n=445]	[n=62,076]	
Ductal [n=50,002]	81.8%	80.0%	X ² (2) p=0.212
Lobular [n=7,390]	9.2%	11.8%	
Other [n=5,129]	9.0%	8.2%	
Total [n=62,521]	100%	100%	
Tumour size (mm):	[n=312]	[n=41,513]	
0-15 [n=23,495]	48.4%	56.2%	MW p=0.003
16-19 [n=12,994]	34.9%	31.0%	
30+ [n=5,336]	16.7%	12.7%	
Total [n=41,825]	100%	100%	
Nodal status:	[n=288]	[n=35,327]	
Positive [n=15,558]	54.9%	43.6%	X ² (1) p<0.001
Negative [n=20,057]	45.1%	56.4%	
Total [n=35,615]	100%	100%	
Death cause:	[n=116]	[n=10,995]	
Breast cancer [n=5,862]	49.1%	52.8%	X ² (1) p=0.432
Other [n=5,249]	50.9%	47.2%	
Total [n=11,111]	100%	100%	

* MW: Mann-Whitney U test (see text).

X²(1) & X²(2): Pearson chi-square test (1 and 2 degrees of freedom respectively) (see text). ** Overall, 0.7% of breast cancers occurred in Aboriginal and Torres Strait Islander women, with this proportion increasing from 0.5% of those diagnosed in the 1990s to 0.8% of those diagnosed in 2000-06.

Table 23: Percentage 5-year crude survivals (95% confidence limits) for invasive breast cancers for women diagnosed in 1991-2006 who were previously screened through BreastScreen Australia, by Aboriginal and Torres Strait Islander status*

Characteristics	Aboriginal and Torres Strait Islander status		Difference (95% confidence limits)
	Yes	No	
Age at diagnosis (yrs.):	[n=446]	[n=61,636]	
Under 50 [n=7,313]	84.8 [76.5, 93.2]	93.1 [92.4, 93.8]	-8.2 [-16.6, 0.1]
50-59 [n=22,024]	84.7 [77.7, 91.7]	91.5 [91.1, 91.9]	-6.8 [-13.8, 0.3]
60-69 [n=20,327]	78.8 [70.1, 87.6]	90.5 [90.0, 90.9]	-11.6 [-20.4, -2.9]
70+ [n=12,418]	76.7 [63.8, 89.5]	82.4 [81.6, 83.2]	-5.7 [-18.6, 7.1]
Residence (ASGC):	[n=422]	[n=61,826]	
Major city [n=42,487]	86.2 [79.9, 92.4]	89.8 [89.5, 90.2]	-3.7 [-9.9, 2.6]
Inner regional [n=13,307]	79.2 [68.3, 90.1]	89.3 [88.7, 90.0]	-10.1 [-21.1, 0.8]
Outer regional [n=5,450]	75.0 [63.3, 86.7]	88.3 [87.2, 89.3]	-13.3 [-25.1, -1.5]
Remote & very remote [n=1,004]	84.0 [74.8, 93.2]	90.3 [88.1, 92.5]	-6.3 [-15.8, 3.2]
Area socio-economic (SEIFA):	[n=421]	[n=61,734]	
1 (lowest SES) [n=12,611]	76.4 [68.7, 84.2]	88.6 [88.0, 89.3]	-12.2 [-20.0, -4.4]
2 [n=13,846]	81.3 [71.0, 91.5]	88.6 [87.9, 89.2]	-7.3 [-17.5, 3.0]
3 [n=11,558]	88.5 [79.5, 97.5]	88.5 [87.8, 90.1]	-0.9 [-9.9, 8.1]
4 [n=10,498]	91.4 [83.3, 99.5]	90.3 [89.6, 90.9]	1.1 [-7.0, 9.3]
5 (highest SES) [n=13,642]	83.5 [66.4, 100.0]	91.2 [90.6, 91.7]	-7.7 [-24.7, 9.4]
Diagnostic period:	[n=454]	[n=63,287]	
1991-94 [n=4,688]	96.3 [89.2, 100.0]	91.9 [91.1, 92.6]	4.5 [-2.7, 11.6]
1995-99 [n=18,711]	83.2 [75.4, 91.0]	89.4 [89.0, 89.9]	-6.3 [-14.1, 1.5]
2000-06 [n=40,342]	78.9 [72.7, 85.1]	89.5 [89.1, 89.9]	-10.6 [-16.8, -4.4]

* Crude survivals from diagnosis to death from any cause.

**Table 24: Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=63,319]	1.00
Yes [n=454]	1.84 [1.61, 2.08]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=8,973]	1.00
50-59 [n=22,035]	1.18 [1.10, 1.27]
60-69 [n=20,341]	1.56 [1.07, 1.29]
70+ [n=12,424]	3.07 [1.40, 1.71]
Residence (ASGC):	
Major city (reference) [n=43,998]	1.00
Inner regional [n=13,314]	1.01 [0.95, 1.07]
Outer regional [n=5,456]	1.09 [1.01, 1.18]
Remote & very remote [n=1,005]	1.05 [0.87, 1.23]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=14,207]	1.00
2 [n=13,854]	0.98 [0.91, 1.05]
3 [n=11,565]	0.93 [0.86, 1.00]
4 [n=10,502]	0.90 [0.83, 0.98]
5 (highest SES) [n=13,645]	0.83 [0.75, 0.90]
Diagnostic period:	
1991-94 (reference) [n=4,689]	1.00
1995-99 [n=18,717]	1.20 [1.12, 1.27]
2000-06 [n=40,367]	1.19 [1.11, 1.28]

* Proportional hazards regression: date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/non-Torres Strait Islander status.

**Table 25: Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 30,852 women with recorded tumour size and nodal status)*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=30,598]	1.00
Yes [n=254]	2.17 [1.55, 3.05]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=3,504]	1.00
50-59 [n=11,590]	1.21 [1.04, 1.40]
60-69 [n=10,359]	1.52 [1.32, 1.77]
70+ [n=5,399]	2.73 [2.35, 3.17]
Residence (ASGC):	
Major city (reference) [n=21,333]	1.00
Inner regional [n=6,216]	1.09 [0.99, 1.21]
Outer regional [n=2,784]	1.17 [1.02, 1.34]
Remote & very remote [n=519]	0.92 [0.67, 1.25]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=7,094]	1.00
2 [n=5,503]	0.97 [0.86, 1.09]
3 [n=6,099]	0.96 [0.86, 1.08]
4 [n=5,902]	0.88 [0.78, 0.99]
5 (highest SES) [n=6,254]	0.81 [0.72, 0.92]
Diagnostic period:	
1991-94 (reference) [n=326]	1.00
1995-99 [n=8,297]	1.09 [0.84, 1.42]
2000-06 [n=22,229]	0.94 [0.72, 1.23]
Tumour size:	
0-15 (reference) [n=16,438]	1.00
16+ [n=14,414]	2.40 [2.22, 2.60]
Nodal status:	
Negative (reference) [n=15,139]	1.00
Positive [n=15,713]	1.10 [1.02, 1.19]

* Proportional hazards regression: date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/non-Torres Strait Islander status.

**Table 26: Relative risk (95% confidence limits) of death from any cause among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 28,073 women with recorded tumour size and nodal status)*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=27,867]	1.00
Yes [n=206]	2.22 [1.53, 3.21]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=3,042]	1.00
50-59 [n=10,487]	1.16 [1.00, 1.36]
60-69 [n=9,468]	1.49 [1.28, 1.73]
70+ [n=5,076]	2.65 [2.27, 3.10]
Residence (ASGC):	
Major city (reference) [n=19,326]	1.00
Inner regional [n=5,812]	1.06 [0.96, 1.18]
Outer regional [n=2,562]	1.15 [1.00, 1.33]
Remote & very remote [n=373]	1.11 [0.78, 1.57]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=6,640]	1.00
2 [n=5,050]	0.99 [0.88, 1.12]
3 [n=5,359]	1.02 [0.91, 1.15]
4 [n=5,359]	0.90 [0.79, 1.02]
5 (highest SES) [n=5,665]	0.84 [0.74, 0.95]
Diagnostic period:	
1991-94 (reference) [n=266]	1.00
1995-99 [n=7,493]	0.85 [0.65, 1.12]
2000-06 [n=20,314]	0.70 [0.53, 0.93]
Time from screen (months):	
Outside 4 (reference) [n=10,406]	1.00
Within 4 [n=17,667]	0.61 [0.56, 0.66]
Tumour size (mm):	
0-15 (reference) [n=14,820]	1.00
16+ [n=13,253]	2.25 [2.07, 2.45]
Nodal status:	
Negative (reference) [n=13,175]	1.00
Positive [n=14,895]	1.06 [0.97, 1.14]

* Proportional hazards regression: date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/non-Torres Strait Islander status.

**Table 27: Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=63,319]	1.00
Yes [n=454]	1.68 [1.37, 1.99]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=8,973]	1.00
50-59 [n=22,035]	1.07 [0.97, 1.16]
60-69 [n=20,341]	1.05 [0.95, 1.15]
70+ [n=14,424]	1.35 [1.29, 1.49]
Residence (ASGC):	
Major city (reference) [n=43,998]	1.00
Inner regional [n=13,314]	0.99 [0.90, 1.06]
Outer regional [n=5,456]	1.03 [0.93, 1.16]
Remote & very remote [n=1,005]	1.08 [0.89, 1.40]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=14,207]	1.00
2 [n=13,854]	1.03 [0.94, 1.12]
3 [n=11,565]	0.97 [0.87, 1.06]
4 [n=10,502]	0.90 [0.80, 1.00]
5 (highest SES) [n=13,645]	0.87 [0.76, 0.95]
Diagnostic period:	
1991-94 (reference) [n=4,689]	1.00
1995-99 [n=18,717]	1.18 [1.08, 1.28]
2000-06 [n=40,367]	1.17 [1.06, 1.27]

* Proportional hazards regression: date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/non-Torres Strait Islander status.

**Table 28: Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 30,852 women with recorded tumour size and nodal status)*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=30,598]	1.00
Yes [n=254]	1.81 [1.14, 2.87]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=3,504]	1.00
50-59 [n=11,590]	1.09 [0.92, 1.29]
60-69 [n=10,359]	1.13 [0.96, 1.34]
70+ [n=5,399]	1.37 [1.13, 1.65]
Residence (ASGC):	
Major city (reference) [n=21,333]	1.00
Inner regional [n=6,216]	1.05 [0.92, 1.09]
Outer regional [n=2,784]	1.12 [0.94, 1.34]
Remote & very remote [n=519]	0.92 [0.62, 1.36]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=7,094]	1.00
2 [n=5,503]	1.11 [0.96, 1.29]
3 [n=6,099]	1.08 [0.93, 1.26]
4 [n=5,902]	0.91 [0.77, 1.07]
5 (highest SES) [n=6,254]	0.88 [0.75, 1.03]
Diagnostic period:	
1991-94 (reference) [n=326]	1.00
1995-99 [n=8,297]	1.11 [0.78, 1.59]
2000-06 [n=22,229]	0.95 [0.66, 1.36]
Tumour size (mm):	
0-15 (reference) [n=16,438]	1.00
16+ [n=14,414]	4.18 [3.72, 4.70]
Nodal status:	
Negative (reference) [n=15,139]	1.00
Positive [n=15,713]	1.28 [1.16, 1.42]

* Proportional hazards regression: date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/and non-Torres Strait Islander status.

**Table 29: Relative risk (95% confidence limits) of death from breast cancer among women diagnosed with invasive breast cancer in 1991-2006 who were previously screened through BreastScreen Australia (note: analysis of sub-set of 28,073 women with recorded tumour size and nodal status)*
- Proportional hazards regression analysis**

	Relative risk
Aboriginal and Torres Strait Islander status:**	
No (reference) [n=27,867]	1.00
Yes [n=206]	1.96 [1.20, 3.21]
Age at diagnosis (yrs.):	
Under 50 (reference) [n=3,042]	1.00
50-59 [n=10,487]	1.06 [0.89, 1.26]
60-69 [n=9,468]	1.10 [0.93, 1.32]
70+ [n=5,076]	1.34 [1.11, 1.62]
Residence (ASGC):	
Major city (reference) [n=19,326]	1.00
Inner regional [n=5,812]	1.01 [0.88, 1.16]
Outer regional [n=2,562]	1.10 [0.91, 1.32]
Remote & very remote [n=373]	1.02 [0.66, 1.58]
Areas socio-economic (SEIFA):	
1 (lowest SES) (reference) [n=6,640]	1.00
2 [n=5,050]	1.12 [0.96, 1.31]
3 [n=5,359]	1.15 [0.99, 1.34]
4 [n=5,359]	0.91 [0.77, 1.08]
5 (highest SES) [n=5,665]	0.90 [0.76, 1.06]
Diagnostic period:	
1991-94 (reference) [n=266]	1.00
1995-99 [n=7,493]	0.79 [0.54, 1.16]
2000-06 [n=20,314]	0.64 [0.43, 0.94]
Time from screen (months):	
Outside 4 (reference) [n=10,406]	1.00
Within 4 [n=17,667]	0.57 [0.51, 0.63]
Tumour size (mm):	
0-15 (reference) [n=14,820]	1.00
16+ [n=13,253]	3.84 [3.39, 4.34]
Nodal status:	
Negative (reference) [n=13,175]	1.00
Positive [n=14,898]	1.18 [1.07, 1.31]

* Proportional hazards regression; date of censoring of live cases, December 31st 2006.

** Non-stated assigned to non-Aboriginal/non-Torres Strait Islander status.

Appendix A Contributors

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Abbreviations

ABS	Australian Bureau of Statistics
ASGC	Australian Standard Geographical Classification
AIHW	Australian Institute of Health and Welfare
DCIS	Ductal carcinoma in situ
NBOCC	National Breast and Ovarian Cancer Centre
SEIFA	Socio-Economic Indexes for Areas
SES	Socio-economic status

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