AMJ Australasian Medical Journal [AMJ 2020;13(6):189-200

Differences in breast cancer treatment pathways for women participating in screening through BreastScreen New South Wales (BSNSW)

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RESEARCH

Please cite this paper as: Shahabi-Kargar Z, Johnston A, Warner-Smith M, Creighton N, Roder D. Differences in breast cancer treatment pathways for women participating in screening through breastscreen New South Wales (BSNSW). AMJ 2020;13(6):189–200.
https://doi.org/10.35841/1836-1935.13.6.189-200

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ABSTRACT

Background
Previous studies have shown that mammographic screening is associated with earlier stage diagnosis of breast cancer and use of breast conserving surgery.

Aims
The current study aimed to quantify and validate these associations in multivariate analysis and investigate surgery type, adjuvant radiotherapy and immediate breast reconstruction (IBR) for invasive breast cancer or ductal carcinoma in situ (DCIS) by participation in BreastScreen NSW mammographic screening.

Methods
A data linkage study of 10,931 women aged 40+ years surgically treated for breast cancers diagnosed in 2009-2011 using registry and routinely-collected data. Multivariable logistic regression was used to adjust treatment outcomes for patient and tumour characteristics.

Results
A third of women undergoing surgery had never screened, 46 per cent had screened recently (within 24 months) through BreastScreen NSW. Breast-conserving surgery (BCS) and use of adjuvant radiotherapy following BCS were more common among recently screened compared with never screened women. Differences in treatment outcomes remained after adjusting for patient and tumour characteristics. There were no significant differences in use of IBR with mastectomy by screening participation, with 9 per cent and 33 per cent of women receiving IBR for invasive cancer and DCIS respectively.

Conclusion
Treatments received by women with invasive breast cancer and DCIS varied by mammographic screening history. This may be due to differences in treatment referral pathways or patient engagement in healthcare.

Key Words
Breast cancer, mammographic screening, mastectomy, breast conserving surgery, cancer treatment

What this study adds:

1. What is known about this subject?
Mammographic screening is associated with earlier stage diagnosis of breast cancer and use of breast conserving surgery.

2. What new information is offered in this study?
Radiotherapy is more common with breast conserving surgery for women previously screened and those born in non-English-speaking countries. This new evidence requires investigation and explanation.

3. What are the implications for research, policy, or practice?

A better understanding of treatment pathways is needed as treatment type can impact on cancer and psychosocial outcomes.

Background

Breast cancer is the most common cancer reported in females to Australian cancer registries.[1] BreastScreen New South Wales (BSNSW) commenced screening in 1991 as part of BreastScreen Australia. The program invites women aged 50–74 years for biennial mammographic screening to reduce breast cancer mortality and morbidity through earlier detection,[2] with all women aged >40 years eligible to participate. Before 2014, 50–69 years was the principal screening target age and >50 per cent of NSW women of this age screened regularly.[2]

Women in the screening target age range receive personal invitations to screen, generally at biennial intervals, by bilateral two-view mammography. Where radiological abnormalities are detected, women are referred to assessment clinics for investigation. Women diagnosed with breast cancer are referred, mostly through their general practitioners, for surgical management.[2]

Effects of screening depend both on screening coverage and treatment of detected cancers. Screening services, in New South Wales (NSW) and nationally, routinely monitor screening participation, recall to assessment, detection of invasive cancers, detection of ductal carcinoma in-situ (DCIS), and interval-cancer rates.[2] The treatment received for breast cancer following screen detection is not part of the routine monitoring conducted by screening services as this information is not generally available.[3]

This study makes use of data linkage methods, using NSW cancer registry data linked to BSNSW, admitted patient and radiotherapy treatment data to compare treatment of primary invasive breast cancer and DCIS by participation in BSNSW prior to diagnosis. More specifically, the study examines the type of surgical resection, either breast conserving surgery (BCS) or mastectomy; radiotherapy treatment following BCS; and use of immediate breast reconstruction at the time of mastectomy. As the data are not limited to those participating in BSNSW, this study compares aspects of care for women up-to-date with screening (within 24 months of diagnosis), women who screened over 24 months prior and women who never screened with BSNSW.

Method

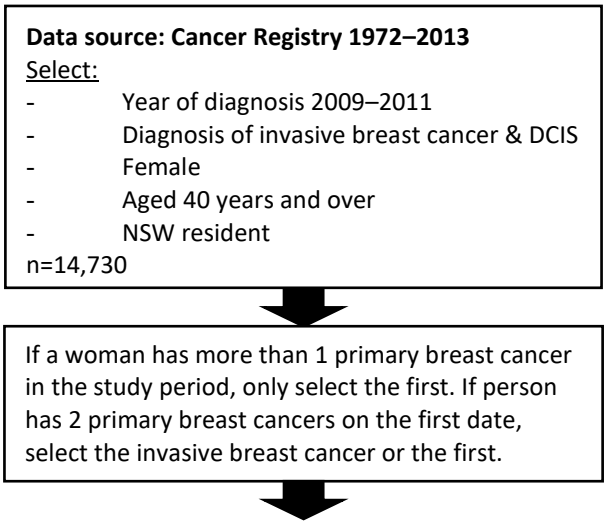
Data sources: Population-based data from the NSW Cancer Registry (CR) were linked to data from the BreastScreen Information System (BIS), the NSW Admitted Patient Data Collection (APDC), and NSW Retrospective Radiotherapy Dataset (RRD) at person-level.

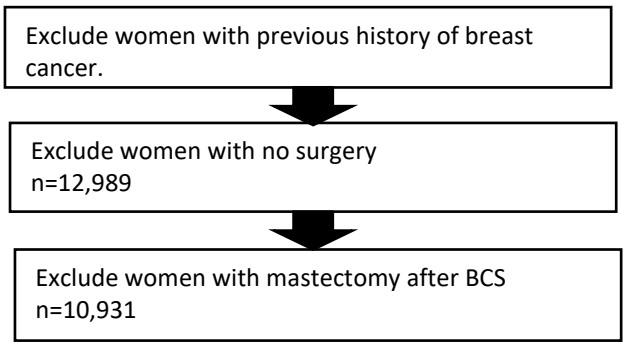
The CR contains legally mandated notifications of invasive cancers and DCIS for NSW residents.[4] It records demographic characteristics and spread of cancer at diagnosis (akin to Surveillance, Epidemiology, and End Results (SEER) summary stage[5]). The BIS includes demographic data, screening appointment details, screening participation and diagnostic data collected by NSW Screening and Assessment Services. The APDC has inpatient data including coded diagnoses and clinical procedures for all NSW hospitals. The RRD has treatment data from NSW public and private radiotherapy services.

Data linkage was performed by the Centre for Health Record Linkage using probabilistic matching. Best-practice data flows and procedures were used to protect privacy.[6] Ethical approval for the study was obtained from the NSW Population and Health Services Research Ethics Committee (HREC/15/CIPHS/15).

Study cohort: All women with a first diagnosis of primary invasive breast cancer or DCIS recorded on the CR for 2009-2011 and with a first breast resection recorded on the APDC were included (Figure 1). The diagnostic codes selected were C50 and D051 from the International Classification of Diseases Australian Modification (tenth edition).[7] Women receiving mastectomy following initial BCS were excluded to enable a clearer distinction of pathways through BCS and mastectomy (Figure 1).

Figure 1: Study cohort selection





Study variables: BSNSW history was the variable of primary interest, classified as (a) screened recently (≤24 months prior to diagnosis), (b) screened >24 months prior to diagnosis, or (c) never screened. The look-back period was 13–15 years.

Demographic and clinical variables, potentially associated with BSNSW participation, were also analysed. They included: age at diagnosis; geographic remoteness of residence,[8] Index of Relative Social Disadvantage (IRSD) of residential area;[9] Aboriginal status; and country of birth (classified as Australia; predominantly English speaking countries; predominantly non-English speaking countries);[10] tumour size and degree of spread.

Three outcomes were used to characterise first-course treatment, namely:

1. Type of first surgical resection, classified as BCS or mastectomy;
2. Adjuvant radiotherapy up to 6-months following BCS;
3. IBR at the time of mastectomy.

Associations of socio-demographic and clinical characteristics with BSNSW history were examined using Pearson chi-square tests. Counts, proportions and p-values are presented. The relationship between BSNSW history and each outcome was modelled using multivariable logistic regression.[11] All analyses were performed separately for women with DCIS and those with primary invasive breast cancer. All models included age at diagnosis, Aboriginal status, country of birth, remoteness and relative disadvantage of place of residence. Degree of spread and tumour size, were included in multivariate models for invasive breast cancer. Variables were retained in the models regardless of statistical significance. No evidence of multi-collinearity was observed. Results from the logistic regression analyses were presented as odds ratios (OR) with 95 per cent confidence intervals (95 per cent CI) and statistical significance. Analyses were performed using SAS Enterprise Guide 7.1.[12]

Results

Cohort characteristics: Overall, 10,931 NSW women underwent surgical resection (9,962 invasive and 969 DCIS). Just under half (5,040) were recently screened through BSNSW and a further fifth (2,087) were screened by BSNSW >24 months before diagnosis. Just over a third (3,804) had never screened through BSNSW. The median age at surgery was 61 years (range 40–98 years).

Socio-demographic and clinical characteristics are presented by BSNSW screening history for women with DCIS and invasive cancer (Tables 1 and 2). A larger proportion of women with DCIS than invasive breast cancer had been screened within 24 months of diagnosis (66 per cent (639/969) Vs 44 per cent (4,401/9,962); p<0.001) and a smaller proportion of those with DCIS had never screened compared to women with invasive breast cancer (24 per cent (235/969) Vs 36 per cent (3,569/9,962); p<0.001). Most women diagnosed with DCIS and invasive breast cancer were aged 50-69 years (69 per cent (667/969) and 57 per cent (5,648/9,962), respectively). Most women of this age group had screened within 24 months of diagnosis (81 per cent (539/667) for DCIS (Table 1); 64 per cent (3,619/5,648) for invasive cancer (Table 2)). By comparison, no history of screening was more common in younger women aged 40-49 years (68 per cent (121/178) for DCIS; 77 per cent (1,383/1,791) for invasive cancer) and the proportion who had screened within 24 month of diagnosis was greater in the older age groups. No other associations were found with screening history for DCIS.

For invasive breast cancer, there were statistically significant differences in BSNSW screening history (Table 2). Screening within 24 months of diagnosis was less common among women born in predominantly non-English speaking countries compared to Australian born (41 per cent (864/2,099) *vs.* 45 per cent (2,958/6,521); *p*<0.001), and among women living in major cities compared with regional or remote areas (43 per cent (3,103/7,165) *vs.* 46 per cent (1,298/2,797); p=0.007). Although a difference in screening history was evident by socioeconomic status (*p*<0.001), a consistent gradient was not apparent. Screening within 24 months of diagnosis was more common among women with small tumours (≤15mm) than larger tumours (59 per cent (2,365/4,021) *vs.* 34 per cent (2,036/5,941); *p*<0.001) and among those with localised tumours rather than with regional or distant spread (51 per cent (2,809/5,555), 36 per cent (1,559/4,307), 34 per cent (128/381); *p*<0.001).

Surgery type: Overall, 65 per cent (7,075) of 10,931 women having a surgical resection for breast cancer had BCS and 35

per cent (3,856) had a mastectomy (Tables 3 and 4). A greater proportion of women with DCIS than invasive cancer had BCS (75 per cent (727/969) *vs.* 64 per cent (6,349/9,962); $p<0.001$). Multivariable logistic regression indicated that compared with the never screened, the odds of BCS in women screened within 24 months of diagnosis were higher for both DCIS (OR 2.2; 95 per cent CI 1.5, 3.3) (Table 3) and invasive cancer (OR 1.5; 95 per cent CI 1.3, 1.7) (Table 4). For invasive cancers, odds of BCS were lower for older women aged 70–74 years (OR 0.8; 95 per cent CI 0.7, 0.9) and aged 75+ years (OR 0.6; 95 per cent CI 0.6, 0.7), compared to the screening target age of 50–69 year olds. While differences in odds of BCS for invasive cancer existed by socioeconomic status, a consistent gradient across socioeconomic quintiles was not evident (Table 4). The greater the degree of spread of invasive cancers, the lower the odds of BCS. Compared with regional spread, the OR was 2.5 (95 per cent CI 2.2, 2.7) for localised and 0.8 (95 per cent CI 0.6, 1.0) for distant spread. Similarly, larger invasive cancers (>15mm) were less likely to be treated by BCS than smaller cancers (OR 0.4; 95 per cent CI 0.4, 0.5).

Radiotherapy following BCS: Of the 7,075 women having a BCS, 82 per cent (5,783) received adjuvant radiotherapy (Tables 5 and 6). The proportion was larger for women with invasive cancer compared with DCIS (83 per cent (5,276/6,349) *vs.* 70 per cent (507/726); $p<0.001$). Women screened within 24 months of diagnosis were more likely to have radiotherapy compared to women who never screened. This was true for DCIS (OR 1.8; 95 per cent CI 1.1, 2.8) (Table 5) and invasive cancer (OR 2.2; 95 per cent CI 1.8, 2.6) (Table 6). Older women were less likely to have radiotherapy with BCS, both for DCIS and invasive cancer. For invasive cancers, the odds of radiotherapy were higher for women born in predominantly non-English speaking countries (OR 1.3; 95 per cent CI 1.1, 1.7) than in Australia. The odds of having radiotherapy with BCS were lower for residents of regional and remote areas compared with major cities, for both DCIS (OR 0.4; 95 per cent CI 0.2, 0.8) and invasive cancers (OR 0.4; 95 per cent CI 0.3, 0.6).

IBR following mastectomy: Of women having a mastectomy, 10 per cent (397/3,856) had IBR (Tables 7 and 8). The proportion was larger for DCIS than invasive breast cancer (33 per cent (79/243) *vs.* 9 per cent (318/3,613); $p<0.001$). Adjusted analyses did not find a difference in IBR use by screening history, neither for DCIS (p=0.899) nor invasive disease (p=0.217).

Multivariable analysis showed age at diagnosis was associated with IBR among women having mastectomy for DCIS and for invasive breast cancer. Among women treated for DCIS, the odds ratio was higher for the younger age group aged 40–49 years (OR 3.1; 95 per cent CI 1.4, 6.8) and lower for the older age group aged 70–74 years (OR 0.3; 95 per cent CI 0.1, 1.2) compared to women aged 50–69 years (Table 7). A similar pattern was observed for women with invasive cancer with a higher odds ratio in the younger (OR 2.4; 95 per cent CI 1.8, 3.2) and lower odds ratio in the older 70-74 year age group (OR 0.2; 95 per cent CI 0.1, 0.5) and 0.1 (0.0, 0.2) for 75+ years compared to women aged 50-69 years (Table 8). For invasive cancers, lower odds ratios of IBR were associated with residence in inner regional areas (OR 0.5; 95 per cent CI 0.3, 0.8) and outer regional/remote areas (OR 0.5; 95 per cent CI 0.3, 0.9) compared to major cities; and with residence in least disadvantaged quintiles compared to the most disadvantaged quintile (quintile 4 OR 2.8; 95 per cent CI 1.8, 4.5; quintile 5 OR 2.6; 95 per cent CI 1.7, 4.1). Lower odds ratios were also associated with regional (OR 0.7; 95 per cent CI 0.5, 0.9) and distant spread of disease (OR 0.4; 95 per cent CI 0.2, 0.8) compared to localised.

Discussion

This study found women screened through BSNSW within 24 months prior to diagnosis were more likely to undergo BCS compared with those who never participated. Screening detects cancers when tumours are smaller and less likely to have spread to lymph nodes and beyond.[13,14] These tumours may be more amenable to BCS. Our finding of greater use of BCS in recently screened women is consistent with differences reported in studies comparing the treatment of screen detected compared with symptomatic breast cancers.[13,14]

The greater use of BCS among women recently screened by BSNSW persisted after adjustment for tumour and sociodemographic characteristics, suggesting other influences were involved. Hypotheses include: (1) women with screen-detected cancers may benefit from more streamlined referral pathways; or (2) women who participate in screening may be more actively engaged in their healthcare and more likely to seek BCS. This is an important finding, as for many women BCS produces a better cosmetic result and confers modest advantages in psychosocial outcomes.[15,16]

For early invasive breast cancer, the evidence is strong that BCS with radiotherapy results in long-term survival equivalent to mastectomy.[17] Also, omission of adjuvant radiotherapy increases risk of breast cancer recurrence.[18] This study found uptake of adjuvant radiotherapy in women

having BCS is 70 per cent for DCIS and 83 per cent for invasive, which accords with other studies.[19-21] Uptake of radiotherapy is positively associated with screening participation, with more evidence of radiotherapy among women screened more recently (within 24 months). This association was not explained by differences in socio-demographic characteristics or tumour characteristics. It is hypothesized that more favourable referral pathways in women screened through BSNSW may have been involved, and stronger engagement of screened women in completing recommended treatments. Higher uptake of adjuvant radiotherapy was also associated with residence in major cities compared to regional and remote areas and with birth in a non-English speaking country compared to birth in Australia. There is strong evidence of lower uptake of radiotherapy following BCS among residents in rural areas[20] and with increasing distance from cancer centres.[22] Access to and completion of multi-modal treatment is particularly challenging in Australia given the vast travel distances faced by rural and remote residents.[23] The finding of higher uptake of radiotherapy among women born in non-English speaking countries was unexpected and warrants more detailed analysis. This is a heterogeneous group from many countries and further investigations would be useful to determine the relative contributions of different subgroups.

No relationship was observed between IBR and BSNSW screening history among women having a mastectomy. This is contrary to United Kingdom data where post-mastectomy IBR was more common among women with screen-detected cancer.[13] Factors such as the capacity of the health-care system to perform IBR and high out-of-pocket costs for private care may have affected IBR access.[24] Higher uptake is associated with greater availability of plastic surgeons,[25,26] access to cancer centres and residence in major cities.[27, 28] Socio-economic disparities in IBR uptake have been found in Australia[28] and internationally,[27,29] with greater uptake among women with private health insurance and residents in less deprived areas. Recent reports indicate increased provision of IBR in NSW, particularly in the private sector.[30] Our study found IBR use was strongly and negatively related to age.[31] A pattern of greater use of IBR was evident for localised compared to more advanced cancer. This is consistent with concerns for the success of IBR in the presence of post-mastectomy radiotherapy, which is often recommended for more advanced higher-grade tumours.[17] Delayed breast reconstruction may produce better cosmetic results and be a preferred option in these instances.

A major strength of this study was the availability of state-wide population-level data through data linkage, which enabled surgical and radiotherapy treatment pathways to be examined for the first time in relation to BSNSW participation. The CR provided highly accurate diagnostic information. Surgical and radiotherapy data included all treatment delivered in public and private facilities across the state. Nonetheless, various gaps in data resulted in blind spots with regard to screening behaviours and treatment delivery. Differences in clinical management relating to screening participation may have been affected by screening outside BSNSW, such as through mammography funded by the Medicare Benefits Schedule (MBS) and interstate screening. MBS funded mammography has not been found to significantly impact on participation in BreastScreen Australia.[32] Women who reside close to state boundaries and participate in BreastScreen interstate are also likely to receive surgical treatment interstate. By limiting the study cohort to women that underwent surgery in NSW any bias caused by misclassified screening status due to interstate screening should be minimised. Receipt of systemic therapies could not be examined as an outcome in this study as these data were not available within the data linkage. Ongoing developments in data collections and linkage in NSW are reducing these data gaps. In the future it will be possible to examine use of MBS funded mammography and receipt of systemic therapies.

Unmeasured covariates and confounders represent a potential weakness of this and many epidemiological studies. All models of the relationships between BSNSW history and treatment outcomes were adjusted for available socio-demographic and clinical variables. However, some residual confounding is likely given the coarseness of these measures. Adequate data were unavailable for characteristics such as frailty and comorbidity. Additionally, choice of surgery and uptake of adjuvant radiotherapy following BCS are known to be affected by other factors that could not be examined in this study such as the availability of nurse counsellors and patient education at the time of diagnosis.[33,34] Further research is required to investigate these factors.

Conclusion

Compared with women not screened through BSNSW, those recently screened were more likely to have a BCS than mastectomy. This was not fully explained by differences in tumour size and degree of spread. Women having a BCS were more likely to receive adjuvant radiotherapy if recently screened through BSNSW. Further research is required to determine the reasons. Among women having a mastectomy, statistically significant differences in IBR were not found by BSNSW screening history. Data linkage enables

examination of the whole screening-treatment pathway. Future studies should include systemic therapies through linkage with MBS and PBS data.

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PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

ETHICS COMMITTEE APPROVAL

NSW Population and Health Services Research Ethics Committee (HREC/15/CIPHS/15)

Table 1: Characteristics of women diagnosed with DCIS and undergoing surgical resection in NSW 2009 to 2011 by screening history

Characteristic	DCIS			
	Never screened	Screened, >24 months	Screened, ≤24 months	
	N (%**)	N (%**)	N (%**)	P-value
Total	235 (24.3)	95 (9.8)	639 (65.9)	
Age group				<0.001
40-49	121 (68.0)	10 (5.6)	47 (26.4)	
50-69	81 (12.1)	47 (7.1)	539 (80.8)	
70-74	17 (25.8)	13 (19.7)	36 (54.5)	
75+	16 (27.6)	25 (43.1)	17 (29.3)	
Aboriginal status				0.462
Aboriginal	--	--	9 (69.2)	
Non-Aboriginal	--	--	630 (65.9)	
Country of birth				0.103
Australia	125 (22.7)	48 (8.7)	378 (68.6)	
Other English-speaking country	21 (24.4)	10 (11.6)	55 (64.0)	
Non-English-speaking country	62 (26.6)	20 (8.6)	151 (64.8)	
Unknown country of birth	27 (27.3)	17 (17.2)	55 (55.5)	
Remoteness				0.475
Major cities	180 (24.3)	74 (10.0)	488 (65.8)	
Inner regional	42 (23.9)	13 (7.4)	121 (68.7)	
Outer regional and remote	13 (25.5)	8 (15.7)	30 (58.8)	
Socioeconomic status				0.462
Quintile 1 (most disadvantaged)	43 (28.5)	13 (8.6)	95 (62.9)	
Quintile 2	33 (18.1)	19 (10.4)	130 (71.4)	
Quintile 3	47 (27.5)	19 (11.1)	105 (61.4)	
Quintile 4	40 (22.6)	15 (8.5)	122 (68.9)	
Quintile 5 (least disadvantaged)	72 (25.0)	29 (10.1)	187 (64.9)	

DCIS = Ductal carcinoma in situ, NSW = New South Wales; *column percentage; **row percentage -- Cells have been suppressed due to small numbers

Table 2: Characteristics of women diagnosed with invasive breast cancer and undergoing surgical resection in NSW 2009 to 2011 by screening history

Characteristics	Invasive breast cancer			
	Never screened	Screened, >24 months	Screened, ≤24 months	
	N (%**)	N (%**)	N (%**)	P-value
Total	3,569 (35.8)	1,992 (20.0)	4,401 (44.2)	
Age group				<0.001
40-49	1,383 (77.2)	140 (7.8)	268 (15.0)	
50-69	1,353 (24.0)	676 (12.0)	3,619 (64.1)	
70-74	207 (24.0)	339 (39.2)	318 (36.8)	
75+	626 (37.7)	837 (50.4)	196 (11.8)	
Aboriginal status				0.007
Aboriginal	70 (48.3)	22 (15.2)	53 (36.5)	
Non-Aboriginal	3,499 (35.6)	1,970 (20.1)	4,348 (44.3)	
Country of birth				<0.001
Australia	2,198 (33.7)	1,365 (20.9)	2,958 (45.4)	
Other English-speaking country	397 (38.4)	189 (18.3)	448 (43.3)	
Non-English-speaking country	864 (41.2)	371 (17.7)	864 (41.2)	
Unknown country of birth	110 (35.7)	67 (21.8)	131 (42.5)	
Remoteness				0.007
Major cities	2,646 (36.9)	1,416 (19.8)	3,103 (43.3)	

Inner regional	715 (32.8)	455 (20.9)	1,010 (46.3)	
Outer regional and remote	208 (33.7)	121 (19.6)	288 (46.7)	
Socioeconomic status				<0.001
Quintile 1 (most disadvantaged)	639 (37.5)	306 (17.9)	760 (44.6)	
Quintile 2	705 (34.7)	408 (20.1)	921 (45.3)	
Quintile 3	637 (32.9)	438 (22.6)	861 (44.5)	
Quintile 4	757 (39.4)	351 (18.3)	813 (42.3)	
Quintile 5 (least disadvantaged)	831 (35.1)	489 (20.7)	1,046 (44.2)	
Degree of spread				<0.001
Localised	1,663 (29.9)	1,083 (19.5)	2,809 (50.6)	
Regionalised	1,687 (43.0)	808 (20.6)	1,431 (36.4)	
Distant	177 (46.5)	76 (19.9)	128 (33.6)	
Unknown	42 (42.0)	25 (25.0)	33 (33.0)	
Size of invasive cancer				<0.001
≤15mm	1,033 (25.7)	623 (15.5)	2,365 (58.8)	
>15mm	2,536 (42.7)	1,369 (23.0)	2,036 (34.3)	

NSW = New South Wales; * column percentage; **row percentage

Table 3: Use of BCS among women diagnosed with DCIS in NSW 2009 to 2011; counts, proportions and odds ratios from multivariate regression analysis*

	DCIS (N=969)		
Characteristics	**BCS**		
	N (%)	**OR (95% CI)**	**p-value**
Total	726 (74.9)		
BreastScreen history			<0.001
Never screened	148 (63.0)	1.0	
Screened, >24 months	67 (70.5)	1.5 (0.8, 2.6)	
Screened, ≤24 months	511 (80.0)	2.2 (1.5, 3.3)	
Age group			0.405
40-49	120 (67.4)	0.9 (0.6, 1.4)	
50-69	520 (78.0)	1.0	
70-74	44 (66.7)	0.6 (0.3, 1.1)	
75+	42 (72.4)	0.9 (0.5, 1.8)	
Aboriginal status			0.581
Aboriginal	11 (84.6)	1.5 (0.3, 7.4)	
Non-Aboriginal	715 (74.8)	1.0	
Country of birth			0.006
Australia	426 (77.3)	1.0	
Other English-speaking country	62 (72.1)	0.8 (0.5, 1.4)	
Non-English-speaking country	179 (76.8)	0.9 (0.6, 1.4)	
Unknown country of birth	59 (59.6)	0.4 (0.3, 0.7)	
Remoteness			0.143
Major cities	561 (75.6)	1.0	
Inner regional	124 (70.5)	0.7 (0.5, 1.1)	
Outer regional and remote	41 (80.4)	0.4 (0.3, 0.7)	
Socioeconomic status			0.884
Quintile 1 (most disadvantaged)	113 (74.8)	1.0	
Quintile 2	137 (75.3)	0.9 (0.5, 1.6)	
Quintile 3	126 (73.7)	1.1 (0.6, 1.8)	
Quintile 4	138 (78.0)	1.2 (0.7, 2.1)	
Quintile 5 (least disadvantaged)	212 (73.6)	1.0 (0.6, 1.6)	

BCS = Breast Conserving Surgery, DCIS = Ductal carcinoma in situ, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals;*Among the cohort of women treated for breast cancer by surgical resection, the percentage that underwent BCS rather than mastectomy; OR derived from multivariate logistic regression (see Methods)

Table 4: Use of BCS among women diagnosed with invasive breast cancer in NSW 2009 to 2011; counts, proportions and odds ratios from multivariate regression analysis*

	Invasive breast cancer (N=9,962)		
Characteristics	**BCS**		
	N (%)	**OR (95% CI)**	**p-value**
Total	6,349 (63.7)		
BreastScreen history			<0.001
Never screened	1,992 (55.8)	1.0	
Screened, >24 months	1,138 (57.1)	1.1 (1.0, 1.2)	
Screened,	3,219 (73.1)	1.5 (1.3, 1.7)	

≤24 months			
Age group			<0.001
40-49	1,057 (59.0)	0.9 (0.8, 1.0)	
50-69	3,907 (69.2)	1.0	
70-74	522 (60.4)	0.8 (0.7, 0.9)	
75+	863 (52.0)	0.6 (0.6, 0.7)	
Aboriginal status			0.125
Aboriginal*	96 (66.2)	1.3 (0.9, 1.9)	
Non-Aboriginal	6,253 (63.7)	1.0	
Country of birth			<0.001
Australia	4,206 (64.5)	1.0	
Other English-speaking country	656 (63.4)	1.0 (0.8, 1.1)	
Non-English-speaking country	1,320 (62.9)	0.9 (0.8, 1.1)	
Unknown country of birth	167 (54.2)	0.6 (0.4, 0.7)	
Remoteness			0.028
Major cities	4,581 (63.9)	1.0	
Inner regional	1,394 (63.9)	1.0 (0.9, 1.2)	
Outer regional and remote	374 (60.6)	0.8 (0.6, 1.0)	
Socioeconomic status			<0.001
Quintile 1 (most disadvantaged)	1,101 (64.6)	1.0	
Quintile 2	1,239 (60.9)	0.8 (0.7, 0.9)	
Quintile 3	1,174 (60.6)	0.8 (0.7, 0.9)	
Quintile 4	1,262 (65.7)	1.0 (0.9, 1.2)	
Quintile 5 (least disadvantaged)	1,573 (66.5)	1.0 (0.9, 1.2)	
Degree of spread			<0.001
Localised	4,179 (75.2)	2.5 (2.2, 2.7)	
Regionalised	1,944 (49.5)	1.0	
Distant	161 (42.3)	0.8 (0.6, 1.0)	
Unknown	65 (65.0)	2.2 (1.4, 3.4)	
Size of invasive cancer			
≤15mm	3,177 (79.0)	1.0	<0.001
>15mm	3,172 (53.4)	0.4 (0.4, 0.5)	

BCS = Breast Conserving Surgery, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals;*Among the cohort of women treated for breast cancer by surgical resection, the percentage that underwent BCS rather than mastectomy; OR derived from multivariate logistic regression (see Methods)

Table 5: Adjuvant radiotherapy among women treated with BCS for DCIS in NSW 2009 to 2011; counts, proportions and odds ratio from multivariate regression analysis

	BCS for DCIS (N=726)		
Characteristics	**Radiotherapy**		
	N (%*)	**OR (95% CI)**	**P-value**
Total	507 (69.8)		
BreastScreen history			0.011
Never screened	94 (63.5)	1.0	
Screened, >24 months	33 (49.3)	0.8 (0.4, 1.7)	
Screened, ≤24 months	380(74.4)	1.8 (1.1, 2.8)	
Age group			<0.001
40-49	88 (73.3)	1.4 (0.8, 2.3)	
50-69	377 (72.5)	1.0	
70-74	30 (68.2)	0.8 (0.4, 1.6)	
75+	12 (28.6)	0.2 (0.1, 0.5)	
Aboriginal status			0.145
Aboriginal	--	0.4 (0.1, 1.4)	
Non-Aboriginal	--	1.0	
Country of birth			<0.001
Australia	300 (70.4)	1.0	
Other English-speaking country	43 (69.4)	0.8 (0.4, 1.5)	
Non-English-speaking country	138 (77.1)	1.1 (0.7 1.7)	
Unknown country of birth	26 (44.1)	0.3 (0.2, 0.6)	
Remoteness			0.010
Major cities	409 (72.9)	1.0	
Inner regional	77 (62.1)	0.6 (0.3, 0.9)	
Outer regional and remote	21 (51.2)	0.4 (0.2, 0.8)	
Socioeconomic status			0.499
Quintile 1 (most disadvantaged)	82 (72.6)	1.0	
Quintile 2	94 (68.6)	0.9 (0.5, 1.7)	

Quintile 3	84 (66.7)	0.9 (0.5, 1.6)	
Quintile 4	90 (65.2)	0.7 (0.4, 1.2)	
Quintile 5 (least disadvantaged)	157 (74.1)	1.0 (0.6, 1.8)	

BCS = Breast Conserving Surgery, DCIS = Ductal carcinoma in situ, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals; *Among the cohort that underwent BCS, the percentage of women receiving radiotherapy; OR derived from multivariate logistic regression (see Methods)

Table 6: Adjuvant radiotherapy among women treated with BCS for invasive breast cancer in NSW 2009 to 2011; counts, proportions and odds ratio from multivariate regression analysis

	BCS for Invasive breast cancer (N=6,349)		
Characteristics	**Radiotherapy**		
	N (%*)	**OR (95% CI)**	**P-value**
Total	5,276 (83.1)		
BreastScreen history			<0.001
Never screened	1,543 (77.5)	1.0	
Screened, > 24 months	886 (77.9)	1.6 (1.3, 2.0)	
Screened, ≤ 24 months	2,847 (88.4)	2.2 (1.8, 2.6)	
Age group			<0.001
40-49	936 (88.5)	1.7 (1.3, 2.1)	
50-69	3,396 (86.9)	1.0	
70-74	416 (79.7)	0.6 (0.5, 0.8)	
75+	528 (61.2)	0.2 (0.2, 0.3)	
Aboriginal status			0.934
Aboriginal	79 (82.3)	1.0 (0.6, 1.8)	
Non-Aboriginal	5,197 (83.1)	1.0	
Country of birth			
Australia	3,471 (82.5)	1.0	<0.001
Other English-speaking country	555 (84.6)	1.0 (0.8, 1.3)	
Non-English-speaking country	1,176 (89.1)	1.3 (1.1, 1.7)	
Unknown country of birth	74 (44.3)	0.2 (0.1, 0.2)	
Remoteness			<0.001
Major cities	4,007 (87.5)	1.0	
Inner regional	1,011 (72.5)	0.5 (0.4, 0.6)	
Outer regional and remote	258 (69.0)	0.4 (0.3, 0.6)	
Socioeconomic status			<0.001
Quintile 1 (most disadvantaged)	897 (81.5)	1.0	
Quintile 2	995 (80.3)	1.0 (0.8, 1.3)	
Quintile 3	924 (78.7)	0.8 (0.6, 1.0)	
Quintile 4	1,060 (84.0)	0.8 (0.7, 1.1)	
Quintile 5 (least disadvantaged)	1,400 (89.0)	1.2 (0.9, 1.6)	
Degree of spread			<0.001
Localised	3,451 (82.6)	0.8 (0.7, 1.0)	
Regionalised	1,663 (85.5)	1.0	
Distant	128 (79.5)	0.7 (0.4, 1.1)	
Unknown	34 (52.3)	0.3 (0.2, 0.5)	
Size of invasive cancer			
≤15mm	2,660 (83.7)	1.0	0.170
>15mm	2,616 (82.5)	1.1 (0.9, 1.3)	

BCS = Breast Conserving Surgery, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals; *Among the cohort that underwent BCS, the percentage of women receiving radiotherapy; OR derived from multivariate logistic regression (see Methods)

Table 7: IBR among women following mastectomy for a diagnosis of DCIS in NSW 2009 to 2011; counts, proportions and odds ratios from multivariable regression analysis*

	Mastectomy for DCIS (N=243)		
Characteristics	**IBR**		
	N (%*)	**OR (95% CI)**	**P-value**
Total	79 (32.5)		
BreastScreen history			0.899
Never screened	36 (41.4)	1.0	
Screened, >24 months	7 (25.0)	0.8 (0.2,2.5)	
Screened, ≤24 months	36 (28.1)	0.9 (0.4, 1.8)	
Age group			0.001
40-49	33 (56.9)	3.1 (1.4, 6.8)	
50-69	--	1.0	
70-74	--	0.3 (0.1, 1.2)	
75+	--	--	
Aboriginal status			0.897
Aboriginal	--	1.2 (0.1, 25.0)	
Non-Aboriginal	--	1.0	

Country of birth			0.155
Australia	37 (29.6)	1.0	
Other English-speaking country	11 (45.8)	1.3 (0.5, 3.6)	
Non-English-speaking country	14 (25.9)	0.5 (0.2, 1.3)	
Unknown country of birth	17 (42.5)	1.7 (0.8, 4.04)	
Remoteness			0.676
Major cities	63 (34.8)	1.0	
Inner regional	--	0.7 (0.3, 1.7)	
Outer regional and remote	--	0.6 (0.1, 3.8)	
Socioeconomic status			0.314
Quintile 1 (most disadvantaged)	12 (31.6)	1.0	
Quintile 2	14 (31.1)	0.7 (0.2, 2.3)	
Quintile 3	10 (22.2)	0.4 (0.1, 1.1)	
Quintile 4	12 (30.8))	0.7 (0.2, 2.2)	
Quintile 5 (least disadvantaged)	31 (40.8)	0.9 (0.4, 2.5)	

IBR = Immediate Breast Reconstruction, DCIS = Ductal carcinoma in situ, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals; *Among the cohort undergoing mastectomy, the percentage of women that had IBR; OR derived from multivariate logistic regression (see Methods) -- Cells have been suppressed due to small numbers.

Table 8: IBR among women following mastectomy for a diagnosis of invasive breast cancer in NSW 2009 to 2011; counts, proportions and odds ratios from multivariable regression analysis*

	Mastectomy for invasive breast cancer (N=3,613)		
Characteristics	**IBR**		
	N (%*)	**OR (95% CI)**	**P-value**
Total	318 (8.8)		
BreastScreen history			0.217
Never screened	179 (11.3)	1.0	
Screened, >24 months	33 (3.9)	0.7 (0.5, 1.1)	
Screened, ≤24 months	106 (9.0)	0.8 (0.6, 1.1)	
Age group			<0.001
40-49	147 (20.0)	2.4 (1.8, 3.2)	
50-69	158 (9.1)	1.0	
70-74	--	0.2 (0.1, 0.5)	
75+	--	0.1 (0.0, 0.2)	
Aboriginal status			0.510
Aboriginal	--	0.7 (0.2, 2.2)	
Non-Aboriginal	--	1.0	
Country of birth			0.250
Australia	194 (8.4)	1.0	
Other English-speaking country	42 (11.1)	1.2 (0.8, 1.8)	
Non-English-speaking country	68 (8.7)	0.8 (0.6, 1.2)	
Unknown country of birth	14 (9.9)	1.4 (0.8, 2.7)	
Remoteness			0.024
Major cities	250 (9.7)	1.0	
Inner regional	44 (5.6)	0.5 (0.3, 0.8)	
Outer regional and remote	24 (9.9)	0.5 (0.3, 0.9)	
Socioeconomic status			<0.001
Quintile 1 (most disadvantaged)	35 (5.8)	1.0	
Quintile 2	47 (5.9)	1.1 (0.7, 1.8)	
Quintile 3	42 (5.5)	1.2 (0.7, 2.0)	
Quintile 4	91 (13.8)	2.8 (1.8, 4.5)	
Quintile 5 (least disadvantaged)	103 (13.0)	2.6 (1.7, 4.1)	
Degree of spread			0.005
Localised	149 (10.8)	1.0	
Regionalised	156 (7.9)	0.7 (0.5, 0.9)	
Distant	--	0.4 (0.2, 0.8)	
Unknown	--	0.6 (0.4, 0.7)	
Size of invasive cancer			<0.001
≤15mm	197 (7.1)	1.0	
>15mm	121 (14.3)	0.7 (0.2, 2.3)	

IBR = Immediate Breast Reconstruction, NSW = New South Wales, OR = Odds Ratio, CI=Confidence Intervals; *Among the cohort undergoing mastectomy, the percentage of women that had IBR; OR derived from multivariate logistic regression (see Methods) -- Cells have been suppressed due to small numbers.