EPIDEMIOLOGICAL ASPECTS OF BREAST CANCER SCREENING RELEVANT TO AOTEAROA

Report prepared for the quality improvement review of clinical safety and quality for BreastScreen Aotearoa

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Breast cancer screening in Aotearoa New Zealand

BreastScreen Aotearoa (BSA) commenced in 1999 for women aged 50 to 64, and was extended to ages 45 to 49 and 65 to 69 in 2004. Digital mammography screening is offered every two years.

Strengths of the programme

The overall design of the Aotearoa New Zealand programme, and the participation rates, compare well with public sector programmes in many other developed countries. Most programmes use a lower age range of 50, but several generally smaller and more recently established programmes start at 45 or 40. The upper age range of 69 is also used by most programmes, with a few extending screening to age 74.

Two-yearly screening is used by almost all programmes worldwide, with the exception of the UK programme using three yearly, and several programmes use a mixture of two-yearly and annual screening.

Participation in the BSA programme is estimated by the coverage, being the number of women screened as a fraction of the census population. This has a target of 70%, and from 2012 to early 2020, coverage was over 70% in Pasifika and non-Māori non-Pasifika, but was around 62 to 65% in wāhine Māori. Coverage must underestimate actual participation, as no account is taken of ineligible women, including higher risk women, or women being screened in the private sector. Reported coverage exceeds 70% in several European programmes, but how it is defined will vary. Coverage is lower in some major countries such as Australia and Canada.

Impact of the BSA programme

Breast cancer mortality in Aotearoa, as in many other developed countries, has fallen by almost half from around 1988 to the latest data available, 2017. This fall began before the screening programme, and is usually attributed to improvements in treatment. The rate of decline did increase after implementation of the programme. The most detailed studies in the BSA programme report that the death rate has been reduced by 17% in the first few years of the programme, and women who participate have a 34% reduction in their risk of breast cancer death. The effects on trends in mortality, and the estimates of individual benefit, are generally consistent with those in other developed countries.

Thus, the BSA programme is consistent with current scientific evidence and programmes operating in other developed countries, and has contributed substantially to reducing breast cancer deaths.

The BSA programme is extensively monitored, with performance criteria set for many aspects of the programme. The extent of monitoring is considerably greater than the monitoring for most health services, including the treatment of breast cancer patients and the screening of women assessed as having higher risks.

Weaknesses and opportunities for improvement

The target of 70% coverage appears to be regarded as a satisfactory level, despite meaning that up to 30% of women do not have the advantages of breast cancer screening. There appear to have been few studies of non-participants in screening. The true participation rates are unknown, as this requires estimating the numbers of women using breast cancer screening outside BSA, having clinical reasons making screening inappropriate for them, or making an informed decision not to participate. Studies of non-participants were done successfully in the Aotearoa pilot programmes, and should be done in the BSA programme.

BSA does not invite women for screening. Women must find out about the programme, and apply to participate; then they can be offered an appointment. Primary health care staff may greatly assist in this and promote the programme, but no systematic approach to encourage this is in place. Many programmes in other countries identify and invite women, and active promotion and support to participants has been shown to be important. Invitations were used in the Aotearoa pilot programmes. Improvements to the invitation system should be developed.

Aotearoa operates two other cancer screening programmes, for cervical cancer and for bowel cancer. These programmes have separate communication processes and advertising. The bowel cancer programme actively gives invitations to men and women in the age range 50 to 64. Thus women in this age group will be actively invited for bowel cancer screening, and may be invited for cervical cancer screening through their general practitioner. Coordination of these different recruitment processes for cancer screening could have many advantages and should be tested. Indeed, coordination of cancer screening with other diagnostic and preventive services, for example for cardiovascular disease and diabetes, may be beneficial.

BSA has extensive records for women participating in the programme. But there appears to be little effective linkage with clinical records for all women diagnosed with breast cancer. The national Cancer Registry and the four more detailed clinical breast cancer registries record if a woman's cancer was screen detected or clinically detected, but do not record whether she was participating in screening, and therefore do not record whether she has had an interval cancer. Such information may be available to clinicians when assessing a newly diagnosed breast cancer patient, but is not consistently recorded. Improved linkage between data sets would be valuable.

The BSA programme is designed for 'average risk' women. 'Average risk' has not been defined. Many women are at higher risk, and in both the private and public sectors such women may receive more intensive screening, for example annual screening or screening from an earlier age. There is no reliable data on the numbers of women who receive such further screening, and there appears to be no linkage of information on such women with the BSA information.

The amount of reporting on the BSA programme is large, and the number of performance indicators is very large. However, while some indicators are reported on rapidly and frequently, such as participation data from screening providers, other indicators are only reported on occasionally with long delays, such as interval cancers. Prioritisation of key indicators, emphasis on regular and rapid reporting, and on the actions to be taken if problems are suggested, all need attention.

Equity

Most attention has been given to the ethnic groups of Māori, Pasifika, and 'Other', meaning non-Māori non-Pasifika (nMnP). Some data are available for Asian, and therefore non-Māori non-Pasifika non-Asian, groups.

Breast cancer mortality is higher in Māori and in Pasifika than in non-Māori non-Pasifika groups. Actual numbers and ratios depend on the time period and age range chosen and the age standardisation methods used. Using Aotearoa data for 1996-2017, the highest mortality rates at ages 45-69 were in Māori (68 per 100,000), and Pasifika (also 68), while the rate in nMnP women was 42 per 100,000.

The incidence rate for ages 45-69 in the same period was highest in Māori, 383 per 100,000, and Pasifika, 331, compared to nMnP, 263.

The survival rates for women with breast cancer are lower in Māori (10 year survival 84%), and Pasifika (81%), compared to Asian (91%) and other women (87%).

Coverage of the BSA programme from Jan 2016 to the Dec 2019 was 72% in non-Māori non-Pasifika, 73 % in Pasifika, and 63 % in wāhine Māori. With the effects of Covid-19 in 2020, the greatest decrease was seen in Pasifika 11.8%, with a decrease of 8% in non-Māori non-Pasifika, and 5% in wāhine Māori. In the latest data available (mid-2020) coverage is lowest in wāhine Māori.

The most recent detailed review of interval cancers applies to screening in 2008-09, showing 39 interval cancers for each 100 cancers detected by screening, and a sensitivity of 72% for 2-yearly screening. The proportion of all invasive cancers detected on screening was about 45% in the period from 2010 to 2016, based on data from the clinical breast cancer registries in the four main centres. From these data the stage distribution of cancers detected was least favourable in Pasifika, both in screened and clinically detected cancers. The stage distribution in wāhine Māori was slightly less favourable than in the nMnP group, but the differences are small.

Future challenges

Over the last decade, the coverage of the BSA programme has been substantially lower in wāhine Māori than in Pasifika or non-Māori non-Pasifika. This still applies in the most recent data, with all coverage rates being reduced by Covid restrictions. There has been little work done on the reasons for nonparticipation in the BSA programme, and only a few localised programmes to improve participation, but some of these have has major success.

While increasing wāhine Māori participation to 70% to achieve equity may be a short-term focus, 70% coverage should not be regarded as acceptable. The true participation rate must be higher, and should be assessed by specific studies. Then programmes to ensure that all women are informed and can access the programme if they choose to do so should be developed. Other disadvantaged groups should be identified and appropriate actions developed.

To allow better evaluation of the programme, linkages between BSA data, clinical records on all breast cancer patients, and information on screening outside BSA, should be improved.

The constantly increasing international scientific knowledge relevant to breast cancer screening needs to be kept under review, especially as it may impact on major aspects of the programme which need further consideration. These aspects include the lower age range (whether screening should commence earlier that age 45), the upper age range (whether screening should continue beyond age 69), higher risk women (should they be identified, by which factors, and should they have more intensive screening are screening using different methods), and lower risk women (can they be identified and benefit from less intensive screening).

This epidemiological report does not cover operational aspects of the screening programmes, funding and staffing requirements, or the issues of information and communication with both participants in the programme and with the community as a whole. Clearly achieving the changes which may be desirable on epidemiological reasoning will depend on these issues.

1. RATIONALE FOR A SCREENING PROGRAMME IN AOTEAROA

Evidence that screening can reduce deaths from breast cancer

The avoidance of death from breast cancer is the ultimate measure of success of a screening programme. On a population level, the introduction of a screening programme should result in a reduction in the mortality rate; on an individual level, participation in the screening programme should reduce the chance of that woman dying from breast cancer.

The Skegg et al. report published in 1988 with 9 authors[1] recommended that breast cancer screening programmes should be introduced in Aotearoa, based on the best possible scientific evidence available: the demonstration that in a large group of women offered breast cancer screening, the death rate from breast cancer is reduced, compared to a comparable group of women who are not offered such screening. The comparability of the two groups is achieved by randomisation; random selection from a single starting group of women.

These randomised trials were enormous logistic exercises, involving thousands of women, study over many years, and advanced scientific methods and reasoning in their interpretation. Sufficient results were available from several trials by the time of Skegg at al.'s 1988 review for the report to recommend proceeding with screening, starting with carefully evaluated pilot programmes.

Results of randomised trials, by age at screening

A detailed review of randomised trials and major observational studies published up to 2015 was done for the US Preventive Services Task Force and published in 2016[2]. No further major trials have been reported since then.

This included results of eight major randomised trials of mammography screening: the Health Insurance Plan of Greater New York (HIP) trial, two Canadian national trials, the Age trial in the UK, and four trials in Sweden, from Stockholm, Malmo, Gothenburg, and the Swedish two county trial, which has results separately from Ostergotland and Kopparberg, giving nine sets of results. Updated data was obtained from several of these trials. The only randomised trial not included was that in Edinburgh, which showed important differences between the screening and control groups at baseline, suggesting inadequate randomisation.

These trials together included over 600,000 women. The main feature which affected the results was the age range of screening, and this meta-analysis assessed results within age groups. The key results are shown in Table 1.

Age	Number of trials	Breast Cancer Mortality Reduction: Relative Risk (95% CI)	Breast cancer % reduction in deaths, 95% CI	Deaths Prevented With Screening 10 000 Women over 10 years, 95% CI
39–49 y	9	0.92 (0.75 to 1.02)	8 (-2 to 25)	2.9 (–0.6 to 8.9)
50–59 y	7	0.86 (0.68 to 0.97)	14 (3 to 32)	7.7 (1.6 to 17.2)
60–69 y	5	0.67 (0.54 to 0.83)	33 (17 to 46)	21.3 (10.7 to 31.7)
70–74 y	3	0.80 (0.51 to 1.28)	20 (-28 to 49)	12.5 (–17.2 to 32.1)
50–69 y		0.78 (0.68 to 0.90)	22 (10 to 32)	12.5 (5.9 to 19.5)

CI: confidence interval

Table 1. Mortality reductions in randomised trials of mammography screening, by age at screening.

Data from[2], Table 1.

This table shows the mortality reductions seen in the randomised trials, expressed as the relative risk and 95% confidence limits, and the equivalent percentage mortality reduction and 95% limits. A relative risk of 0.9 is equivalent to a 10% mortality reduction. Also shown is the estimated number of deaths prevented by screening 10,000 women regularly over 10 years. The comparison is between all women offered screening, and women not offered screening: the benefit to the group offered screening will be diluted as some women offered screening will choose not to participate. So the results apply to the effects of the programme of screening. The benefit to women who choose to participate in screening must be larger, but it is not directly measured as the participant group are not randomly selected.

The results show statistically significant reductions in mortality at ages 50 to 59, and at ages 60 to 69. The result for the combined group aged 50 to 69 is a 22% reduction in mortality, and 12.5 deaths prevented by screening 10,000 women for 10 years.

For younger women aged 39 to 49, the reduction in mortality was 8 percent, and was not statistically significant, the 95% limits being from a reduction of 25% to an increase in mortality of 2%. Statistically, the reduction is close to the usual boundary for statistical significance, and in an alternative method of analysis, 'short case accrual', the estimate is on the borderline of significance; but the results shown in the table above are those emphasised by the authors in their summary.

For women aged 70 to 74, the reduction in mortality was 20%, but was not statistically significant, the 95% limits being from a reduction of 49% to an increase in mortality of 28%. These wide limits are due to the small number of women in this age group involved in the trials.

The analysis also assessed the reduction in advanced cancers, defined as stage 3 or 4, or tumour sizes in excess of 40 or 50 mm. This also showed age differences. For women aged 50 and over, there was a significant reduction in advanced cancers, a 38% reduction, with confidence limits from 17% to 54%. For women aged 39 to 49, there was no significant reduction, reduction being only 2%, with 95% limits from 26% reduction to 37% excess.

In summary this analysis shows significant reductions in breast cancer mortality in randomised trials of screening mammography for women aged 50 to 69. This evidence has been the basis for the introduction of breast cancer screening programmes worldwide.

The UK Age trial

A more direct test of extending the screening eligibility age downwards is given by The Age trial carried out in the UK[3]. Over 160,000 women aged 39 to 41 were randomised to either start annual mammography screening immediately, or to the UK standard care of no screening until age 50. The early screening group showed a significant reduction in mortality in the 10 years from study entry of 25%, relative risk 0.75, 95% limits 0.58 to 0.97 (Figure 1). The absolute benefit was about 10 deaths prevented from 10000 women screened from age 40. The study also suggested that overdiagnosis in this younger age group was small. There was no effect on mortality after 10 years of follow-up. This trial used film screening and mainly single view mammography, with participation rates of around 70%; so the mortality benefit might be higher with more modern methods. The conclusion was that reducing the lower age limit for screening (in the UK) from 50 to 40 years could potentially reduce breast cancer mortality.

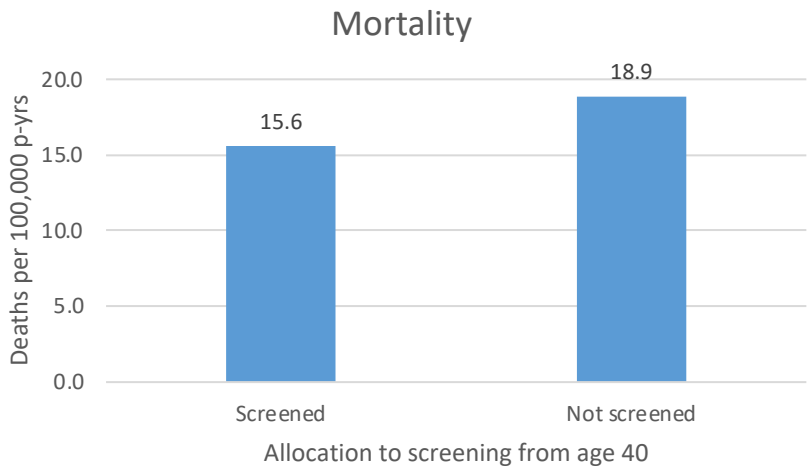

Figure 1. Mortality results for the UK Age trial

Breast cancer deaths per 100,000 person – years in 10 years from study entry. Relative risk 0.75, 95% confidence limits 0.58 to 0.97. Data from[3]. Deaths in screened 83 in 532,729 person-years; in not screened 219 in 1,058,236 person-years.

Screening interval

The choice of a two-yearly interval for screening, at all ages, was set at the inception of the BSA programme, and has not been changed. The relative effectiveness of different screening frequencies is a complex question, and while two years is most frequently used, a few programmes worldwide use 1 or 1.5 years, and the UK programme uses 3 years.

If a programme could use a longer interval between screens, and therefore fewer screens over a lifetime, it would reduce costs, and reduce false positives and other detriments of screening. However, a longer interval would be expected to mean an increased risk of interval cancers and a smaller mortality benefit.

Simon Baker, Madeleine Wall and Ashley Bloomfield[4] reported in a review by the NSU (National Screening Unit) on the appropriate screening interval for women aged 45 to 49, when extension of the BSA programme to that group had been approved. They concluded that there was no strong scientific evidence to support screening more frequently than every two years, but some observational studies did support shorter screening intervals. The two-year interval was agreed by BSA, however it was recommended that “emerging evidence on the screening interval be regularly monitored”.

UK trial comparing 3 year and annual screening at ages 50-69

The optimal frequency of breast cancer screening has been a subject of debate since the inception of the UK National Breast Screening Programme, which uses 3-yearly screening. In the only randomised trial comparing different screening intervals, nearly 100,000 women aged 50-62 years who had had a first, prevalent, screen were randomly allocated to three further annual screens, or to one screen 3 years later[5]. Mortality was not directly assessed as follow-up was short; breast cancer deaths were predicted by two established predictive models based on the size, lymph node status and histological grade of the invasive tumours diagnosed. While the women allocated to annual screening had smaller cancers, their predicted deaths were not significantly reduced. The conclusion was that annual screening, as compared to 3-yearly screening, would have a small effect or no effect on breast cancer mortality, and that improvements to other aspects of the screening programme would be more productive.

European Commission guidelines on breast cancer screening

The guidelines for the European Commission[6] have been developed with very comprehensive methods.

The methods are worth describing as they may indicate some principles relevant to future developments in Aotearoa. These include systematic reviews of the literature up to December 2018 [6], and classification of scientific evidence by the well-documented GRADE system (Grading of Recommendations Assessment, Development and Evaluation)[7].

The European Commission report specifies core components for trustworthy guidelines[8]. They say that the guidelines need to:

"be developed by a knowledgeable, multidisciplinary panel of experts and representatives from key affected groups; be based on a systematic review of the existing evidence; consider important patient subgroups and patient preferences as appropriate; be based on an explicit and transparent process that minimizes distortions, biases, and conflicts of interest; provide a clear explanation of the logical relationships between alternative care options and health outcomes; provide ratings of both the quality of evidence and the strength of the recommendations; and be reconsidered and revised as appropriate when important new evidence warrants modifications."[6]

To produce these guidelines[8], an open call system was used to select a panel including patients, healthcare professionals, epidemiologists, guideline methodologists, and others. Women advocates are members of this guideline group with full voting rights. Systematic reviews of the published scientific evidence were done independently by scientists linked to the Cochrane Collaboration. Formal conflict of interest rules were followed. In considering the evidence, important subgroups of women were specifically considered, for example different age groups, and there was a focus on evidence supporting the best ways to communicate the guidelines to women to inform their decisions. Evidence to Decision frameworks (EtD) were used, which are designed to minimise the influence of competing interests, to use evidence in a structured transparent way, to consider anticipated harms and benefits of options considered, and to consider the costs and feasibility of the options. There is a commitment to reviewing and updating the recommendations when new evidence becomes available, and to the process of using international stakeholder feedback to ensure the recommendations remained timely and relevant.

The report on breast cancer screening and diagnosis[6] lists 40 questions considered up to May 2019, although it concentrates on major characteristics of programmes.

Mammography screening by age; European Commission guidelines, 2020							
	Recommendation				**Interval**		
Age		Type	Certainty			Type	Certainty
40-44	Don't do	Conditional	Moderate		don't do		
45-49	Yes	Conditional	Moderate		2 or 3 years better than 1	Conditional	Very low
50-69	Yes	Strong	Moderate		not annual	Strong	Very low
					2 better than 3	Conditional	Very low
70-74	Yes	Conditional	Moderate		not annual	Strong	Very low
					3 better than 2	Conditional	Very low

Table 2. European commission guidelines on screening by age group.

Data from [6].

Table 2 gives the European commission recommendations for organised mammography screening by age group. For age 40 to 44, screening is not recommended. For ages 45 to 49, 50 to 69, and 70 to 74, screening is recommended, with the recommendation being 'strong' for ages 50 to 69. A 'strong' recommendation is defined as one which may be adopted as policy in most situations. For the age groups 45 to 49 and 70 to 74, the recommendation is 'conditional', which means that 'policy-making will require substantial debate and involvement of various stakeholders'.

For these recommendations of screening versus no screening, the strength of the evidence is graded as 'moderate'. The grading system used has four categories: high, moderate, low, and very low. The moderate category means that "We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different".

The recommendations on the interval for screening are also given in Table 2. For the age range 50 to 69, a strong recommendation against annual screening is given, with the conditional recommendation that every two years is better than every three years.

For age 45 to 49, screening every two or three years is recommended rather than annual screening.

For age 70 to 74, there is a strong recommendation against annual screening, and the conditional recommendation that 3 yearly screening is better than 2 yearly.

For all these recommendations on intervals, the strength of the evidence is given as "very low", which is defined as "we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect".

For these recommendations of screening interval, the EC group had available one randomised trial comparing annual to 3 yearly screening in the UK[5] (noted above), and observational studies, indirect comparisons, and the results of modelling studies. They also undertook their own modelling. They note that in all age groups, more frequent screening (such as annual) should result in greater mortality reductions and lower interval cancer rates, but also produces more false positive results, more intensive follow-up, and a higher risk of radiation induced breast cancer.

Comment

The GRADE classification of strength of evidence is developed mainly for clinical interventions, and is less appropriate for other issues. The top two grades of 'high' and 'moderate' can normally only be achieved on randomised trial evidence, although randomised trials may be impossible or inappropriate for many questions. Observational studies, even of high quality, will usually result only in a "low" classification. The 'very low' classification implies observational studies in which sources of bias and error are very likely not to have been dealt with effectively. It is interesting that European Commission group made two 'strong' recommendations in the above table on the basis of 'very low' quality evidence, implying that despite being defined as very low quality, it was regarded as adequate to influence policy.

2. BREAST CANCER SCREENING PROGRAMMES WORLD WIDE

REGION	COUNTRY	YEAR STARTED	AGE RANGE	METHOD	INTERVAL	COVERAGE
Aust – NZ	Aotearoa	1999	45–69	DM	2	72
	Australia	1991	50–74	MM	2	55
Northern Europe	Norway	1995	50–69	DM	2	77
	Sweden	1986	NA	FM, DM	1.5–2	77
	Finland	1987	50–69	DM, US	2	76
	Denmark	2001	50–69	DM	2	72
Western Europe	United Kingdom	1989	50–70	DM	3	84
	Netherlands	1989	50–75	FM, DM	2	78
	Ireland	2000	50–64	DM	2	76
	Luxembourg	1992	50–69	DM	2	60
	Spain	1990	45/50–69	DM	2	60
	Germany	2002	50–69	DM	2	53
	France	1989	50–74	FM, DM, CBE	2	52
Asia	South Korea	1999	40–	MM, CBE	2	50

Table 3. Features of population-based programmes worldwide with reported coverage over 50%.

Data from[9]. DM digital mammography; FM film mammography; MM mammography, any method; US ultrasound; CBE clinical breast examination.

The table above is taken from a review published in 2022 which describes key features of breast cancer screening programmes worldwide[9]. The selected table above shows only countries reported as having population based programmes with coverage rates above 50%.

Most programmes use digital mammography. Finland also uses ultrasound in screening and France incorporates clinical breast examination. Most programmes start at age 50, with only Spain starting at age 45/50 (meaning that in some areas it is 45, in others 50). The screening interval is most commonly two years; but the United Kingdom programme screens three yearly, and in Sweden the interval varies from 1 to 2 years.

The coverage given in this review for Aotearoa is 72%; several countries in northern and western Europe have higher coverage rates, the highest being the UK at 84%. Coverage is lower in Australia (55%). The full table shows that Canada has screening at ages 50-69, but only 47% coverage. Many countries have opportunistic screening, such as the US and several central and south American countries.

3. EFFECTS ON BREAST CANCER MORTALITY FROM BSA PROGRAMME

Trends in breast cancer mortality in Aotearoa

The mortality rate in women in Aotearoa, assessing the whole population and adjusting for changes in the age distribution, increased moderately from around 25 per 100,000 from the earliest year available, 1948, to about 30 in 1988-1990 (Figure 2). Changes in diagnosis and death certification may have contributed to the rise in the earlier years, but this is not documented. It seems unlikely that death certification changes would affect the trends from 1990.

From 1990, the death rate has decreased by almost half, dropping from around 30 to 17 per 100,000 in 2017, the most recent year available. The BSA programme started in 1999 for women aged 50 to 64, and was extended to 45 to 69 from July 2004.

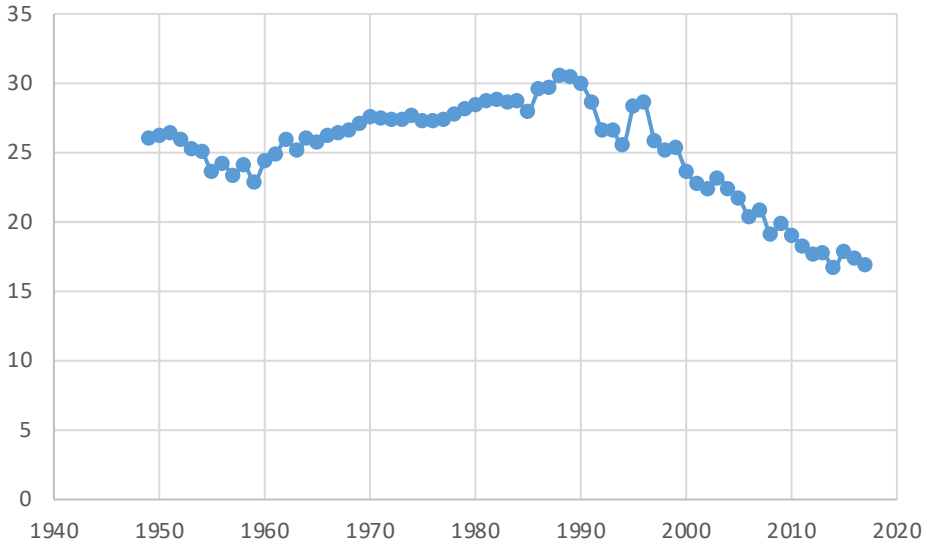

Figure 2. Mortality rate from breast cancer, women, Aotearoa, whole population, 1948 to 2017.

Age standardised to WHO standard population. 3 year moving average to 1990, annual data 1991 to 2017.

Trends in breast cancer mortality by ethnic group

Information on breast cancer deaths by ethnic group is available only from 1996 (Figure 3). During this whole period the average death rate was 19.6 per 100,000 in non-Māori non-Pasifika (nMnP) women, and 31 per 100,000 in both wāhine Māori and Pasifika, that is, a 59% higher rate. The mortality rates decreased in all groups, with generally similar overall trends, although the pattern for Pasifika is less clear as the annual numbers are smaller.

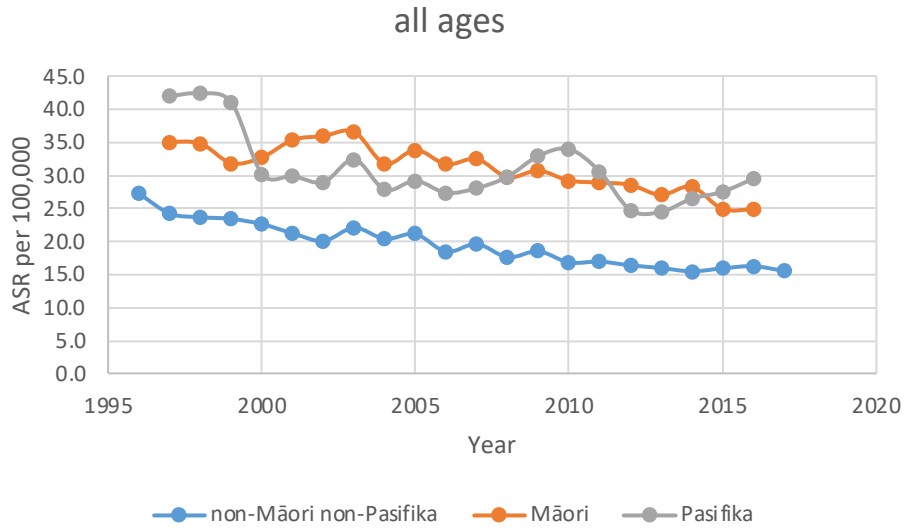

Figure 3. Mortality rates from breast cancer, 1996 to 2017, by ethnic group; age standardised, all ages.

Māori and Pasifika rates as 3 year moving average. Age standardised to the WHO 'world' population.

The rates by age group are shown in Table 4. The mortality rates in the screening age group (45-69) are 63% more in Māori, and 61% in Pasifika, than the rates in nMnP women. At ages over 70, the excesses are 48% and 44% respectively.

At younger ages, under 45, the excess in Māori is 57%, but the excess in Pasifika is greater (107%). However, the numbers are small and variations in data accuracy may be important.

	RATES PER 100,000			% EXCESS	
AGE	MĀORI	PASIFIKA	NMNP	MĀORI	PASIFIKA
0-44	4.9	6.5	3.1	57	107
45-69	68.4	67.7	41.9	63	61
70+	172.8	169.1	117.1	48	44
All	31.0	31.0	19.6	59	59

Table 4. Mortality rates, average 1996 to 2017, by ethnicity and age range.

Age standardised rates per 100,000 (WHO world standard), and % excess compared to nMnP rates.

Assessment of mortality benefit of breast cancer screening in Aotearoa

Extensive assessments of the effect on breast cancer mortality of the BSA programme have been made in work commissioned by BSA and NSU programme led by epidemiologists in New South Wales, and published in routine reports and in peer-reviewed papers [10;11].

Richard Taylor et al.[10] assessed the mortality trends in breast cancer in the screening age group, 50 to 64 years, from 1974 to 2014 (Figure 4).

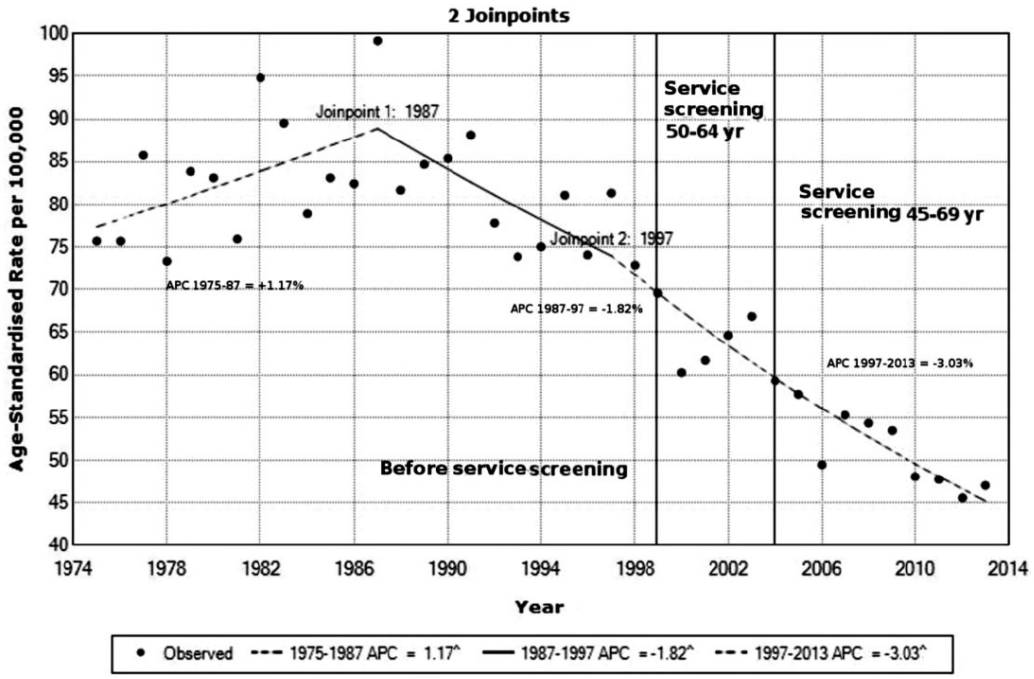

Figure 4. Time trends in breast cancer mortality rates at ages 50-69, 1975 to 2013, Aotearoa

From Taylor et al.[10]. Reproduced with permission from the Journal of Medical Screening.

This shows that mortality in this age group increased from the earliest year measured to about 1987. From 1987 to 1999, mortality was reducing considerably; during most of this period the death rate declined by 1.8% per year, falling from nearly 90 to 70 per 100,000. This was before the introduction of the BSA screening programme. There was some limited screening during this period, from the pilot programmes and private screening, but it was quite small. During that time the treatment for breast cancer, particularly early breast cancer, improved considerably; similar falls in mortality were seen in most developed countries, and the generally accepted reason is improvements in therapy.

The BSA programme at ages 50 to 64 commenced in 1999, and the age range was widened to include both women aged 45 to 49, and those aged 65 to 69, in 2004. During this period from the beginning of the screening programme to the latest year assessed, 2015, the mortality rate continued to fall, from about 70 to about 45 per 100,000. The decline was more rapid than it had been earlier, 3.0% percent per year. The greater decline is presumably due to the effects of the screening programme: indeed, one can argue that if by 1999 most patients were receiving the improved therapy, most of the decline of the next years could be due to breast cancer screening. This analysis considers the whole Aotearoa female population within age groups, and does not give data on trends in different ethnic or social groups.

Participation in the BSA programme reached about 70% in 2015. If there has been since 2015 steady and high levels of the use of better treatment, and of involvement in screening, further improvements might not be expected; we may have reached a new stable state. However, participation in screening fell during the Covid-19 epidemic. Thus, information on mortality trends within age and ethnic groups in recent years is needed, but the latest available seems to be 2017.

This analysis is generally consistent with the results in other developed countries, where mortality rates from breast cancer have also declined, and the extent of the decline is consistent with the results of randomised trials. Taylor et al.[10] comment that in Aotearoa breast cancer screening was introduced considerably later than in many other countries, which makes its assessment easier as the main improvements in breast cancer treatment would have occurred prior to the introduction of screening. By this, they are likely to be referring to the use of adjuvant chemotherapy; but further improvements have been introduced more recently, such as Herceptin.

Taylor et al.[10] also performed a more valid but considerably more complicated analysis of mortality. The weakness with the simple analysis presented above is that it looks at death rates in a certain year; but women who die of breast cancer in that year could have had their initial diagnosis of breast cancer quite recently or many years before, and if the diagnosis was some years before it would have been before the breast cancer screening programme was available. The more advanced analysis looks at deaths in a given year, but counts only deaths from breast cancers diagnosed during the years when screening was available. This analysis showed that for women aged 50 to 64, deaths declined by 17% once screening was available, and for women in the wider age range 45 to 69 the decline was 15%. These declines would to be expected to increase with more years of follow-up.

Thus this study confirms that the introduction of the national BSA programme has resulted in a reduction in deaths, evident on a population basis.

In a further study, the same investigator team assessed the impact on mortality risks for individuals[11]. This is a more complex study based on individual linkage of health data from the BSA programme, the national cancer Registry, and the national death Registry. This linkage was done within the Ministry of Health, with only de-identified data being available to the researchers. This study assesses individual risk of breast cancer deaths in terms of each woman's years of life before screening, and years after screening. In the results, adjustments are made for age at death and for ethnicity (Māori, Pasifika, or other). Importantly, an adjustment is made for 'screening selection bias'. This bias is caused by the fact that women who choose to participate in screening will differ from women who choose not to participate, in many ways which relate to health beliefs and health behaviours; and international research shows that the women who choose to participate tend to have a lower risk of breast cancer death than those who choose not to participate, irrespective of any actual effect of screening.

The results show that after such adjustments, women who participated in BSA screening had a 34% reduction in the risk of breast cancer deaths, confidence limits 25 to 43%, based on a screening coverage of 71%.

Further, these investigators estimated that the mortality reduction in women who had had regular screening (defined as being screened at least three times with an average screening interval of 30 months are less) was 39%, while in those who had been screened, but less regularly, the reduction was 31%, again based on the most recent data with 71% overall participation.

This analysis also showed that women participating in screening had smaller tumours, were more likely to have localised disease and less likely to have had distant disease, and were more likely to have pathologically well-differentiated cancers. They were less likely to have multiple tumours. The investigators concluded that the results were in agreement with other evaluations of mammography programmes in other countries, and with the original randomised trials.

A study with a similar concept, although using different methods, has been done in Sweden[12], showing that women participating in screening has a 41% reduction in their risk of dying of breast cancer in 10 years, and a 25% reduction in the risk of being diagnosed with advanced breast cancer. Further, participation in the most recent two screenings had greater benefits than less regular participation[13].

In summary, breast cancer screening programmes in Aotearoa were set up on the basis of favourable results from randomised trials conducted in other countries. Careful evaluations both at the population level and at the individual level have been conducted for the BSA programme, using methods comparable to those used in the best international studies. These studies have confirmed a substantial beneficial effect of breast cancer screening.

Comment: what we can learn from death rates

The ultimate measures of success in breast cancer screening programme are a reduction in the risk of death in a woman who chooses to participate in the programme, and a reduction in the death rate of the whole population following the introduction of the programme.

These beneficial effects are not easy to measure. They take considerable time. A reduction in mortality would not be expected to occur immediately, but would continue over several years. The introduction of breast cancer screening will be gradual over several years, and during that time many other improvements in breast cancer management may occur. A dominant view is that improvements in treatment and the use of breast cancer screening both contribute to the decrease in mortality rates. Countries which implement breast cancer screening programmes rely on that logic, shown by the major UK review led by Michael Marmot[14]: "The panel's view is that the benefits of screening and those of better treatments are reasonably considered independent" (page 2207).

It can be argued that these are synergistic, in that screening leads to a more favourable stage distribution of cancers, and that will complement the improvements in treatment which have mainly been in regard to early cancer, such as adjuvant chemotherapy. However, it can also be emphasised that the randomised trials were done many years ago, and since then treatment has improved greatly, and with this improvement screening may be no longer as important; (If breast cancer could be easily treated, irrespective of the stage at diagnosis, screening would be irrelevant). Thus, some experts feel that screening is of little or no value.

Using trends in mortality to estimate the effect of screening is a very limited and potentially misleading process. Simple inspection of trends such as those in Figure 2 shows that there is not an obvious effect such as mortality rates dropping rapidly after the introduction of screening. The other analyses linking incidence and mortality data described above are more valid, but quite complex. The justification for breast cancer screening programmes in scientific terms still depends on the results of the randomised trials, with observational studies have a secondary place.

Those randomised trials were set up many years ago, and used methods which are now obsolete, such as film mammography and more limited assessment methods after a positive mammogram. It would be ideal to have randomised trial using contemporary methods of screening, and of patients treated with up-to-date clinical management. But further trials for average risk women are unlikely to be feasible. Careful observational studies can give more information, and screening trials in particular high-risk groups of women may be done.

4. EQUITY IN BREAST CANCER MORTALITY, INCIDENCE AND SURVIVAL

Mortality and incidence 2007-17

Wāhine Māori and Pasifika women have a higher incidence and mortality from breast cancer than non-Māori non-Pasifika, with the differences being greater for mortality. Figure 5 is based on cancer registry and mortality data for 2007-2017. Incidence is higher by 39% in Māori and 23% in Pasifika, while mortality is higher by 65% in Māori and 71% in Pasifika.

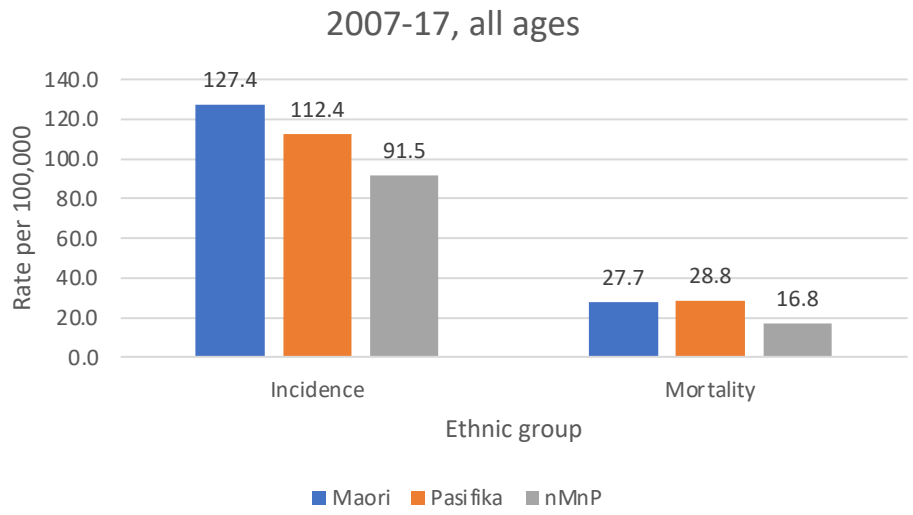

Figure 5. Incidence and mortality rates, all ages, by ethnic group, 2007 to 17.

Age standardised to the WHO world population.

Incidence trends over time, ethnicity, age

Te Aho o Te Kahu states[15]: "Rates of breast cancer have increased slightly over the past 20 years for both wāhine Māori and non-Māori. There are probably multiple causes for this trend, including increased exposure to factors associated with breast cancer (for example, rising rates of obesity). However, the increase may also reflect the expansion of the inclusion age for the national breast screening programme in 2004 (originally offered to women aged 50–64 years and expanded to 45–69 years), which has led to an increase in the detection of breast cancer among those newly included age groups." The trends in incidence rates are shown in Figure 6.

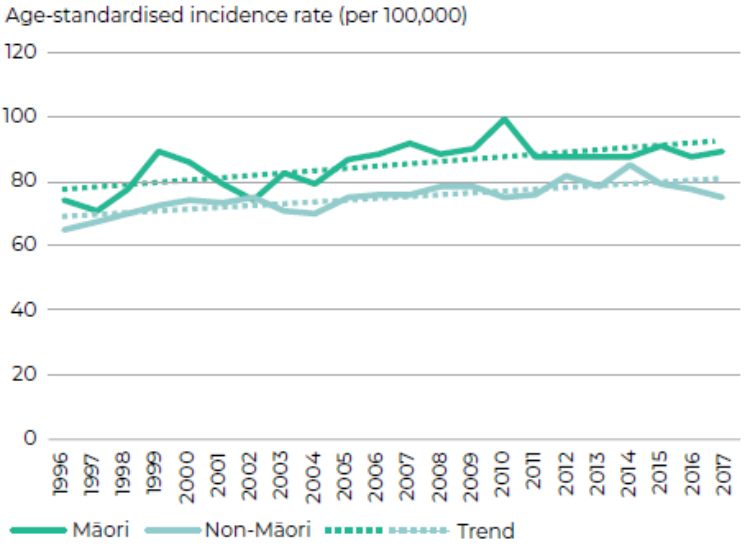

Figure 6. Trends in incidence of breast cancer in Māori and non-Māori, 1996 to 2017.

The rates differ from those in Figure 5 because of a slightly different calculation method.

Changes in the classification systems for ethnicity affected incidence data in 2006, so more reliable data is available for 2007 to 2019. For all ages, the incidence rates for Māori and Pasifika were higher than for nMnP women (Figure 7), with slight increases over time in Māori and nMnP and a greater increase in Pasifika.

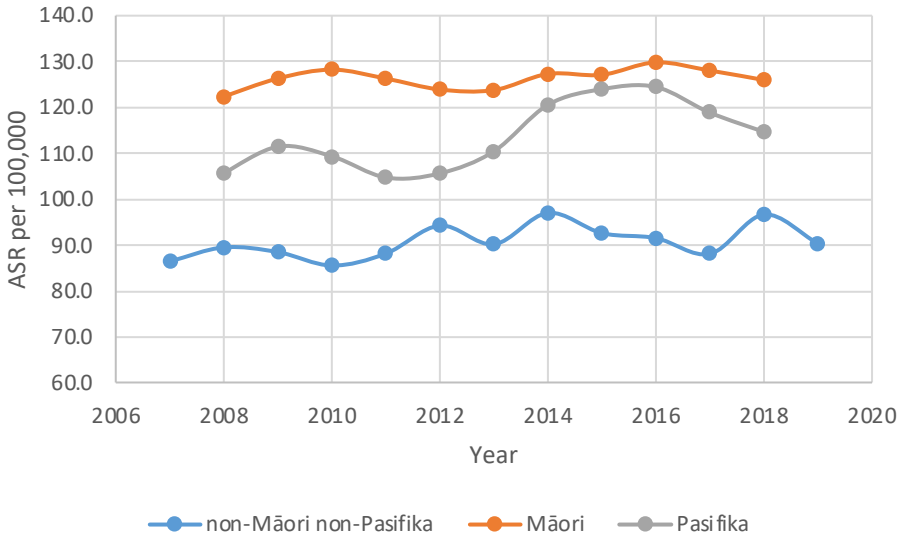

Figure 7. Trends in incidence of breast cancer in Māori, Pasifika, and non-Māori non-Pasifika, 2007 to 2019, all ages.

Age standardised rates, WHO world standard; 3 year moving averages for Māori and Pacific

The average rates in 2007-2019 were, at all ages, 39% higher in Māori and 23% higher in Pasifika, compared with nMnP. The excesses in the screening age group were 45% in Māori and 26% in Pasifika (Table 5).

	RATES PER 100,000			% EXCESS	
AGE	MĀORI	PASIFIKA	NMNP	MĀORI	PASIFIKA
0-44	22.9	25.2	18.9	20.9	33.0
45-69	383.0	331.7	263.5	45.4	25.9
70+	393.5	315.2	295.0	33.4	6.8
All	127.4	112.4	91.5	39.3	22.9

Table 5. Average incidence rates, 2007 to 2019, by age and ethnic group.

The higher incidence rates in Māori and Pasifika are more marked at ages 45-49 and above, and Pasifika and nMnP rates are similar above age 70 (Figure 8). In all groups, the rates at age 70-74 are much lower than at age 65-69. This could be due to the cessation of screening at age 69, but more analysis is needed.

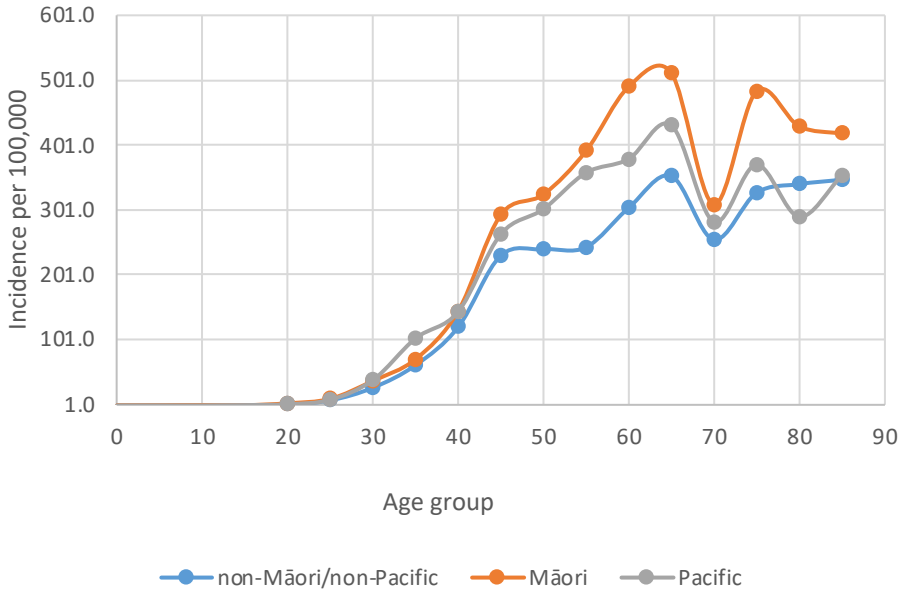

Figure 8. Incidence rates of breast cancer by 5-year age group, average 2007-2019

Data from NZ Cancer Registry. On axis, '40' refers to age group 40-44, and so on.

Survival after diagnosis

The higher mortality rates, compared to less elevated incidence rates, shows that patient survival from the time of diagnosis is reduced. Survival figures for all women with breast cancer in Aotearoa diagnosed in 1994 to 2011 are shown in Figure 9 for Māori and non-Māori.

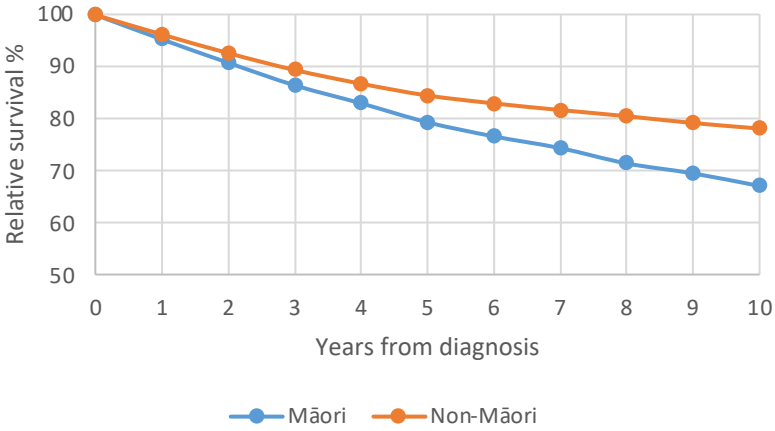

Figure 9. Survival from diagnosis in women with breast cancer.

From the NZ Cancer Registry[16]

More detailed analysis from the 4 clinical cancer registries is available[17]. Figure 10 shows breast cancer specific survival up to 10 years for patients in the registries diagnosed up to 2017, showing higher survival for Asian and NZ European women than for Māori, with Pasifika having the lowest survival:

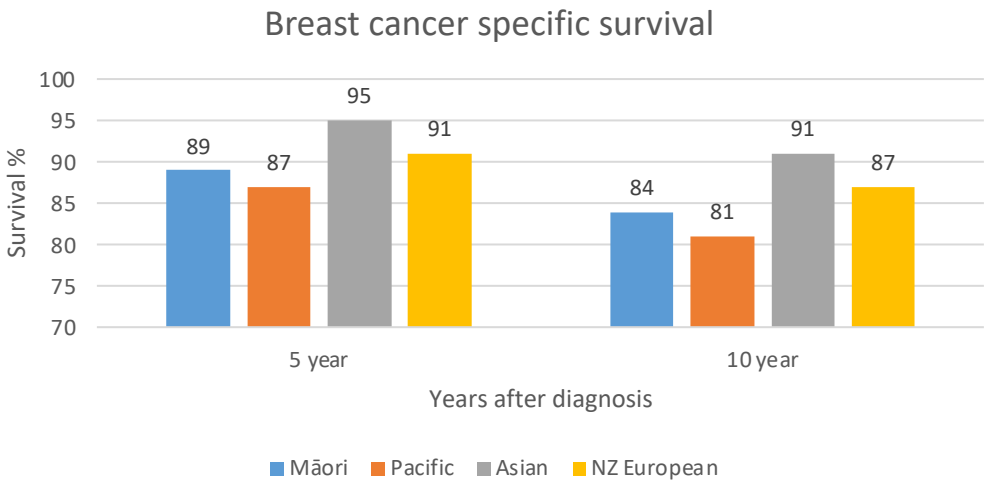

Figure 10. Survival at 5 and 10 years from diagnosis, registries in Auckland, Waikato, Wellington, and Christchurch, by ethnicity.

The data further shows the considerable improvements in all groups over time (Figure 11). From patients diagnosed in 2003-5 to those diagnosed in 2015-17, 5-year disease specific survival has increased from around 85% to 95%: that is, the proportion of woman who die from breast cancer in the first 5 years from diagnosis has dropped from 15% to 5%. The differences by ethnicity are smaller than this time effect, but in all time periods survival is highest in Asian women and lowest in Pasifika. In the latest time period, survival was higher in Māori than in Europeans.

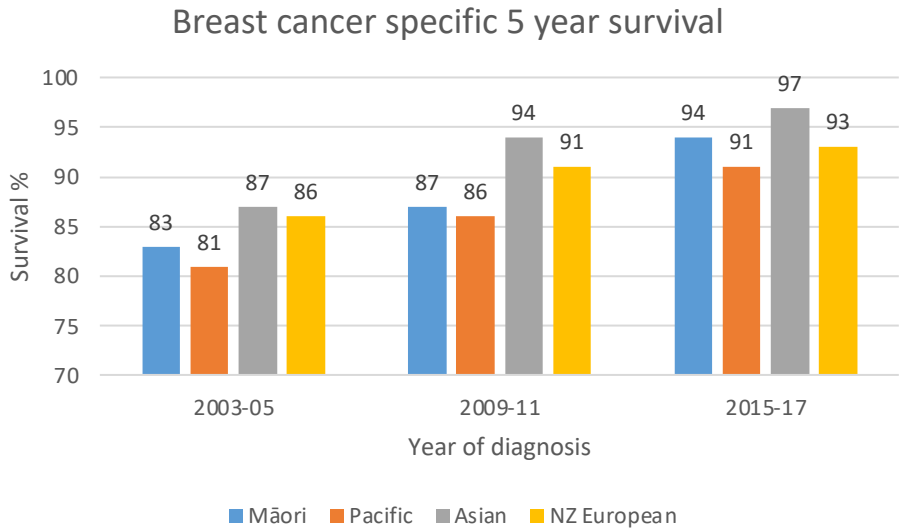

Figure 11. Survival at 5 years from diagnosis, registries in Auckland, Waikato, Wellington, and Christchurch, by ethnicity and year of diagnosis.

Wider aspects of inequity

This report considers only ethnicity in regard to breast cancer. However, many factors can be important indicators of inequities, and in international reports are often given as or more prominence than ethnicity. These factors include social and economic deprivation, accessibility of services related to residence, immigration status, time of residence in the country, languages of communication, and more personal factors such other disease conditions, chronic disability, the health of the family, and family and employment responsibilities. A few of these factors are recorded in the National Cancer Registry, such as region, urban or rural residence, and deprivation score.

The BSA routine reports show results of the program by age group (45-49, or 50-69), and by provider, and otherwise considers only ethnicity as a factor giving variability. Studies based on the National Cancer Registry such as[18] consider ethnicity, but also socio-economic deprivation assessed by the NZ deprivation decile scale, and rural or urban residence categorised into several groups. Breast cancer incidence, stage distribution, and survival are related to all these factors[18]. In a more extensive study, anonymous linkages were made between cancer registrations, mortality data, and five national censuses, allowing analysis of household income, adjusted for inflation and for the number of people in the household [19]. The main assessment was of time trends in survival. From breast cancer, survival improved over time, but there was excess mortality in Māori (37%) and in low-income patients (28%); and while the excess in Māori decreased over time, the excess in low-income patients remained stable[19]. Studies using the more detailed clinical breast cancer registries have more extensive data on relevant factors. As examples, the use of breast conserving surgery is influenced by deprivation status and whether private health care is used, as well as by ethnicity and age[20;21]. The use of radiotherapy in patients for whom it is recommended in guidelines was reduced in Māori, Pasifika, those with more co-morbidity, and in rural residents [22].

There has been little attention given to factors other than ethnicity, age group, and provider (and therefore, region) in considering inequities in breast cancer screening. It is likely that socio-economic deprivation, income levels, urban/rural residence, and comorbidity, which have been shown to be associated with incidence, mortality, stage distribution, and survival, have important influences on how women interact with the breast screening programme. Other factors which should be considered include time of immigration, usual language, disabilities, and sexual identification, but no information is available on such factors in relationship breast cancer screening in Aotearoa. Further exploration of many factors would require specially designed studies, such as the use of more extensive data

linkages. The IDI (integrated data infrastructure) is a major Aotearoa project to allow linkage of many different datasets, including census data, under controlled confidentiality conditions (https://www.stats.govt.nz/integrated-data/integrated-data-infrastructure). It already has had considerable use in health applications.

To address these issues, more detailed data could be recorded on BSA participants, although collecting valid data in a busy clinical program without reducing participation or increasing anxiety is a challenge. For some key issues, such as influences on participation, data on BSA participants will be inadequate without comparable data on non-participants or on all eligible women, so specific studies or linkages to other databases such as the census may be most valuable.

5. KEY ISSUES FOR A SUCCESSFUL SCREENING PROGRAMME

Key steps in the screening pathway

Some essential issues which will determine the effectiveness of a screening programme are shown in the diagram Figure 12, which shows a very simplified screening pathway.

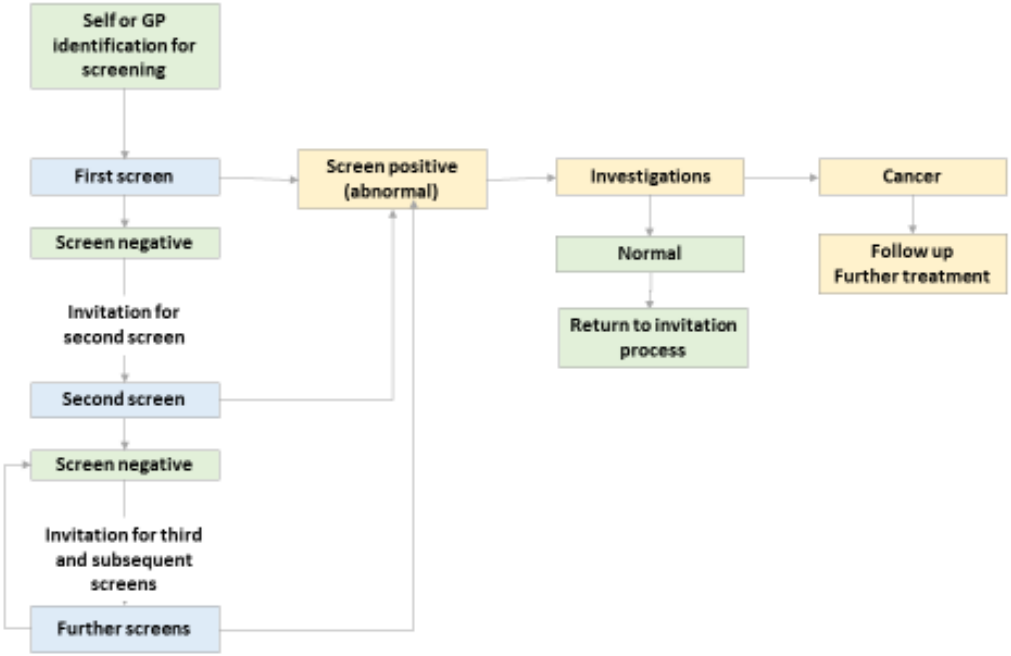

Figure 12. Simplified screening pathway

These key steps are:

A: the pathway of normal screens

- identification of eligible women
- invitation to screening, by the programme, self-identification or GP referral
- performance of first screen
- if the first screen is negative, invitation per second screen, performance of second screen;
- if second screen is negative, invitation for third and subsequent screen, performance of that screen;
- this process continues through the woman's life. The BSA programme is for 12 screens, at two yearly intervals from age 45 to age 69.

If any of the screens are positive, showing an abnormality requiring further investigation, the woman enters:

B: the pathway of assessment

- Following an abnormal screen, invitation for further assessment, and performance of further assessments, leading to a diagnosis, which will be either:

Normal, so the woman returns to normal screening pathway and will be invited for a further screen at two yearly intervals

Cancer, so at this point the woman and leaves the screening programme and enters:

C: the pathway of treatment

- On the basis of a diagnosis of cancer, invitation for further specialist assessment, consideration of treatment options, clinical treatment and clinical follow-up under the management of specialist care.

Comment

All these major steps are essential to an effective screening programme. Each step involves many organisational details, which should be based on the best available and relevant scientific evidence, and the experience of breast cancer screening programmes in Aotearoa and worldwide. Some specific studies will be needed to answer key questions.

Methods of achieving these key steps have been set up in the BSA from its inception. As scientific and clinical knowledge constantly grows, the evidence-based rationale for each of these key steps needs to be reviewed regularly.

Performance indicators

The BSA National Policy and Quality Standards[23] sets standards for BSA under eight headings: access and participation, client focus, timeliness, cancer detection, assessment, management and governance, information management, and professional requirements. These cover the process from providing information, arranging appointments for screening, the screening itself, recall and further assessment, up to the diagnosis of cancer, and the infrastructure issues to manage the programme.

The management of patients diagnosed with cancer is not covered. Invitation processes are not covered as the programme is set up on the basis that women make the appointments for screening. There are 327 indicators listed in the document.

An extensive review by the European Commission Initiative on Breast Cancer (ECIBC) identified performance indicators associated with mortality (and therefore with success of a screening programme), selected for "relevance, measurability, accurateness, ethics and understandability"[24]. The investigators identified 1325 indicators in various reports, reduced to 96 and then to 39 by careful review. They finally selected 13 indicators, shown in Table 6.

1	Screening coverage
2	Participation rate
3	Recall rate
4	Breast cancer detection rate (4a: initial and 4b: subsequent screenings)
5	Invasive breast cancer detection rate
6	Cancers > 20 mm
7	Cancers ≤ 10 mm
8	Lymph node status
9	Interval cancer rate
10	Episode sensitivity
11	Time interval between screening and first treatment
12	Benign open surgical biopsy rate
13	Mastectomy rate

Table 6. Key indicators in breast cancer screening.

From Muratov et al. [24].

6. PARTICIPATION IN SCREENING

Coverage in the BSA programme

'Coverage' is defined as a measure of participation, being the number of women screened in the previous 2 years, in a defined age group and geographic region, as a proportion of the census population.

However, not all women are eligible for the programme.

The BSA programme eligibility criteria

The eligibility criteria for the BSA programme are [23, p.6]:

"Currently, BreastScreen Aotearoa offers free mammography every two years to women who:

- are aged 45–69 years
- have not had mammography within the previous 12 months
- are not pregnant or breastfeeding – breastfeeding women who meet the other criteria are able to have a mammogram within BSA no sooner than three months after lactation has ceased
- are free from breast cancer – women previously diagnosed with breast cancer are eligible for screening at least five years after diagnosis
- are asymptomatic
- are eligible for public health services in Aotearoa."

Thus, women who are symptomatic are excluded: they are expected to seek consultation and investigations through the normal health system, usually starting with a general practitioner visit.

Beyond that, it is a "one size fits all" programme, in that the same screening process is offered to all women in the eligible age range.

Reported coverage

Figure 13 shows the coverage for women aged 50-69 years, from Dec 2015 to June 2020, by ethnic group, from[25]. Figure 14 shows the data for the age group 45-49. The patterns are very similar. The target value is 70%.

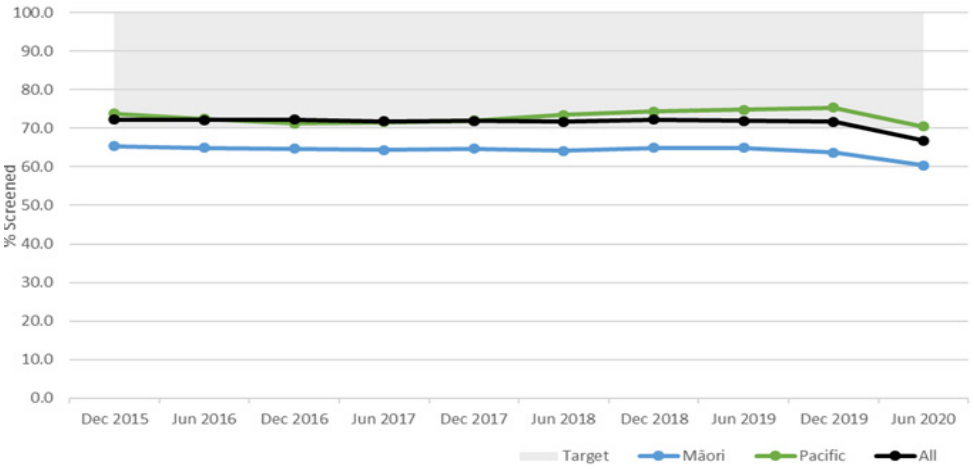

Figure 13. Coverage (screened in last 2 years) in 2-year periods up to the date shown on the axis, BSA programme, age 50-69.

Data from[25]

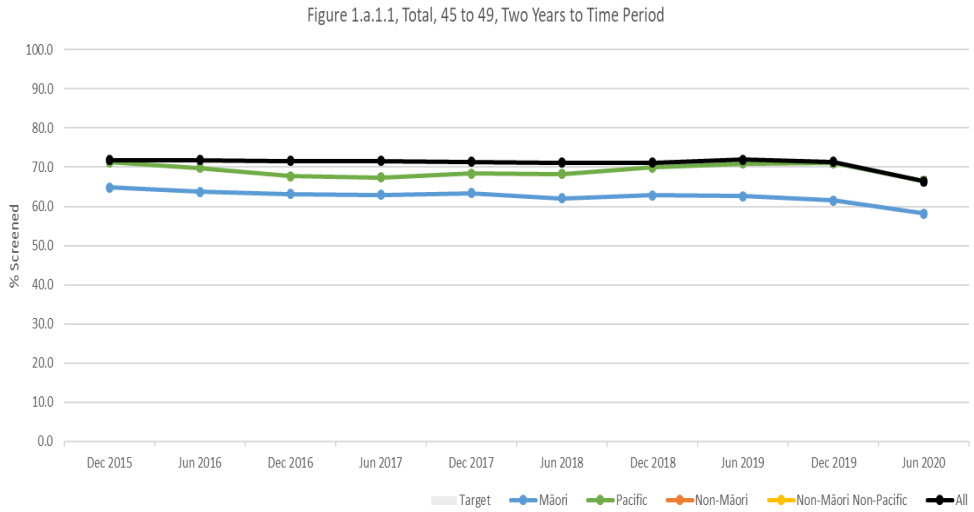

Figure 14. Coverage (screened in last 2 years) in 2-year periods up to the date shown on the axis, BSA programme, age 45-49.

Data from [25].

From Dec 2015 to Dec 2019, the target of 70% was met in all women and in Pasifika women at age 50-69 years, and by all women aged 45-49, with Pasifika rates somewhat lower. In wāhine Māori the coverage was about 65% at age 50-69, and 61-65% at age 45-49.

More recent data and the effects of Covid-19 disruptions are discussed in a later section.

These data are dependent on the accuracy of both the recording of ethnicity in BSA and the population data used. There are concerns that Pasifika population numbers may be underestimated, as their participation in the census is low[26]. If this is so, coverage will be overestimated.

7. FACTORS AFFECTING PARTICIPATION

Participation in BSA programme

Before the national BSA programme was set up in 1999, pilot programmes were set up in Otago-Southland and in Waikato. Extensive evaluation of these programmes was carried out by academic groups separate from the programmes' management. In the pilot programmes, women were actively identified and invited for screening, eligible women being identified through general practitioner lists or other sources.

In Otago/Southland[27], a survey of 191 participants in a first screen and of 174 non-participants, showed that practical difficulties such as access to transport, travel time, and inconvenience were barriers to participation, and 20% of women expressed concern or fear of the procedure, or were influenced by negative reports from other women. Of participants, 90% intended to attend for re-screening, as did 43% of non-participants. This study used a standardised telephone interview by a university team on random samples of women attending or not attending for screening. Response rates for women who could be contacted were 98% for participants and 86% from nonparticipants, but more nonparticipants could not be contacted because of address changes.

A randomised trial in 482 women in Otago-Southland[28] found that the attendance for screening was higher (71%) after an invitation letter signed by their general practitioner, than after a similar invitation letter sent only from the screening centre (62%). In a further randomised trial, women who had not replied to the initial invitation from the screening centre were randomised to receive either the routine postal reminder, or a telephone reminder: there was no difference in responses, 49 and 48% of the two groups attending for screening[28].

In a survey of all general practitioners in Otago-Southland during the pilot programme there, with 71% response (141 respondents), every GP except one actively supported the programme, and most were involved in sending invitations and receiving reports, although 82% felt that such work should be reimbursed in the full programme[29].

A study investigated how women found out about the Waikato pilot breast cancer screening programme and what influenced them to participate, using a questionnaire survey with 55% response rate [30]; information came from letters of invitation (42%), family doctors (42%), television (32%), and newspapers (27%). The most important influences for attending screening were the letter of invitation (28%), and knowing someone with breast cancer (27%). The authors pointed out an inconsistency between the government policy to provide a population-based screening programme and the operation of the Privacy Act 1993, which prevents use of other sources of information to update addresses for population groups most likely to benefit from screening.

Few studies appear to have been published on the recruitment process since the commencement of the national programme, although there may be some in unpublished reports.

Thomson et al.[31] worked with the Te Whānau-ā-Apanui Community Health Service ('TWAACH'), which provides primary health care to a rural, coastal, predominantly Māori community in the Eastern Bay of Plenty. They increased screening participation in the BSA programme by Māori from 45% to about 98% from 2003 to 2005-07 by using local input, flexibility and collaboration between services, without new services or resources.

Studies of participation in other countries

Mottram et al.[32] reported a major review of factors associated with attendance for breast cancer screening in 2021. From literature to June 2019, 66 relevant studies were identified. Meta-analyses showed higher attendance is associated with higher socio-economic status and higher income, being married or cohabiting, and having a high or medium level of education. There were no differences by age group or by urban-rural residence. Women with a previous false positive result were less likely to reattend.

A large number of other factors were reviewed, usually from only one or two studies, so meta-analyses were not done. Factors associated with being less likely to attend included a negative attitude about breast cancer screening, having no access to a vehicle, and receiving disability benefits or having long-term limiting illness.

European Commission guidelines on invitations

In the European Commission guidelines discussed earlier in this report[6,] there was a 'strong' recommendation for using a letter to invite women aged 50 to 69 to screening, and a 'conditional' recommendation that using a letter with the general practitioner's signature, with a fixed appointment, or followed by a phone call or written reminder, was appropriate.

They also gave a 'conditional' recommendation to using a targeted communication strategy for socially disadvantaged women, those with intellectual disability, and those not speaking the predominant language. However, in this report they do not go into further detail about which communication strategies are more effective, and they note that some tailored interventions had negative effects. They also give a 'conditional' recommendation for using a decision aid that explains the benefits and harms of screening instead of a regular invitation letter.

Information and shared decision making

From a systematic review of 22 studies of women's values and preferences, Mathioudakis et al.[33] concluded that women give greater value to the possibility of an earlier diagnosis than to the risks of a false positive result or overdiagnosis, and give great value to time-efficient screening processes and rapid delivery of results. Anxiety produced by delay in getting results was seen as a significant burden, and overdiagnosis was seen as difficult to understand.

A review of studies relating to shared decision-making or the use of decision aids in breast cancer screening emphasised the importance of the relationship between the patient and clinician, the importance of explicit information, and the influences of sociocultural factors[34]. Other small studies have explored shared decision-making[35-37], and reported on the advantages of involving a nurse navigator[38].

Screening process and women's experience

Women's anxiety levels before, during and after mammography were assessed in the Waikato breast cancer screening pilot[39], in a postal questionnaire survey with 54% response. Wāhine Māori and Pasifika reported higher levels of worry than NZ European and Asian women about developing breast cancer, while awaiting their appointment, and about results. Anxiety was also related to level of education, a family history of breast cancer, and stress and pain during mammography. Most women were reassured after receiving a normal result.

In the Otago-Southland pilot programme, pain during mammography was the most common factor given as a reason for not re-attending screening. The radiologists in that programme estimated that 2.5% of women screened would have pain severe enough to make them not reattend[40], and give several suggestions to minimise pain: good explanation of the need for breast compression, applying compression for the minimum time possible, relaxant aromatherapy, cold compresses and arnica cream, mild analgesics taken before the appointment, and avoidance of mammography during or just prior to menstruation.

In a Cochrane review, Miller et al.[41] identified seven randomised trials published up to 2007 on methods to reduce pain and discomfort. Pain was reduced by giving good information, giving women more control over the compression process, and using breast cushions: premedication with paracetamol (Panadol) had no effect.

In a systematic review, Pagliarin et al.[42] identified 48 studies of women's experiences of mammography. All studies reported a high level of satisfaction, and a very high willingness to be rescreened despite temporary pain, discomfort and anxiety. High satisfaction was supported by effective information and communication, good interpersonal skills of the staff, and quick delivery of results.

Comment

The most recent report [25] shows that participation in the breast cancer screening programme was close to the set target of 70% during two-year periods ending in December 2015 up to December 2019, for the total population. Coverage in Pasifika women aged 45 to 49 was slightly below target during this period, but increased from June 2018 to reach target figures. Screening participation from wāhine Māori, however, was around 60% at ages 50 to 69, and 62% at ages 45 to 49, during this period. This demonstrates a long-standing difference in coverage between wāhine Māori and others, not greatly changed since December 2015.

The total female population for ages 45 to 69 in mid-2019 is given as 725,601[25]. If 70% were screened, that would be 535,547, leaving 299,563 women not screened by the BSA. In the two years to June 2020, the BSA programme provided screening for 510,215 women, that is 25,432 fewer than the target number, based on this population estimate.

So, there are about 25,000 women unscreened, who should be screened according to the coverage target set at the inception of the BSA programme. However, there are about 300,000 women in the resident population who are not being screened.

The coverage as estimated by the proportion of the census population which is screened, must be an under-estimate of the true participation rate, as there are many women in the census population who are not eligible for screening. The eligibility criteria for the programme exclude various groups. Further, some women will choose to have the screening from a private provider, and so will be screened, but not recorded on BSA statistics.

It would be valuable to estimate the number of women in the population who are ineligible for screening on these grounds, and the number who are eligible but choose to get screening outside the programme. There may be value in reviewing the eligibility criteria, for example the exclusion of women diagnosed with breast cancer within 5 years assumes they are getting good follow-up in clinical services, but that is not checked or documented.

Further, some women may make a personal choice not to participate in the public mammography programme screening, either because they prefer no screening, or because they prefer an alternative method of screening, such as clinical assessment or other methods. Assessing the numbers of women making these choices, and ideally some assessment of the information they are using to make the choices, would require special studies, which would have to be conducted with sensitivity and cultural appropriateness. Perhaps some such studies have been done in Aotearoa. The programme has been running for many years, and if such studies are not available, they would seem important.

These methods would give a more accurate estimate of true participation. This may indicate that the pre-set target of 70% is appropriate, as it may relate to a considerably higher true participation rate. Or it could indicate whether this target should be raised. Careful studies of the reasons for non-participation in screening could distinguish between women for whom screening is inappropriate, women who make an informed choice not to participate in screening, and women who would like to participate but are prevented by some barriers, which could include limited or misleading information, difficulties in arranging appointments, access to appointments, and other issues. This last group is important because those barriers should be modifiable.

8. CONTINUED PARTICIPATION IN PROGRAMME (RESCREENING)

Importance

Screening is designed to detect tumours which have not yet caused symptoms, but are big enough to be detected on screening. After a screening episode, a further tumour may reach this threshold and will only be detected by screening if another screen is performed. Thus, screening programmes are planned for regular screening, at an interval which needs to be set based on scientific evidence.

Rescreening in the BSA programme

The BSA programme was initially designed for two yearly intervals, applied at all ages, and this is still the situation. A woman entering the programme at age 45, who repeatedly tests negative, therefore should have 12 screening episodes before age 69.

The target assessed is for screening within 20 to 27 months of the previous negative screen, and is 75% after the first screen, and 85% after a second or further screen. This is on the basis that women who have consented to two screens are more likely to continue in the programme than those who have only had one.

In June 2018 – June 2020[25], as shown Figure 15, at ages 45-49, the first target of 75% was achieved for non-Māori non-Pasifika (78%), but not for Māori (71%) or for Pasifika (70%). The target of 85% after a second or a further screen was almost achieved for non-Māori non-Pasifika (85%), but not for Māori (81%) or for Pasifika (81%).

At ages 50-67, rescreening after the first screen was lower and below target in nMnP women (65%), and in Māori (56%) and Pasifika (56%). Women who have their first screen after age 50 may differ from others. After a second or further screen, it was on target in nMnP women (85%), but not in Māori (82%) or Pasifika (81%).

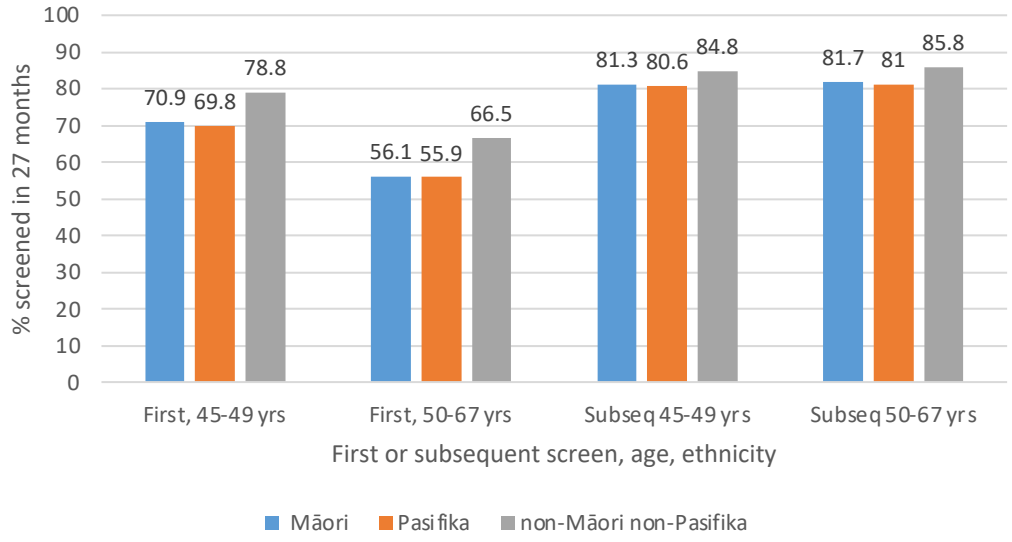

Figure 15. Rescreening: percentage of women getting the next screen within 20 to 27 months.

By first or subsequent screen, age group, and ethnicity, BSA data, 2018-2020 [25].

Reasons for not rescreening

In the Otago-Southland pilot programme, 81 women who had attended a first screen and had received an invitation for rescreening but had declined, were interviewed[43]. The main reason given was that the previous mammography had been painful (46%). Other factors were illness in themselves or their spouse, practical difficulties in arranging time, and in a few women, negative experiences with staff in the first mammography, the belief that rescreening was unnecessary because the first mammography have been normal, or because the women used self-examination. The response rate in this survey was approximately 83%.

In a systematic review of 20 studies assessing the influence of mammography pain on further participation in breast cancer screening[44], 25 to 46% of women not re-attending gave pain as a reason.

Comments: achieving high rescreening rates

The current programme is almost achieving the pre-set performance targets in the three major groups. However ideally, nearly all women who have been screened once should be rescreening regularly.

Achieving high rescreening rates would seem to be easier than increasing initial screening rates, as women who have been screened once have already accepted the programme, identified themselves to the programme, and their identification and address data is reasonably current.

Could the current system be improved? For example, could community leaders be involved (such as marae and churches)? Could women who attend the screening be asked not only for their own identification details, but to give permission for their information to be shared with such community leaders for this purpose?

Have there been research projects to explore the reasons for non-continuation in the programme? This would seem fairly easy to do, as the identities of women who have had one or more screens but not the next appropriate screen are known to the programme. In principle possible reasons for not continuing with screening would include: medical issues which would make further screening inappropriate, such as breast cancer occurrence or other severe disease (are women with interval cancers notified to the programme, and removed from routine rescreening?); choice of a private or alternative programme; the woman's perception of the importance of screening to her (this may have decreased since the previous screen); barriers to a further screen, such as personal costs, inconvenience of an appointment; and a bad experience at the previous screen, such as pain, discomfort or embarrassment, or bad interactions with staff. Several of these factors can be potentially changed, so it would be important to know if they have effects on subsequent screening. Studies on innovative programmes to increase programme retention are relevant.

9. EFFECTS OF COVID AND SERVICE DISRUPTIONS; PRIORITISATION

Effects of Covid disruptions

In Aotearoa, there was a national lockdown due to Covid-19 in March to April 2020, during which time cancer registrations were reduced, and endoscopies and radiotherapy services reduced[45]. However, services rapidly resumed and the impact on cancer care has been largely mitigated[45]. The Covid pandemic does not appear to have increased inequities in cancer diagnosis or treatment for Māori[46] in general, although for lung cancer there was a reduction in cancer registrations and in bronchoscopies in Māori, but no shift in stage distribution[47].

Effects on participation in BSA

Coverage in the BSA programme exceeded 70% in Pasifika and in 'non-Māori non-Pasifika' women in the two-year period ending at the end of 2020 (Figure 16). Then it fell sharply reaching minimum levels in the two-year period ending at the end of 2022.

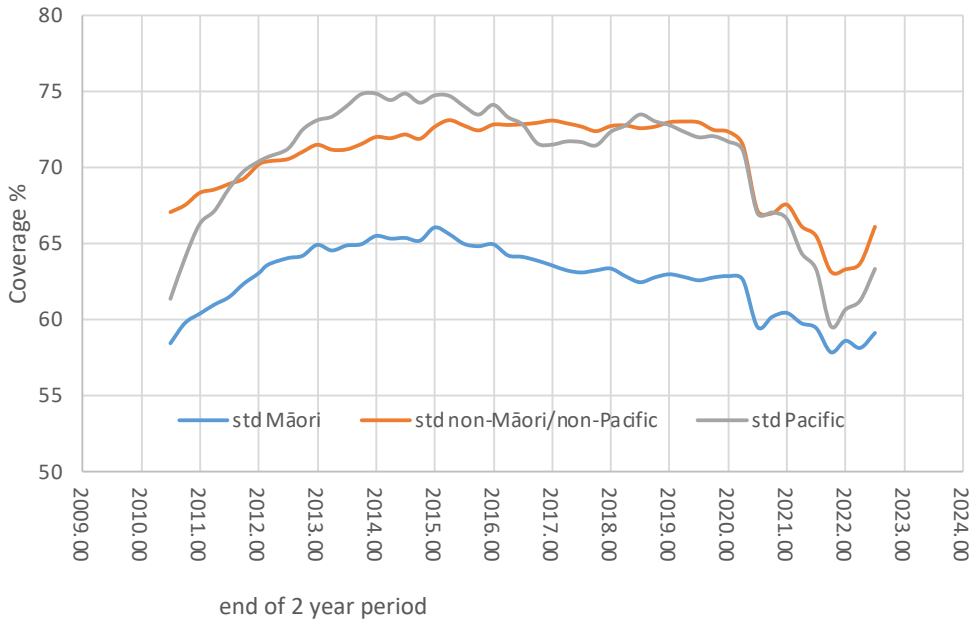

Figure 16. Coverage (screened in last two years), BSA programme, age 45 to 69, 2010 to 2022.

Further analysis has been done on the data for two-year periods up to the date shown on the axis Figure 17 from https://minhealthnz.shinyapps.io/nsu-bsa-coverage-dhb/ accessed Aug 20, 2022. For comparison, the Ministry website used a baseline of Feb 2020 to assess later falls by quarter. The fall was greater in Pasifika (max 11.8%) and in non-Māori non-Pasifika (8%) women than in wāhine Māori (5%).

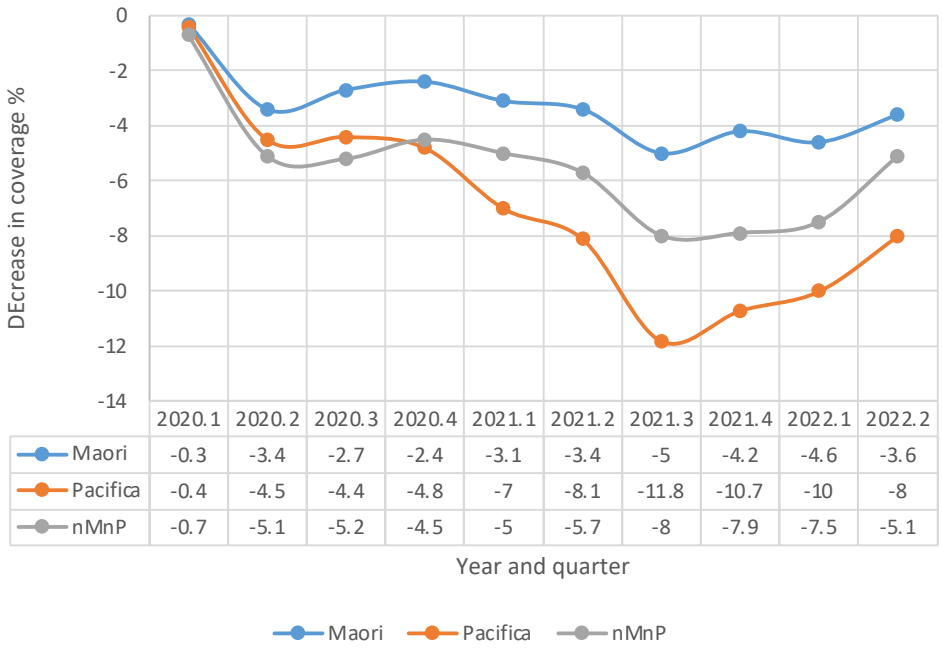

Figure 17. Decrease in coverage in BSA in Covid period.

From https://minhealthnz.shinyapps.io/nsu-bsa-coverage-dhb/ *accessed Aug 20, 2022.*

The effects, as proportional declines, were similar at all ages. Figure 18 shows the data for wāhine Māori; patterns were generally similar in other ethnic groups. This shows the Covid experience, but also a substantial drop in coverage in younger wāhine since 2015, which should be examined further.

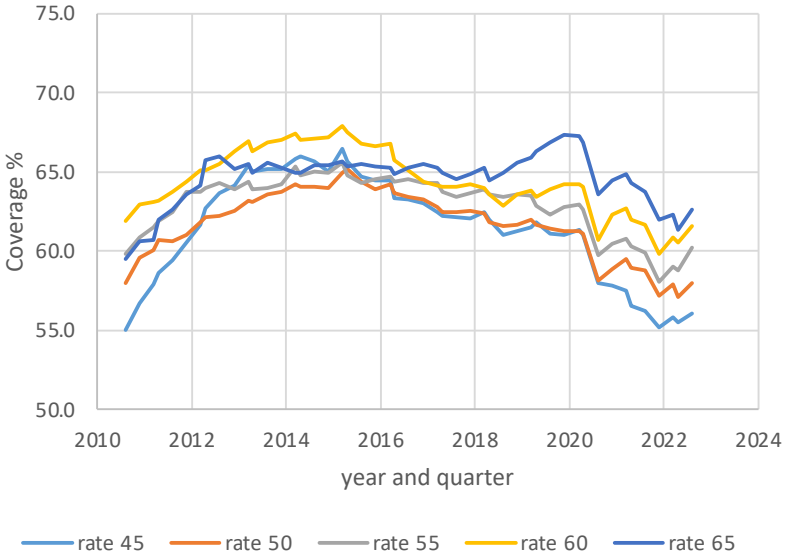

Figure 18. Wāhine Māori: trends in coverage from 2011 to 2022 by age group.

Age ranges 45-49, etc. Data is for two-year periods up to the date shown on the axis, BSA programme, by age.
From https://minhealthnz.shinyapps.io/nsu-bsa-coverage-dhb/ *accessed Aug 20, 2022.*

International studies

The Covid epidemic has had major effects on all health services, including both breast screening and breast cancer treatment. Studies of its impact are being produced frequently. A 2021 review documents the effects of the Covid epidemic on breast cancer screening programmes in nine countries, including Australia but not Aotearoa[48]. The paper presents estimates of excess breast cancer mortality in Scotland, based on modelling, for service disruptions of different lengths. They estimate a 3 – month delay would result in stage shifts and a 6% increase in the mortality of cases diagnosed in that year over the next five years, and a 6-month delay in 22% excess deaths; of the excess deaths, about 68% would be in clinically detected cases and 32% in screen detected cases. Results are similar to another UK analysis[48].

Prioritisation for mammography

Prioritising women for screening within the service restrictions caused by Covid is a difficult issue.

In the Ontario, Canada programme service restrictions produced a considerable backlog of mammographic screening. When services resumed, a prioritisation framework was introduced for mammographic examinations[49]. The Ontario system provides both screening examinations and diagnostic mammograms following abnormal screening results, so the priorities set were:

1. diagnostic assessments;
2. screening for high-risk women, defined as those having a genetic mutation, or a family history and an estimated lifetime risk of at least 25%, or previous radiation therapy to the chest, these being criteria already in place to define women categorised as high risk.
3. screening for average risk women, and within this category priorities were set as: A. Initial screens, B. annual or one year rescreening as applying to women with a family history or previous benign breast disease making them eligible for annual mammography; and C, all other screens, looked on the basis of the length of screening delay. Table 7 shows the prioritisation framework used.

PRIORITY	SERVICE	DESCRIPTION
I	Breast assessments	OBSP diagnostic mammograms should be triaged based on site capacity, in the following order: a. Abnormal screening results, BI-RADS 4 and 5 b. Abnormal screening results, BI-RADS 0 c. Short-term follow-up, BI-RADS 3*
II	High Risk OBSP	High Risk OBSP screening mammograms
III	OBSP (average risk)	Where capacity challenges exist, screening mammograms should be booked in the following order: a. Initial screens b. Annual† or 1-year rescreens‡ c. All other screens, booked on the basis of length of screening delay, wherever possible

Note: Reproduced with permission from Ontario Health.
BI-RADS = Breast Imaging-Reporting and Data System, OBSP = Ontario Breast Screening Program.

* The management of BI-RADS 3 follow-up cases, and prioritization within this framework, is at the discretion of the reporting radiologist.

† Annual (ongoing) screening recall recommendation due to family history of breast and/or ovarian cancer or a history of high-risk pathology lesions.

‡ One-year (temporary) screening recall recommendation due to high breast density ≥ 75% or as recommended by the reporting radiologist.

Table 7. Prioritisation framework used to deal with backlog of mammography following the Covid epidemic in Ontario, Canada.

Data from[49].

The Ontario study[49] showed that using the prioritisation system resulted in a more rapid decrease in backlog examinations for high-risk women, with the resulting shift towards higher risk women and an increase in cancer detection rates.

In the US, a prediction model for the risk of advanced breast cancer in women undergoing mammography screening developed from an extensive database shows the numerous factors involved[50]. The prediction model includes age, race and ethnicity, body mass index, breast density, family history of breast cancer, prior breast biopsy, menopausal status and screening interval. It was shown to classify women into groups of high, intermediate, and low to average risk with good validity. But such detailed data is not available in routine screening programs.

Comment

The effects of the service restrictions due to Covid on cancer services in general in Aotearoa seems to have had only a short effect, with services coming back to pre-Covid levels quite quickly. But substantial backlogs of major services including breast cancer screening would have resulted. The effects of continuing restrictions due to Covid are not documented yet.

Breast cancer screening providers have made efforts to resume normal services and clear the backlog as soon as possible, and the data on numbers of screens performed shows that levels are returning towards pre-Covid levels, as shown elsewhere in this report. No generally accepted prioritisation schemes have been used in this process. The Ontario scheme described above has been possible because the Ontario screening programmes already defined higher risk women on the basis of genetic conditions, family history, estimated risk and past radiation therapy. Aotearoa screening providers will not normally have that information available. The Ontario prioritisation scheme does not consider age.

The Ontario programme prioritises initial screens, with all other screens having a lower priority but based on the length of screening delay, that is, prioritising women whose previous screen was the longest time ago.

One logical approach to the prioritisation of screening within eligible women would be to use factors related to the positivity rate of screening. The positivity rate shows the frequency of detection of a preclinical cancer in an asymptomatic woman. We know that the positivity rate is higher for initial screens than for subsequent screens, increases with age, and it is likely to be higher in Māori and Pasifika than another groups. It will increase with the length of time since the previous negative screen. Thus, from information on age, ethnicity, number of previous screens, and intervals from last negative screen, the likelihood of a positive screen at the next screening could be estimated, and this could be used as an indicator for prioritisation. Developing such a predictive model could be relatively straightforward if the information from the screening programme is available.

Further refinements could be considered. The calculations could be based on invasive cancers only, or on advanced cancers only, on the logic that the highest priority women are not those who have the highest chance of having any breast cancer, but the highest chance of having potentially fatal disease.

10. DETECTION RATES, SENSITIVITY AND INTERVAL CANCERS

The objective of screening is to identify cancers present in the women who are screened but which have not produced signs or symptoms and thus have not been diagnosed by normal clinical methods.

Detection rates

The detection rates are higher in first than in later screens, and higher for older women. Figure 19 shows BSA data for the 2 year period July 2018 to June 2020.

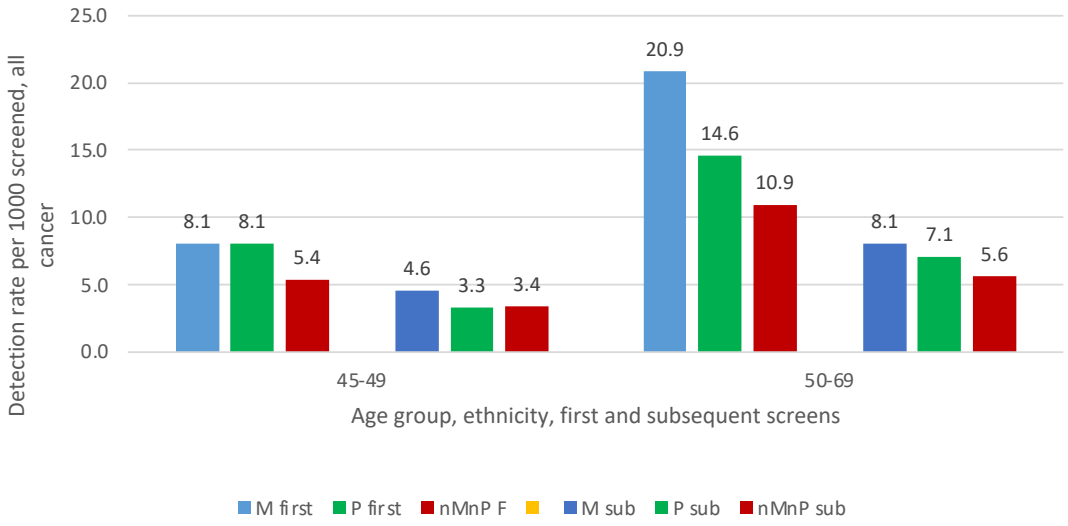

Figure 19. Detection rates of all cancer (invasive + DCIS) per 1000 screened in BSA, 2018-2020, by age group, ethnicity, and first or subsequent screens.

Data from[25, Table 18.]

These data show higher detection rates in Māori and Pasifika in almost all categories. However, the numbers of cases are small and these figures are imprecise: for example, the high detection rate of 20.9 in Māori, age 50-69, and first screens, is based on 37 cases and has 95% confidence limits of 15.8 to 28.0. It is not significantly greater than the rate in Pasifika, but is significantly higher than the rate in non-Māori non-Pasifika.

In situ cancers (DCIS)

A proportion of the cancers detected are in situ cancers, mainly ductal carcinoma in situ (DCIS). This proportion is much higher in screen detected cancers than in clinically detected cancers, as shown in data from the four clinical registries, Figure 20.

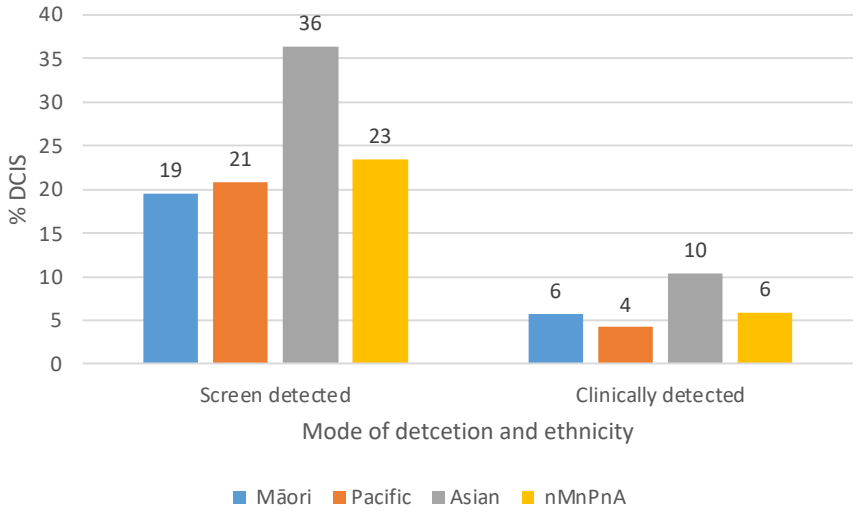

Figure 20. Proportion of in situ cancer by method of detection, 4 clinical registries.

Data from [17, p. 168].

Interval cancers

Interval cancers are defined as cancers in a woman who has had a negative screening examination, which are diagnosed in the interval prior to her next screening.

Some of these may not have been of a detectable size at the previous screening, and further review of the previous mammogram will confirm that it showed no abnormality. Thus 'interval cancers' are not necessarily 'missed cancers'.

In some cases, probably very few, review of the previous mammograms will show an abnormality which should have been detected at that time and appropriate assessment undertaken; this is a missed case. For this conclusion to be reached, it is important that the review of previous mammograms uses the same process as is used generally in the screening programme: one way to assure this is to review previous mammograms by including them, without special identification, within a large number of routine mammograms being routinely assessed.

There will also be value in reviewing prior mammograms of women with interval cancers with more detailed means than would be used in routine screening assessment. Such assessments done as a research project may indicate findings which could be considered in future routine assessments of mammograms.

Interval cancers and sensitivity within BSA

Sensitivity of screening is defined as the number of cancers detected at screening divided by the number of cancers present. But this cannot be directly measured. An observable, although approximate, estimate of screening sensitivity is therefore the number of cancers detected on screening divided by the sum of this number and the number of interval cancers diagnosed before the next screen.

The protocol for ascertaining and reporting interval cancers in BSA was published in 2006[51].

The most recent analysis for BSA is for women screened from 2008 to 2009[52]. From linkage between the BSA programme and the national cancer Registry, interval cancers were identified.

	WOMEN SCREENED	DETECTED AT SCREENING	0-12 MONTHS	12-24 MONTHS	0-24 MONTHS
			(NUMBER)	(NUMBER)	(NUMBER)
Initial and later screens	417108	1757	245	441	686
Rates per 10,000		42.1	5.9	10.6	16.4
Target			<=7.1	<=15.1	
Sensitivity %			87.8	79.9	71.9

Table 8. Interval cancers and sensitivity, BSA, 2008-2009

The report[52] gives more detailed results, separating first and subsequent screens, and gives data by age, ethnicity, and screen provider. Table 8 shows the overall data. During screening in 2008 to 2009, the detection rate of cancers at screening was 42.1 per 10,000 women screened. For women with a negative screening test, the incidence rate in the first year after screening was 5.9 per 10,000, in the second year was 10.6, and in total for the two-year period before the next scheduled screen was 16.4 per 10,000.

If we assume all cancers coming to diagnosis in the two years after a normal screen were present at the time of that screen, the programme sensitivity is 42.1 /58.5, or 71.9%. However, that assumption may not be true; some cancers coming to diagnosis in the two years following screening may not have been observable at the time of the screening, so the 71.9% may be a minimum estimate. The interval cancer rates are substantially below (that is, better than) the targets set of 7.1 per 10,000 in the first year and 15.1 in the second year, and are similar to results from the UK, and lower than results for similar years from Australia[52].

The overall data for the two years 2008-09 shows a similar interval cancer rate in Māori (16.2 per 10,000 screened) and in nMnP (16.9 per 10,000), and because the detection rate at screening is higher is Māori, the sensitivity is higher (82% compared to 70%) (Table 9).

	MĀORI	NMNP
All screens	35221	367043
Screen detected cancers	259	1428
Interval cancers, 0-12 mo	17	225
Interval cancers, 12-24 mo	40	395
Interval cancers, 0-24 mo	57	620
Screen detected rate/10000	73.5	38.9
Interval rate 0-24 months/10000	16.2	16.9
2 year sensitivity %	82.0	69.7

Table 9. Interval cancers, 2008-09, in Māori and in non-Māori non-Pasifika.

Data from[52].

There were only 9 interval cancers recorded in Pasifika, so their rates are too imprecise to assess. Digital mammography was introduced in February 2006 and the use of digital methods was complete by 2013[11]. Thus for 2008 to 2009, both film and digital mammography would have been in use. It would be useful to have a more recent review of interval cancers.

Proportion of cancers detected by screening

The data from the four clinical registries shows that the proportion of cancers detected by screening has been about 45% since 2009 (Figure 21).

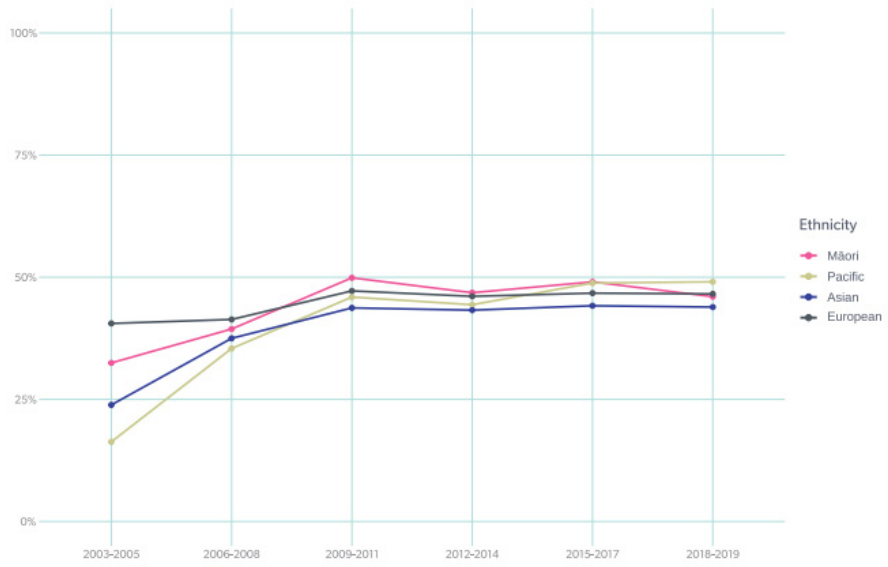

Figure 21. Proportion of invasive cancers that were screen detected, 4 clinical registries.

Data from [17, p. 75.]

Comment

Interval cancers can be identified as they occur. When a woman is assessed and diagnosed as having a new breast cancer which has presented clinically, her screening records and mammograms should be available to the team treating her. That way, the cancer can be immediately labelled as an interval cancer if her last mammographic report was negative. Interval cancers can be classified into true intervals, minimal signs, occult cancers, and false negative cancers [53;54]. A false negative cancer is defined as where the previous mammogram shows that 'an abnormality is clearly visible and warrants assessment'. Mullooly et al.[53] did a systematic review of publications up to 2019 and identified 46 publications describing assessments of interval cancers; 37 reports were from Europe, two from Australia, but none from Aotearoa. They showed that the methods used in reviews of mammograms were highly variable, as were the results: the proportion of false negative cancers ranged from 4 to 40%. They present a useful discussion of open disclosure and duty of candour principles. An earlier systematic review of the frequency of interval cancers summarised 24 studies, but none from Australia or Aotearoa [55]. Assessing interval cancers by review of previous mammograms is presumably done in most clinical services, but information on this is not recorded in BSA records or in the clinical cancer registries.

The data for interval cancers in BSA shows that with the two-year programme the sensitivity is 72%. Thus, if all women participated in the programme, the proportion of cancers which would be screen detected would be 72%, and if a random 70% participated the proportion screen detected in the population would be about 50%. The data also show that for each 100 cancers detected at screening, there are 39 interval cancers.

Thus, it can be estimated that of all invasive cancers in women in the screening eligible age groups, about 45% are detected on screening, 18% are interval cancers in women who have been screened, and the remaining 37% are in women not participating in the programme, so may be ineligible for screening. That would suggest that efforts to include women currently not participating in the programme could have a considerable effect. However, these approximate calculations depend on combining data on interval cancers from the BSA from only two years in the past with data from the four clinical registries, which cover only major urban areas.

11. STAGE DISTRIBUTION AND SURVIVAL OF BREAST CANCER IN AOTEAROA

The most useful intermediate endpoint to assess the effects of screening is stage distribution. Stage is the extent of cancer at the time of diagnosis. Screening is expected to improve the stage distribution, consistent with an ultimate reduction in mortality.

The proportional stage distribution for the 4 clinical breast cancer registries, 2010-2016, is shown in Figure 22 for screen detected cancers at age 45-69.

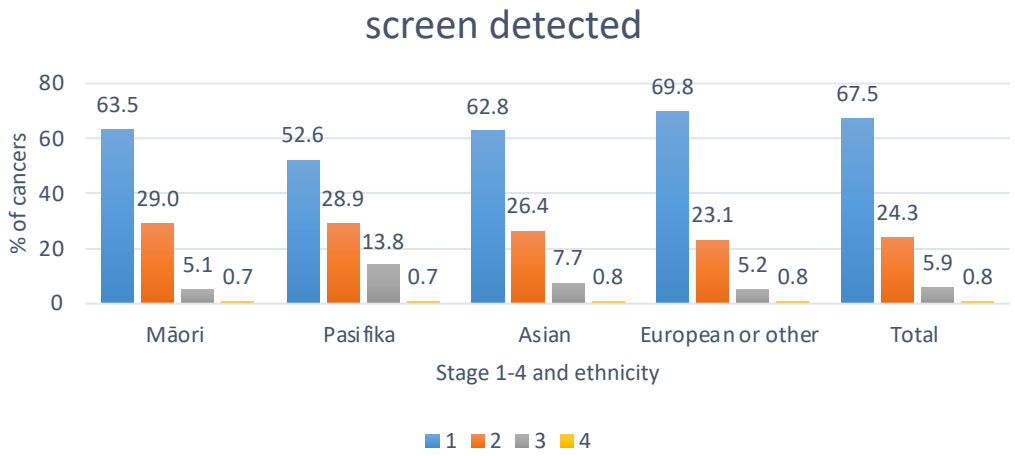

Figure 22. Stage distribution invasive breast cancers, age 45-69, 2010-16, screen detected.

Of all screen detected cancers (n=3136), 68% were stage 1 and 24% stage 2; these are often grouped as 'early' breast cancer and so together are 92%. 6% were stage 3, and less than 1% (36 cases) were stage 4. The stage distribution shows fewer stage 1 and more stage 2 in Māori than in the 'Other' group, and fewer stage 1 and more stage 2 and stage 3 in Pasifika.

The distribution in clinically detected cases in the same age group and years is very different, Figure 23. Of clinically detected cancers, only 32% were stage 1, and 41% stage 2, giving 73% as 'early' cancers. 10% were stage 3, and 6% (211 cases) were stage 4. The proportion of stage 1 cancers is highest in the 'Other' group, lower in Māori, and lowest in Pasifika; the proportion of stage 4 cancers is highest in Pasifika.

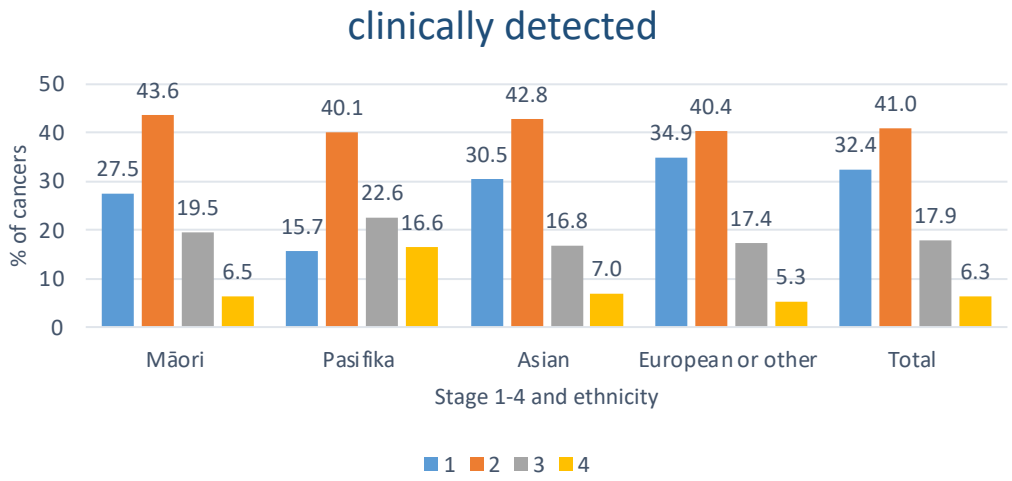

Figure 23. Stage distribution invasive breast cancers, age 45-69, 2010-16, clinically detected

Comment

These data are based on the four clinical registries. Staging was recorded for over 97% of invasive cancers, although the proportion of unknown stage was higher in Pasifika. However, the comparison variable is simply screen detected or clinically detected, as recorded on the hospital record. Thus, interval cancers in women involved in the screening programme are grouped as clinically detected. Further, screen detected does not necessarily mean detected by the BSA programme, but would include screen detected in private care or other ad hoc screening. What would be much more useful would be a comparison between women who have had screening the BSA programme and those who had not, so all cancers in screened women, both screen detected and interval cancers, could be compared to all cancers in unscreened women. This would require linkage between the screening records and the hospital records of breast cancer patients.

Any comparison between screen detected and clinically detected cancers, in the characteristics of cancers such as stage distribution and in the survival from the point of diagnosis, will be affected by lead-time bias. That is, as the time of diagnosis is moved forward, even if screening has no effect on survival (that is, the woman dies at the same time as if she had not been screened), survival time measured from the time of diagnosis will be increased. This is why the true effect of screening can only be assessed in randomised trials. Various adjustments for this lead-time can be made, but will always be approximations and will depend on the assumptions used. Similar effects are given by 'prevalence duration bias', meaning that cancers which are inherently slower growing are more likely to be detected on screening, as they spend more time in the size interval between being detectable on screening and being detected clinically.

Factors related to stage distribution, 2000 to 2013

Seneviratne et al.[56] studied stage distribution using the combined Auckland and Waikato clinical breast cancer registries for women diagnosed in 2000 to 2013 (12,390 women). Staging data were complete on all but 5 patients. In this whole period, 19.7% of women had advanced cancer, stage 3 (15.1%) or stage 4 (4.6%). The proportion with advanced cancer was 27.6% in those diagnosed clinically (which includes interval cancers and cancers in unscreened women), and only 7.3% in screen detected women. Clinically detected and screen detected women differ in many other characteristics, so multivariate analysis was used to assess these factors. Screen detection had the largest effect of any factor studied, with an adjusted odds ratio for non-screening of 3.8 (95% limits 3.3-4.3). Other factors associated with increased risks of advanced cancer were younger age, Pasifika (ratio 1.7) or Māori (ratio 1.3) ethnicity, and higher deprivation status (7+, ratio 1.3). There was no effect of urban/rural residence, or of region. Women of Asian ethnicity had a lower proportion of advanced cancers. The proportion of advanced cancers showed a small but non-significant decrease over time from 2000 to 2013.

The results of analysis specifically for stage 4, metastatic, cancers were generally similar, except that the proportion showed a small increase over time. The authors noted that this has also been observed in the US, and considered that differences in diagnostic and staging methods could contribute.

Ethnic disparities, stage distribution and screening, 2000-2014

Tin Tin et al.[57] also studied the combined Auckland and Waikato clinical breast cancer registries, for women diagnosed 2000 to 2014, 13,657 patients. They assessed ethnic disparities in breast cancer mortality, and the factors contributing to them. Late stage at diagnosis was the most important factor, and this in turn was influenced by screening.

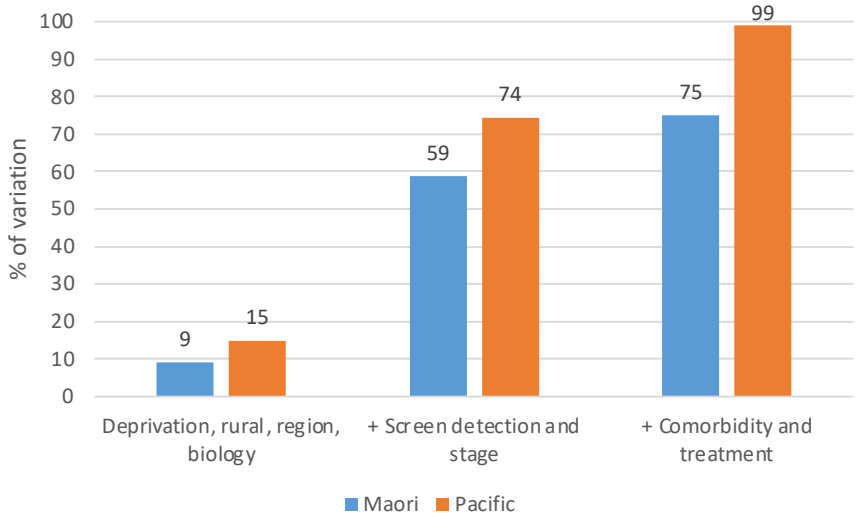

Figure 24. Cumulative proportion of ethnic differences in mortality in breast cancer patients explained by various factors.

Simplified diagram from data in[57].

For Māori patients, compared to non-Māori non-Pasifika patients, there was a 76% increased risk of breast cancer mortality, assessed as the hazard ratio. Deprivation status, rurality, region, and tumour factors (histology, receptors, grade) accounted for only 9% of this difference. Screen detection and stage distribution accounted for 50% of this difference, while the differences in treatment accounted for 16%. That leaves 25% of the difference between Māori and nMnP breast cancer patients unexplained.

For Pasifika patients, there was a larger, 97% increased risk of breast cancer mortality. Deprivation status, rurality, region, and tumour factors accounted for 15% of this difference, with screen detection and stage distribution contributing 59%, and treatment differences accounting for 25%. 99% of the difference in mortality is explained by these factors.

In this analysis the ethnic differences in stage distribution are only partially due to differences in screening, so substantial ethnic differences apply to the normal clinical diagnostic process, outside screening.

This study considers the complexity of the factors contributing to breast cancer mortality and their interactions, and illustrates this in a causal diagram, Figure 25:

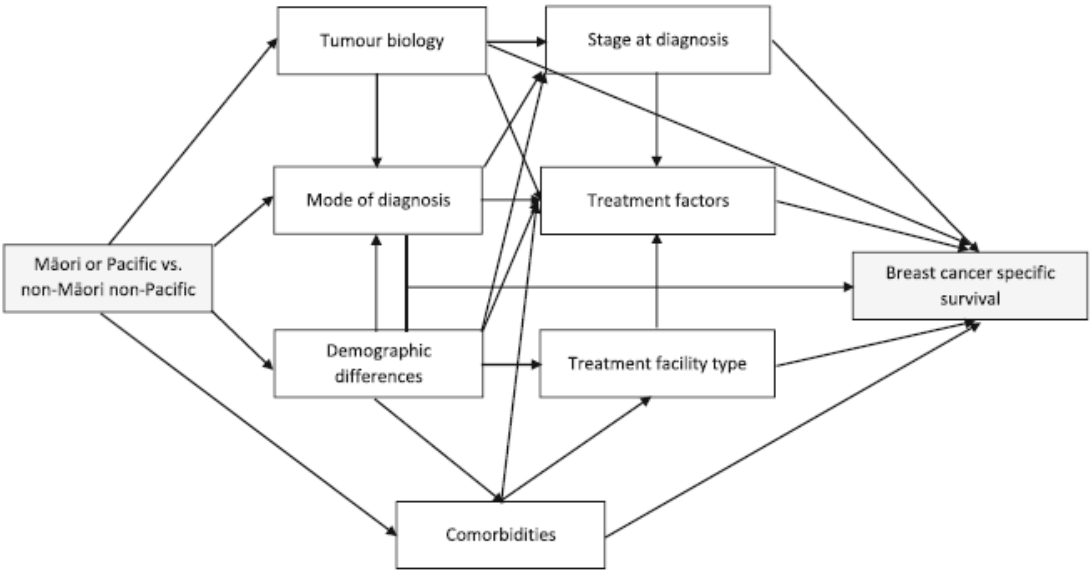

Figure 25. Conceptual diagram of major factors affecting breast cancer mortality.

From[57]

An earlier study based on the Waikato clinical Registry comparing Māori with NZ European women had similar findings, and specific assessment of possible breast cancer biological differences between the ethnic groups found no substantial effects[58].

Cancer survival in screen detected and non-screen detected breast cancer

Using again the combined Waikato and Auckland clinical breast cancer registries, for patients aged 45 to 69 diagnosed in 2005-2013, 5540 patients, Lawrenson et al.[59] compared women with screen detected cancers (57%) to those with non-screen detected cancers (43%); Figure 26. This showed major differences in survival for non-screen detected cancer, with five-year survival rates of 80% for Pasifika, 84% for Māori, and 91% for NZ European women. However, for screen detected cancers, there was no significant difference by ethnicity, with five-year survival rates of 94% for Pasifika, 97% for Māori and 98% for NZ European women. The authors note that the equity of outcomes by ethnicity for screen detected cancers may be related both to the earlier diagnoses produced by screening and also the management protocols of the BSA for screen detected cancers, while more variation in treatments is likely for non-screen detected cancers.

Similar results were found in an earlier study of Waikato patients [60;61].

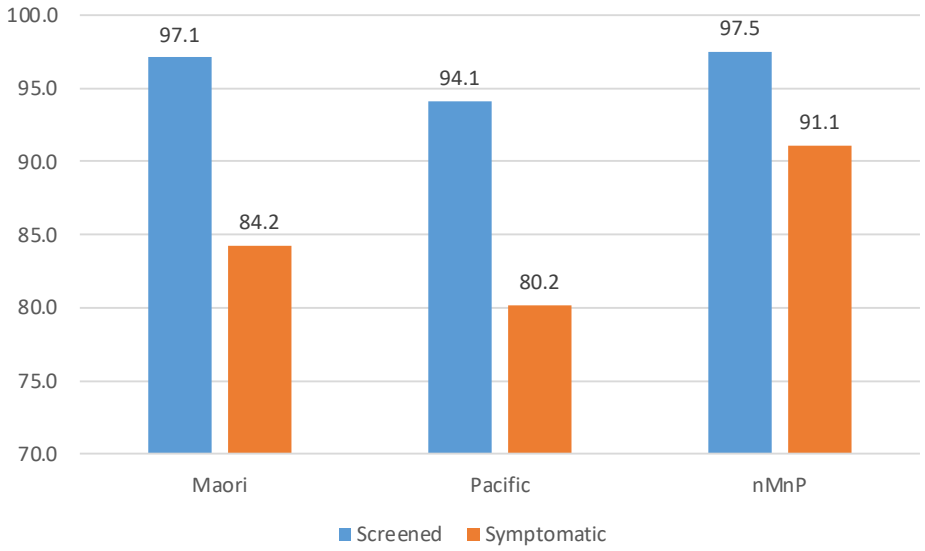

Figure 26. Five-year breast-cancer specific survival of women with stage 1-3 breast cancer, by mode of detection (screen or symptomatic) and ethnic group.

Women aged 45 to 69, diagnosed with invasive breast cancer between January 2005 and May 2013, in Auckland or Waikato (total number = 5540). Data from [59].

12. EFFECTS ON CANCER INCIDENCE FROM BREAST CANCER SCREENING, AND OVERDIAGNOSIS

The incidence of breast cancer can be considered both as the frequency in the population, expressed usually as the number of newly diagnosed cases per year in the population considered; and as the risk to an individual woman, which may be expressed as the cumulative risk over a certain number of years.

Factors affecting breast cancer incidence

The incidence of breast cancer in Aotearoa, as in most other developed countries, has likely increased over the last 50 or more years, but data from earlier years is not available.

The incidence is affected by the distribution of risk factors in the population; these factors include several which have changed over time:

- fertility patterns (women who have many children, and women who have a first child at a younger age have lower risks of breast cancer);
- overweight and obesity (obesity increases risk for post-menopausal women, but may decrease risk in pre-menopausal);
- menstrual patterns (women with the earlier menarche and later natural menopause have higher risks, probably due to intrinsic hormonal factors)
- hormone replacement therapy (some types may increase risk)
- alcohol consumption (increases risk, particularly consumption before first pregnancy)
- tobacco smoking (increases risk, also possible effect of passive exposure)
- reduced physical exercise (regular exercise may be protective)
- In addition, for many other factors there have been studies suggesting increases in risk, but the evidence is less firm.

Risk factors for breast cancer also include features which would not generally show great variations with time, such as family history: breast cancer risk is increased in women with a family history of the disease in first degree relatives, and in more complex genetic situations.

Other general demographic features may have their effects through variations in the factors listed above, but may also have other effects. This includes socio-economic factors (assessed in Aotearoa through deprivation status), and ethnic background. Wāhine Māori and Pasifika women have higher breast cancer incidence than the nMnP ('Other') group that is predominantly of European origin.

The observable incidence is the diagnosis of invasive breast cancer. In the absence of screening, this will occur when a cancer has progressed to being observable as a breast lump or has produced other signs or symptoms. More sensitive diagnostic methods are designed to diagnose cancer when it is smaller; thus, mammography works by detecting cancers which are too small to have caused a noticeable breast lump or to have caused other symptoms. So, changes in diagnostic methods over time, but also changes in pathological criteria for diagnosis, will affect recorded incidence, and over time would be expected to contribute to an increase in recorded incidence.

Effects of screening on incidence: over-diagnosis

When screening is introduced for the first time, it introduces a lower threshold for detection, so any woman who is harbouring a breast cancer which is too small for routine clinical detection, but large enough to be detected by screening, will be diagnosed. This will cause an immediate increase in the recorded incidence of breast cancer in the population, sometimes referred to as the 'prevalence bump'.

In the ideal situation, that increase in incidence will be temporary. If screening rates in the population are maintained, the effective diagnostic threshold in the population is now reduced, and the incidence rate of cancer growing to the new threshold should be the same as the incidence rate before screening, but with cancers detected when they are smaller. Similarly, there will be a shift in the age distribution as cancers will be detected at a younger age.

However, a major concern with screening programmes generally (not just for breast cancer) is that some of the small cancers detected by lower threshold given by screening, if left in place, would not further develop. They might not progress at all, might progress very slowly, or might regress. If that occurs, the recorded incidence rate in the presence of screening will not reduce to be equivalent to the incidence rate before screening, as the screen detected cancers will include a proportion of non-progressive tumours.

This is a very major problem, as if small tumours are detected through screening, they have to be treated as early cancers. A woman who has a small tumour detected by screening, which if left alone would not progress further, can then be severely harmed by the screening process. She is diagnosed as having cancer, and treated on that basis, with all the physical and emotional ill effects of the treatment. But for her, that treatment is unnecessary; without screening, she would remain unaware of the cellular lesion in her body. This phenomenon is known as 'overdiagnosis', and is a risk which must be considered with any screening programme, and indeed with any major diagnostic change for any disease.

Study of overdiagnosis in the BSA programme

Overdiagnosis has been carefully assessed in the BSA programme[62]. An analysis of breast cancer incidence rates by age from 1994 to 2014, and comparison to the screening programme, shows the effects. As shown in Figure 27, when the programme was introduced for ages 50 to 64 in 1999, incidence rates in this age group increased by 18%, but with continued screening in later years they fell again to being only 5% higher than the pre-screening rates, a non-significant difference. This suggests that the 18% increase was mainly due to the expected increase in the diagnosis of existing pre-clinical cancers, and the extent of overdiagnosis was small. For the age groups 45 to 49, and 65 to 69, diagnosis rates did not increase when the programme was introduced for the 50-to-64-year age group; but after it was extended to include these younger and older age groups, their rates increased by 21% and 18% respectively. We need more recent years' data to see if the incidence rates at age 45 to 49 and at age 65 to 69 decrease to their pre-screening levels, which should happen if there is no overdiagnosis. The rates for women at ages 70 to 74, who have never been included in the screening programme, are shown for comparison; there is a 5% decrease in the most recent years, which may be due to the earlier diagnosis of cancers at ages up to 69.

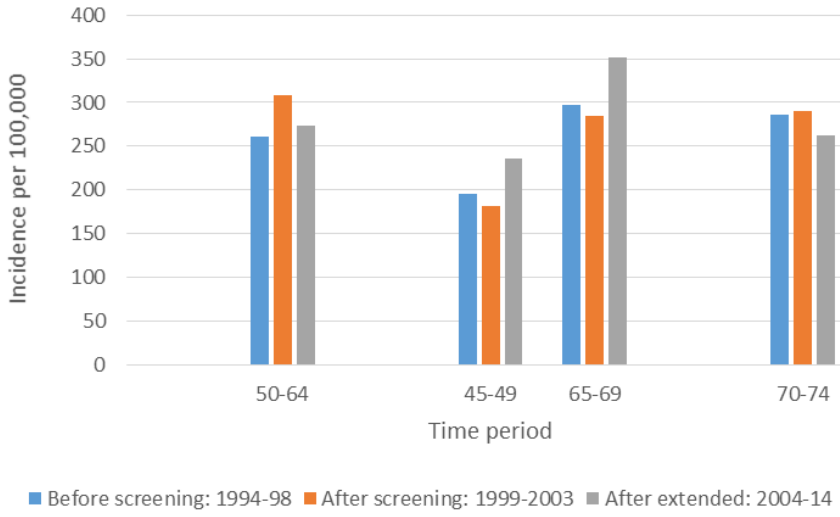

Figure 27. Incidence rates of breast cancer, all Aotearoa women, by time period in relation to screening programme, and by age.

Data from[62].

This careful study provides good evidence that overdiagnosis has not been a major problem in the BSA programme. Similar findings have been found in Spain and in Denmark. However, in some other breast cancer screening programmes overdiagnosis has been recognised as a substantial problem; these include New South Wales, Norway, Sweden, England, and the Netherlands. For example, a review of the United Kingdom screening programme in 2012 estimated overdiagnosis as accounting for 19% of screen detected cancers[63]. Indeed, a major conclusion from the Aotearoa assessment was "overdiagnosis is not inevitable in population mammography screening programmes". The reasons why the Aotearoa programme has avoided this serious problem while other major programmes have not done so, is not clear. One suggestion is that the medico-legal situation, with no fault insurance in Aotearoa, has protected against clinicians and pathologists loosening their diagnostic criteria from fear of legal consequences of misclassifying a cancer as a benign tumour[62].

International studies of overdiagnosis

In contrast to the Aotearoa findings, many studies in other countries have estimated a substantial proportion of overdiagnosis. In a systematic review for the European commission, Canelo-Ayber et al.[64] estimated overdiagnosis at 17% (95% confidence interval 15 to 20%) for screening at age 50 to 69, and at 23% (interval 18 to 27%) for screening at ages under 50. These authors note that estimating overdiagnosis is a complex issue based on many assumptions, and issues such as the clinical impact of DCIS and the probability of spontaneous regression in some cancers are important[65]. Other methodological problems and the influence of the background risk have been discussed[66].

Informing women about overdiagnosis

The issue of informing women considering screening, and the general public, about overdiagnosis is an important issue. Hersch et al.[67] used a randomised trial of 879 women who had not been screened recently to assess a decision aid with added information on overdiagnosis, finding it improved women's understanding, without affecting the women's subsequent participation in screening.

NSU information on overdiagnosis

The national screening unit (NSU) produced a position statement on the harms of breast cancer screening in 2014[68]. It briefly discusses overdiagnosis and DCIS. It cites results comparing numbers of cases of overdiagnosis to numbers of breast cancer deaths prevented by breast cancer screening, given as ten overdiagnosis to one death prevented from the 2013 Cochrane review[69], three overdiagnosis to one death prevented from the UK review[14], and one overdiagnosis for every two breast cancer deaths averted from the Euroscreen analysis[70].

13. RISK-BASED SCREENING

An alternative to the current BSA programme would be to stratify eligible women on the basis of their estimated risk of breast cancer, and provide different screening protocols for those categorised as being at increased risk, and perhaps also for those categorised as being at very low risk.

Assessment of risk

Risk assessment systems usually rely on family history or on breast density, or use multiple factors and a predictive model of how these together predict risk. The risk predicted may be short- or long-term incidence risk, mortality risk, or the risk of advanced breast cancer.

One of the major issues is that large-scale screening programmes do not normally collect the information required for a risk assessment, and to collect this information reliably is a substantial challenge.

An individual woman's risk of breast cancer can be assessed by a predictive model, and several of these are available. These are statistical models which use information on various risk factors to predict that individual's future risk of breast cancer and her current risk of harbouring an undetected cancer. The development and validation of these models is quite complex, and all models have limitations [71].

In a study, six models were assessed using data from a Melbourne cohort study, and two (BOADICEA and IBIS) found to be the best[72]. The BOADICEA (Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm) uses polygenetic risk scores, mammographic density, and many other factors[73], so it requires DNA analysis and is only suitable for women under personalised care.

The IBIS (International breast Cancer intervention study) model is also known as the Tyrer-Cuzick model[74] uses family history, reproductive history, hormone replacement therapy, history of benign breast disease, and later versions add mammographic density and genetic information.

The Gail model or Breast Cancer Risk Assessment Tool (BRCAT) score is an older model based on age, age at first menstrual period, age at first live birth, number of first-degree relatives with breast cancer, and number of previous breast biopsies with abnormal findings[75]. It is still a useful model, and requires only information given by the woman.

The BOADICEA, IBIS and Gail models, and one other, have been assessed in regard to the UK programme, and the additional value of breast density and DNA information assessed[76].

Risk-based screening in Australia

The Royal Australian College of General Practitioners recommends supplemental ultrasound or MRI for asymptomatic women with a risk of breast cancer three times above the population average, and the Australian government guidelines recommend annual MRI and mammography before age 50 for women with 30% or greater lifetime risk of breast cancer, and annual mammography for those with a 17 to 30% lifetime risk[77].

The breast screening programme in Victoria, Australia introduced a stratified system in 2017, stratifying women into average, moderately increased, and potentially high risk[78]. Women categorised as a moderately increased risk who have concerns, and all women with potentially high risk, are referred to the general practitioner for a further evaluation.

In an Australian 2022 review[77], it was noted that most Australian programmes offer annual mammography to women selected on the basis of history of benign breast disease, personal or family history of breast or ovarian cancer, or genetic factors known to increase breast cancer risk, but there was great variation between programmes. They note other factors of relevance include Indigenous status, socio-economic status, remoteness of residence, cultural and linguistic diversity, and use of hormone replacement therapy. Few of these factors are assessed within breast cancer screening programmes; hormone replacement therapy is recorded for screening participants in several states, and breast density is routinely assessed at the Western Australian programme. Information on high-risk genetic mutations is collected in some programmes. In the Western Australia programme, cancer detection rates and interval cancer rates were shown to be higher in women with some of these risk factors[79].

Options for more risk-based, personalised approaches to early detection of asymptomatic breast cancer in Australia are being explored in a Cancer Council Australia project[80]. The "Roadmap for Optimising Screening in Australia – Breast (ROSA)*" project began in 2018 (https://www.cancer.org.au/about-us/policy-and-advocacy/early-detection-policy/breast-cancer-screening/optimising-early-detection). The research team is assembling evidence, undertaking modelling evaluations and working with stakeholders to reach evidence-based consensus on optimal pathways for risk-based approaches to the early detection of breast cancer.

Other countries

Some Canadian screening services routinely record breast density and offer annual mammography for women with dense breasts; women receiving annual mammography had significantly lower rates of interval cancers than those with 2 yearly screening, 0.89 per 1000 compared to 1.45 per 1000[81].

The UK programme has reported national data on genetic factors conferring high risk, and the use of alternative or supplemental MRI screening for these women. Breast density and molecular DNA studies have been assessed in categorising risk[76]. A focus group study with health professionals about high-risk programmes raised issues about service constraints and workload, risk communication methods, and accentuation of inequity if risk stratification decreased screening uptake for underserved groups[82].

The European Collaborative on Personalized Early Detection and Prevention of Breast Cancer (ENVISION) brings together several international research consortia working on different aspects of the personalized early detection and prevention of breast cancer. In a consensus conference held in 2019, the members of this network identified research areas requiring development to enable evidence-based personalized interventions that might improve the benefits and reduce the harms of existing breast cancer screening and prevention programmes[83].

Low-risk women

The identification of women at low risk of breast cancer, who could be offered less intense cancer screening, has also been considered. In the UK, the opinions of women and of health professionals has been assessed[84,85], with both groups finding low risk stratification acceptable in principle but with issues of communication, informed choice, and logistics being raised.

In Western Australia, screening outcomes have been compared between women with no recorded risk factors and those with at least one, assessing women with a delayed subsequent screen (more than 27 months). Women with no risk factors but delayed screens had similar detection rates but a higher proportion of node positive cancers; the authors concluded that using a longer screening interval in low-risk women was not appropriate[86].

Comment

Despite the fact that all women in Aotearoa are eligible for the BSA standard programme, it is assumed that some women at higher risk, identified as such by themselves or by their GPs, will seek further investigation as an addition or alternative to BSA. District Health Authorities have investigation pathways for such women. However, there is no agreed national protocol for such high-risk pathways, no established criteria for the assessment of risk, and no monitoring or assessment at a national level, apart from any which may be done by the providers themselves.

If a stratified system is to be used, the methods used for assessment of risk need to be considered carefully, and their performance when applied to a large-scale programme needs to be assessed, looking at false positive and false negative assessments, and acceptability to women, including any impact on participation in the screening programme. The logistics and costs of applying such risk assessments need to be considered.

Then if risk assessment is used, the appropriate protocols for each category of women defined by the risk assessment need to be agreed, implemented, and monitored, and their effects assessed.

Breast density

Breast density relates to the amount of fibroglandular (non-fatty) tissue in the breast; denser breast tissue has more fibroglandular tissue. Breast density can be influenced by genetics, age, weight, hormonal treatments, ethnicity and physical activity[87].

Breast cancers can be masked by dense breast tissue, making them harder to diagnose on mammography. Women with increased breast density have a higher incidence of subsequent breast cancer.

BSA position

The BSA's position on breast density, Sept 2019[87], is:

> *"BSA has reviewed the evidence on breast density. For women with dense breasts who otherwise have an average risk of breast cancer, there is insufficient evidence to recommend additional imaging (such as ultrasound or MRI). The harms of extra imaging, such as causing anxiety, unnecessary needle biopsies, over-diagnosis and cost, are likely to outweigh the benefits. This is the reason breast density is not currently measured within the BSA programme, or many other population-based screening programmes such as the UK, Europe and Australia (excluding Western Australia)."*
>
> *"Women with dense breasts at an otherwise average risk of breast cancer can be managed within BSA by regular mammography every two years."*

The BSA programme also states that the risk of missing a cancer by this masking effect is less since the programme has become fully digital[87].

Position statement of RANZCR

The RANZCR (Royal Australian and Aotearoa College of Radiologists) is the professional body for radiologists in Australia and New Zealand. Their position statement in Nov 2018[88] concludes:

> *"It is important to note that in women who have dense breasts but no other risk factors for breast cancer, there is no evidence that the benefits of additional imaging tests outweigh the harms".*

Thus, their position supports that of BSA. However, they also state:

> *"Breast Density is an important but complex topic, best considered during a discussion between the woman and her GP/specialist as part of an individualised and holistic approach to her health."*
>
> *"The College reporting guidelines for mammography recommend that breast density be listed in the mammogram report. This does not apply to the BreastScreen programmes in Australia or New Zealand, where a formal report is not issued."*

Measurement of breast density

The RANZCR position statement notes:

"For clinical assessment, the radiologist viewing the mammogram estimates the percentage and distribution of white fibrous and glandular tissue present relative to the volume of the breast.

Breast density is categorised into four groups using the American College of Radiology Breast Imaging Reporting and Data System (BI-RADS):

a. The breasts are almost entirely fatty

b. There are scattered areas of fibroglandular density

c. The breasts are heterogeneously dense, which may obscure small masses

d. The breasts are extremely dense, which lowers the sensitivity of mammography

Researchers often group the two highest and the two lowest density groups together into "dense" and "non-dense" groups."

The statement notes that in Australia, dense breasts (categories c or d) are found in 66% of women below age 50, 41% aged 50 to 75, and 33% over age 75. The College states that the risk of developing breast cancer is increased by 1.2 to 2.1 times for a woman with dense breasts, compared to category b. This is a level of risk similar to having a first-degree relative diagnosed with breast cancer.

The College states that using a software programme that processes the raw information obtained when the mammogram is taken can give more consistent and reliable results, as it takes into account the volume of the breast and is not influenced by the different image processing used by manufacturers of mammography machines.

Breast density and breast cancer risk

Meta-analyses confirm an increased risk in association with increased breast density, with relative risks depending on the categories compared and the measure of density used; around 2 or 3 comparing high to average density groups[89;90].

A study from Singapore shows that women who have breast density assessed from a single mammography at age 50 to 64 have an increased risk of breast cancer over the next 10 years[91].

Breast density in Aotearoa women

Ellison-Loschmann et al.[92] reported on breast density assessed in 4,239 women who underwent routine mammography screening at the Waitakere and Takapuna fixed sites and the mobile units operating in Northland from December 2010 to June 2011. Breast density was assessed by the Volpara system, a computer algorithm. The paper reports on variations of density by age and ethnicity; it does not report on screening outcomes. The authors' main conclusion was that that wāhine Māori had higher breast density than non-Māori non-Pasifika.

The study reports on two measures of breast density, described as the 'volumetric absolute mammographic density', and the 'volumetric percent mammographic density', and presents results both for analysis by categories of density, and quantitative analysis using geometric means. The conclusion that breast density is higher in Māori is based on the geometric mean for absolute mammographic density being significantly higher in Māori. This effect was mainly in women over 50, with women under 50 showing only a smaller and non-significant difference. There was no excess in Māori in percent mammographic density.

The categorised analysis is perhaps more relevant, as if density were used in screening, it would be used with women with density above a certain cut-off receiving a different screening programme. The results for women in the top quintile of absolute density are shown in Figure 28. This shows no difference in women under age 50, except in lower proportion in Asian women. For women over 50, the proportion in the top quintile is 21% in Māori, 15% in Pasifika and in NZ European, and 10% in Asian women.

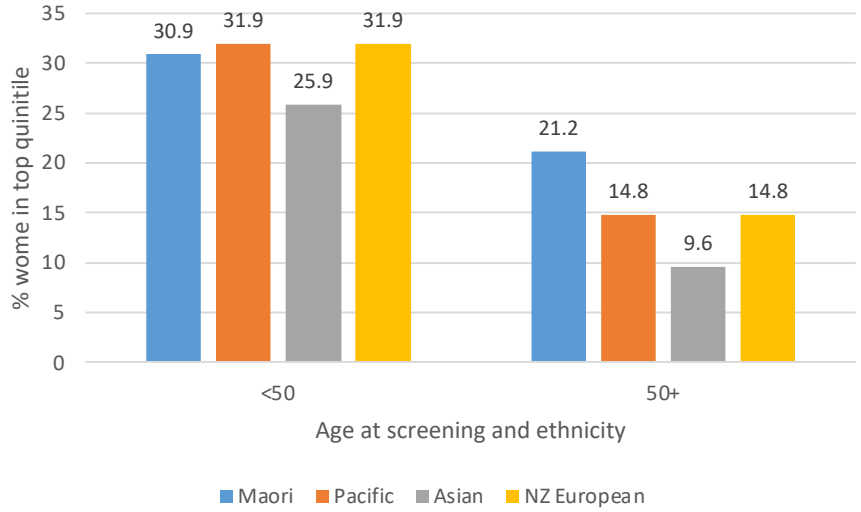

Figure 28. Proportions of women in the top quintile of absolute mammographic density.

Data from[92].

Effects of notification of breast density

Pirikahu et al.[93] assessed rescreening rates within the Western Australia screening programme from 2008 to 2017, using the radiologist's assessment of density, considering categories c and d in the BR-RADS criteria as "dense'. Women in the targeted age groups (50-69, increasing to 50-74 in 2013) informed of having dense breasts showed a small increase in rescreening after the first screen (58% compared to 56%), but no significant increases after the second or subsequent screens. In women under age 50, those with dense breasts showed a small but significant decrease in rescreening, after first or subsequent screens. In women over the targeted age there were no differences.

A decrease in rescreening in the programme may be due to women selecting other modes of screening. In the Western Australia programme, women with dense breasts are informed of that fact and recommended to consult your doctor. About 50% of notified women consulted their doctor, and of those about 50% were referred for a further imaging, and about 20% had ultrasound[94].

If breast density is measured, the issue of how best to communicate that information with the patient is also complex. In the Western Australia screening programme, of women notified of having dense breasts after screening, 66% felt more informed, but 21% were anxious, and 33% confused[95]. Intention for rescreening was slightly decreased (91% compared to 93% in women without dense breasts), but was increased in those who also reported anxiety.

A randomised trial in Australia tested the effect, on normal volunteer subjects, of hypothetical mammogram reports including or not including breast density information, showing that women receiving breast density information are more likely to seek supplementary screening and more likely to be anxious, confused, or worried about breast cancer[96].

A related issue is how information on breast density should be given to the general public and to women enquiring about breast cancer screening. In Australia, the ethical and legal issues have been considered [97], as have the views of women[98] and general practitioners[99;100].

An international systematic review of the impacts of breast density information identified 29 studies and highlighted the limited information in the community about breast density, and the lack of evidence about best practices for communication about breast density[101]. Another international systematic review assessed online information on breast density from 42 websites in five English speaking countries, concluding that the information varied greatly and was not generally presented in an understandable way[102].

In the United States, legislation has required that breast density assessed in mammographic screening should be notified to the patient. A systematic review of 14 studies assessing the effects showed that notification led to an increased use of supplemental screening, although the extent of the increase varied greatly between different studies[103]. The increased utilisation was greater if notification included a follow-up telephone call informing women about additional screening benefits, and if the state's law mandated insurance cover for supplemental screening. In some studies, there were reported increases in biopsy rates and cancer detection rates after the implementation of the legislation.

Supplemental screening for women with dense breasts

Considerable attention has been given to whether different screening methods, such as digital breast tomosynthesis, ultrasound, or MRI should be used instead of or as well as digital mammography for screening women with dense breasts. A consensus view illustrated by the two position statements reviewed above is that such methods may increase detection rates and reduce interval cancer rates, but also increase referral and false positive rates, and a favourable overall effect has not been demonstrated.

Comment

In women with dense breasts, mammograms are more difficult to interpret and there is the risk of the density appearances masking a cancer. The RANZCR states that the addition of ultrasound to mammography increases cancer detection rates for women with dense breasts, citing a systematic review published in 2018[104]. However, they also conclude that ultrasound and other supplementary imaging may cause higher false positive results, and their recommendation is that there is no evidence that the benefits of additional imaging tests outweigh the harms. The policy of the BSA is consistent with this. On this basis, there is no justification for using supplementary methods in addition to routine mammography in screening, even for women with dense breasts.

There is good evidence from research studies that in women with greater breast density the risk of subsequent breast cancer is increased. This raises the question of whether women with high breast density identified at the first mammographic screening should have a different programme of subsequent screening, such as more frequent mammography, or supplemental methods.

If breast density information in routine screening is to be used to influence subsequent screening, the method of measuring breast density and its recording become critical. Ideally there should be standardised protocol applied throughout the screening programme. Breast density can be assessed by the radiologist using criteria such as the BI-RADS system noted above, and this may be assisted by computer or artificial intelligence systems. Many studies of consistency between radiologists have found substantial inter-observer variation.

Breast density can also be assessed and recorded by a computerised system, such as the Volpara system used in 2010-11 in a research study in northern Aotearoa[92], and in many developments since. The use of an automated system has clear attractiveness in terms of consistency in a large screening programme, and linkage between assessment and recording.

So, if breast density were to be used, a full review of the methods available for reducing routine screening, including issues of staff time and costs, would be needed.

If breast density is recorded, how that information should be given to the screened woman is important. Both detrimental and positive effects of giving information can be envisaged; the information might increase anxiety and concern, but might also increase participation in further screening. How the information should be given to the general public, for example in publicity about screening, is also an important issue. Women in different ethnic and social groups may have different needs.

Preliminary studies suggest that women and primary care practitioners support having more information on breast density. Breast density is often recorded, and presumably communicated to the patient, in clinical practice outside the screening programmes. Several screening programmes around the world are incorporating breast density information, and others are considering it.

Breast density may be somewhat higher in wāhine Māori, although this is based on one study several years ago and the effect applies only to women over age 50[92].

If risk assessment uses several risk factors, an important issue is whether models have to be developed within each country, or whether models can be applied from one population to another. For example, several U.S. predictive models incorporate factors for ethnicity on US criteria, but no published models have been developed in Aotearoa to take account of the Aotearoa ethnic categories. In Aotearoa a model to predict the outcome of breast cancer in breast cancer patients after diagnosis has been developed using Aotearoa data, and shown to be as valid as similar British models[105], but an accepted Aotearoa model for the risk of incident breast cancer has not been developed.

In summary, a comprehensive assessment of breast density assessment and its potential value in the screening programme should be considered.

14. SCOPE AND METHODS FOR THIS EPIDEMIOLOGICAL REVIEW, LIMITATIONS AND ACKNOWLEDGEMENTS

This epidemiological review has been prepared by Prof. Mark Elwood on request from the Review Group for the Quality improvement review of clinical safety and quality for BreastScreen Aotearoa, and has had extensive discussion and input from the review group.

It is designed to cover epidemiological aspects of breast cancer and breast cancer screening which are relevant to the review group. The opinions expressed beyond those referenced to other work are those of the author, and are not necessarily the consensus opinions of the review group.

The scope of the review has been determined by issues raised in the review group. This review aims to cover the basic epidemiology of breast cancer and key issues in breast cancer screening in Aotearoa, with reference to selected published work from other countries, emphasising major systematic reviews.

It is not intended to be a comprehensive review of the literature. The sources used have been identified through review of major reports of breast cancer screening in Aotearoa and in other countries, and searches of literature in PubMed in recent years, up to July 2022. A comprehensive systematic review would be preferable but would require more time.

As well as members of the review group, valuable input has been given by others including Karen Bartholomew, Jason Gurney, Chris Lewis, Kay Sowerby, and Madeline Wall.

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