Abt Global

**Final Report:**

# Evidence Synthesis and Review

## BreastScreen Australia, Department of Health and Aged Care

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**Submitted to:**
Alison Lang
Director,
Screening Policy and BreastScreen Section
Department of Health and Aged Care
Australia

**Submitted by:**
Dr Sanjoti Parekh
Abt Global
Phone: +61 7 3891 4136
Email: Sanjoti.parekh@abtglobal.com


*Abt acknowledges the Australian Aboriginal and Torres Strait Islander peoples as the first inhabitants of the nation and the traditional custodians of the lands where we live, learn and work*


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BOLD
THINKERS
DRIVING
REAL-WORLD
IMPACT
We proudly share our RAP artwork produced by artist Stephen Hogarth

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# Acronyms and Abbreviations

| | |
|---|---|
| ABUS | Automated breast ultrasound |
| AI | Artificial intelligence |
| AIHW | Australian Institute of Health and Welfare |
| ASR | Age standardised rate |
| BIRADS | Breast Imaging Reporting and Data System |
| BS | BreastScreen |
| BSA | BreastScreen Australia |
| CALD | Culturally and linguistically diverse |
| CEM | Contrast enhanced mammography |
| DBT | Digital breast tomosynthesis |
| DHAC or 'the Department' | Department of Health and Aged Care |
| EAG | Expert Advisory Group |
| EUSOBI | European Society of Breast Imaging |
| FFDM/DM | Full-field digital mammography |
| HHUS | Handheld ultrasound |
| IBC | Invasive breast cancer |
| MBI | Molecular breast imaging |
| MRI | Magnetic resonance imaging |
| MSU | Mobile screening unit |
| NESB | Non-English-speaking background |
| OECD | Organisation for Economic Co-operation and Development |
| PICO | Population, Intervention, Control, Outcomes |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| RCT | Randomised controlled trial |
| ROSA | Roadmap for Optimising Screening in Australia - Breast |
| SEIFA | Socio-Economic Indexes for Areas |
| SES | Socio-Economic status |
| US | Ultrasound |
| WHO | World Health Organization |

# *Executive Summary*

## Background

A BreastScreen Australia National Policy and Funding Review (the BSA Review) is being undertaken to inform the future strategic direction of the BSA Program. The BSA Review is being jointly led by the Commonwealth and State and Territory Governments with the purpose of developing recommendations that support:

- Evidence based best practice in breast cancer screening,
- National consistency,
- A sustainable and equitable increase in Breast Screen Australia Program participation that enhances consumer experience and achieves improved service effectiveness, productivity, and efficiency.

The BSA Review is comprised of four workstreams: Evidence and Synthesis Review ('the Review' presented in this document), Quality and Safety, Funding, and the BSA Review Final Report and recommendations.

This document responds to the first workstream, Evidence and Synthesis Review (the Review). Considering the BSA's past investment in funding evidence on risk-based screening through the 'Roadmap for Optimising Screening in Australia – Breast' (ROSA) project, this review focuses on the contemporary evidence to support policy changes in Australia to avoid duplication of the work that the ROSA project completed. The Review provides available evidence, published over past ten years, on breast cancer screening technologies, pathways and intervals used for breast cancer screening stratified by various age groups, ethnicity, and other risk factors.

The Review provides considerations which will be assessed by the other workstreams for feasibility and cost effectiveness to assess their suitability for implementation, prior to the overall recommendations that will be made in the BSA Review Report.

## Methodology

The Review aimed to provide robust evidence on breast cancer screening technologies, alongside an assessment of the intervals and approach to screening for priority populations. English-language systematic reviews and/or meta-analysis, randomised controlled trials and randomised studies were included. These studies included screening with technologies such mammography, contrast-enhanced mammography (CEM), magnetic resonance imaging (MRI), digital breast tomosynthesis (DBT) and ultrasonography. These studies reported on outcomes such as cancer detection rates, interval cancer rates, recall rates and false positives. Furthermore, the focus on priority populations included women from Indigenous backgrounds, those living in rural and remote regions, and women from culturally diverse backgrounds. The detailed methodology and focus for this Review was co-designed with the BSA Expert Advisory Group.

The databases PubMed, Embase, and the Cochrane library were used for undertaking systematic literature searches. These searches were supplemented by checking official clinical trials registry websites and reference lists. EndNote and Rayyan were used as tools to ensure efficiency in the Review process. Investigators extracted and confirmed data and rated study quality; discrepancies were resolved through consensus. Data was extracted into an Excel file before undertaking detailed analysis and synthesis. Limitations of this review include a tight timeframe to undertake the review (16 weeks), English language only studies, and heterogeneity between studies in terms of comparator technology used and outcomes.

The review also mapped the available information from the jurisdictions across Australia to assess the consistency between the jurisdiction specific screening policies.

## Key Findings

From 1,079 studies identified via databases, 54 studies fulfilled the eligibility criteria and a further two studies were identified via manual searches of reference lists from the eligible studies. Evidence on screening pathways and technologies was available via high-quality studies whereas there was limited high-quality evidence on priority populations.

### Screening Pathways

The evidence suggests that the current two-yearly mammograms for women with an average risk of breast cancer is still best practice in population-based screening. For women with high-risk of breast cancer due to an increased focus on risk management tailored to individual patients, there has been a shift from age-based screening recommendations to personalised suggestions for the recommendation of technologies used and screening intervals based on various risk factors. This may be an important consideration for population-based screening programs.

The evidence from majority of the guidelines recommends mammographic screening for average risk women aged 40-74 years while optimal age recommended is 50-69 years. The evidence indicates that the upper age for mammograms should be based on the overall health status of an individual. The evidence also suggests biennial mammography screening for average risk populations.

The most studied risk factors indicating a higher-than-average risk of breast cancer included high breast density, personal history of pre-cancerous lesions and/or breast cancer; a family history of breast cancer; a known genetic predisposition of breast cancer; and history of chest radiation therapy. There was evidence that suggested women at higher-than-average risk of breast cancer could start screening early but not earlier than 30 years of age. There was also evidence that annual mammography and/or other technologies such as DBT, ultrasound or MRI for high-risk women or as an adjunct to mammography, should be considered.

The evidence indicates that text-message reminders sent by GP practices and/or other relevant pathways is a cost-effective and easier way to implement interventions to improve screening participation.

## Priority Populations

The evidence was limited on breast screening in Aboriginal and Torres Strait Islander women and there were no studies that met the eligibility criteria for this review. However, other types of studies that focused on screening in Indigenous populations, nationally or internationally, were included in this review. The one study that met the eligibility criteria focused on the impact of interventions on increasing participation in screening programs. The findings indicate that appropriate health education and accessible, convenient and culturally sensitive breast cancer screening services can improve the rates of screening Indigenous population groups, but caution in the interpretation of findings is required given the lack of studies specifically exploring the Aboriginal and Torres Strait Islander population.
For rural and remote regions, mobile mammography programs have shown to be successful, some increasing participation by almost 10%. Increasing breast cancer risk awareness among underserved women is crucial to address existing disparities.

The evidence suggests that providing culturally sensitive, tailored education programs is key to improving screening participation among culturally and linguistically diverse women. However, consideration needs to be given to the individual requirements of each cultural group.

## Screening Technologies

Currently, digital mammography is the standard technology used in the BSA program. The latest BSA Monitoring Report found that the invasive breast cancer rate within the program was 6.05 per 1000 screens, with an interval cancer rate of 0.91 per 1000 screens. This Review provides evidence that other technologies can support increased cancer detection rates and could be beneficial (in terms of cancer detection) as a supplemental technology to mammography in screening for breast cancer. There are benefits and drawbacks for all the technologies considered under this Review for their use as a population-wide screening tool and only some of these technologies such as DBT have a strong enough evidence base to justify the exploration of their use in population-based screening programs.

Consideration also needs to be given to women with a high risk of breast cancer including those with high breast density. High breast density can increase an individual's risk of breast cancer and reduce the sensitivity of mammography to identify cancers. Evidence indicates that there is a chance that supplemental screening using additional technologies (for example MRI or ultrasound) in women with high breast density can increase the false positive rate and overdiagnosis. However, the balance of the risks and benefits needs to be considered in light of the increased early cancer detection rates that might make this potential risk worthwhile.

The evidence indicates that there could be two separate screening pathways using available technologies one for average risk women and another for high-risk women. It also highlights the importance of continued research into the role of risk assessment tools, and how these could be used to accurately stratify women according to their risk factors.

## Suggested future activities

Below are a list of suggested activities BreastScreen could consider based on the evidence gathered through this Review. They would need to be assessed for their feasibility and cost effectiveness to assess their suitability for any future implementation.

1. Develop a nationally consistent policy for women assessed as high- risk as determined by agreed high-risk criteria
2. Create activities that build trust amongst the CALD community such as working with the community leaders to provide tailored information.
3. Continue to schedule regular mobile mammography unit visits to specific locations and undertake a feasibility study to implement solutions such as leveraging telehealth technologies for consultation and result reporting to ensure continuity of care.
4. Address the low rate of participation in Aboriginal and Torres Strait Islander women through a holistic approach including assessing feasibility of providing:
   - Logistical assistance such as support for scheduling screening appointments
   - Appointment flexibility such as group appointments
   - Personalised support from Aboriginal Health Workers
   - Culturally appropriate education regarding screening and its benefits and harms to support informed decision making
   - Nationally consistent age for initiation of breast screening
5. Test cost-effectiveness and feasibility of DBT as a supplemental screening method for women with higher breast density.
6. Undertake a one-year review for evidence on the use of MRI as a screening technology especially for women with identified higher risk of breast cancer.
7. Undertake a review of evidence on artificial intelligence (machine reading) for breast screening after one to two years.
8. Assess feasibility of establishing nationally consistent guidelines for:
   - Data sharing to support the use of high-quality data for decision-making
   - Reporting which may involve standardised reporting of breast density
   - Recall and reminder system.

# 1. Background and Context

## 1.1 Purpose of this review

A BreastScreen Australia National Policy and Funding Review (BSA Review) is being undertaken to inform the future strategic direction of the BSA Program and to develop recommendations for evidence-based best practice in breast cancer screening in the Australian context. The BSA Review is comprised of four workstreams: Evidence and Synthesis Review (this document), Quality and Safety, Funding, and BSA Review Report.

In light of the international interest in risk-based screening, and BSA's past (2018 - 2023) investment in exploring the role of risk-based screening through the Roadmap for Optimising Screening in Australia – Breast (ROSA) project, this Evidence and Synthesis focuses on the contemporary evidence to support policy changes in Australia to avoid duplication of the work that the ROSA project completed.

This Evidence and Synthesis Review (the Review) provides evidence on breast cancer screening technologies and intervals used for breast cancer screening stratified by various age groups, ethnicity, and other risk factors. It provides considerations which will be assessed by the other workstreams for feasibility and cost effectiveness to assess their suitability for implementation, prior to overall recommendations made in the BSA Review Final Report.

## 1.2 Breast cancer

Breast cancer is the most commonly diagnosed cancer among females, and is estimated to account for 28% of the 2023 cancer diagnoses in females in Australia.[4] The 2015-2019, five-year relative survival chance for individuals diagnosed with breast cancer was 92%, an increase from 78% recorded in the 1990-1994 reporting period.[4] Breast cancer can be invasive or non-invasive, and is commonly divided into pathologic subgroups which influence prognosis and survival rates, the risk of recurrence, and treatment options alongside the metastatic status of the cancer at the time of diagnosis.[5]

A 2018 review into the evidence surrounding risk factors for breast cancer found the main one to be age, with breast cancer occurring mainly in women over the age of 50 years.[6] Early detection of breast cancer, through methods including breast awareness, clinical breast examination, and screening mammography, is important for promoting improved outcomes. Detecting breast cancer when it is small and confined to the breast offers better prognosis, increased treatment options, and improved quality of life.[7-9] Breast cancers diagnosed at, or within two years of screening are associated with higher survival rates than cancers not detected through population screening.[10] In Australia, it is estimated that participating in breast screening offers a reduction in breast cancer mortality of between 30–49%.[11, 12]

In Australia, there are disparities in cancer outcomes for Aboriginal and Torres Strait Islander people. Among those identifying as Aboriginal and/or Torres Strait Islander people, breast cancer 5-year unadjusted survival rates were estimated to be 6-15% lower than in people who do not identify as Aboriginal and/or Torres Strait Islander. Racism and discrimination, limited access to culturally safe specialised and multidisciplinary care services alongside patient-related factors and perceptions contribute to Aboriginal and/or Torres Strait Islander populations having more advanced breast cancers at the time of diagnosis, and a lower uptake of surgical management options.[13-15]

## 1.3 Breast screening

### 1.3.1 International evidence

Globally, there is consensus among high-income countries on the eligibility criteria for and frequency of breast cancer screening. The World Health Organization (WHO) recommends population-based mammography screening programs for women between 50-69 years old, with a two-year screening interval in well-resourced settings.[16] This aligns closely with the screening process in many high income countries, with some variation in the selective recommendations for people aged 40-49 and 75+, as well as some countries recommending three-year screening intervals.[17, 18] The average participation rate of those eligible according to each country policy among Organisation for Economic Co-operation and Development (OECD) countries in 2021 was 54.3%[19]; this is a decrease from 60.8% in 2015[20] which is likely due to the COVID-19 pandemic. The 2021 participation rate for Australia (47.1%) suggests there are opportunities for encouraging increased participation from the Australian population.[21, 22] Table 1 below shows the range of participation rates in selected OECD countries for 2021.

*Table 1: Selected countries' mammography screening (%) in women aged 50-69 years within the past two years, 2019 and 2021 (or nearest years)[19]*

| Country | 2019 | 2021 |
|---|---|---|
| Denmark | 83.2 | 83 |
| United States | 76.5 | 76.1 |
| United Kingdom | 75.1 | 64.2 |
| New Zealand | 71.1 | 63.3 |
| OECD | 59.1 | 54.3 |
| Australia | 54.5 | 47.1 |
| Mexico | 45.4 | 20.2 |

*Note: Data for Mexico from 2020 instead of 2021. Data for United States is from survey data; data for all other countries from Program data.[19]*

Breast density is routinely assessed as part of population screening programs in Austria, Czech Republic, Taiwan, and parts of Denmark, Canada and Australia. The assessments in Austria, Denmark and Canada use Breast Imaging Reporting and Data System (BIRADS) (see 1.4.2 Risk factors for breast density assessment in Australia). While reporting breast density is recommended in the European Union by the European Society of

Breast Imaging (EUSOBI), this practice currently occurs only in Austria and Czech Republic. Outside the EU, reporting occurs in Taiwan and parts of Canada and Australia. In USA, as of September 2024, assessment using BIRADS and reporting will be mandated.[23]

For women with high breast density, supplemental ultrasound, digital breast tomosynthesis (DBT) and magnetic resonance imaging (MRI) are practiced internationally. In Europe, DBT is recommended by the EUSOBI. In Germany, out of pocket ultrasound or MRI is offered; in Canada ultrasound is offered; and in USA, supplemental screening is mandated in five states. Based on findings from the DENSE trial in the Netherlands, supplemental MRI for women aged 50-70 years with extremely dense breasts has been recommended by EUSOBI, however the same findings led to the Netherlands not recommending supplemental MRI.[23]

Other than age and gender, risk-stratified breast screening programs are currently being researched across the world, but no country has implemented additional factors into risk stratification within their national population-based screening programs for breast cancer.[24] Risk-stratified screening proposes a reduction in screening frequency for those at low risk of breast cancer, and an increase in screening frequency for those at a higher than average risk.[24, 25] It is estimated that implementing risk-stratified screening would be cost effective with an estimated 2.9% increase in excess deaths among those considered 'low risk', but there are concerns about the acceptability of reduced screening in these people who are stratified as 'low risk'.[25, 26]

### 1.3.2 Screening in Australia

In order to reduce breast cancer mortality through early detection, the BSA program was introduced nationally between 1991 and 1995 for women aged 50 to 69 years and then expanded in 2013, to extend the eligibility age to include women aged 70 to 74. Currently, all women aged 50-74 are actively invited to receive a free mammogram every two years. The jurisdictions are responsible for actively inviting women and do so through various methods. Free screening mammograms are also available to those aged 40-49 and over 75, but these age groups are not actively invited , due to the evidence that there was limited benefit in breast cancer mortality reduction of screening in both these younger and older age groups.[27, 28] The extension of the screening age to 74 was made in response to the 2009 evaluation of BSA, which also recommended addressing inconsistencies across jurisdictions, and concentrating on increasing participation with a focus on priority populations.[29]

Women can choose to be screened outside the Program by paying for screening through a private radiology service. There are also MBS rebates available that allow doctor referrals for diagnostic mammography of women that meet a certain clinical criterion. Participation data from the private system is not captured in national and BSA reporting, meaning true participation rates are unable to be calculated.

Women at high risk of breast cancer are eligible to attend specialised services such as Familial Breast Cancer Clinics, for example the one at the Princess Alexandra Hospital in Queensland.[30] This level of risk identification is based on the family history and is summarised in the RACGP Guidelines for preventive activities in the general practice.[31] Women who fall into the RACGP's 'potentially high risk' category will generally be eligible for referral to family cancer clinics, where these are available. These family cancer clinics can provide a more personalised assessment

of risk, advice on genetic testing, preventative treatments, and tailored multimodal screening (including supplementary ultrasound and MRI) outside the BSA program.

### *Jurisdictional differences in policy implementation*

While BSA is a national program there are differences in implementation across states and territories. In January 2024 BSA conducted a national stocktake of state and territory policies to better understand the differences. An overview of the stocktake is provided in Appendix 6.1. It is important to note that results from Tasmania were not available at the time of writing, and that the results were self-reported by state and territory BreastScreen programs and therefore may not reflect implementation differences in individual services. The policy stocktake covered risk factors and technology and highlights the inconsistencies in policy implementation across jurisdictions. The goal of future changes to BSA policies, in particular on risk-based screening, would be to have nationally consistent policies and practices.

### *Participation rates*

A total of 47% of the target population participated in the BSA program in 2020-2021, a decrease from 54% in 2018-2019 as a result of the COVID-19 pandemic, which resulted in suspended services and delayed screening due to risk of COVID-19 infection.[19] In first-time participants whose screening detected cancer, 48% were small breast cancers. Small breast cancers are associated with more treatment options and lower morbidity and mortality rates. However, just 28% of breast cancers detected outside the screening program are small breast cancers.[27]

*Table 2: Participation rates for whole population and priority populations, 2020-2021*

| Age group | SEIFA 1 Number (ASR%) | Very Remote Number (ASR%) | Aboriginal and/or Torres Strait Islander Number (ASR%) | NESB Number (ASR%) | Australia Number (ASR%) |
|---|---|---|---|---|---|
| 40+ years | 371,845 (27.9%) | 10,544 (26.8%) | 30,397 (22.8%) | 281,053 (22.3%) | 1,941,429 (29.2%) |
| 40–49 years | 28,330 (9.7%) | 1,863 (16.0%) | 4,573 (10.1%) | 26,173 (6.7%) | 171,945 (10.2%) |
| 50–69 years | 270,026 (44.0%) | 7,289 (36.3%) | 22,678 (34.4%) | 211,634 (36.5%) | 1,414,929 (46.5%) |
| 50–74 years | 330,268 (44.8%) | 8,280 (37.1%) | 25,338 (34.9%) | 249,270 (37.0%) | 1,705,274 (47.1%) |

Participation rates across Australia vary, with the age-standardised participation rate for the target age group 50–74 ranging from the lowest 34.6% in the Northern Territory to the highest 56.0% in Tasmania in 2020–2021.[32]

## 1.4 Screening considerations for breast cancer

Epidemiologically, population-based screening refers to the application of a test to all people in an identified target population who do not have symptoms of the disease of condition being screened for, and that there is treatment intervention that is effective, available, easily accessible and acceptable to all patients with the disease or condition revealed through screening.[33] The purpose of screening an asymptomatic

individual is to detect early evidence of abnormalities in order to recommend preventive strategies or treatment that will provide a better health outcome than if the disease were diagnosed at a later stage.[34].
It is critical that the benefits of population-based breast cancer screening programs outweigh the potential harms, with strong evidence to support the effectiveness of screening on mortality rates. For breast cancer, this is particularly important in considering the risks associated with overdiagnosis and overtreatment, the distress that may be caused to people who are recalled for further investigations, and it must be cost effective.[35]

### 1.4.1 Risk-based screening and the ROSA project

The Roadmap for Optimising Screening in Australia – Breast (ROSA) project, commenced in 2018, aimed to investigate the evidence for moving towards risk-based breast screening in Australia, with a goal of further reducing mortality from breast cancer. In 2021 the age-standardised mortality rate from breast cancer in women aged 50-74 years was 38 deaths per 100,000.[27] Through technical reports, the ROSA project highlighted the importance of breast density being considered as both a risk factor and a factor that could influence the accuracy of screening. ROSA however found limited evidence about how to identify, screen and manage women who fall into higher-risk groups for breast cancer.

The ROSA project also identified some of the resourcing challenges surrounding breast cancer screening, including a wide variation in the practices and activities between states and territories, the challenges surrounding workforce and funding resources, and opportunities for greater coordination between multidisciplinary teams for the early detection of breast cancer. While the evidence for informing Australian policy at this point in time was limited, the ROSA project resulted in a roadmap, with recommendations including reviewing existing guidelines and policies, designing and trialling risk-based screening programs in Australia, and conducting more targeted evidence reviews, with a focus on exploring the evidence gaps in the emerging available technologies.[36] The overarching principle of the Roadmap is that 'any approach to risk-based breast cancer screening should be done in a way that sustains or improves on usual BreastScreen participation'.[37](p12)

### 1.4.2 Risk factors

Current breast cancer screening guidelines in Australia are based on age and gender, reflecting that age is the greatest risk factor for breast cancer. In Australia more than three quarters of breast cancers occur in women aged over 50.[27] There is increasing evidence internationally that there are other risk factors that could be considered in population screening policies.[6] These include: geographic location, socio-economic status, dense breasts, individual history of breast cancer, and family history of breast and other cancers.

Breast density is an established risk factor for breast cancer[6] however the sensitivity of mammography for women with dense breasts is lower than for women with non-dense breasts.[38] BSA estimates that one-third of women aged 50 years and over in Australia have higher breast density; other estimates are one quarter to half of women aged 40-75 years have extremely dense breasts.[39, 40] Breast density can be measured during mammography using a visual assessment according to the Breast Imaging Reporting and Data System (BIRADS) or an automated

volumetric measurement using software such as Volpara. Breast density is not routinely measured in the technology and reporting requirements instituted in the current BSA program; if it is measured, it is not routinely reported to participants or their health care providers (see appendix 6.1. for relevant jurisdictional policies).

BreastScreen WA notifies women if they have dense breasts and its study on the impact of breast density notification on screening outcomes concluded that for women in the target age group (50-69 prior to 1 July 2013 and 50-74 from then on), notification does not deter women from rescreening.[41] For younger women aged 40-49 years , the study also concluded that notification appears to decrease the likelihood of rescreening.[41]

Some international studies indicate that increasing mammography screening frequency to annual for women with extremely dense breasts may reduce the interval cancer rate and increase program-wide sensitivity while others indicate supplemental technologies* such as ultrasound could be beneficial to reduce underdiagnosis in women with high breast density.[42-45] There does appear to be an increasing perception (among healthcare professionals, women and policy makers) that mammographic density should be measured and reported, even if the clinical pathways from that point on are unclear.[46] Risk information could be used to inform screening and assessment pathways. Examples include:

- Eligibility criteria – in particular, the target age and invitation age for breast cancer screening programs. There is variation across states and territories in policies for inviting or reminding women under 50 years.
- Intervals between screening – the current two-year (biennial) intervals are recommended by the World Health Organization. There is variation across states and territories in policies and criteria for annual screening.

Breast cancer screening risk assessment tools are used to estimate an individual's risk of developing breast cancer. These tools are important for determining the most appropriate screening and prevention strategies for each person. With the application of these tools, the healthcare providers determine appropriate screening recommendations, such as the frequency of mammograms, and the technologies that can effectively detect the cancer. It's important to note that while these tools can provide valuable information, they are not perfect predictors of individual risk, and healthcare providers consider multiple factors when making screening recommendations. As documented by the ROSA project, breast cancer risk assessment tools based on self-reported information about family history and prior breast biopsies can identify women at higher or lower risk.[37](p68) Risk assessments used in Australia, such as iPrevent, currently do not include breast density. In relation to risk assessment tools, the ROSA project recommended that well-validated tools are evaluated in the BSA context, and that evidence on the effectiveness of breast density tools be collected.[37](p8)

* Supplemental or adjunct screening can be sequential (as a follow-up test to mammography) or simultaneous (in the same episode as mammography). In this review the term supplemental is used to indicate either sequential or simultaneous, unless where specified.

### 1.4.3 Priority populations

Australia's priority populations such as Aboriginal and Torres Strait Islander people need extra focus to ensure inclusive and equitable access to breast cancer screening. The 2020-2021 participation rate in BSA screening program for this population was 35%, lower than the general population (47%). Aboriginal and Torres Strait Islander women aged 50-74 years were also found to have a lower incidence of breast cancer than the general population (288 compared with 314 new cases per 100,000 women, age standardised), but higher mortality rates (53 compared with 40 deaths per 100,000 women, age standardised).[27] Therefore, prioritising engagement and uptake in the BSA program is of particular importance in this group.

In 2023, a study was undertaken to identify the extent to which Aboriginal and Torres Strait Islander people were considered in the development, design, implementation of seven current breast screening policies in Australia. The study concluded that the current policy does not meet needs of Aboriginal and/or Torres Strait Islander women and requires change to improve breast cancer mortality outcomes.[47] Examples of activities conducted by BSA programs to increase participation and rescreening in priority populations include designing and providing shawls with Aboriginal artwork for Aboriginal and Torres Strait Islander women to wear during screening.[48] Establishing permanent screening clinics in remote locations, increasing the coverage of mobile screening services to additional remote communities, and encouraging health professionals to undertake mammographic training have been recommended to address lack of access for Aboriginal women to screening services in Northern Territory.[49]

In 2020-2021 participation rates for people from non-English speaking (37%), very remote areas (37.1%) and the lowest socioeconomic group (44.8%) were all lower than the general population.[27] Examples of activities conducted by BreastScreen programs to increase participation and rescreening in priority populations include culturally-relevant communication strategies such as in-language reminder letters and phone calls, staff training in cultural awareness, community peer educators and pharmacies engaged to promote screening.[48]

Other priority groups, for which there are no 2020-2021 national participation rates available, include:

- Transgender and gender diverse people, who may need breast screening depending on their hormonal and surgical history, and these policies are guided by state and territory-based BreastScreen programs resulting in inconsistencies.[50] Community consultation conducted in collaboration with BS Victoria in 2023 reinforced the need for inclusive screening services and information and provided recommendations including increased visibility of screening services within gender diverse communities.[51]
- People with disabilities, for whom participation in screening may be impacted by issues of access and missing out on invitations due to not being on the electoral roll.[52] The importance of building partnerships between screening programs and disability organisations, and recognising that targeted and tailored activities will be required to increase participation for the range of disability communities are just two recommendations from consultations in Victoria.[52, 53]
- People with mental health diagnoses.
- People experiencing homelessness.

People with breast implants, a history of mastectomy, or the presence of atypical breast lesions also need special consideration in the decision to provide breast screening.[54] The issue of low participation in screening and the challenge of how to increase participation for priority populations as well as the target population is an area of continued action for BreastScreen Australia and its state and territory programs. The role of communication about the program and the role of past screening experiences have been found to be key to increasing participation.[55] The role of private screening in Australia and understanding the participation rates in the private sector will be critical to informing strategies to increase participation in breast cancer screening.

### 1.4.4 Screening technologies

BSA uses bilateral full-field digital mammography (FFDM) for all screening, and as noted in the results of the BSA state and territory policy stocktake, other technologies are used in assessment when participants have a positive screen result. There is an increasing evidence base for the use of current and emerging screening technologies including magnetic resonance imaging (MRI), digital breast tomosynthesis (DBT), ultrasound, and contrast-enhanced mammography (CEM); there is research into the use of these technologies as supplemental to traditional mammography as well as standalone screening tools. AI is also available to support screen reading. In 2021 BSA commissioned a series of reviews on screening technologies which were an update to previous reviews conducted in 2018; the reviews are referenced in this section.

**Artificial intelligence (AI)** in breast imaging can be used as a decision support tool to direct the reader's attention to areas of interest in the mammogram or as an alternative to human readers, among other applications.[56] There is limited published evidence on AI for both applications however in the 2021 review the authors found mixed results for AI systems used as standalone (alternative to human readers), and small improvements in performance when used as a decision support tool. The 2021 review concluded that "AI systems appear to be promising, but there is still some way to go before such systems are ready for implementation into real-world screening programs".[57] As noted in the national stocktake summary (Appendix 6.1) there are various activities and plans in progress related to the use of AI in the BSA Program.

**Contrast-enhanced mammography (CEM)** combines an iodine-containing contrast with digital mammography and can detect cancers not otherwise visible on a standard mammogram. In a 2021 review commissioned by BSA on the potential role of CEM, the authors concluded that CEM as a future primary screening test "is likely to be limited given the radiation exposure and iodinated contrast risks."[58] In addition, CEM imaging time is longer than FFDM. The ROSA project did not report any studies with risk-stratified results where CEM was used in population screening.

**Digital breast tomosynthesis (DBT)** DBT can be used as a primary screening tool or as a supplement to DM.[59] A further tool of DBT is synthetic 2D mammography, when 2D images are created from the DBT images and thus reducing the radiation exposure to the participant. Literature on DBT reports on its sensitivity, specificity and safety[59] and the ROSA project found that DBT combined with 2D imaging increased cancer detection rates across all risk groups based on age, compared to digital mammography.[37]

*"There is growing confidence that as a screening strategy DBT could enhance a screening program with several programs moving to pilot DBT as the screening test"[59](p3)*

**Magnetic resonance imaging (MRI)** is publicly available in Australia to asymptomatic women under 50 years at high risk of breast cancer, due to its high sensitivity.[60] MRI has also been trialled for its sensitivity for detecting breast cancer in women with high breast density [38], however high sensitivity can lead to higher false positive results. Similarly, the ROSA project found that supplemental MRI for high-risk women compared to DM alone increases cancer detection and false positive recall rates.[37]

**Ultrasound (US).** The ROSA project found that, compared to digital mammography alone, ultrasound as a supplement to digital mammography can increase cancer detection rates and false positive rates for women with dense breasts and/or women at very high risk of breast cancer. Further, these rate increases appeared greater for women with denser breasts.[37]

Recommendations on technologies from the ROSA project included that targeted research consider the expected benefits and risks of technologies – including DBT, ultrasound, MRI and CEM – as primary or supplemental tools in risk-stratified screening groups.[37](p8) Similarly, the technology used for screening may also be dependent on risk stratification for an individual. This could mean individuals assessed as having a higher risk of breast cancer are offered alternate or supplementary screening tools, and a further review of the evidence is needed to inform such changes to the screening program. However the current evidence on clinical evaluations of risk-stratified screening is limited, epidemiological evidence is sparse, and randomised trials have only begun in recent years.[24]

The results and discussion sections of this review provide evidence on the interdependent factors described above to ensure that approaches considered for implementation of feasible screening pathways, are based on robust information and evidence. Potential changes to the screening program will also need to consider the resources required to support these changes equitably and in perpetuity, including workforce constraints and technology provision. An exploration of the variation in service provision across different states and in Australia will also be required to support the assessment of the consistency and needs of the BSA program.

# 2. Approach and Methods

## 2.1 Approach

For this review, the definition and process for a 'Systematic Review' (the Review) recommended by the Cochrane Reviews Methods Group was used, which states that *"A systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a specific research question. Researchers conducting systematic reviews use explicit, systematic methods that are selected with a view aimed at minimising bias, to produce more reliable findings to inform decision making"*.[61]

The design for the systematic review was based on the established guidance from Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA).[62]

***Aim***

The Review aimed to provide robust evidence on breast cancer screening technologies and intervals used for breast cancer screening stratified by various age groups, ethnicity and other risk factors.
Systematic literature searches were completed by following an established set of guidelines to

- Review the literature and summarise evidence against the key review questions
- Undertake a brief evidence analysis (between the questions asked and the evidence identified) to assess the strength of the evidence.

***Review design***

The design for this study followed established guidance from Khan et al (2003) methodological framework for conducting and reporting systematic reviews.[63] It recommends five stages as follows:

1. Framing the question for a review
2. Identifying relevant studies
3. Study selection and assessing quality of studies
4. Summarising the evidence
5. Interpreting the findings

The overarching review question, and the draft review methodology was presented to the Expert Advisory Group (EAG) for their input and advice. The consultation and co-design process ensured that the review methodology is robust and inclusive due to the systematic feedback provided by the EAG.

## 2.2 Identifying the research question

The themes to be addressed by the Review are specified in the form of structured questions before beginning the Review work. Appropriate models (i.e PICO – Population, Intervention, Comparison and Outcomes) were used to assist with formulating and assessing research questions. To ensure equity in understanding screening practices and future pathways, questions related to priority populations such as Aboriginal and Torres Strait Islander people and the population from lower socio-economic background as well as high risk populations were added in the research questions in consultation with the EAG.

***Overarching review question:*** What is the current evidence for breast cancer screening technologies and screening intervals for various age and risk group populations?
Under this overarching question the detailed evaluation questions for each study elements were developed in consultation with the EAG and DHAC and the systematic review responded to these questions (Table 3 below).

*Table 3: Study elements and corresponding research questions*

| Study element and its description | Research questions |
|---|---|
| **Population/Priority population**<br>• Age groups: eligibility age<br>• Ethnicity: Aboriginal and/or Torres strait Islander; CALD<br>• SES: Lower socioeconomic background, education<br>• Rural and remote populations<br>• Risk factors: breast density, family history, personal history | • What approaches work better for improving to breast cancer screening participation among Aboriginal and Torres Strait Islander people in Australia, rural and remote populations and for those with lower socioeconomic background?<br>• What is the evidence for the age-based eligibility criteria for breast cancer screening?<br>• What risk factors need to be considered in deciding the type of screening technologies/methods used for breast cancer screening? |
| **Intervention/Technology:** Screening methods and intervals:<br>• Screening technologies: mammography; contrast enhanced mammography; ultrasound; MRI; tomosynthesis; Artificial Intelligence<br>• Intervals for screening: Annual; Biennial; Every three year | • What breast cancer screening technology and screening intervals recommended in various age and risk groups?<br>• Does the current evidence support biennial or annual breast cancer screening intervals for all age groups and/or for priority populations?<br>• What screening technology or combination of technologies work best for various risk groups? |
| **Comparison:** Technology use in various population groups, age groups, and at various screening intervals. | • Compare different screening strategies, including different screening intervals, ages to begin or end screening, and personalization of the screening program based on risk factors, markers, or risk assessment tools.<br>• For priority populations: What works best to increase screening participation rates among priority populations? |

| Study element and its description | Research questions |
|---|---|
| **Outcome:** Increased participation rate, early detection and morbidity and mortality rates. | Outcomes were guided by the results of the included studies. The most common outcomes studied were early detection rates, false positive rates and recall rates. The screening participation rate was the key outcome for priority populations. |

## 2.3 Identifying relevant studies

### 2.3.1. Search guidelines and databases searched

Systematic review is performed using the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (See Appendix 6.2-Prisma Checklist).[62] and included searches of three electronic databases, namely PubMed, Embase and Cochrane library. This was supplemented by searching official clinical trials registry websites and checking reference lists. Search terms and strategies used in previously conducted literature reviews on the same subject were explored. Search terms were finalised under EAG guidance. The keywords used to guide the search terms for each topic are presented in the table below.

*Table 4: Study topic and key words by each topic*

| Topic | Keywords Used for Search Terms |
|---|---|
| Breast cancer | Breast cancer, breast neoplasm, breast tumour, breast carcinoma, mammary cancer |
| Screening | Early detection, mass screening, screening, early diagnosis |
| Age groups | Age group, age, eligibility |
| Interval | Screening interval, frequency, annual, biennial, triennial |
| **Risk Factors** | |
| Breast density | Breast density, mammographic density |
| Personal history of benign breast lesions | Benign, non-malignant, non-cancerous, Atypical Lobular Hyperplasia, Lobular Carcinoma in Situ, Lobular Neoplasia, Atypical Ductal Hyperplasia |
| Family history of breast cancer | Family history, inherited, hereditary |
| **Technology** | |
| Mammography | Mammography |
| Ultrasound | Ultrasonography, ultrasound, echo mammography |
| MRI | MRI, magnetic resonance imaging |
| Tomosynthesis | Tomosynthesis, digital breast tomosynthesis, 3D-mammography, x-ray breast tomosynthesis |
| Machine reading *(the 'artificial intelligence' topic has been filtered to this to capture an area where there is likely to be the most evidence)* | Machine reading, machine learning, screen reading |
| Contrast enhanced mammography | Contrast enhanced mammography, contrast enhanced mammogram |
| **Priority Populations** | |
| Aboriginal and Torres Strait Islander People | Aboriginal, Indigenous Australian, First Nations, Torres Strait Islander |
| People from a Culturally and Linguistically Diverse background | Culturally and Linguistically Diverse, CALD, Black Asian ethnic minority *(equivalent of CALD in UK)*, BAME, multicultural, non-English speaking, religion |
| People living in non-metro areas (outer regional, rural, and remote) | Rural, remote, regional, non-metro, distance |
| People with a lower socioeconomic status | Socioeconomic status, social class, poverty, education, occupation, income |

Steps of search strategy used for each database and the number of results generated are recorded and presented (see example of various databases searches and results obtained in Appendix 6.3). The initial search was limited to title and abstract only. Due to two key areas of focus for this review, two different categories of searches were implemented: ***Technology*** and ***Priority populations.*** Technology search assisted in responding to the overarching review question and enabled finding evidence for technologies used for breast cancer screening and its intervals by risk factors. Priority populations search resulted in publications on breast cancer screening specific to those high priority groups such as Aboriginal and Torres Strait Islander People, people from a Culturally and Linguistically Diverse background and rural and remote population. De-duplication of the studies gathered from various databases was undertaken before applying the selection criteria.

## 2.4 Study selection and assessing quality of studies

### 2.4.1 Selection criteria

The **inclusion and exclusion criteria** are included below.

***Inclusion criteria***

- Studies researching various breast cancer screening strategies
- Studies exploring screening technologies, intervals and its effectiveness and appropriateness by various risk factors
- Research articles published in English language and comparable countries (OECD or developed countries)
- Published between last 10 years (from 01 Jan-2014 to 01 Jan -2024)
- Type of study design: systematic reviews, meta-analyses and RCTs only. This included umbrella reviews, which are reviews of systematic reviews.
- Research limited to human studies only
- Full publication or manuscript available for review
- Relevant reports and research articles recommended by clinical experts
- For priority populations such as Aboriginal and Torres Strait Islander women, due to a scarcity of high-level evidence, Level 4 evidence was included based on the relevance and importance criteria.

***Exclusion criteria***

- Not published in English
- Cost-effectiveness studies and reporting was out of scope for this review as it is part of the fourth workstream of the larger BreastScreen Australia National Policy and Funding Review

Two levels of screening (title and abstract and a full text) used the pre-specified and agreed set of inclusion/exclusion criteria. Studies that met the inclusion criteria in the second stage of screening (full text screening) were included in the Review.

### 2.4.2 Screening of titles and abstracts

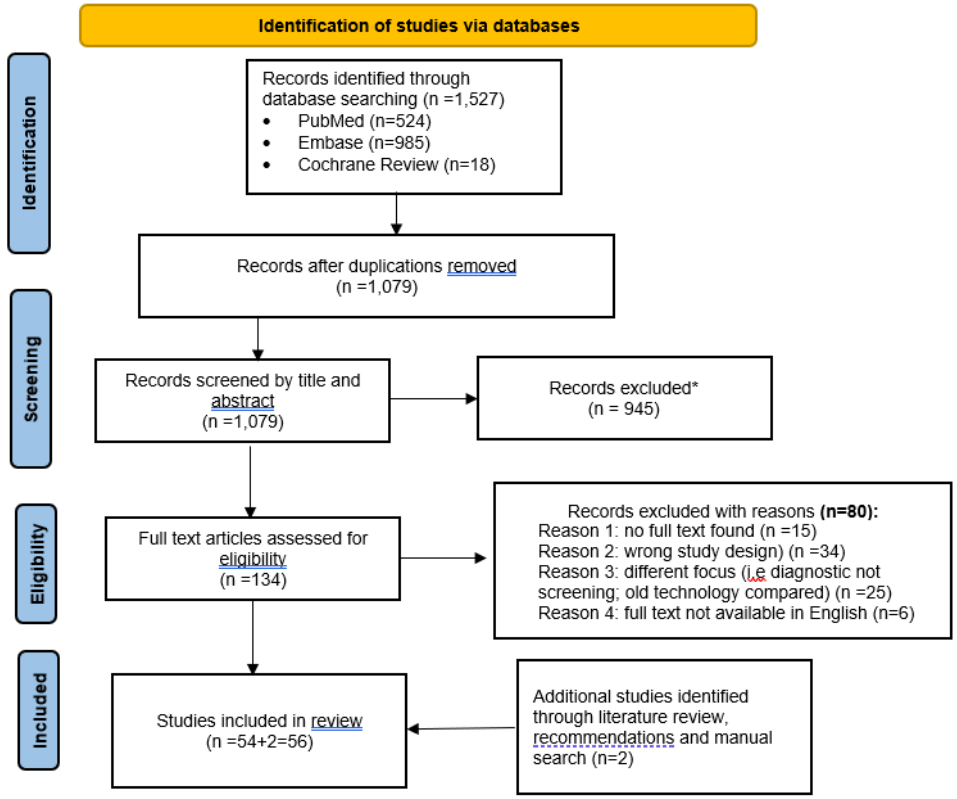
Titles and abstracts were reviewed by two reviewers independently and a third reviewer verified a random sample of articles to ensure that the criteria were applied correctly. This increased the sensitivity of the study selection. Where the two reviewers had a disagreement on inclusion or exclusion of any studies, the third reviewer reviewed to ensure appropriate decision-making.

### 2.4.3 Full-text screening

The studies to be included for a full text review were identified by screening title and abstract. The full texts of the identified studies were downloaded and screened using pre-determined inclusion/exclusion criteria. Two reviewers screened independently full texts of relevant articles and the third reviewer verified a sample of articles (10%) by the two reviewers to ensure reliability and validity of the process. This ***maximised specificity*** of the selected articles. The PRISMA flow diagram (Figure 1 below) is used to report the process and outcomes of the study selection
To ensure that this review is comprehensive, further searches were undertaken. This included:

- Checking references of included studies for further relevant studies
- Including relevant grey literature, reports or unpublished studies by contacting authors or key researchers in the field, where appropriate
- Resolving disagreements through discussion and/or using the third reviewer, where necessary.

*Figure 1: PRISMA diagram*




*Reasons excluded included wrong study design, different focus, different study context (i.e developing country), and old technology compared etc.

Clinical trials registry platforms were searched for identifying ongoing, relevant prospective breast cancer screening studies that could potentially supplement and update existing findings. The search terms and strategies used for the review databases were used for trial registry searches.

Three clinical trials registry platforms were searched:

- Australian New Zealand Clinical Trials Registry (ANZCTR): An online registry of clinical trials being undertaken in Australia, New Zealand and elsewhere. Six ongoing trials were found.

- PROSPERO: The UK-based platform maintained by Centre for Reviews and Dissemination and funded by the National Institute for Health Research (NIHR). The search resulted in 21 ongoing clinical trials records.
- Clinical Trials.gov (Unites States): This platform is maintained by the National Library of Medicine, USA. A total of 108 clinical trials focused on breast cancer screening were found.

Overall, a total of 54 studies were found through a systematic review, with two additional relevant studies identified through literature review and reference searching. Since the focus was on high-quality evidence, the majority of included studies (37/56) were systematic reviews with or without meta-analyses, followed by 18 randomised controlled trials (RCTs) and one rapid review. Among these, the largest number of studies (n=42) focused on technology, with fewer studies (n=14) addressing priority populations, screening pathways, and assessment.

## 2.5 Summarising the evidence

### 2.5.1 Data collection

A total of 56 full text articles that fulfil the inclusion criteria were included in the review. Data extraction and charting of the selected studies was performed simultaneously. It included the following:

- Two reviewers independently extracted data from included studies and the third reviewer undertook random checks to ensure quality and rigour.
- Limiting data extraction to key study characteristics (breast screening technology or intervals) and outcomes (early detection rate and recall rates etc), as needed.
- Conducting risk-of-bias assessment: The full texts of all included articles were assessed for reporting quality by two independent reviewers. The following factors outlined in the National Health and Medical Research Centre (NHMRC) guidelines was explored to reduce bias where required[64]:
    - selection bias-problems with the comparability of participants or populations in a study
    - performance bias or confounding-factors other than the intervention or exposure of interest that influence the effect estimate
    - detection bias-problems with measurement or classification of exposure or outcomes
    - attrition bias or publication bias- missing information.
- For all study outcomes considered (for example, cancer detection rates, screening participation rates), the data extraction presented summary data, effect estimates/changes and confidence intervals, where possible.

### 2.5.2 Charting

Three reviewers extracted data using a predesigned extraction form (Table 5). Key information extracted were as follows:

| Author and Date | Journal/website name | Study design | Study population | Place of study | Data period covered | Limitations | Level of Evidence | Information on recommended screening technologies/ methods | Major findings/results |
|---|---|---|---|---|---|---|---|---|---|
| **Author/s name and date** | Include the name of the journal/website | What design and methods used in the study? (RCT, systematic review, descriptive studies) | **Age:**<br>No of women:<br>- < 40<br>- 40-44<br>- 45-49<br>- 50-74<br>- >75<br>**Priority groups:**<br>No of women<br>- Aboriginal and Torres Strait Islander<br>- CALD/religion<br>- Rural and remote<br>- Lower SES/occupation/education level<br>**Risk factors:**<br>No of women<br>- High breast density<br>- Family history +<br>- Personal history | Country of study conduct | Data period | Clearly describe limitations of the methods used in the studies | Strength of evidence (SoE): Where does the study fall on the SoE pyramid? Apply GRADE system (Table 6 below) | Considered as recommended screening methods | Briefly summarize what the authors found regarding the study topic. *(Present results of each systematic reviews and meta-analysis done, including confidence intervals and measures of consistency.)* |

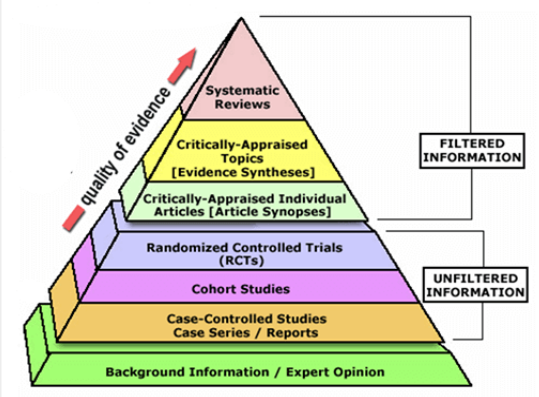
- A. Study characteristics such as publication details, study population
- B. Information on study quality and findings including major findings that briefly summarize the evidence regarding screening technologies and intervals used for breast cancer screening by various risk factors (age groups, ethnicity, breast density).

*Table 5: Data extraction template*

### 2.5.3 Level of evidence

Medical researchers and practitioners rank research evidence according to its quality and rigour. These levels when pictured together form a pyramid with the highest quality evidence at the top of the pyramid as there is less of this available. This pyramid is often referred to as the "Evidence Pyramid" and often used to define the level of evidence in the systematic review along with the GRADE system tool.[65]

*Figure 2: The Evidence Pyramid*




While the Evidence Pyramid broadly guided to define the level of evidence in the Review along with GRADE system tool, the NHMRC Evidence Hierarchy was also used to further critical appraisal and standardizing the quality of evidence obtained.[66] This was chosen because it provided specific guidelines for assessing evidence about screening interventions, and was designed for the Australian context. When needed, the Level of Evidence guidelines from Johns Hopkins Nursing Evidence Based Practice were also employed, as these provided further details about grading different types of systematic reviews.[67]

Data synthesis process was undertaken simultaneously with data charting and summarising the evidence. These included synthesising the main findings including the appraisal of strength of evidence for each main outcome, considering their relevance and benefits to key findings and learnings that would inform the breast screening strategy in Australia.

*Table 6: Grading the Level of Evidence*

| Level of Evidence | Types of studies included (screening interventions) |
|---|---|
| Level I | A systematic review of level II studies |
| Level II | A randomised controlled trial |
| Level III-1 | A pseudorandomised controlled trial (i.e. alternate allocation or some other method) |
| Level III-2 | A comparative study without concurrent controls:<br>• Historical control study<br>• Two or more single arm study |
| Level III-3 | A comparative study without concurrent controls:<br>• Historical control study<br>• Two or more single arm study |
| Level IV | Case Series |

*Source: NHMRC Evidence Hierarchy[66]*

## 2.6 Supplementary methods

The systematic review process resulted in a coherent and logically synthesised information including results that inform the breast cancer screening strategies in Australia (Results section below). The process was also complemented by key informant interviews, analysis of relevant quantitative data, and learnings from previous reports and grey literature as described below.

### 2.6.1 Key informant interviews

In addition to engagement with the EAG and the Department, consultations with key experts in the field and other stakeholders nominated by the Department were undertaken, to identify key reports and grey literature. These key informants were also consulted during the design phase of the Review to support understanding of the current context for screening from their perspectives. See Table 7 below.

*Table 7:List of key informants interviewed during this review*

| Expert | Affiliation |
|---|---|
| Professor Sanchia Aranda | Expert Advisory Group, Committee Chair<br>Chair of City Cancer Challenge, Cancer Council and Former CEO of Cancer Council Australia |
| Professor Viviene Milch | Chair, BSA Clinical Advisory Group<br>Medical Director, Head, Clinical Policy Advice, Cancer Australia |
| Professor David Roder | Chair, Cancer Epidemiology and Population Health, School of Health Sciences, University of South Australia |

### 2.6.2 Quantitative data, reports and grey literature

Breast screening data, previous review reports (ROSA report) and grey literatures informed the background section of the report and contributed to the discussion part of the report. Data on the age ranges of women receiving a breast screening service as well as information about equity in accessing these services provided relevant background to discussions regarding various screening approaches. The data is accessed via various reports from the Australian Institute of Health and Welfare (AIHW). Some datasets used to gather background information are listed below (Table 8 below). Appendix 6.4 includes the details of the data that was reviewed, and the background section (page 1) includes the summary of this data.

*Table 8: Examples of datasets that were used to gather quantitative data.*

| Dataset | Information |
|---|---|
| BreastScreen Australia monitoring report 2023: Participation and Rescreening | Participation rates by age, remoteness, socio-economic status, CALD, and Aboriginal and/or Torres Strait Islander status (2020-2021)<br>Preliminary participation (2021-2022)<br>Rescreening within 27 months by age and territory (after 2019 screening) |
| BreastScreen Australia monitoring report 2023: Diagnosis | Screen-detected and interval cancers<br>Program sensitivity* |
| BreastScreen Australia monitoring report 2023: Outcomes | Incidence by age-groups, remoteness, and Aboriginal and/or Torres Strait Islander status |
| Screening Program Data: AIHW | Available data on breast cancer screening activity (Up to Jul 2023 Quarter) |

* Interval cancers are detected by physical exam and/or symptoms within 18 months following a negative screening exam (either mammogram or MRI). As current imaging occurs every 2 years, it is important to understand the detection rates and rates of interval cancers across various age groups as a background.

Quantitative data is reviewed, summarised and triangulated with the systematic review evidence to ensure that the considerations for implementation of appropriate screening approaches or pathways consider stratification by age groups, geography or ethnicity as much as feasible with the available evidence.

### 2.6.3 Limitations

This systematic review has some limitations. The key limitation is related to the timeline of this review which needed to be completed within four months. Even though a comprehensive systematic search was performed, in some areas of focus no studies that met the quality criteria were found (For example: reviews into breast screening in Aboriginal and Torres Strait Islander populations). While studies that focused on First Nations populations in other countries were included and summarised, they may not be reflective of Aboriginal and Torres Strait Islander screening experiences.

Other limitations include the following:

- Studies published in English language only
- The SRs that indicated heterogeneity in the endpoint and methodology of the included studies impacting ability to undertake metanalysis
- Potential overlap in the included studies of the systematic reviews covering the same years
- Limited generalisability of the study results due to differing contexts, study population and differences in health systems priorities and funding mechanisms etc.

The included studies were of high quality, published studies, and expert opinions (see section 2.6.1) were sought at every stage of the project to ensure the relevance and credibility of findings thus reducing the impact of these limitations.

# 3. Results

## 3.1 Screening pathways

This section includes results from the systematic review about the use of risk factors (i.e breast density, age, personal history) to establish screening pathways. It includes information on screening intervals, the eligibility age for screening and the screening technology based on risk factors. There were five studies (four systematic reviews and one RCT) with a primary focus on screening intervals for women in different risk and age groups (*Table 9*). While there were some discrepancies in recommendations for screening and assessment pathways across various contexts, the commonly suggested approach was annual or biennial mammographic screening for women at average risk.

A 2022 systematic review by Canelo Aybar et al [68] aimed to inform the European Commission Initiative on Breast Cancer recommendations through exploring benefits and harms of annual, biennial, or triennial breast cancer mammography screening for women at average risk of breast cancer. It concluded that for women at average risk of breast cancer, screening intervals present varying trade-offs across age groups. Biennial screening for women aged 50–69 seems to be suitable while, in younger women, annual screening might be less suitable, and for women aged 70–74, longer screening intervals may also be more advantageous.

Cutler et al [69] conducted a systematic review and meta-analysis to estimate the likelihood that pre or postmenopausal women with no prior diagnosis will remain free of Invasive Breast Cancer (IBC). It estimated that over 99.7% of pre/postmenopausal women with no prior diagnosis continued with no IBC each year, with 93.41% still IBC free after 25 years. Thus, the study provides medical rationale for decreasing the frequency of mammograms for post-menopausal women without a prior diagnosis of invasive breast cancer.

Duffy et al., [70] conducted a RCT to estimate the effect of mammographic screening at ages 40-48 years on breast cancer mortality. The study found that initiating mammography screening before the age of 50, starting at 40 or 41 years, was linked to a relative decrease in breast cancer mortality of 25%. However, this effect diminished after 10 years, while the absolute reduction remained consistent. It suggests that lowering the screening age from 50 to 40 years could potentially decrease breast cancer mortality in line with the results of this study. However, further research is necessary to determine whether advancements in early-detection technology and breast cancer treatment could alter the observed reduction in breast cancer mortality seen in randomized controlled trials of screening among individuals aged 40–49 years.

Ren et al, [18] systematically reviewed current breast cancer screening guidelines to provide evidence for good clinical practice in different countries. Various countries had slightly different approaches for women at average and high risk; additional details are provided in the discussion section below.

Van den Ende et al.'s systematic review explored evidence on the benefits and harms of breast cancer screening with mammography in women aged 40–49 years.[71] The results showed no significant effect on breast cancer mortality in women aged 40–49 years offered screening. For women aged 40-49 who were screened annually for five years, overdiagnosis of invasive breast cancer at 5 years post-cessation of the five-year study interval was estimated to be 32% and at 20 years post-cessation of the screening interval to be 48%. Based on the current evidence, extending mammography screening to younger age groups is not recommended.

*Table 9: Key findings from the studies focusing on screening and assessment pathways*

| Study | Location | Design | GRADE Level | Focus | Key Findings | Technology | Other Findings |
|---|---|---|---|---|---|---|---|
| Canelo-Aybar et al., 2022 [68] | Global | Systematic review | 2 | It explores benefits and harms of annual, biennial, or triennial breast cancer mammography screening for women at average risk of breast cancer. | ***Annual screening*** may decrease the risk of BC mortality compared to triennial screening among attenders to the prevalent screening (RR = 0.89, 95% CI 0.73−1.07). | Mammography alone (Annual, biennial or triennial) | Screening intervals have different trade-offs for each age group. The balance favours biennial screening in women 50–69. |
| Cutler et al., 2020 [69] | Global | Systematic review and meta-analysis | 2 | It estimates the likelihood that pre- or post-menopausal women with no prior diagnosis will remain free of IBC in order to enable evidence-based screening recommendations. | ***Reduced screening frequency for menopausal women*** as 94% of postmenopausal women with no prior IBC history are estimated to remain IBC diagnosis-free over their next 25 years, i.e., the end of life for many. | Mammography | It supports the medical justification for ***reducing the frequency of mammograms for menopausal women with no prior IBC diagnosis.*** |
| Duffy et al., 2020 [70] | United Kingdom | RCT | 2 | To estimate the effect of mammographic screening at ages 40–48 years on breast cancer mortality. | ***Annual mammographic screening at 40–49 years*** resulted in a reduction (25% reduction (RR 0.75, 95% CI=0.58 to 0.97; p = 0.03) in breast cancer mortality at 10 years; no statistically significant reduction was observed thereafter. | Mammography was studied. The study results obtained were prior the DM and universal two-view imaging, so the effectiveness nowadays may be greater than that observed in this study. | Reducing the lower age limit for screening from 50 to 40 years could potentially reduce breast cancer mortality. |
| Ren et al, 2022 [18] | Global | Systematic review | 2 | To provide references for good clinical practice in breast cancer screening in different countries. | ***Annual or biennial mammography*** for average-risk women aged 40-74 years and for high-risk populations, earlier age annual mammography or annual MRI recommended. | Mammography-most commonly suggested technology.<br>Other technologies such as DBT, US, MRI often recommended for high- risk women or as an adjunct to mammography | - |
| van Den Ende et al, 2017[71] | United Kingdom, Canada | Systematic review | 1 | To provide an overview of the evidence on the benefits and harms of breast cancer screening with mammography in women aged 40–49 years. | Extending mammography screening to younger age groups cannot be recommended yet. | Mammography | However, modelling studies indicate cost-effectiveness of breast cancer screening with digital mammography in women aged 40–49 years. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

The synthesised information on screening and assessment pathways obtained through the systematic review and proposed appropriate recommendations for breast cancer screening in Australia, covering both women at average risk and those at high risk* is included below.[31]

***For average risk women:***

***Age:***

- The majority of the breast cancer screening guidelines recommended mammographic screening for average risk individuals aged 40-74 years
- Optimal age recommended was 50-69 years

Upper and lower age limits that were recommended were varied. There was a suggestion that upper age be determined based on the individuals' health status.

***Screening Technology and Intervals:***

- Most evidence suggest annual or biennial mammography screening for average risk populations.
- Annual mammography or other technologies such as DBT, Ultrasound scan, or MRI often recommended for high-risk women or as an adjunct to mammography.

However, it must be acknowledged that the majority of the study results included in the systematic reviews were based on data collected prior to the increasing use of DBT or other adjunct technologies in global breast screening. Therefore, the type of technology recommended nowadays could differ from that observed in this study. Seeking expert opinion is therefore essential when making recommendations.

***For high-risk women:***

Most commonly studied risk factors included high breast density, personal history of pre-cancerous lesions and/or breast cancer; the family history of breast cancer; the known genetic predisposition of breast cancer; and the history of mantle or chest radiation therapy.

***Age***

- Starting age should be earlier than the average-risk group, but not less than 30 years

***Screening Technology and Intervals:***

- Annual MRI or other adjunct technologies in addition to mammographic screening were recommended.

Overall, for high-risk populations, due to an increased focus on precise risk management tailored to individual patients, there has been a shift from age-based screening recommendations to personalised suggestions for the recommendation of technologies used and screening intervals based on varied risk factors which may be an important consideration for population-based screening programs.

## 3.2 Priority populations

This section includes results on breast cancer screening participation and prioritisation for different priority populations including the following:

* Note that in this section, risk categories used for Australia are based on the definitions by RACGP: average risk, moderate risk, and high risk.

- People from Aboriginal and Torres Strait Islander backgrounds
- People living in rural and/or remote Australia and people from disadvantaged socio-economic backgrounds
- Culturally and linguistically diverse (CALD) populations
- People with family or personal history of risk of breast cancer: No studies that met the criteria for this systematic review were found regarding screening strategies for individuals with a family and personal history. However, some studies on screening assessment and pathways covered screening strategies for individuals with a family and/or personal history as part of the recommended approach for high-risk populations.

### 3.2.1 Aboriginal and Torres Strait Islander people

No systematic review studies that met the inclusion criteria were found regarding interventions that promote participation among the Australian Aboriginal and Torres Strait Islander people. In the absence of systematic review, a rapid review was included [72] that explored screening interventions published in the last six years for all types of cancers . It focused on its impact on increased participation in screening programs among global Indigenous or First Nations populations and considered factors such as knowledge, attitude, or intent to screen. It is important to note that all these findings are not applicable to Australian First Nations people. Some Australian studies which did not meet the strict inclusion criteria of this review were reviewed to provide guidance on developing the considerations for this population group and are included in section 4.1.2 .

This rapid review identified the following barriers that may impact screening participation rates among Indigenous populations:

- Attitudes and beliefs about cancer
- Health system challenges
- Lack of trusting relationships with health care providers and health organizations
- Lack of knowledge or awareness about cancer and cancer screening
- Barriers associated with demographics and health determinants
- Impacts of colonialism, discrimination, and/or racism.[72]

The rapid review [72] found only one study (Table 10 below) which focused on screening specifically for breast cancer by a First Nations population (Native American women). The study had a smaller sample size (n=21) and moderate response rate; therefore, caution must be exercised for generalizing the results. This study explored the change in the participation to the breast cancer screening as a result of the intervention that provided appropriate health education and accessible, convenient and culturally sensitive breast cancer screening services. The intervention comprised of both clinic- and community-based intervention components. The clinic-based component included a patient-doctor discussion on mammography, a mammography brochure and poster, a follow-up letter, and a flowchart used by the doctor when advising patients. The community-based component included six 90-min intergenerational discussion groups and a congratulatory gift upon completion of a mammogram.

None of the participants had a mammogram in the two years prior to the study. The study showed moderate success with over half of 21 participants (52%; n = 11; 95% CI = 30% to 74%) undergoing

mammography within six months after the end of the intervention. Additionally, nearly a third of 20 participants (30%; n = 6; 95% CI = 15% to 52%) improved their intention to undergo mammography during the intervention. Qualitative analysis of the study also showed that women better understood the importance of being aware of breast changes after the end of the intervention. See suggested future activities in section 5.

*Table 10: Key findings from the study focused on the participation of Indigenous or First Nations populations*

| Study | Location | Design | GRADE Level | Focus | Study Intervention | Key Findings: Participation Rates | Other Findings |
|---|---|---|---|---|---|---|---|
| Bryant et al., 2021 [72] | USA (American Indian, Alaskan Native), | Rapid Review* | 4 | Indigenous population (American Indian/Alaska Native women aged 52-74 years) participation to breast cancer screening | Clinic- and community-based components that promoted mammography screening through multiple system levels, including individual, family/social support, organizational/practice, and community & environmental levels | 30% improved their intention to do a mammogram. 52% had a mammogram by six months post-interventions that improved knowledge, attitude, or intention to screen. | The use of community coordinators who spoke to participants in their native languages may have promoted a better understanding of the screening program by overcoming language and cultural barriers. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.2.2 People living in rural and remote areas and/or people from disadvantaged socio-economic backgrounds

There were two systematic reviews [73, 74] (

* For priority populations, due to a scarcity of high-level evidence, Level 4 evidence based on the relevance and importance criteria was included.

Table *11* below) exploring the effectiveness of mobile mammography clinics in reaching underserved rural and remote populations, many of whom came from disadvantaged socio-economic backgrounds. Although the included studies in these systematic reviews were not conducted in Australia, the challenges faced by rural and remote populations and the interventions aimed at improving their participation in screening are likely to be similar, as evidenced by other similar studies.

*Table 11: Key findings from the studies focusing on the participation of people living in rural and/or remote areas*

| Study | Location | Design | GRADE Level | Focus | Key Findings | Factors influencing participation | Other Findings |
|---|---|---|---|---|---|---|---|
| Abdel-Aleem et al, 2016 [73] | USA | Systematic review | 2 | Effectiveness of offering onsite mobile mammography combined with health education in increasing breast cancer screening rates compared to offering health education only | Women offered mobile mammography and health education may be more likely to undergo mammography within three months of the intervention than those in the comparison group (55% Vs 40%; odds ratio (OR) 1.83, 95% CI 1.22 to 2.74) | Women living in remote or difficult-to-reach areas have poor access to screening services. | The total cost per patient screened may be higher for mobile units than for static clinics. |
| Vang et al., 2018 [74] | USA | Systematic review | 3a | Promoting mammographic screening participation among underserved women (rural/remote and with lower SES background ) | Mobile mammography clinics may be effective at reaching underserved women. Adding patient navigation to mobile mammography programs may promote attendance at mobile sites and increase follow-up adherence. | Most of the women screened in mobile units were from ethnic minority group, low income, and/or uninsured. Other challenges included patient retention, patient follow-up, and women inaccurately perceiving their breast cancer risk. | Mobile mammography users had higher rates of being recalled for further imaging than users at fixed sites (16% vs 13%). This may have been due to a lack of previous images and follow-up evaluation. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

Overall, the findings obtained from both systematic reviews indicate that mobile mammography programs effectively reach underserved women. It increased the breast screening participation among rural and/or remote women in USA compared to static clinic for mammography screening (55% Vs 40%; OR 1.83, 95% CI 1.22 to 2.74) [73].

In Vang et al's study [74], the majority of the women were from racial/ethnic minority backgrounds, primarily African American and Hispanic, uninsured, and from low-income households. Mobile mammography participants demonstrated notably low rates of adherence to screening guidelines, with only 12% to 34% adhering to the 1-year guideline and 40% to 48% adhering to the 2-year guideline. These figures fall below USA national averages of 50% for the 1-year guideline and 64% for the 2-year guideline, significantly lagging behind the Healthy People 2020 target of 81% screening among women aged 50 to 74. These findings highlight the disparities in breast cancer screening among underserved women and emphasize the importance of employing outreach strategies, such as mobile mammography, to enhance access and adherence to screening guidelines. Some evidence included in this systematic review suggests that underserved women, particularly African American women, may benefit from initiating screening at age 40 or even earlier, contrary to the recommendations of the US Preventive Services Task Force.[75] Increasing breast cancer risk awareness among underserved women is crucial to address existing disparities. The review also indicates that mobile mammography users

typically do not return to the same mobile unit for subsequent screenings. This trend may be attributed to the transient lifestyles of mobile mammography users, particularly those from low-income households. Additionally, concerns regarding image quality and service standards may also discourage women from revisiting mobile clinics. See suggested future activities in section 5.

### 3.2.3 People from culturally and linguistically diverse backgrounds

There were four studies[76-79] that met the inclusion criteria and explored interventions to improve breast screening participation among people from culturally and linguistically diverse backgrounds. In general, all studies suggest that providing culturally sensitive, tailored education programs is key to improving screening participation among culturally and linguistically diverse women. However, consideration needs to be given to the individual requirements of each cultural group.

A systematic review of UK-based, qualitative studies concerning challenges faced by Black, Asian and Minority Ethnic (BAME) women revealed three overarching themes: knowledge-related, access-related and cultural-related factors. The emphasis of the ***importance of knowledge was highlighted*** by all studies included in the qualitive synthesis; it identified a lack of knowledge about the process and role of breast cancer screening as a key barrier to screening attendance.[76]

Brevik et al's study [77] provided evidence that ***culturally tailored education increased attendance at mammography by 18%*** (RR = 1.18, 95% CI, 1.091.28, P < .001) among ethnic minority women. Further study by Brevik et al [78] explored whether women's screening histories impact mammography screening attendance after tailored education. The results indicated that tailored education increased attendances at mammography by 54% among the women who had never been screened and by 26% among ever screened women. Although the increase is more than double among never screened women than among ever screened women, the difference was not statistically significant. Nevertheless, the study suggested that tailored education may increase breast screening attendance, both among never and ever screened women.

Kelly et al's study [79] determined type of intervention that have successfully increased screening uptake amongst minorities. The study examined fourteen studies exploring interventions to improve breast cancer screening and the technology assessed was mammography. Various studies examined differing interventions (Appendix 6.4). The study highlighted the importance of tailored approach for each population, taking into account local and cultural factors. See suggested future activities in section 5.

*Table 12: Key findings from the studies focusing on the participation of the culturally and linguistically diverse population*

| Study | Location | Design | GRADE Level | Focus | Study Intervention | Key Findings: Participation Rates | Other Findings |
|---|---|---|---|---|---|---|---|
| Baird et al., 2021 [76] | United Kingdom | Systematic review: Qualitative synthesis | 3 | To identify the barriers to UK Black, Asian and Minority Ethnic (BAME) women attending breast screening and provide evidence for solutions to the public health problem of ethnic variation within screening attendance. | Providing culturally sensitivity educational interventions and educating healthcare staff on the public health promotion is important | Knowledge-, access- and cultural-related factors were identified as particularly influential factors specific to ethnic minority women. | In addition to the need for community interventions and national public health campaigns, the importance of public health promotion at the point of care is highlighted. The patients' decision to attend screening is directly influenced by their encounters with healthcare staff. |
| Brevik et al., 2020 [77] | Europe, the United States, Canada, Australia, and New Zealand | Systematic review: Meta-analysis of RCTs | 1 | To determine the effectiveness of culturally tailored education on attendance at breast and cervical cancer screening among ethnic minority women (women from Asian, African, Hispanic, or Oceanian origin). | Culturally tailored educational interventions may increase attendance at breast and cervical cancer screening among ethnic minority women. | Culturally tailored education increased attendance at mammography by 18% among ethnic minority women. | - |
| Brevik et al., 2021 [78] | Global | Systematic Review and Meta-analysis | 1 | To assess if women's screening histories (never screened or ever screened) impact mammography screening attendance after tailored education. | Meta-analysis indicated that tailored education gives statistically increased attendances at mammography of 54% among the women who had never been screened and 26% among ever screened women. | After tailored education, RR for mammography attendance for women never screened was 1.54 (95% CI, 1.24–1.91) RR for attendance for women ever screened was 1.26 (95% CI, 1.11–1.43; P< 0.001). | Although these findings must be interpreted with caution, the findings suggest that women's screening history is an important yet often ignored variable that affects the effectiveness of tailored education on mammography screening attendance. |
| Kelly et al., 2018 [79] | Global | Systematic review | 2 | To determine which interventions have successfully increased screening uptake amongst minorities | Interventions studied included mass media, video, print material, lay health workers, navigator and group discussion | The media-alone group had increased participation baseline of 74% to 75.6% post-intervention (P = .37) with the LHW group increasing from 64.7% to 82.1% (P < .001). | The study highlighted the importance of tailored approach for each population, taking into account local and cultural factors. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

While the focus of this systematic review did not extend to the general population's participation in breast cancer screening, two high quality randomised controlled trials on this topic did meet other inclusion criteria of this review. These studies explore the role of specific interventions to increase screening participation, and were found and included as their key terms matched the search terms used the review (specifically 'eligibility' and 'socioeconomic status'). The two studies were conducted in the United Kingdom, which has a similar health system to Australia, and therefore the results of these studies are likely to be relevant for considering the role of interventions to increase screening participation among Australian women, including those from priority populations, despite not being designed to evaluate outcomes of these subgroups.

The finding of RCT conducted by Allgood et al assessed the effect on participation of sending invitations for breast screening with a timed appointment to women who did not attend their first offered appointment.[80] The results showed increased participation within 90 days of the first offered appointment in the intervention group (22%) than in the control group (12%); Relative risk of 1·81 (95% CI 1·70–1·93; p<0·0001). The study by Kerrison et al proposes that text-message reminders sent by GP practices are a cost-effective and easier to implement intervention to improve screening participation. By improving patient mobile numbers in GP records, it is possible to increase attendance for screenings.[81] Text reminders can also be implemented to increase participation in other cancer screening programs.

*Table 13: Key findings from the studies assessing interventions to increase uptake of breast screening participation*

| Study | Location | Design | GRADE Level | Focus | Study Intervention | Key Findings: Participation Rates | Other Findings |
|---|---|---|---|---|---|---|---|
| Allgood et al, 2017[80] | England | RCT | 2 | To assess the effect on screening participation of sending invitations for breast screening with a timed appointment to women who did not attend their first offered appointment within the NHS Breast Screening Program | Sending invitations with a timed appointments for first time non-attenders | Increased participation nearly twice: RR of participation 1·81 (95% CI 1·70–1·93; p<0·0001) | Policy of second appointments with fixed date and time for non-attenders of breast screening is effective in improving participation and the strategy can be easily implemented by the screening sites. |
| Kerrison et al., 2015[81] | United Kingdom | RCT | 2 | To explore whether text message reminders improved uptake and reduced missed appointments for prevalent round of screening | Text message reminder 48 hours prior to appointment with reminder of time, day, venue of the appointment | Uptake of breast screening was 59.1% among women in the normal invitation group and 64.4% in the text-message reminder group (OR 1.26, 95% (CI): 1.05–1.48, p=0.01). | Sending women a text-message reminder before their 1st breast screening appointment significantly increased attendance. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

## 3.3 Screening technologies

This section presents the results of the evidence available on the use of technologies for breast cancer screening. Available evidence is for: molecular breast imaging, contrast-enhanced mammography, artificial intelligence, ultrasound, magnetic resonance imaging, and digital breast tomosynthesis. These technologies have generally been assessed as supplemental tools alongside full-field digital mammography and compared to mammography alone.

Full-field digital mammography is the standard technology used in the BreastScreen Australia program. The latest monitoring report from the program found that the invasive breast cancer rate within the program was 6.05 per 1000 screens, with an interval cancer rate of 0.91 per 1000 screens. The percentage of participants who were recalled for further assessment was 11.1% in the initial screening round, and 4.0% in subsequent screening rounds.[27]

This systematic review found 42 papers relating to the use of breast cancer screening technologies. Many of these papers were systematic reviews with or without meta-analysis, which means there is likely overlap within the studies which were analysed by various researchers. Some of the studies included in this review were reviews of multiple technologies, and therefore are included in several sections of the results below. Where papers examined the role of risk factors, the results are presented below with reference to the risk factors, which mainly relates to breast density.

### 3.3.1 Molecular breast imaging

Only one of the included systematic review and meta-analysis assessed the role of molecular breast imaging (MBI) in screening, as part of many different supplemental imaging technologies. This review included two studies examining the role of MBI as a supplemental tool to mammography. They estimated that using molecular breast imaging to screen mammography-negative women could lead to an additional 9 breast cancers being detected per 1000 screens.[82] One other study made a reference to MBI, but this was a review of the global guidelines for breast cancer screening, which noted that there was not sufficient data to support the use of molecular breast imaging as a screening tool.[18] A summary of this study is provided in Table 14.

*Table 14. Outcomes and key findings from the studies focusing on molecular breast imaging*

| Study | Locations | Design | GRADE Level | Focus | Outcomes/Key Findings |
|---|---|---|---|---|---|
| Mizzi et al., 2022[82] | Global | Systematic Review and Meta Analysis | 3 | Examining the effectiveness of supplementary imaging modalities for breast cancer screening in women with dense breasts. | • Additional 9 breast cancer cases detected per 1,000 women.<br>• Recall rate of 82 per 1,000 women. |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.3.2 Contrast-enhanced mammography

Three of the included studies assessed the use of contrast-enhanced mammography (CEM) as a supplemental imaging modality to digital mammography.[82-84] These studies were all reviews (two systematic review with meta-analyses, and one umbrella review with a primary studies analysis)

assessing the use of different types of supplemental imaging modalities against mammography alone, with a focus on breast density.

Two of the reviews included just one study regarding CEM in their review, and this was a retrospective cohort study.[82, 84] The study found high cancer detection rates using CEM when compared with mammography alone, with an incremental cancer detection rate of 13.1 per 1000 screens.[85] However, this retrospective study was conducted in a population with a high rate of higher breast density and family histories of breast cancer, and therefore may not be applicable to population-based screening.

The final systematic review included studies relating to both breast cancer screening and diagnosis.[83] All four of the studies about the use of CEM in this paper were relating to its use as a diagnostic tool, rather than in screening. The results showed that contrast-enhanced mammography alongside mammography could increase cancer detection rates by 37% in a diagnostic setting, but no results were reported about the technology's use in population-wide screening.[83] The outcomes of these papers are presented in Table 15.

*Table 15. Outcomes and key findings from the studies focusing on contrast-enhanced mammography*

| Study | Location | Design | GRADE Level | Focus | Outcomes/Key Findings |
|---|---|---|---|---|---|
| Hadadi et al., 2021[83] | Global | Systematic Review and Meta Analysis | 3 | Comparing the diagnostic performance of mammography alone versus mammography combined with adjunctive imaging modalities. | • Cancer detection rate increased by 37% in a diagnostic setting |
| Lobig et al., 2023[84] | Global | Systematic Review | 1 | Assessing the screening performance of supplemental imaging modalities for women with dense breasts. | One CEM study (Sorin et al.[85]):<br>• Incremental cancer detection rate of 13.1 per 1000 screens in high-risk population |
| Mizzi et al., 2022[82] | Global | Systematic Review and Meta Analysis | 3 | Examining the effectiveness of supplementary imaging modalities for breast cancer screening in women with dense breasts. | One CEM study (Sorin et al.[85]):<br>• Incremental cancer detection rate of 13.1 per 1000 screens in high-risk population |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.3.3 Artificial intelligence (machine reading)

The systematic review search identified four studies which met the inclusion criteria relating to the role of artificial intelligence (AI) to support breast cancer screening.[86-89] As described in the methodology, the searches and inclusion criteria focused on machine reading, as the area of artificial intelligence with the largest research base. All of these papers assessed the use of machine reading alongside mammography, with one of those papers also examining AI with digital breast tomosynthesis.[86-89] Three of the four studies were systematic reviews, with one randomised controlled trial. These papers are summarised in Table 16.

Two of the systematic reviews investigating the combination of AI and radiologist interpretations of mammograms reported that when AI and a single-read mammogram are used, small improvements in

diagnostic accuracy (measured by area under the curve, AUC) could be seen. This improvement was less pronounced when standalone AI was compared to radiologists.[86, 89] The other systematic review about AI and mammography found mixed results in the assessment of the accuracy of AI when compared to or combined with radiologist's interpretation of mammography, showing that AI was often less accurate than both a single radiologist or a consensus of two or more radiologists. This study concluded that the evidence was insufficient to recommend AI be introduced into breast cancer screening programs.[87]

The randomised controlled trial exploring the use of AI with mammography used a machine reading system to create computer-generate risk scores, which were used to triage screening examinations to be assessed by either a single radiologist, or two radiologists. The study randomly assigned 80,000 women to this AI system, or a standard double reading without AI. The results showed that cancer detection rates, recall rates, and false positive rates were not significantly different between the intervention and control groups, suggesting that the use of this AI triaging system was as accurate as mammograms which had been read by two radiologists. The trial also assessed the time needed for interpretation, and found a 44.3% reduction in workload in the AI intervention group.[88] This randomised controlled trial will also report on the endpoint of interval cancer rate of the 100,000 enrolled participants, and these results will be expected by 2025.[88]

Finally, the systematic review which also explored the role of AI in digital breast tomosynthesis found that the systems used for AI in mammography can be easily adapted. They also found that using AI with tomosynthesis had an accuracy level either higher than or as good as that of tomosynthesis which has been interpreted by two radiologists. However, this section of the systematic review included just four studies exploring AI with tomosynthesis.[89] See suggested future activities in section 5.

*Table 16. Outcomes and key findings from the studies focusing on AI (machine reading)*

| Study | Location | Design | GRADE Level | Focus | Outcomes/Key Findings |
|---|---|---|---|---|---|
| Anderson et al., 2022[86] | Global | Systematic Review | 3 | To describe the current state independent external validation of AI technologies for screening mammography. | • Statistically significant improvement in AUC for radiologist + AI vs radiologist alone |
| Freeman et al., 2021[87] | Global | Systematic Review | 3 | To examine the accuracy of artificial intelligence for the detection of breast cancer in mammography | • Mixed results when comparing AI to single and double radiologist reads |
| Lång et al., 2023[88] | Sweden | Randomised Controlled Trial | 1 | To assess the clinical safety of an AI-supported screen-reading protocol compared with standard screen | • CDR of 6.1 per 1000 in intervention, 5.1 per 1000 in control (no significant difference)<br>• Recall rates of 2.2% in intervention, 2% in control (no significant difference)<br>• False positive rate of 1.5% (no difference in groups)<br>• 44.3% reduction in workload |
| Malliori et al., 2022[89] | Global | Systematic Review | 3 | To gather evidence on overall performance and readiness of AI to be deployed in population screening practice. | • Single reading + AI is comparable to a double human read |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.3.4 Ultrasound

Twelve studies were found about the use of ultrasound alongside mammography which met this systematic review's inclusion criteria.[46, 82-84, 90-97] As a supplement to mammography, seven of these studies assessed handheld ultrasound (HHUS), four assessed both handheld and automated ultrasound, and one meta-analysis analysed results of studies relating only to automated breast ultrasound (ABUS). Ten of the twelve included papers about ultrasound were systematic reviews, umbrella reviews, or meta-analyses, and the final two were randomised controlled trials.

The results of the systematic reviews and randomised controlled trials examining the use of ultrasound alongside mammography were varied. Most of the studies found that using handheld ultrasound as a supplement to mammography could lead to an extra 2 – 5.5 cancers per 1000 screens being detected when compared to mammography alone.[46, 82-84, 91, 92, 96] One of the meta-analyses found that supplemental ultrasound could detect 97% of occult breast cancers which had been missed by mammography.[94] This increase in cancer detection rates was particularly pronounced in women who had high breast density, in the studies which examined the results by this risk factor.[84, 95] Automated breast ultrasound appears to increase the cancer detection rates slightly more than handheld ultrasound, to a rate of approximately 6.6 per 1000 screens.[46, 82-84, 90]

Some of the papers included in the systematic review also assessed other outcomes such as interval cancer and recall rates. Of those, the addition of ultrasound to mammography was found to decrease interval cancer rates by between 1.5 – 5 per 1000 screens.[91, 96, 97] However, many of the studies found that the use of supplemental ultrasound increased recall rates, false positive rates, and biopsy rates significantly. When compared to mammography alone, studies estimated that both false positive rates and recall rates were approximately doubled when supplemental ultrasound was used.[82-84, 91-93, 97] Table 17 on the next page presents the outcomes and key findings of the papers examining the use of supplemental ultrasound.

*Table 17. Outcomes and key findings from the studies focusing on ultrasound*

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Gatta et al., 2023[90] | Global | Meta Analysis | 1 | To investigate the effectiveness of supplementing screening mammography with three-dimensional automated breast ultrasonography (3D ABUS) | 51.5% increase in CDR when FFDM combined with 3D ABUS (28.1 vs 17.4 per 1000) | - | Increased recall rate (11.89 per 1000) | - | Smaller lesion size (13.62 mm vs 13.86 mm) |
| Glechner et al., 2023[91] | Global | Systematic Review | 2 | To assess the comparative effectiveness and safety of mammography in combination with breast ultrasonography versus mammography alone | Increased CDR - 5.0 vs 3.2 per 1000 women screened | Decreased ICR – 5 vs 10 per 10,000 women screened | - | Increase in false positives (123 vs 86 per 1000 women) | Additional 3 cases per 1000 in women with dense breasts, no significant difference in non-dense breasts |
| Hadadi et al., 2023[83] | Global | Systematic Review and Meta Analysis | 3 | Comparing the diagnostic performance of mammography alone versus mammography combined with adjunctive imaging modalities. | 49% increase in CDR for HHUS, 44% increase in CDR for ABUS | - | Increased recall (103% increase for HHUS, 90% increase for ABUS) | - | - |
| Harada-Shoji et al., 2021[97] | Japan | Randomised Controlled Trial | 2 | To evaluate the performance of adjunctive ultrasonography with mammography for breast cancer screening, according to differences in breast density. | Increased CDR – 68 vs 38 per 1000 screenings | Reduced ICR (0.5 vs 2 per 1000) | Increased recall 13.8% vs 8.6% | - | Similar results between both dense and non-dense breasts |
| Hussein et al., 2023[46] | Global | Systematic Review and Meta Analysis | 3 | To compare clinical outcomes of the most common available supplemental screening modalities | Incremental CDR of 4.3 per 1000 women for HHUS and ABUS | ICR of 0.6 for HHUS, and 3.0 for ABUS per 1000 | - | - | - |
| Lobig et al., 2023[84] | Global | Systematic Review | 1 | Assessing the screening performance of supplemental imaging modalities for women with dense breasts. | Estimated CDR of 7.1 per 1000 (HHUS) and 12.3 per 1000 (ABUS) | ICR for 2 studies were 0 per 1000 (but had a follow up period of 1 year) | - | - | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Mizzi et al., 2022[82] | Global | Systematic Review and Meta Analysis | 3 | Examining the effectiveness of supplementary imaging modalities for breast cancer screening in women with dense breasts. | Incremental CDR of 3 for HHUS and 6 for ABUS per 1000 women | - | Recall rates of 13.3% for HHUS and 13.2% for ABUS | - | - |
| Rebolj et al., 2018[92] | Global (mainly USA, Italy, South Korea) | Systematic Review and Meta Analysis | 3 | To measure the relative increase in cancer detection from supplemental ultrasound screening | Incremental CDR of 4 per 1000 women | - | Recall rates doubled | - | - |
| Shen et al., 2015[93] | China | Randomised Controlled Trial | 2 | To compare the performance of ultrasound and mammography | Supplemental ultrasound increased CDR – 2.02 vs 0.72 per 1000 women | - | - | No statistically significant difference | - |
| Yang et al., 2020[94] | USA, South Korea, Italy, Singapore, China, Japan, Sweden | Systematic Review and Meta Analysis | 1 | To investigate the performance of primary ultrasound and supplemental ultrasound (S-US) | Supplemental ultrasound CDR was 3 per 1000 screenings | - | - | - | Supplemental ultrasound could detect 96% of occult breast cancers missed by mammography |
| Yuan et al., 2020[95] | USA, Korea, Italy, Singapore, Israel, Austria, Sweden, Thailand | Systematic Review and Meta Analysis | 3 | Examining the diagnostic performance of mammography alone plus US for breast cancer in women with dense breasts. | Incremental CDRs of 1.4 – 7.7 per 1000 | - | - | - | - |
| Zeng et al., 2022[96] | USA, Netherlands, Japan, Italy | Systematic Review | 2 | To explore the effect of supplemental screening compared to mammography alone. | Incremental CDR of 5.6 per 1000 screenings | ICR for ultrasound was 0.49 – 1.9 per 1000 vs 0.45- 5 per 1000 for mammography | 12.6% increased recall rate | - | - |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.3.5 Magnetic resonance imaging

Eight papers were identified by this systematic review met the inclusion criteria for the use of magnetic resonance imaging (MRI) to supplement mammography in breast cancer screening.[46, 82-84, 96, 98-100] MRI is more commonly used in diagnosis than in screening, and therefore there have been a limited number of studies exploring this topic. The studies included within this review consisted of five systematic reviews (with or without meta-analysis), one umbrella review, and two randomised controlled trials. The majority of these papers focused on women with a high risk of breast cancer, especially relating to high breast density.

The papers included in this systematic review found that MRI as a supplemental technology increased Cancer detection rates significantly compared to the use of mammography alone, as shown in the summary in Table 18. The studies found that incorporating MRI to supplement mammography could increase the number of cancer detections by 10 – 25 cases per 1000 screens.[46, 82, 84, 96, 100] The two randomised controlled trials explored the use of supplementary MRI in women who had either extremely dense breasts, or a family history of breast cancer. These studies found cancer detection rates of 14.2 and 16.5 per 1000, compared to 4.9 for mammography alone.[99, 100] Interval cancer rates were also found to have decreased among women who received supplementary MRI, with studies reporting a reduction from 5 to 2.5 per 1000, and from 0.45 – 5 to 0.3 – 0.8 per 1000 when compared to mammography alone.[84, 96, 99] Where reported, MRI supported the consistent detection of earlier-stage, smaller cancers when compared to mammography.[96, 100]

One systematic review with a meta-analysis found that adding MRI to mammography increased the cancer detection rate by 116%, but also increased the recall rate by 171%, and increased the rate of false positives by between three and six times the rate of when mammography is used alone.[83] These increased false positive and recall rates were echoed by some of the other included studies which reported these outcomes, which found false positives rates of 79.8 – 156 per 1000, and recall rates varying from 73 – 94.9 per 1000.[82, 84, 99, 100] Finally, a systematic review assessing the global guidelines for breast cancer screening found that annual MRI is already recommended for women at high risk (due to personal history of pre-cancerous lesions, a family history of breast cancer, or high breast density) in some countries, including the USA, Brazil, and some European countries.[18] See suggested future activities in section 5.

*Table 18. Outcomes and key findings from the studies focusing on magnetic resonance imaging*

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Ahmad et al., 2022[98] | Global | Systematic Review | 3 | To assess the effectiveness of MRI in screening women for breast cancer | - | - | - | - | MRI was more precise and sensitive than mammography for high-risk women, but evidence on cost-effectiveness was limited |
| Bakker et al., 2019[99] | Netherlands | Randomised Controlled Trial | 2 | The RCT to study the effect of supplemental MRI on the incidence of interval cancers in women with extremely dense breast tissue. | CDR of 16.5 per 1000 screenings | Reduced ICR (2.5 vs 5.0 per 1000 screenings) | Recall rate of 94.9 per 1000 screenings | False positive rate of 79.8 per 1000 screenings | - |
| Hadadi et al., 2021[83] | Global | Systematic Review and Meta Analysis | 3 | Comparing the diagnostic performance of mammography alone versus mammography combined with adjunctive imaging modalities | 116% increase in cancer detection rates (dense breasts), 78% increase in non-dense breasts | - | Large increase in recall rates with supplemental MRI (171% for dense breasts, 201% for non-dense breasts) | - | - |
| Hussein et al., 2023[46] | Global | Systematic Review and Meta Analysis | 3 | To compare clinical outcomes of the most common available supplemental screening modalities | Incremental CDR of 25.7 per 1000 screenings | ICR of 0.8 per 1000 screenings | - | - | Invasive cancer detection rate of 19.9 per 1000 screenings |
| Lobig et al., 2023[84] | Global | Systematic Review | 1 | Assessing the screening performance of supplemental imaging modalities for women with dense breasts. | CDR ranged from 3.5 – 28.6 per 1000 screenings | - | - | - | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Mizzi et al., 2022[82] | Global | Systematic Review and Meta Analysis | 3 | Examining the effectiveness of supplementary imaging modalities for breast cancer screening in women with dense breasts. | Incremental CDR of 20 per 1000 screenings | - | Recall rates of 73 per 1000 women | - | - |
| Saadatmand et al., 2019[100] | Netherlands | Randomised Controlled Trial | 2 | To compare annual MRI and clinical breast examination plus biennial mammography versus screening with annual mammography and clinical breast examination | Increased CDR of 14.2 vs 4.9 per 1000 | No significant difference | - | Higher false positive rate – 156 vs 90 per 1000 | - |
| Zeng et al., 2022[96] | USA, Italy, Spain, Norway, Australia | Systematic Review | 2 | To explore the effect of supplemental screening compared to mammography alone. | Higher CDR range of 14.2-16.5 vs 2.7-7.4 per 1000 screenings | Reduced ICR – 0.3-0.8 vs 0.45-5 per 1000 | Incremental recall rate of 9.5% | - | Smaller median tumour size (9-9.5mm vs 17mm) |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

### 3.3.6 Digital breast tomosynthesis

Digital breast tomosynthesis was the technology with the largest evidence base within this systematic review findings. A total of 26 papers on the use of digital breast tomosynthesis in breast cancer screening that met the inclusion criteria were found.[82-84, 89, 101-122] Eleven of the included studies were randomised controlled trials, and the other 15 were systematic reviews, umbrella reviews, or meta-analyses. Most of the studies included assessed tomosynthesis compared to digital mammography, although there were some studies which explored the use of synthetic mammography, which uses the data from tomosynthesis to create 2D images similar to a digital mammogram.

Cancer detection rates were reported by 23 of the included studies, and 22 of these studies found an increase in cancer detection rates with the addition of digital breast tomosynthesis compared to mammography alone. The method of reporting cancer detection rates varied among the studies, but these rates with the use of tomosynthesis ranged from an increase of 33% – 60%, with incremental cancer detection rates of 1.6 – 4.1 per 1000 screens being reported. The highest cancer detection rate of 9.06 per 1,000 screens was reported in a meta-analysis when digital breast tomosynthesis was used for breast cancer screening, compared to a detection rate of 5.7 per 1,000 screens when digital mammography was used alone.[112]

Two of the included studies compared the difference in cancer detection rates when tomosynthesis was used to screen women with dense and non-dense breasts. These papers both found that the incremental cancer detection rate was more pronounced in women with dense breasts. One systematic review and meta-analysis found a 32% increase in cancer detection rates for the use of tomosynthesis over digital mammography for women with non-dense breasts, but this number rose to 60% for women with dense breasts.[105] Similarly, another systematic review and meta-analysis reported an incremental cancer detection rate of 1.6 per 1000 screens for women with non-dense breasts, and 3.5 per 1000 screens in women with dense breasts when digital breast tomosynthesis was used.[111]

Studies also reported other outcomes such as interval cancer rates, recall rates, and false positive rates. Four studies reported outcomes on interval cancer rates, and all of these found that there was no significant difference in interval cancer rates when tomosynthesis was compared to mammography alone.[101, 108, 109, 122] Findings relating to the recall rates with the use of digital breast tomosynthesis found mixed results when compared to mammography alone. Of the 17 studies which reported recall rates, six found no significant difference, five found increased recall rates of between 14% and 24%, but another six papers found decreased recall rates, with reductions of between 2% and 30%.[82, 83, 101-107, 111-116, 118, 119, 122] The recall rates were also found to be higher in women with higher breast density. These varied results do not provide an overall consensus on what the introduction of digital breast tomosynthesis would do to recall rates in a national screening program.

Similarly, the results relating to false positive rates associated with the use of digital breast tomosynthesis were heterogeneous. Some studies found that false positive rates increased (with one study calculating this to be increased by 22%, and another reporting an increase of 3 false positive results per 1000 screens), while others found that false positive rates were decreased, with one study reporting a reduction of 9.3 false positive results per 1000 screens.[83, 101-103, 106, 115, 117] There were some differences associated with breast density, with one paper reporting a reduction in false positive rates in women with low breast density, but no difference in women with high breast density. As a final outcome, two studies included in this systematic review reported the difference in time associated with

interpreting digital breast tomosynthesis screens compared to mammography screens. One of these studies estimated that 70% more time was needed for interpretation.[117] The other study reported that an extra 27 seconds was needed for the interpretation of tomosynthesis, and an extra 47 seconds was needed for a consensus to be reached.[107]

The role of mammography when using digital breast tomosynthesis was also a key topic in many of the included papers. While many of the other technologies were used as a supplement to full-field digital mammography, tomosynthesis offers another option, by using synthetic mammography alongside the tomosynthesis. Synthetic mammography creates 2D images, similar to those from traditional mammography, using the same data from the tomosynthesis scan. Studies which used synthesised mammography found similar results to those which used digital mammography alongside tomosynthesis.[104, 106, 115, 119, 120] Two studies compared the use of synthetic and digital mammography with tomosynthesis, and found no difference in cancer detection rates.[103, 122] One of these studies was a systematic review and meta-analysis, which also found that using synthetic mammography plus tomosynthesis did not impact interval cancer rates, reduced recall rates, and increased the positive predictive value of screening compared to using digital mammography plus tomosynthesis, while also reducing the radiation dose of screening.[122] Table 19 presents the key findings and outcomes of the digital breast tomosynthesis studies included in this review. See suggested future activities in section 5.

*Table 19. Outcomes and key findings from the studies focusing on digital breast tomosynthesis*

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Amaroli et al., 2022[101] | Italy | Randomised Controlled Trial | 2 | To prospectively compare DBT with DM in a population-based screening setting. | 44% higher CDR at initial screening | ICD did not differ significantly | 24% higher recall rate | 22% increase in false positives | - |
| Coop et al., 2016[102] | Global | Systematic Review | 3 | To assess the efficacy of tomosynthesis as a screening tool for breast cancer. | CDR ranged from 5.4 – 8.1 per 1000 screens (vs 4.0 – 6.1 per 1000) | - | Recall rate ranged from 5.3% - 9.1% (vs 6.1% - 12%) | Reduced false positives | - |
| Georgi Rossi et al., 2024[103] | Italy | Randomised Controlled Trial | 2 | To compare the screening performance of digital tomosynthesis versus mammography | 51% increase in CDR (incremental CDR of 2.6 per 1000 screenings) | - | Increased recall (5.84% vs 4.96%) | False positives increased from 4.43% to 5.05% | - |
| Hadadi et al., 2021[83] | Global | Systematic Review and Meta Analysis | 3 | To compare the diagnostic performance of mammography alone versus combined with adjunctive imaging modalities | 38% increase in CDR for dense breasts, 9% increase in CDR for non-dense breasts | - | No significant difference in recall rates for dense breasts, 17% reduction in recall for non-dense breasts | - | - |
| Heindel et al., 2022[104] | Germany | Randomised Controlled Trial | 2 | To compare digital breast tomosynthesis plus s2D mammography with digital screening mammography for the detection of invasive breast cancer. | Invasive CDR of 7.1 per 1000 vs 4.8 per 1000 screenings (increase of 48%) | - | No significant difference in recall rates | - | - |
| Heywang-Köbrunner et al., 2022[105] | Australia, Europe (Spain and Italy) | Systematic Review and Meta Analysis | 2 | To compare DBT +s2D to DM alone in screening | 40% increase in CDR (32% for low breast density, 60% for high breast density) | - | 29% reduction in recall rates (35% for low breast density, 16% for high breast density) | - | - |
| Hodgson et al., 2016[106] | USA, Italy, Norway | Systematic Review | 3 | To investigate the relative performance of digital breast tomosynthesis (DBT) compared with FFDM alone | Incremental CDR of 2.43 per 1000 screenings | - | Reduction in recall rate of 6.6 per 1000 screens | Reduction in false positives of 9.3 per | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1000 screens | |
| Hofvind et al., 2019[107] | Norway | Randomised Controlled Trial | 2 | To investigate performance measures and economic aspects of using digital breast tomosynthesis and synthetic 2D mammograms versus digital mammography alone | No significant difference between groups (0.66% vs 0.61%) | - | - | - | Mean time spent on screen reading was 1m 6s for DBT vs 39s for DM. Mean time spent on consensus was 2m 51s for DBT vs 2m 4s for DM |
| Hofvind et al., 2021[108] | Norway | Randomised Controlled Trial | 2 | To follow women randomised to screening with DBT or DM | - | ICR of 1.4 vs 2.0 per 1000 screenings | - | - | - |
| Houssami et al., 2021[109] | Norway, Sweden, Italy | Meta Analysis | 3 | To undertake a collaborative individual participant data meta-analysis to assess the impact of DBT screening (versus DM) on interval BC rates in population screening | - | No significant difference in ICR | - | - | Interval cancers were more frequently node-negative with DBT |
| Houssami et al., 2021[110] | Norway, Sweden, Italy | Meta Analysis | 3 | A study-level meta-analysis aiming to examine the effect of DBT versus mammography screening | CDR of 9.03 per 1000 vs 5.95 per 1000 for DM | ICR of 1.5 vs 1.75 per 1000 screenings | - | - | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Li et al., 2022[111] | USA, Europe | Systematic Review and Meta Analysis | 3 | To determine if DBT screening is detecting differentially from DM screening | Incremental CDR for high density in European studies = 3.5, US studies = 1.5 per 1000. Low density European studies = 1.6, US studies = 0.8 per 1000. | - | Incremental recall rate for high density in European studies = +1%, US studies = -3.5%. Low density European studies = +0.2%, US studies = -1.8%. | - | - |
| Libesman et al., 2022[112] | Global | Meta Analysis | 3 | To estimate and compare the breast cancer detection rate for DBT and DM screening | CDR of 9.1 per 1000 screenings vs 5.7 per 1000 screenings | - | Recall rate increased from 3.59% to 4.11% | - | - |
| Lobig et al., 2021[84] | Global | Systematic Review | 1 | To provide an assessment of screening performance of supplemental imaging modalities | CDR ranged from 5.4 – 6.9 per 1000 screens | - | - | - | - |
| Malliori et al., 2022[89] | Global | Systematic Review | 3 | To gather evidence on overall performance and readiness of AI to be deployed in population screening practice. | - | - | - | - | AI improved cancer detection performance, while reducing reading times |
| Marinovich et al., 2018[113] | USA, Europe | Meta Analysis | 3 | To summarise all the available evidence on cancer detection and recall for tomosynthesis vs 2D mammography screening | Incremental CDR of 1.6 per 1000 screenings | - | 2.2% decrease in recall rates | - | - |
| Maxwell et al., 2017[114] | United Kingdom | Randomised Controlled Trial | 2 | To compare recall rates with 2D mammography with and without concurrent DBT | - | - | No significant difference in recall rates (2.8% vs 2.7%) | No significant difference in false positive rates (2.4% vs 2.2.%) | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Mizzi et al., 2022[82] | Global | Systematic Review and Meta Analysis | 3 | To examine the effectiveness of supplementary imaging modalities for breast cancer screening | Incremental CDR of 4 per 1000 screenings | - | Recall rates of 60 per 1000 screenings | - | - |
| Moshina et al., 2020[115] | Norway | Randomised Controlled Trial | 2 | To identify differences in screening outcomes, using digital breast tomosynthesis combined with two-dimensional synthetic mammography versus digital mammography. | The CDR did not differ between technology groups among any density category | - | Recall rates lower for density grades 1 (2.1% vs 3.3%) and 2 (3.2% vs 4.3%) | Lower false positives for density grades 1 (1.6% vs 2.8%) and 2 (2.4% vs 3.6%) | No difference then recall or false positive rates for Volpara density grades 3 or 4 |
| Pattacini et al., 2022[116] | Italy | Randomised Controlled Trial | 2 | To compare interval and overall breast cancer incidence after screening with DBT plus DM versus DM alone. | Increased CDR of 8.6 per 1000 vs 4.5 per 1000 | Detection at second round was 19% lower in DBT+DM arm | Similar recall rates (3.8% vs 3.9%) | False positives reduced from 30 per 1000 to 27 per 1000 | - |
| Pattacini et al., 2018[117] | Italy | Randomised Controlled Trial | 2 | To compare digital mammography plus digital breast tomosynthesis (DBT) versus DM alone for breast cancer screening | Increased CDR (8.6 vs 4.5 per 1000) | - | Recall rate 3.5% in both arms | False positives decreased by 3 per 1000 | Reading time for DBT was 70% longer than DM |
| Phi et al., 2018[118] | USA, Europe, South Korea | Systematic Review and Meta Analysis | 3 | To systematically review and to meta-analyse the accuracy of digital breast tomosynthesis versus digital mammography | 33% increase in CDR with DBT | - | 72% reduced recall rate | - | - |
| Weigel et al., 2023[120] | Germany | Randomised Controlled Trial | 2 | To compare the invasive breast cancer detection rate of DBT plus SM versus DM screening for different breast density categories | Incremental invasive CDR of 5.8 per 1000 in women with extremely dense breasts, and 2.7 per 1000 in women with dense breasts | - | Higher recall rates with higher breast density. No significant difference between screening technologies | - | - |

| Study | Location | Design | GRADE Level | Focus | Outcome Cancer Detection Rate | Outcome Interval Cancer Rate | Outcome Recall Rate | Outcome False Positives | Outcome Other |
|---|---|---|---|---|---|---|---|---|---|
| Weigel et al., 2023[119] | Germany | Randomised Controlled Trial | 2 | To compare invasive breast cancers detected with DBT plus versus DM | Incremental CDR of invasive cancers in women aged 60-70 of 21.6 per 1000 | - | Comparable recall rates (4.9% vs 5.1%) | - | - |
| Yun et al., 2017[121] | USA, Italy, Norway, Sweden | Meta Analysis | 3 | Evaluating the benefit of adding digital breast tomosynthesis (DBT) to full-field digital mammography (FFDM) compared to FFDM alone for breast cancer detection | Significantly higher CDR (most pronounced for cancers under 2cm) | - | - | - | - |
| Zeng et al., 2021[122] | USA, Italy, Spain, Norway, Australia | Systematic Review and Meta Analysis | 2 | To compare the screening performance of synthesized mammography plus digital breast tomosynthesis with digital mammography plus DBT or DM alone. | Incremental CDR of 2 per 1000 screens. No difference between DBT + DM and DBT + SM | No significant difference in ICR | Recall rate reduced from 6% to 5% | - | - |

*Note: Due to heterogeneity in outcomes among the included studies, the results tables present the information that was available, but there will be some gaps in outcomes.*

*In summary, results of this systematic review indicate that there is limited high-quality evidence for breast cancer screening technologies such as molecular breast imaging, contrast-enhanced mammography, machine reading, and ultrasound. Stronger evidence is available for the use of magnetic resonance imaging and digital breast tomosynthesis in increasing cancer detection rates, but there were findings related to recall rates, false positives, and interval cancer rates which must also be considered. The discussion section of this report will explore the findings of this systematic review within the context of their potential impacts on the BreastScreen Australia program. Research on the use of supplemental technology and pathways for breast cancer screening is ongoing, with important trials currently underway. For example, the UK-based 'PROSPECTS' trial, which will examine the use of digital breast tomosynthesis for population-based screening in 100,000 women, a trial to assess the use of MRI in women determined as 'high-risk' by a deep learning model, and the 'MISS' trial to determine the most appropriate screening intervals for women aged 45-49.[1-3] Results from such studies would be important to consider for its impact on the screening BSA policy.*

# 4. Discussion

This systematic review of systematic reviews and meta-analyses provides evidence on screening strategies to improve access and participation from women from priority populations and on the supplementary screening technologies that might allow increased cancer detection rate with possibly lower recall rates. This discussion below contextualises this information in the light of BSA screening program and proposes considerations for further possible changes to the policy.

### 4.1.1 Screening Pathways

The evidence from the literature included in this systematic review indicates that the screening pathways for average-risk and high-risk women differ.

- For average-risk women, majority of the studies and guidelines suggested annual or biennial mammographic screening for individuals aged 40-74 years, with an optimal range of 50-69 years. For screening policy beyond 75 years had varied recommendations, based on health status and life expectancy.
- For high-risk women, common risk factors studied included high breast density, personal history of pre-cancerous lesions or breast cancer, family history, known genetic predisposition, and history of chest radiation. The evidence indicating that the screening could start earlier than for average-risk groups, but not before age 30.
- Regarding screening technology and intervals, annual MRI or other adjunct technologies were recommended in addition to mammography. Overall, for high-risk populations, due to differing individual risk of the patients, there has been a shift from a merely age-based screening to screening recommendations tailored to individual situation. This includes personalised recommendations for screening technologies, starting age, and screening intervals.

### 4.1.2 Priority Populations

The priority populations included in the Review were:

- People from Aboriginal and Torres Strait Islander backgrounds
- People living in rural and/or remote Australia and people from disadvantaged socio-economic backgrounds
- Culturally and linguistically diverse (CALD) populations
- People with family and personal history of breast cancer

This section will summarise the results of the review into these priority populations, and contextualise these results within the Australian breast screening landscape.

***Aboriginal and Torres Strait Islander people:***
No studies meeting the criteria were found regarding interventions promoting participation in cancer screening among Aboriginal and Torres Strait Islander populations. However, this review included one study on Indigenous populations in America, which explored cancer screening interventions' impact on participation, considering factors like knowledge, attitude, or intent to screen. The study identified key challenges, including attitudes and beliefs about cancer, health system challenges, lack of trusting relationships with health care providers, and impacts of colonialism, discrimination, or racism. It demonstrated moderate success, after the implementation of clinic- and community-based interventions with over half of the participants undergoing mammography within six months post-intervention. Qualitative analysis of the study also showed that women better understood the importance of being aware of breast changes after the end of the intervention.[72]

As the participation of Aboriginal and Torres Strait Islander women is an important consideration for BreastScreen Australia, some studies which did not meet the strict inclusion criteria of this review were reviewed to provide guidance on developing the considerations for this population group  These studies mainly highlighted the importance of addressing the barriers to screening such as access, cultural safety, fear, and lack of education.[47, 123-127]

*Keeping in line with the principle of "Nothing About Us, Without Us", a co-design process that focuses on developing comprehensive strategies for increasing screening in Aboriginal and Torres Strait Islander women will be vital for the future of BreastScreen Australia.  Based on the available literature, suggested interventions and support mechanisms to improve screening uptake amongst Indigenous population include the following:*

- *Logistical assistance such as support for scheduling screening appointments*
- *Appointment flexibility such as group appointments*
- *Personalised support from Aboriginal Health Workers*
- *Culturally appropriate education regarding screening and its benefits and harms to support informed decision making*

***People living in rural and/or remote Australia and people from disadvantaged socio-economic backgrounds:***
This systematic review included two reviews examining the effectiveness of mobile mammography clinics in reaching underserved rural and remote populations, many of whom came from disadvantaged backgrounds.[73, 74] Although the included studies in these systematic reviews were not conducted in Australia, the challenges faced by rural and remote populations across the world are similar.[128] Overall, the findings obtained from both systematic reviews indicate that mobile mammography programs effectively reach underserved women. It increased the breast screening participation among rural and/or remote women in USA compared to static clinic for mammography screening. There are studies that did not fulfil the inclusion criteria however present a list of interventions that could be applicable to rural areas however will require further research due to lack of strong evidence.

Mobile mammography units play a crucial role in improving breast cancer screening accessibility in rural and remote areas of Australia. Along with the screening provision of the clinics, raising awareness about the importance of breast cancer screening and encouraging women to participate is suggested as a pathway to improve the participation. Community engagement can be promoted through collaborating

with community leaders, local health services, and Aboriginal and/or Torres Strait Islander health organisations (such as NACCHO/ACCHOS) to ensure culturally sensitive outreach in the remote areas.

Another systematic review focusing on mobile screening units (MSUs) for the early detection of cancer was analysed, although this paper was not specific to breast cancer and therefore did not meet the inclusion criteria for the review. This systematic review concluded that these MSUs provide greater access to screening in diverse under screened groups alongside offering early detection services.[129] MSUs are a practical way for service providers to increase physical and economic access to screening while reducing barriers for clients (structural barriers and out-of-pocket costs). Several associated challenges and risks were also discussed by the authors of this systematic review in using the MSUs which need to be considered as a part of the feasibility study by the BSA if this approach is further considered for implementation. These challenges include:

- The need to assess the cost-effectiveness of the MSUs compared to the fixed clinics
- If the examinations are conducted by a nurse technician on the MSU and any abnormalities that are found upon interpreting the exam, will require the patient to travel to a fixed clinic to visit a physician on a separate date raising the issue regarding the follow-up (or loss to follow-up) and decision-making processes. With the sparsity of health care services across rural Australia will exacerbate this issue of need to visit a fixed clinic where fixed clinics might be not available nearby.
- Poor and undefined roads may necessitate the recalibration of sensitive diagnostic machinery if transported by MSU. In rugged Australian outback and terrain this risk is real.
- Perceptions of MSUs may differ from fixed-clinics, as MSUs are generally perceived as less clinical than hospital-based clinics.

While there is a lack of evidence regarding whether mobile mammography clinics can improve breast cancer outcomes, it is well established that mammography screening is associated with decreased mortality from breast cancer. The research indicates that there are some strategies, when applied alongside mobile mammography clinics, have increased success in such mobile programs. These include:

- Funding for examinations and follow-up care
- Coupling mammography with educational efforts,
- Partnership with trusted local community leaders to encourage participation,
- Proper selection of the target population
- Packaging of additional screening services such as cervical cancer and osteoporosis screening with mammography, and
- Preregistration rather than walk-in access.[130]

Monitoring the effectiveness of mobile mammography programs in rural and remote areas by collecting data on screening rates, detection rates, and outcomes; BSA can assess the program's impact, identify areas for improvement, and allocate resources effectively.

*It is clear that mobile mammogram units are important in breast cancer screening. Undertaking an analysis of risk versus benefits of such clinics including cost-effectiveness will allow to the development of targeted solutions such as scheduling regular mobile van visits to specific locations and leveraging*

*telehealth technologies for consultation and result reporting could help overcome some challenges that might present.*

***Culturally and linguistically diverse (CALD) populations:***
Four studies were found focused on improving breast screening participation among culturally and linguistically diverse populations. The studies emphasise the importance of providing culturally sensitive, tailored education programs. A systematic review of UK-based qualitative studies highlighted knowledge, access, and cultural factors as key challenges faced by Black, Asian, and Minority Ethnic (BAME) women, with a lack of knowledge identified as a major barrier to screening attendance.[76] The studies found that culturally tailored education increased mammography attendance among ethnic minority women and highlighted the importance of a tailored approach for each ethnic population.[76, 131] Some examples of the strategies could include:

- Building healthcare providers awareness of cultural beliefs, practices, and healthcare-seeking behaviours related to breast cancer screening.
- Engaging with CALD communities through community leaders, cultural organisations, local general practitioners and religious institutions to build trust and raise awareness about breast cancer screening.
- Language Access: Provide language support services such as interpreters and translated materials,
- Recruit and train community members from CALD backgrounds to serve as peer educators or navigators to promote behaviour change
- Identify and address practical barriers to screening, such as transportation issues
- Codesign screening programs – for example, information about cancer screening could be provided in the context of "staying well" at a community event that is not branded as a cancer screening event reducing the stigma around cancer.

In November 2023, the Australian Government released the Australian Cancer Plan.[132] This 10-year strategy aims to improve prevention, screening, treatment and management of all cancers for all people across Australia. The Australian Cancer Plan also aims to improve health equity for people from diverse backgrounds. This includes improving communication between healthcare providers and people from diverse backgrounds through training the workforce in cultural competency, effective use of interpreter services, improving data collection and linkages to enable better identification of specific cultural demographics, and increasing health literacy through targeted cancer care information and resources, as well as access to interpreters and language-appropriate digital platforms to liaise with patients. The outcomes from this work can be measured in the coming years.

*For increasing participation of people with culturally and linguistically diverse backgrounds, activities that build trust amongst the CALD community such as working with the community leaders, local area general practitioners and tailoring information to each community beliefs and practices might be advantageous.*

***People with family and/or personal history of breast cancer:***
No studies that met the Review criteria were found regarding screening strategies for individuals specifically with a family history of breast cancer and personal history of lesions. However, some studies

on screening assessment and pathways and technology covered screening strategies for individuals with a family and/or personal history as part of the recommended approach for high-risk populations.

It has been established in the literature that women with a family and personal history of breast cancer often require more vigilant screening pathways due to their increased risk. More vigilant screening pathways have been shown to reduce rates of breast cancer mortality among those with family and personal history.[133] These could include early start of the screening for women with family history or annual mammograms or use of supplementary technology to ensure low false negatives. This review was not able to confirm these pathways as the focus of this review was the population-wide screening. *However, this discussion indicates that it is essential to consider increased risk of breast cancer for women with family and/or personal history of breast cancer and to ensure that they work closely with their general practitioners to develop a screening plan tailored to their individual risk factors and preferences. This could be part of a risk-based screening pathway for women entering into a breast screening program, and has been explored in depth by the ROSA project. The research outcomes and recommendations of the ROSA project regarding the role of risk-based screening provide more detail on this topic.*

### 4.1.3 Technology

The results of the current systematic review showed that while there is some evidence that many technologies can support increased cancer detection rates as a supplement to mammography in screening for breast cancer, only some of these have a strong enough evidence base to justify the exploration of their use in population-based screening programs. This section of the discussion will give an overview of the findings for each technology assessed, and what this means for the potential use of technology in the BreastScreen Australia program.

The first technology assessed was molecular breast imaging, for which there was just one study within the systematic review.[82] While this study showed positive results in terms of increased cancer detection rates, there is not enough evidence currently available to generalise this information to the general population or recommend it's use in breast cancer screening programs. Similarly, the limited inclusion of high-quality evidence relating to the use of contrast-enhanced mammography specifically for breast cancer screening meant that the meta-analysis studies could not conduct subgroup analyses for this imaging modality. There are also risks associated with the increased radiation dose, and use of contrast agents which suggest contrast-enhanced mammography is not suitable for population-based screening.[134] *Therefore, this review cannot report on any significant high-quality evidence related to molecular breast imaging or contrast-enhanced mammography which would be generalisable to the population-based breast cancer screening program.*

Artificial intelligence is showing early promise, particularly when it is used to replace one radiologist in a double-read mammogram or tomosynthesis screen. The use of AI as the second reader is anticipated to significantly reduce the workload and time required for the interpretation of screening tests. While there is evidence to suggest that machine reading is as accurate, or more accurate, than the interpretations of two radiologists, one of the systematic reviews included in the review did find mixed results in relation to accuracy outcomes.[87] BreastScreen New South Wales are currently conducting a study to determine whether artificial intelligence-based interpretation of mammograms is safe and effective for the potential introduction into their screening programme.[135] *This suggests that ongoing research into the use of AI to supplement screening technologies may provide stronger results supporting*

*the accuracy and safety of AI, but at this point in time, the evidence base is not large or strong enough to support the suggestion of incorporating AI into the Breast Screen Australia program.*

The use of both handheld and automated breast ultrasound as a supplement to mammography has been shown to increase cancer detection rates in screening. Ultrasound appears to be particularly beneficial for detecting cancers which have been missed by mammography, especially in women with high breast density. At the moment, ultrasound is commonly used in assessment clinics which women are referred to after screening, however the evidence in this systematic review suggests that ultrasound should not be used in the general screening program. This is because the increased cancer detection rate is lower than that of other technologies, and adding ultrasound to mammography can double the rates of women who are recalled for additional testing, and double the number of false positive screening results. This would significantly increase the resources needed to manage the increased assessment appointments and add to the negative impacts associated with receiving false positive screening results, without seeing the same benefits associated with a much higher cancer detection rate. *The evidence for ultrasound as a supplementary technology is strong along with evidence for not using ultrasound as population-based screening technology due to significant increase in resources needed, higher false positives, and higher recall rates without benefits of much higher cancer detection rates. For women with high breast density, ultrasound can support increased cancer detection rates, however, recall rates remain significantly higher than with the use of other supplemental technologies such as digital breast tomosynthesis.*

The findings from the papers in the systematic reviews that explored the use of MRI for breast cancer screening showed that the use of MRI alongside mammography could increase the cancer detection rates significantly for women at high risk of breast cancer. These increased cancer detection rates were higher than those seen with other supplementary technologies assessed in this systematic review including ultrasound, molecular breast imaging, and contrast-enhanced mammography. However, using MRI to support mammography showed high rates of false positive results and recalls, which could significantly increase the workload required for screening, as well as increasing the potential risks of screening associated with receiving a false positive screening result. These risks will be explored in more detail in the section (3.1.4) of the discussion.

The improved cancer detection rates of MRI screening suggest that this technology could be an important tool in detecting breast cancer, however this must be balanced with the associated higher false positives and recall rates leading to sometimes unnecessary biopsies or anxiety. This limitation of MRI evident in the literature explains why the majority of the research on MRI for breast screening has been focused on MRI for women with particularly high risk of breast cancer, including those with extremely dense breasts or with a very strong family history. The evidence suggests that MRI is more accurate in women with dense breast tissue. Due to having a substantially higher risk of developing breast cancer in this group, the assessment of the balance between cancer detection and higher risks associated with false positive results would likely be different in this group. The evidence suggests that it could be beneficial for women with higher risk of breast cancer, including high breast density, to receive supplementary MRI screening in order to support the early detection of cancers. Additionally, MRI does not use compression, which reduces the pain associated with repeated mammograms over time in this group of women. However, MRI is an invasive procedure requiring intravenous contrast, which can contribute to an increased risk of side effects, and therefore is unlikely to be suitable for population-based screening.[136] *This systematic review did not find enough evidence to recommend this screening pathway for population-based screening yet, but the use of MRI in the BreastScreen Australia program*

*could be evaluated in future research, with considerations about the use of a risk tool to determine and identify eligible women at a very high risk of breast cancer based on factors that increase the risk of breast cancer such as family history or breast density.*

Finally, there is a strong evidence base for the use of digital breast tomosynthesis in screening women for breast cancer. Using tomosynthesis as a supplementary tool for mammography allows for significantly higher cancer detection rates. There is mixed evidence about the impact that tomosynthesis can have on interval cancer rates, recall rates, and false positive rates. However, as the incremental cancer detection rates are highest in women with high breast density, for whom full-field digital mammography is less suitable, the potential for varying recall and false positive rates may be justifiable if tomosynthesis was used for screening in this population.

Further Australian-based research has been ongoing in BreastScreen Victoria about the role of digital breast tomosynthesis in their screening program. The initial trial did not meet the eligibility criteria for this systematic review as it was a pilot trial, however, due to the high relevance to this review, a summary is presented here. A prospective pilot trial of digital breast tomosynthesis with synthesised 2D images was compared with standard mammography at a BreastScreen Victoria service. All women who attended the service were invited to participate, and the pilot of 10,000 women found a cancer detection rate of 9.8 per 1000 screens when tomosynthesis was used, compared to 6.6 per 1000 screens with mammography, although this was only statistically significant in women over the age of 60 and those with high breast density. The use of tomosynthesis in this setting increased recall rates from 3.0% to 4.2%, but this increased recall rate was only significant in women with high breast density.[137]

The pilot trial also recorded the median screen reading time for each technology, with the median time for tomosynthesis being 67 seconds, and mammography being 16 seconds.[137] A follow up of the trial two years later found lower interval cancer rates in the tomosynthesis group (1.8 per 1000 screens vs 3.1 per 1000 mammography screens).[138] BreastScreen Victoria is now implementing another trial comparing hybrid 2D and 3D mammography with traditional 2D mammography screening, and results are expected in 2026.[139]

While the findings of the systematic review and this ongoing Australian research show very promising results, further exploration of the feasibility and cost-effectiveness of introducing tomosynthesis into the national BreastScreen Australia screening program is needed. *However, digital breast tomosynthesis combined with synthetic mammography appears to be an effective and safe screening method with benefits for women with high breast density. For this reason, an exploration of the feasibility of implementing digital breast tomosynthesis into the BreastScreen Australia program is suggested.*

### 4.1.4 Balancing risks and benefits

While the role of breast cancer screening in detecting cancer and reducing mortality is well established, there are also risks that must be balanced when population-wide screening decisions are made. Overdiagnosis and overtreatment represent significant challenges in breast cancer screening programs, raising concerns about the balance between benefits and harms. Overdiagnosis occurs when screening detects cancers that would not have become clinically apparent or harmful during an individual's lifetime. This consequently can lead to interventions which may have been unnecessary, and therefore expose patients to potential harms.[140]

The estimates of the prevalence of overdiagnosis vary widely, but it is an important consideration when assessing effectiveness of any technology or change to breast cancer screening programs. The risks associated with overdiagnosis, overtreatment, and the psychological impacts of receiving false positive results must be weighed up against the potential benefits of screening.[141, 142] *Because supplementary technologies do increase the risk of these false positive results, and may contribute to overdiagnosis, this systematic review suggests that they are not used in the general population, but focused on specific groups who are at an overall higher risk of breast cancer.*

High breast density both increases an individual's risk of breast cancer, and also reduces the sensitivity of mammography to identify cancers.[43, 44] For this reason, the considerations from this systematic review are focused on offering supplemental screening to women with high breast density. *There is the chance that supplemental screening using additional technologies (for example MRI or ultrasound) in women with high breast density can increase the risk of negative outcomes such as false positives and overdiagnosis. However, the balance of the risks and benefits needs to be considered in the light of the increased early cancer detection rates might making this potential risk worthwhile. There are studies that discuss the supplemental breast cancer screening and density conundrum. Supplemental screening of women with dense breasts makes intuitive sense, given that 64% of all interval cancers occur among women with dense breasts.[143] However, it is premature to routinely recommend supplemental screening to all women with dense breasts, since not all women with dense breasts are at increased risk of a missed cancer[144]. As this report is focused on population-based screening and not on the women with high breast density only, this is not discussed further.[143-145] Nonetheless, this highlights the importance of continued research into the role of risk assessment tools, and how these could be used to accurately stratify women according to their risk factors, and therefore make decisions about balancing the risks of supplemental screening.*

### 4.1.5 Health system considerations

In order to understand the context in which this review was taking place, grey literature about the Australian breast cancer screening program was assessed, and interviews were conducted with experts in this field as described in the methods section. From this, some key considerations about what any changes to the program would mean for the health system were identified. This section of the discussion will briefly highlight some of the challenges and opportunities for BSA when considering the implementation of new pathways in the program.

First, the healthcare context in Australia means that women can choose to be screened outside the Program by paying for screening through a private radiology service. There are also MBS rebates available that allow doctor referrals for diagnostic mammography of asymptomatic women that meet a certain criterion. Women who receive private breast cancer screening are not captured in the datasets for estimating participation rates, and therefore it is difficult to estimate a realistic national breast cancer screening rate for Australia.[146] Furthermore, women who can afford to be screened privately may get access to technology which the general population do not get.

The issues surrounding data in the BreastScreen Australia program are not restricted to the lack of information from the private sector, but the experts who were interviewed as part of this review also acknowledged that work needed to be done to strengthen the data collection and sharing. As described earlier in the review, states and territories around Australia provide their breast cancer screening in different ways, and this extends to the type of data they collect and how it is shared. This can cause

particular issues for data relating to women who move between more than one jurisdiction. *To support the use of high-quality data for decision-making, nationally consistent data sharing guidelines, which may involve the reporting of breast density, amongst other critical data points could be discussed for implementation.*

The creation of nationally consistent guidelines is key for BreastScreen Australia to ensure that women around the country are able to access equitable care. The experts suggested that these guidelines are made on a national level, and that all states and territories should follow them, with the opportunity for adding further policies on as necessary to serve their populations, while acknowledging that this could introduce further inconsistency. In order to be supported to make fully informed decisions, provision of consistent information for participants in the program is also an important consideration. Providing potential participants with information about the benefits and risks of breast screening, alongside the explanation for any risk-specific differences in screening technology can support women to make informed choices about their participation in the breast cancer screening program.

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*In summary the discussion provides insights into the current evidence with regards to participation of priority population in the screening program, screening intervals and technologies that could be considered in the near future. Whilst the discussion includes key learnings from the review, the considerations based on the available evidence are discussed in the next section.*

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# 5. Suggested future activities

This review provides robust evidence on breast cancer screening technologies and intervals used for breast cancer screening stratified by various age groups, ethnicity, and other risk factors. Results of this systematic literature search and synthesis of the findings informed the development of suggested future activities that could be assessed by the BSA for its suitability for implementation. These activities, which focus on eligibility, screening intervals, screening and assessment pathways and technologies, will need to be assessed by BSA for their feasibility and cost effectiveness to assess their suitability for implementation.

| **Develop a nationally consistent policy for women assessed as high- risk as determined by an agreed high-risk criteria** | |
|---|---|
| Focus | Screening pathways |
| Evidence | Refer to section 3.1, 3.3.5 and 4.1.1<br>For high-risk women, common risk factors studied by the studies included in the review were high breast density, personal history of pre-cancerous lesions or breast cancer, family history, known genetic predisposition, and history of chest radiation. The evidence indicated that the screening could start earlier than for average-risk groups, but not before age 30. There was also evidence that annual mammography and/or other technologies (such as DBT, ultrasound or MRI) for high-risk women or as an adjunct to mammography, could be considered. |

| **Create activities that build trust amongst the CALD community such as working with the community leaders to provide tailored information.** | |
|---|---|
| Focus | Culturally and Linguistically Diverse Populations |
| Evidence | Refer to sections 3.2.3 and 4.1.2<br>There is strong evidence that culturally sensitive, tailored education programs are key for improving screening participation among CALD women. However, consideration needs to be given to the individual requirements for each cultural group. |

| **Continue to schedule regular mobile mammography van visits to specific locations and undertake a feasibility study to implement solutions such as leveraging telehealth technologies for consultation and result reporting to ensure continuity of care.** | |
|---|---|
| Focus | Rural/remote regions |
| Evidence | Refer to sections 3.2.2 and 4.1.2<br>There is limited evidence for interventions to improve screening participation in people living in rural and remote areas, or from a lower socioeconomic background. However, there is evidence that mobile mammography programs effectively reach underserved women in rural/remote areas. |

| **Address the low rate of participation in Aboriginal and Torres Strait Islander People through a holistic approach including assessing feasibility of providing:**<br>• **Logistical assistance such as support for scheduling screening appointments**<br>• **Appointment flexibility such as group appointments**<br>• **Personalised support from Aboriginal Health Workers**<br>• **Culturally appropriate education regarding screening and its benefits and harms to support informed decision making**<br>• **Nationally consistent age for initiation of breast screening** | |
|---|---|
| Focus | Aboriginal and Torres Strait Islander People |
| Evidence | Refer to sections 3.2.1 and 4.1.2<br>There is limited evidence on interventions to increase participation amongst this population group in the systemic review or review literature. However, other studies that explored participation in screening programs among Aboriginal and/or Torres Strait Islander populations considered factors such as knowledge, attitude, or intent to screen. The literature indicates that addressing the barriers to screening that are linked to access, cultural safety, fear, and education is vital. Context of access to primary health care, annual health checks to identify those who would benefit from participating in mammographic screening and well-planned pathways developed between screening services and local health services to screening. |

| **Test cost-effectiveness and feasibility of DBT as a supplemental screening method for women with higher breast density.** | |
|---|---|
| Focus | Technology |
| Evidence | Refer to sections 3.3.6 and 4.1.3<br>There is strong evidence for digital breast tomosynthesis (3D mammography) that offers potential benefits over traditional 2D mammography, including improved cancer detection rates and reduced false positives. It is noted that DBT has no mortality related causal association, but many longitudinal studies provide evidence for early detection when using DBT as supplementary technology and that early detection of breast cancer is associated with reduction in mortality associated with breast cancer. Digital breast tomosynthesis combined with synthetic mammography appears to be an effective and safe screening method with benefits for women with high breast density. |

| **Undertake a one-year review for evidence on the use of MRI as a screening technology especially for women with identified higher risk of breast cancer.** | |
|---|---|
| Focus | Technology to be reviewed in the near future |
| Evidence | Refer to sections 3.3.5 and 4.1.3<br>This systematic review did not find enough evidence to recommend this screening pathway for population-based screening. The use of MRI in the BreastScreen Australia program could be evaluated in future research, with considerations about the use of a risk tool to determine and identify eligible women at a very high risk of breast cancer, based on factors that such as family history or breast density, where |

| **Undertake a one-year review for evidence on the use of MRI as a screening technology especially for women with identified higher risk of breast cancer.** | |
|---|---|
| | the benefits of MRI are likely to outweigh the potential risks associated with the technology. |

| **Undertake a review of evidence on artificial intelligence (machine reading) for breast screening after one to two years.** | |
|---|---|
| Focus | Technology to be reviewed in the near future |
| Evidence | Refer to sections 3.3.3 and 4.1.3<br>Artificial intelligence is showing early promise, particularly when it is used to replace one radiologist in a double-read mammogram or tomosynthesis screen. The review suggests that ongoing research, such as the BreastScreen New South Wales trial, into the use of machine reading to supplement screening technologies may provide stronger results supporting the accuracy and safety of AI, but at this point in time, the evidence base is not large or strong enough to support the suggestion of incorporating AI into the Breast Screen Australia program. The evidence about other uses for AI is also still pending. |

| **Assess feasibility of establishing nationally consistent guidelines for:**<br>• **Data sharing to support the use of high-quality data for decision-making**<br>• **Reporting which may involve standardised reporting of breast density**<br>• **Recall and reminder system** | |
|---|---|
| Focus | Standardising National Approach to data collected during Screening |
| Evidence | Refer to sections 1.3.2, 4.1.5 and appendix 6.1<br>The concerns surrounding data in the BreastScreen Australia program are related to inconsistency in the data collection and lack of data sharing strategies for women within the program. As described earlier in the review, states and territories around Australia provide their breast cancer screening in different ways, and this extends to the type of data they collect and how it is shared. |

# 6. Appendix

## 6.1 Stocktake Results

The following information has been summarised from state and territory responses in the BSA policy stocktake activity conducted in January 2024. The same information is presented in tables below, tabulated for simplicity.

### 6.1.1 Risk factors

**Age.** No jurisdictions actively invite participants aged 40-49 years. At the time of the stocktake, ACT indicated that it would commence invitations for Aboriginal and Torres Strait Islander participants aged 40-49 in March 2024. No jurisdictions actively invite participants aged 75 years or older.
**Priority populations.** Most jurisdictions noted in the stocktake that they implement practices to support participation rather than have specific policies for priority populations. ACT, NSW and NT have screening policies for Aboriginal and Torres Strait Islander participants; in NSW this is through a pilot project that recommends Aboriginal and Torres Strait Islander participants commence screening from 40 years of age, and in NT this is through an internal block booking process for regional mobile visits.
SA is the only jurisdiction with a transgender policy, which is that participants must be on HRT and have commenced HRT 5 or more years prior to be eligible.
NT and SA support participants from culturally and linguistically diverse backgrounds, and participants with disability. In NT participants are asked if they have a disability or need assistance, and in response they are given a longer appointment and physical assistance if needed. SA is currently exploring a sensory clinic trial for participants with neurodiversity.
**Reminders.** Screening reminders for participants aged 40-49 years are sent only if participants are Aboriginal and Torres Strait Islander (ACT, NSW) or are considered high risk (Victoria). Reminders for this age group are sent to all participants in SA, WA, NT and Queensland. Participants aged 75 years and older do not receive reminders, except in Queensland where they receive a reminder if they were recalled to assessment at their most recent screen.
**Risk assessment tool.** The iPrevent self-assessment tool is promoted in ACT, NSW, Victoria, SA and WA and participants are encouraged to complete it prior to screening, with their GP if assistance is required. NT uses its own risk assessment questions. No risk assessment tools are used in Queensland.
**Breast density measurement and reporting.** Breast density is measured using the Volpara tool/software in Victora and SA, and subjective measurement by the radiologist readers in NSW and WA. An RCT using Volpara is underway in Queensland. ACT and NSW are awaiting funding approval and feasibility studies respectively prior to introducing software. Breast density is reported to participants except in Victoria.
**Screening interval.** Annual screening policies are in place in all states and territories and invitations are sent. The age criteria applied differs across jurisdictions, for example 40 years and over (NT, QLD), and 50-74 years (SA).
**Genetics.** Questions about genetic abnormality related to breast cancer are asked in NT and the information is stored on patient history paperwork and the client information system.
**Family history.** All states and territories ask about family history and record the information in the relevant client information system or register. In NSW and WA, the family history information is used to determine screening interval.
**Personal history.** All states and territories except WA ask about personal history and record the information in the relevant client information system or register. In NSW the personal history information is used to determine screening interval.

A number of other risk factors were included in the policy stocktake, such as ovarian cancer, menopausal hormone therapy, menstrual history and parity, however the stocktake results have not been included in this summary as the evidence and synthesis review does not include these risk factors.

***Summary of risk factor results from BSA state and territory policies stocktake, 2024***

| | ACT | NSW | VIC | SA | WA | NT | QLD |
|---|---|---|---|---|---|---|---|
| Invitations 40-49 years | X | X | X | X | X | X | X |
| Invitations ≥75 years | X | X | X | X | X | X | X |
| Reminders 40-49 years | P<br>Aboriginal and/or Torres Strait Islander | P<br>Aboriginal and/or Torres Strait Islander | P<br>High risk | P | P | P | P |
| Reminders ≥75 years | X | X | X | X | X | X | X |
| Risk assessment tool | P<br>iPrevent | P<br>iPrevent | P<br>iPrevent | P<br>iPrevent | P<br>iPrevent | P<br>Own tool | X |
| Breast density measured | X | P<br>Subjective | P<br>Volpara | P<br>Volpara | P<br>Subjective | X | P<br>RCT<br>Volpara |
| Breast density reported | X | X<br>GP only | X | P | P | X | P<br>Trial |
| Annual screening | P | P | P | P | P | P | P |
| Genetics | X | X | X | X | X | P | X |
| Family history | P | P | P | P | P | P | P |
| Personal history | P | P | P | P | X | P | P |

## 6.1.2 Technologies

**Tomosynthesis.** Tomosynthesis is not used in screening in any state or territory. It is used in assessment in all jurisdictions. Victoria is undertaking a prospective clinical trial exploring tomosynthesis use in screening.

**AI.** AI is not currently used in risk assessment prior to screening, in screening, or in assessment in any state or territory. There are various activities and plans in progress: ACT is awaiting the ability to conduct a trial, it was not stated if the trial is for screening or assessment; NSW is conducting an evaluation of machine reading, due for completion mid 2024; in Victoria two trials have been funded and are in planning phase, one on AI in mammogram reading (benchmarking) and the BRAIx RCT; SA is also participating in the BRAIx RCT; WA has been involved in historical research for AI in screen reading.

**Ultrasound.** Ultrasound is not used in screening in any state or territory. It is used in assessment in all jurisdictions. BS Victoria has commenced discussions on its potential use for high density and other risk factors but at this stage does not have any plans to introduce ultrasound in screening.

**MRI.** MRI is not used in screening or assessment in any state or territory. In Victoria and Queensland participants are referred outside the BreastScreen program. BS Victoria has commenced discussions on

its potential use for high density and other risk factors but at this stage does not have any plans to introduce MRI in screening.

**CEM.** CEM is not used in screening in any state or territory, and the only state where it is used in assessment is in a trial in Victoria. BS Victoria is in early discussions about using CEM in screening for higher risk participants and is in early discussions with researchers regarding a grant proposal for a clinical trial; BS NSW is also considering a trial for possible use in assessment.

***Summary of technology results from BSA state and territory policies stocktake, 2024***

| | ACT | NSW | VIC | SA | WA | NT | QLD |
|---|---|---|---|---|---|---|---|
| Tomosynthesis in screening | X | X | X | X | X | X | X |
| Tomosynthesis in assessment | P | P | P | P | P | P | P |
| AI in risk assessment | X | X | X | X | X | X | X |
| AI in screening | X | X | X | X | X | X | X |
| AI in assessment | X | X | X | X | X | X | X |
| Ultrasound in screening | X | X | X | X | X | X | X |
| Ultrasound in assessment | P | P | P | P | P | P | P |
| MRI in screening | X | X | X | X | X | X | X |
| MRI in assessment | X | X | X | X | X | X | X |
| CEM in screening | X | X | X | X | X | X | X |
| CEM in assessment | X | X | X Trial | X | X | X | X |

## 6.2 PRISMA Checklist

| Section and Topic | Item # | Checklist item |
|---|---|---|
| **TITLE** | | |
| Title | 1 | Identify the report as a systematic review. |
| **ABSTRACT** | | |
| Abstract | 2 | Use the PRISMA 2020 for Abstracts checklist. |
| **INTRODUCTION** | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. |
| **METHODS** | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. |

| Section and Topic | Item # | Checklist item |
|---|---|---|
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. |
| **RESULTS** | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. |
| Study characteristics | 17 | Cite each included study and present its characteristics. |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. |
| **DISCUSSION** | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. |
| | 23b | Discuss any limitations of the evidence included in the review. |
| | 23c | Discuss any limitations of the review processes used. |
| | 23d | Discuss implications of the results for practice, policy, and future research. |
| **OTHER INFORMATION** | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. |
| Competing interests | 26 | Declare any competing interests of review authors. |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. |

## 6.3 Searches

Example 1: Technology (PubMed)

| Database | Search string | Results |
|---|---|---|
| PubMed | ((((((((((breast neoplasm[MeSH Terms]) OR (breast neoplasm[Title/Abstract])) OR (breast tumor[Title/Abstract])) OR (breast tumour[Title/Abstract])) OR (mammary cancer[Title/Abstract])) OR (breast carcinoma[Title/Abstract])) OR (breast cancer[Title/Abstract]))) AND ((((((((early detection of cancer[MeSH Terms]) OR (cancer early detection[MeSH Terms])) OR (mass screening[MeSH Terms])) OR (cancer screening[Title/Abstract])) OR (screening test[Title/Abstract])) OR (early diagnosis[Title/Abstract])) OR (early detection[Title/Abstract])) OR (screening[Title/Abstract])))) **AND** ((((((((((mammography[MeSH Terms]) OR (mammographies[MeSH Terms])) OR (mammography[Title/Abstract])) OR (mammographies[Title/Abstract])) OR ((((((ultrasonography, mammary[MeSH Terms]) OR (mammary ultrasonography[MeSH Terms])) OR (ultrasound mammography[MeSH Terms])) OR (ultrasound[Title/Abstract])) OR (ultrasonography[Title/Abstract]) ) OR (echomammography[Title/Abstract]))) OR ((((“magnetic resonance imaging”[MeSH Terms]) OR (magnetic resonance imaging[Title/Abstract])) OR (magnetic resonance imag*[Title/Abstract])) OR (MRI[Title/Abstract]))) OR ((((((tomosynthesis[Title/Abstract]) OR (digital breast tomosynthesis[Title/Abstract])) OR (breast tomosyntheses[Title/Abstract])) OR (3D-mammography[Title/Abstract])) OR (X-ray breast tomosynthesis[Title/Abstract])) OR (X-ray breast tomosyntheses[Title/Abstract]))) OR ((((machine learning[MeSH Terms]) OR (machine learning[Title/Abstract])) OR (machine reading[Title/Abstract])) OR (screen reading[Title/Abstract]))) OR ((contrast enhanced mammography[Title/Abstract]) OR (contrast enhanced mammogram[Title/Abstract])))))) **AND** ((((((((((((breast density[Title/Abstract]) OR (mammographic density[Title/Abstract])) OR (“breast density”[MeSH Terms])) OR ((((benign[Title/Abstract])) OR (non-malignant[Title/Abstract])) OR (non-cancerous[Title/Abstract]))) OR (((((age group[MeSH Terms]) OR (age groups[MeSH Terms])) OR (age[Title/Abstract])) OR (eligibility[Title/Abstract])) OR (eligible[Title/Abstract]))) OR (((((((screening interval[Title/Abstract]) OR (year interval[Title/Abstract])) OR (frequency[Title/Abstract])) OR (regular screening[Title/Abstract])) OR (annual[Title/Abstract])) OR (biennial[Title/Abstract])) OR (triennial[Title/Abstract])))) ) OR (family history[Title/Abstract])) OR (inherited[Title/Abstract])) OR (hereditary[Title/Abstract])) OR (Atypical Lobular Hyperplasia[Title/Abstract])) OR (Lobular Carcinoma in Situ[Title/Abstract])) OR (Lobular Neoplasia[Title/Abstract])) OR (Atypical Ductal Hyperplasia[Title/Abstract])) **AND** ((y_10[Filter]) AND (clinicaltrial[Filter] OR meta-analysis[Filter] OR randomizedcontrolledtrial[Filter] OR systematicreview[Filter])) | 372 |

| Database | Search string | Results |
|---|---|---|
| | Filters: Clinical Trial, Meta-Analysis, Randomized Controlled Trial, Systematic Review, in the last 10 years | |

Example 2: Priority Populations (Embase)

| Database | Search string | Results |
|---|---|---|
| Embase | #1 'breast tumor'/exp OR 'breast tumor' OR 'breast neoplasm':ti,ab,kw OR 'breast tumor':ti,ab,kw OR 'breast tumour':ti,ab,kw OR 'mammary cancer':ti,ab,kw OR 'breast carcinoma':ti,ab,kw OR 'breast cancer':ti,ab,kw OR 'breast cancer'/exp OR 'breast cancer'<br>#2 'early cancer diagnosis'/exp OR 'early cancer diagnosis' OR 'mass screening'/exp OR 'mass screening' OR 'cancer screening':ti,ab,kw OR 'screening test':ti,ab,kw OR 'early diagnosis':ti,ab,kw OR 'early detection':ti,ab,kw OR 'screening':ti,ab,kw<br>#3 #1 AND #2<br>#4 'indigenous people'/de OR 'indigenous':ti,ab OR 'indigenous australian':ti,ab OR 'torres strait island*':ti,ab OR 'aboriginal':ti,ab OR 'first nations australia*':ti,ab OR 'australian aborigine'/de OR 'indigenous australian'/de<br>#5 'cultural diversity'/de OR 'cultural diversity':ti,ab OR 'culturally and linguistically divers*':ti,ab OR 'cultural linguistic divers*':ti,ab OR 'cald':ti,ab OR 'bame':ti,ab OR 'black asian ethnic minorit*':ti,ab OR 'minorit*':ti,ab OR 'non-english speaking':ti,ab OR 'multicultur*':ti,ab OR 'multi-cultur*':ti,ab<br>#6 'rural health care'/de OR 'rural population'/de OR 'rural':ti,ab OR 'remote':ti,ab OR 'regional':ti,ab OR 'non-metro':ti,ab<br>#7 'social status'/de OR 'social class'/de OR 'low socioeconomic':ti,ab OR 'low socio-economic':ti,ab OR 'low socioeconomic status'/de OR 'poverty'/de OR 'poverty':ti,ab<br>#8 'cultural diversity'/de OR 'cultural diversity':ti,ab OR 'culturally and linguistically divers*':ti,ab OR 'cultural linguistic divers*':ti,ab OR 'cald':ti,ab OR 'bame':ti,ab OR 'black asian ethnic minorit*':ti,ab OR 'minorit*':ti,ab OR 'non-english speaking':ti,ab OR 'multicultur*':ti,ab OR 'multi-cultur*':ti,ab OR 'religio*':ti,ab<br>#9 'rural health care'/de OR 'rural population'/de OR 'rural':ti,ab OR 'remote':ti,ab OR 'regional':ti,ab OR 'non-metro':ti,ab OR 'distance':ti,ab<br>#10 'social status'/de OR 'social class'/de OR 'low socioeconomic':ti,ab OR 'low socio-economic':ti,ab OR 'low socioeconomic status'/de OR 'poverty'/de OR 'poverty':ti,ab OR 'education':ti,ab OR 'income':ti,ab OR 'occupation':ti,ab<br>#11 #4 OR #8 OR #9 OR #10<br>#12 #3 AND #11<br>#13 #3 AND #11 AND ([systematic review]/lim OR [meta analysis]/lim OR [controlled clinical trial]/lim OR [randomized controlled trial]/lim) AND [2014-2024]/py | 482 |

## 6.4 Summary of AIHW data for priority populations

*Figure 3: Participation in BreastScreen Australia, by age, state and territory, 2020–2021*

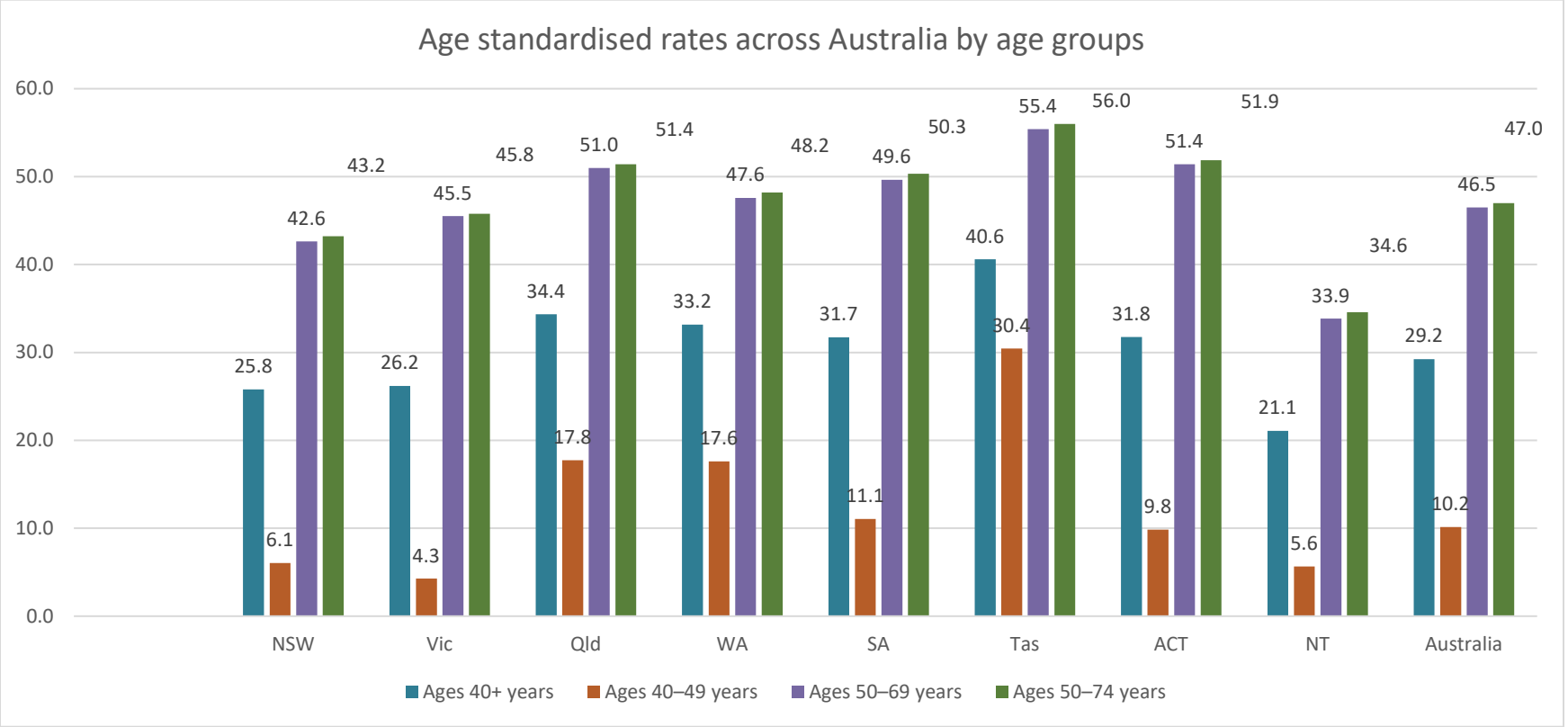
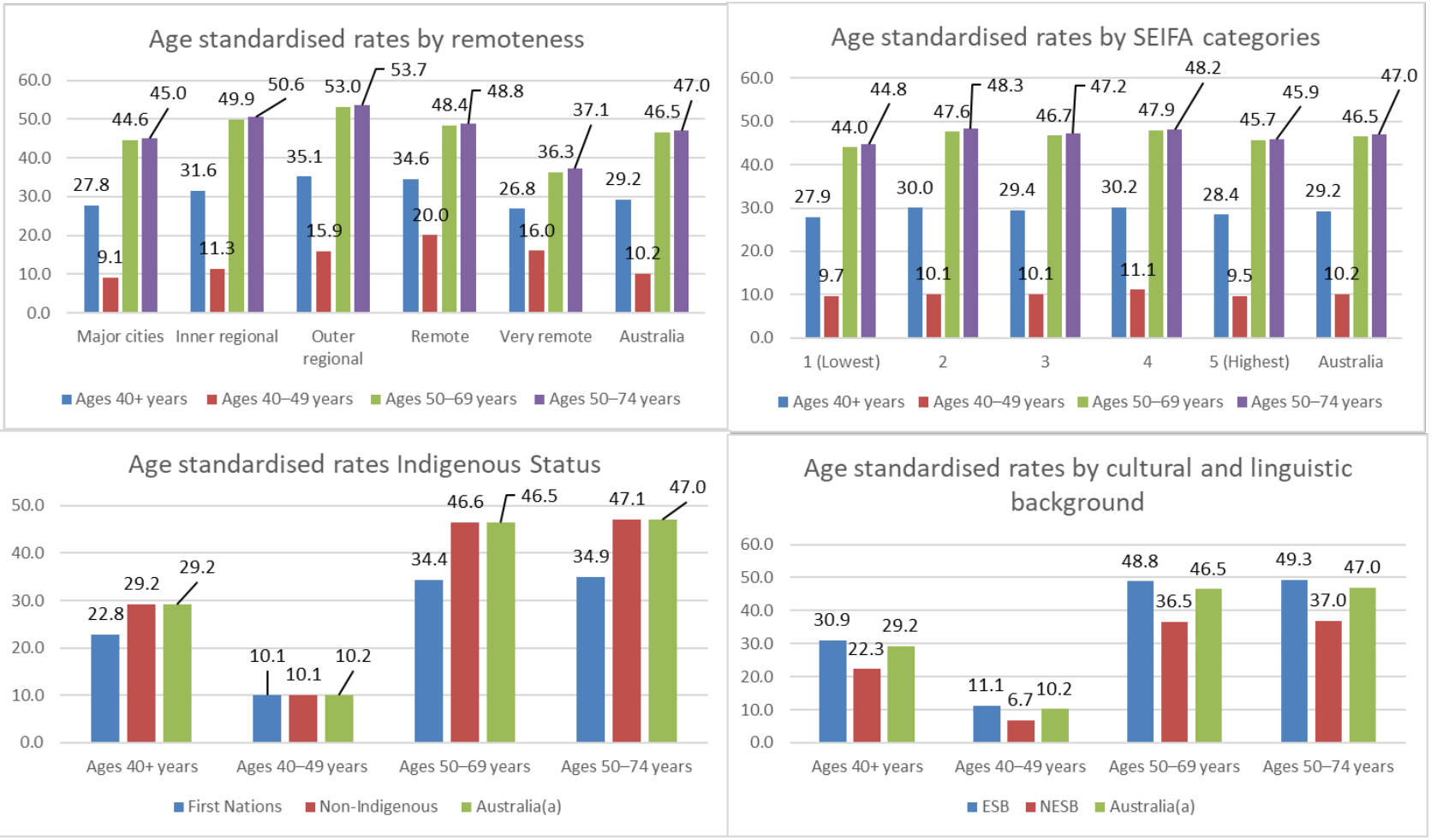


*Figure 4: Participation in BreastScreen Australia, by age and priority populations, 2020–2021*



## 6.5 Intervention and effect of the studies included in Kelly et al's study[79]

| Ethnic minority studied | Intervention/s | Effect/Result |
|---|---|---|
| Pakistani/Bangladeshi women[147] | Effect of a link- worker to usual care (n = 527). | There were no differences in screening uptake (49% intervention; 47% control). |
| Vietnamese women[148, 149] | Mass media alone OR with Lay Health Worker (LHW) intervention (n = 1100). | Media education alone 74% at baseline vs 75.6% post intervention (p=0.37), media with lay health worker intervention 64.7% v 82.1% (p<0.001). Mass media conducted neighbourhood wide interventions; it had no significant increase in screening uptake, but methodological issues may have influenced outcomes. |
| Chinese and Korean women[150, 151] | A comparison of cultural video, generic video and control (fact sheet) (n = 664) | Neither cultural video or generic video improved uptake compared to fact sheet. Spiritual video and education session 56% screened vs 42% control (P = .004). |
| Latina women[152, 153] | church-based navigator group compared to group receiving written info (n = 4739) | A comparison of group discussion with and without video (n = 400) saw screening increase significantly for each group from baseline (P < .001) (22% and 18%).59 The difference was not significant between groups. |
| African American women[154-160] | The majority of interventions (n = 4) focused on LHWs. A comparison of LHW interactive computer intervention (n = 181) on mammography uptake compared to control (pamphlet) group.<br><br>Three other studies: multistage escalating intervention using reminder letter; comparison of leaflet, video (29% screened), interactive computer interventions | Half of LHW interventions were significant, one borderline: interactive computer intervention vs pamphlet (15% vs 18% uptake), Cosmetologists as lay health workers - no significant difference but attrition rate was high (50%).<br><br>LHW deliver multifaceted education program - increase in screening from baseline, LHW intervention for those who already had appointment. Three other studies: multistage escalating intervention using reminder letter (screening uptake low, no significant difference between groups); comparison of leaflet (18% screened), video (29% screened), interactive computer interventions (50% screened) with significant difference between video and computer group.<br><br>A comparison of group education classes and brochures found significant increase in screening (80% class vs 53% brochure). |

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