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Systematic Review

Strategies enhancing the patient experience in mammography: A scoping review

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ABSTRACT

Introduction: A positive experience in mammography is essential for increasing patient attendance and reattendance at these examinations, whether conducted for diagnostic or screening purposes. Mammograms indeed facilitate early disease detection, enhance the potential for cure, and consequently reduce breast cancer mortality. The main objective of this review was to identify and map the strategies aiming to improve the patient experience in diagnostic and screening mammography.
Methods: This scoping review was performed following the JBI methodology and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). Searches were performed through databases of MEDLINE, Embase.com, CINAHL, APA PsycINFO, Cochrane Central Register of Controlled Trials, Web of Science, ProQuest Dissertation and Theses, and three clinical trial registries. This review considered studies evaluating the effect of interventions, occurring within the mammography department, on the patient experience.
Results: The literature search yielded 8113 citations of which 60, matching the inclusion criteria, were included. The strategies were classified into eight categories. The most represented one was breast compression and positioning, followed by relaxation techniques and analgesic care, communication and information, screening equipment, examination procedures, patient-related factors, physical environment, and finally staff characteristics. The studied outcomes related to patient experience were mainly pain, anxiety, comfort, and satisfaction. Other types of outcomes were also considered in the studies such as image quality, technical parameters, or radiation dose. Most studies were conducted by radiographers, on female patients, and none mentioned the inclusion of male or transgender patients.
Conclusion: This review outlined a diversity of strategies to improve patient experience, although technique-based interventions were predominant. Further research is warranted, notably on psychological strategies, and on men and transgender people.
Implications for practice: This scoping review provides guidance to healthcare providers and services for better patient/client-centered care.

Introduction

Mammography is routinely used to detect changes in breast tissue that may be indicative of early-stage breast cancer (BC), which is the most frequently diagnosed malignancy and the main cause of cancer death in women in a vast majority of the world's regions.[1] With a 20 % risk of BC before the age of 75,[1] preventive measures are of paramount importance and mammography is the gold standard for BC screening. Indeed, early detection allows the management of potentially curable diseases and therefore a reduction in the mortality associated with this malignancy.[2–4]

Mammography examination may however lead to several psychological phenomena to patients, such as anxiety, fear of the diagnostic result, uncomfortable experience, and pain related to breast compression.[5,6] During mammography, the breast must be compressed, to be as thin as possible for each of the four projections performed, two views per breast namely a craniocaudal and a mediolateral oblique views. Breast compression is pivotal for dose reduction and image quality, to avoid additional views or

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examinations.[7] The psychological and physical burdens caused by breast compression have also been demonstrated by physiological studies, which showed an increase in the activity of the patient's heart and other muscles during the examination.[8,9]

Cumulatively, these issues can discourage patients from participating in regular screenings, which can have serious implications for BC early detection and treatment.[10,11] To address these concerns, healthcare professionals have developed strategies to improve patient experience in mammography. For example, patient education about what to expect during mammography can help to reduce anxiety and provide reassurance.[12] Giving women control of breast compression,[13] the use of flexible compression paddles,[14] or a cushion on the paddle[15] can also be employed to reduce pain. By knowing and implementing these strategies, healthcare providers can help to make mammography a more comfortable and less stressful experience for patients, ultimately improving their willingness to undergo regular screenings and reducing the burden of BC.

Many strategies to ensure a more favourable patient experience during mammography have been tested. However, they are scattered in a multitude of articles preventing a complete overview of all the interventions that can be implemented, all the healthcare providers involved, all the beneficiaries, and all the outcomes. According to a preliminary search in several databases (MEDLINE, Cochrane Database of Systematic Reviews, JBI Evidence Synthesis, PROSPERO, and Open Science Framework), the published systematic and scoping reviews are either outdated[16] or of limited scope by covering solely one dimension of patient experience in mammography, the anxiety.[17] However, patient experience also results from other key aspects such as pain, satisfaction, or preferences.[6] Consequently, a scoping review on this topic is necessary to advance our understanding of the ways to reduce pain, anxiety, and other negative experiences associated with mammography, ultimately improving patient outcomes and quality of care. Such review should additionally help to identify gaps in the literature and highlight areas where further research is needed.

In this context, our primary objective was to comprehensively identify and map the interventions aiming to improve the patient experience, in diagnostic or screening mammography, that have been evaluated. The secondary objective focused on characteristics of the strategies, including the mammography participants (eg, women, and men) involved, the healthcare professionals performing the intervention, the outcomes reported, and the context. This scoping review also provided insights into interventions currently under study, as evidenced by clinical trial registries.

Methods

This scoping review was performed according to the JBI methodology and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).[18–20] The methodology is also aligned with the Arksey and O'Malley's framework, which exemplifies the use of scoping reviews for evaluation studies of interventions.[21,22] The detailed protocol is published elsewhere[23] and registered in Open Science Framework (https://osf.io/fn865/). The slight deviations from the protocol relate to categorisation of the interventions and language limitation and are described below.

Search strategy

A systematic search was conducted in the following seven electronic databases MEDLINE (Ovid), Embase.com (Elsevier), CINAHL (EBSCO), APA Psycinfo (Ovid), The Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, and ProQuest Dissertation and Theses (Supplementary file). Additionally, to identify interventions under study, ongoing clinical trials were searched in the US National Institutes of Health (ClinicalTrials.gov), the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP), and the International Standard Randomized Controlled Trial Number (ISRCTN). Studies published after 2000 were considered for inclusion. Although it was intended to have no language limitation, due to the large number of retrieved documents, they were included if written in any language using the Latin alphabet.

Eligibility criteria

The inclusion criteria were as follows: 1) Participants: Adult women, men, transgender, nonbinary, or intersexual persons undergoing diagnostic or screening mammography; 2) Concept: Interventions occurring within the mammography department and aiming to improve patient experience (eg.: pain, anxiety), through for instance reduce breast compression or relaxation techniques; 3) Context: No geographical or cultural limit; 4) Type of source: Experimental and quasi-experimental studies, including studies for which the only possibility was to work on pre-existing groups, as long as a comparison was made (e.g. screening personal with different characteristics[24]).

Study selection, data extraction and categorisation

Search results were imported into EndNote 20 (Clarivate Analytics, PA, USA) to remove duplicates, then into Rayyan (Qatar Computing Research Institute, Doha, Qatar) for selection. Three researchers performed independently an initial screening based on the title and abstract and subsequently screened the full text. Finally, they independently extracted data from the selected documents and another researcher reviewed all the extractions to ensure accuracy and completeness. The extracted data included specific details about the study characteristics (e.g., authors, year, title), country of study conduction, objectives, settings, participants (e.g., sample size), intervention types and providers, and measured outcomes. The critical appraisal of the publications was not conducted, following guidance for scoping reviews.[25]

The interventions were categorised into eight themes. Six of them corresponded to the one defined in the protocol (*i.e.* breast compression and positioning; relaxation techniques and analgesic care; communication and information; physical environment; staff characteristics), two were added to cover new themes addressed in the articles (*i.e.* screening equipment -excluding compression devices; patient-related factors), and one category from the protocol was removed because no articles covered this theme (*i.e.* patient preparation for mammography).

Results

Study selection process

A total of 8113 documents were retrieved (Fig. 1). After removing duplicates, titles and abstracts of 4540 documents were screened and 4445 sources were excluded. Two documents were not retrieved, and the remaining 93 reports were assessed for eligibility on full text. Among them, 37 were excluded (Supplementary file). Thus, 56 studies matched the inclusion criteria and four additional articles were identified through reference list searches, resulting in a total of 60 included studies.

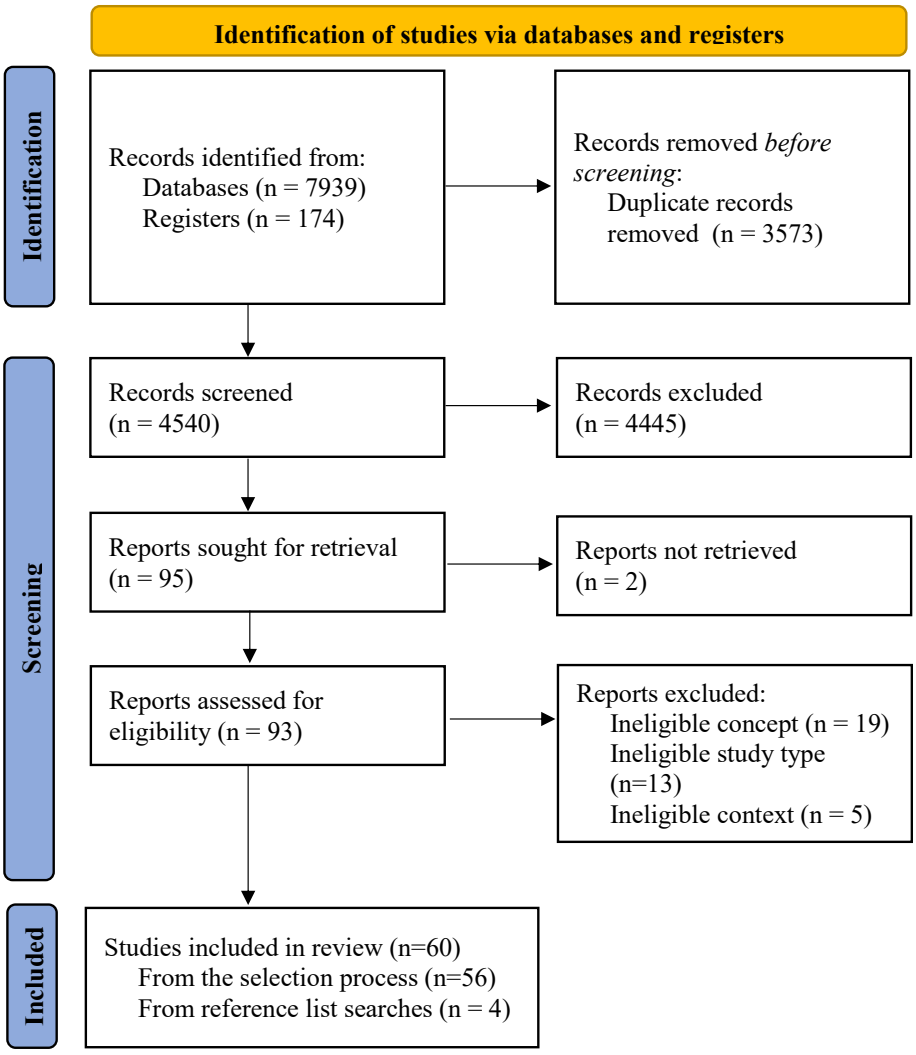

Figure 1. Search results and study selection flow.

Characteristics of included studies

The 60 included studies were conducted in 22 different countries (Fig. 2). The most represented country was the USA (n = 17; 28.3 %), followed by the Netherlands (n = 6; 10 %), Australia (n = 4; 6.7 %), and Spain (n = 4; 6.7 %). No study has been conducted at a multinational level.

The number of studies has steadily increased between the periods 2006–2011 and 2018–2023, with six and 24 studies, respectively. Between the years 2000 and 2005, an intermediate number of studies were published (n = 13).

Most studies were research articles (57/60), whereas three studies were clinical trials.[26–28] Two more studies were found as clinical trials but because their results were published during the course of this review, they were counted as research articles.[29,30] Accordingly, the extraction was performed on these documents allowing access to more detailed information.

Strategies

The interventions evaluated in the included studies could be classified into eight categories (Table 1; supplementary file). Breast compression and positioning, the most represented category (n = 22; 36.7 %), entails a broad range of strategies of which the most studied were self-compression (7/22),[13,29,31–35] reduced compression (4/22),[36–39] MammoPad application (*i.e.* a compressible cushion; n = 4),[15,40–42] a flexible compression paddle,[14,43] and a pressure-based paddle.[44–47] The use of the pressure-based paddle and flexible paddle were simultaneously evaluated in one article[46] whereas another one combined these same paddles with self-compression.[47] Finally, the implementation of breast positioning sheets was studied in one article.[48]

Among the 11 studies (18.3 %) focusing on relaxation techniques and analgesic care, most of them (5/11) employed an analgesic premedication,[26–28,49,50] such as paracetamol or lidocaine. In one study, lidocaine is considered against music.[26] Three articles have tested the effect of music,[30,51,52] one of which compared its effectiveness to relaxation.[51] Finally, massage,[53] physical exercises,[54] and a multi-sensory relaxing environment[55] were each evaluated in one article.

In all studies under the communication and information category (n = 10; 16.7 %), the intervention consisted of informing the patients,[12,56–64] about the mammography procedure, breast compression, or pain in particular. In three of these studies, emotional support was additionally offered to the mammography participants.[57,59,64] In the majority of cases (6/10), the information was delivered orally,[57,59–62,64] and completed by a flip book of slides in one of the studies.[62]

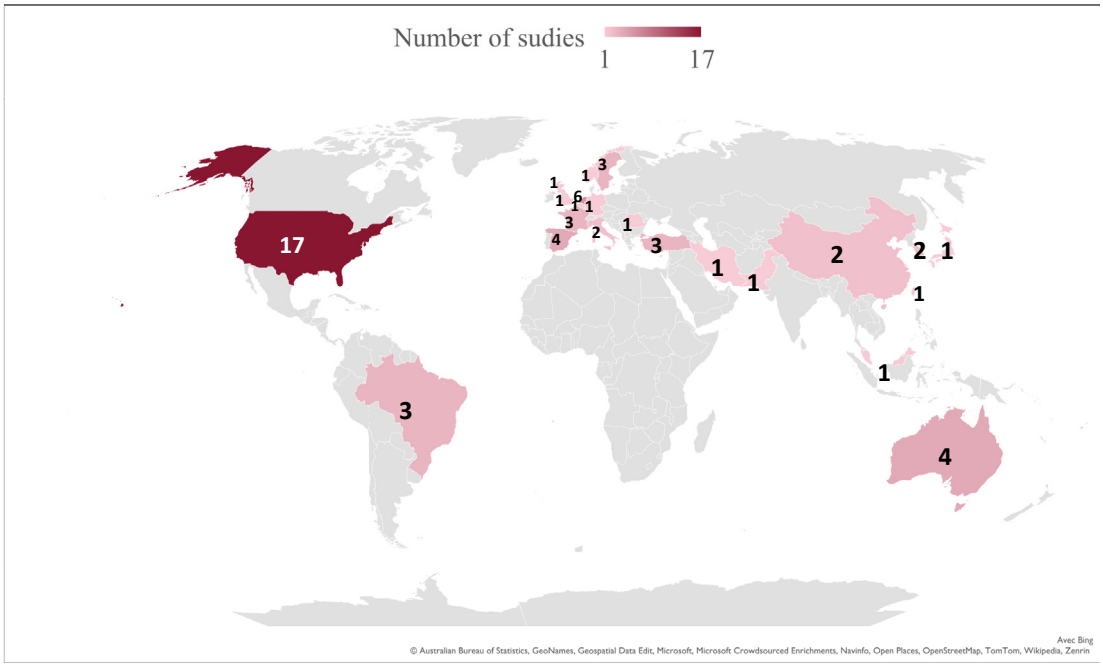

Figure 2. Geographic locations of included studies.

The effect of screening equipment on the patient experience was investigated in seven articles (11.7 %) among which three compared breast computed tomography (BCT), either cone-beam BCT[65,66] or spiral-beam BCT,[67] to digital mammography[65] or digital mammography and ultrasound[67] or diagnostic mammography with or without ultrasound.[66] Mammography was also compared to automated breast ultrasound (ABUS)[68] or to a pink luminous breast device emitting a LED red light to detect breast abnormalities.[69] The remaining two studies confronted different devices: one compared contrast-enhanced spectral mammography (CESM) to contrast-enhanced MRI (CEMRI),[70] and the other compared mammography with or without ultrasound to these same radiological examinations plus magnetic resonance imaging (MRI).[71]

Among the three articles on examination procedures (5 %), two concerned the patient's position during mammography, either sitting or standing,[72,73] and one studied the satisfaction regarding the addition of a clinical breast examination to the mammography examination.[74] Three articles evaluated the influence of patient-related factors (5 %) on the experience during mammography acquisition. More precisely, coping was considered in two studies,[75,76] and another compared pain related to breast compression throughout the menstrual cycle.[77]

In the category of physical environment (5 %), the experience of mammography in mobile versus fixed sites was examined in two articles,[78,79] whereas the last one considered mammogram-only clinics *versus* conventional ones.[80] Finally, one article investigated the category of staff characteristics (1.7 %), which explored not only the radiographers' training but also the respective years of experience and whether they had ever had a mammogram as patient.[24]

Population of interest

The 60 articles included account for a total of 23519 participants. Most of the studies were conducted on women (53/60). The remaining seven articles referred only to "patients" or "participants",[30,35,44,65,70,74,79] but none mentioned mammography examinations on men or transgender people. The majority (42/60) of the studies were carried out in a BC screening context, of which 11 included both screening and diagnostic patients.[12,13,24,28,32,34,35,47,53,55,60]

Healthcare providers

Most of the interventions were provided by radiographers either alone (24/60) or in partnership with patients when they guided them through self-compression procedures (8/60).[13,29,31–35,47] Three interventions were exclusively patient-mediated,[69,75,76] they concerned coping, for example. Some interventions involved a nurse,[50,52,59,64] a massage therapist,[53] a physician,[74] a psychologist,[57] or a *promotora*, *i.e.* a culturally appropriate community health worker for the Hispanic-Latino community.[62]

Outcomes

The effect of the interventions on patient experience was assessed using six main outcomes. The most frequently estimated outcome was pain (43/60), followed by comfort (24/60), anxiety (20/60), satisfaction (20/60), preference (5/60), and then patient depression level (1/60). Some studies have considered solely one experience-related outcome; thus, for instance, pain was exclusively reported in 14 studies. However, these outcomes have often been assessed together in a single article.

Of the 60 articles, 30 analyzed patient experience exclusively. The remaining 30 studies estimated other outcomes related to image quality (n = 22), technical parameters such as breast compression force (n = 19), clinical aspects such as breast thickness (n = 18), or radiation dose (n = 13). Four other outcomes were examined in the studies, but in a more anecdotal way, namely safety, based on the report of side effects (n = 3), duration of the examination (n = 2), and workflow (n = 1).

Discussion

The aim of this study was to identify and map the interventions applied in clinical practice to improve the patient experience in mammography, considering the type of patients, the healthcare

Table 1
Intervention, provider, population, outcomes, and context of each study.

Category of intervention	Intervention	Intervention provider	Population	Experience-related outcomes	Other outcomes	Context	Study
Breast compression and positioning	Flexible paddle	Radiographer	- 288 women - Age: 50-75 years	- Pain	- Dose - Image quality - Clinical parameters	Screening	Broeders et al., 2015[14]
	Flexible paddle	Radiographer	- 28 women - Mean age: 56.4 ±11.3 years (40–70)	- Pain	- Clinical parameters - Technical parameters	Screening	Dustler et al., 2021[43]
	Mammopad	Radiographer	- 100 Chinese women - Mean age: 49.7 ± 7.3 years (32-70)	- Pain - Comfort	- Dose - Image quality	Screening	Chan et al., 2016[40]
	Mammopad	Radiographer	- 394 Women - Mean age: 55.41 ± 10.8 years	- Anxiety - Pain	- Image quality - Clinical parameters - Technical parameters	Screening	Dibble et al., 2005[15]
	Mammopad	Radiographer	- 505 women	- Comfort	- Dose - Image quality - Technical parameters	Screening	Markle et al., 2004[41]
	Mammopad	Radiographer	- 838 asymptomatic women	- Pain	- Image quality - Technical parameters	Screening	Tabar et al., 2004[42]
	Positioning sheets	Radiographer	- 184 women	- Pain	- Dose - Image quality - Clinical parameters - Technical parameters	Screening	Timmers et al., 2015[48]
	Pressure-based paddle	Radiographer	- 433 women - Mean age ± SD: 60.2 ± 7.8 (49–75)	- Pain	- Dose - Image quality - Clinical parameters	Screening	de Groot et al., 2015[45]
	Pressure-based paddle	Radiographer	- 343 patients (Pain score assessment group)	- Pain	None	Diagnostic	Jeukens et al., 2019[44]
	Pressure-based paddle and Flexible paddle	Radiographer	- 4675 women - Mean age ≈ 59.4 years (95% CI ≈ 59–59.7).	- Pain	- Dose - Technical parameters	Screening	Moshina et al., 2019[46]
	Pressure-based paddle and Flexible paddle and Self-compression	Radiographer & Patient	- 103 women	- Comfort - Satisfaction	- Dose - Image quality - Clinical parameters - Technical parameters - Radiographer perspective	Screening & Diagnostic	Van Lier et al., 2020[47]
	Reduced compression	Radiographer	- 130 Malaysian women - Mean age: 48,6 years (40-69)	- Anxiety - Pain	- Image quality	Screening	Abdullah Suhaimi et al., 2015[36]
	Reduced compression	Radiographer	- 51 women (study part 2) - Mean age: 56.4 ± 9.6 years (41-78)	- Pain	- Dose - Image quality - Clinical parameters - Technical parameters	Diagnostic	Agasthya et al., 2017[37]

	Reduced compression	Radiographer	- 45 women - Mean age: 65 years (49–84)	- Comfort	- Image quality - Clinical parameters - Technical parameters	Diagnostic	Förnvik et al., 2010[38]
	Reduced compression	Radiographer	- 114 women - Mean age: 60 years (40-86)	- Comfort	- Image quality - Clinical parameters - Technical parameters	Screening	Poulos et al., 2003[39]
	Self-compression	Radiographer & Patient	- 448 women - Mean age: 59.81 years (95% CI: 59.34–60.28)	- Comfort - Pain - Preference - Satisfaction	- Dose - Clinical parameters - Technical parameters	Screening	Arenas et al., 2022[31]
	Self-compression	Radiographer & Patient	- 100 women - Median age: 59 years (34-89)	- Pain - Satisfaction	- Dose - Image quality - Clinical parameters - Technical parameters - Workflow	Screening & Diagnostic	Balleyguier et al., 2018[32]
	Self-compression	Radiographer & Patient	- 148 women - Median age ≈ 61 years (1st-3rd quartile ≈ 52-69 years)	- Anxiety - Comfort - Pain - Preference	- Dose - Image quality - Clinical parameters - Technical parameters	Screening	Dontchos et al., 2019[33]
	Self-compression	Radiographer & Patient	- 548 women - Mean age ± SD: 61.35 ± 6.34	- Pain - Satisfaction	- Image quality - Clinical parameters - Technical parameters - Radiographer perspective - Safety	Screening & Diagnostic	Henrot et al., 2019[13]
	Self-compression	Radiographer & Patient	- 150 women - Mean age: 53.4 (34-74 years)	- Pain - Satisfaction	- Image quality - Technical parameters	Screening & Diagnostic	Morales et al., 2006[34]
	Self-compression	Radiographer & Patient	- 495 women - Mean age ± SD: 57 ± 13.7	- Anxiety - Comfort - Pain - Satisfaction	- Dose - Image quality - Clinical parameters - Technical parameters - Exam duration	Diagnostic	Iotti et al., 2023[29]
	Self-compression	Radiographer & Patient	- 106 patients - Age: 40-90 years	- Anxiety - Comfort - Pain - Preference	None	Screening & Diagnostic	Ulus et al., 2019[35]
Communication, information	- Information - Emotional support -> Verbal	Nurse	- 436 women - Age: 50-69	- Anxiety - Pain - Satisfaction	None	Screening	Fernandez-Feito et al., 2015[64]
	- Information - Emotional support -> Verbal	Nurse	- 50 women - Mean age ≈ 52 ± 7 years (40-70)	- Anxiety	None	Screening	Lungulescu et al., 2018[59]
	- Information - Emotional support -> Verbal	Psychologist	- 60 women - Mean age: 55 years (41-70)	- Anxiety - Comfort - Depression - Pain	None	Diagnostic	Caruso et al., 2001[57]

(*continued on next page*)

Table 1 (*continued*)

Category of intervention	Intervention	Intervention provider	Population	Experience-related outcomes	Other outcomes	Context	Study
	- Information -> Multimedia	Not applicable	- 150 women - Mean age ≈ 54 years (SD ≈ 8)	- Anxiety - Pain	None	Screening	Kuo et al., 2021[58]
	- Information -> Multimedia	Not applicable	- 613 women	- Anxiety - Comfort - Pain	None	Screening & Diagnostic	Mainiero et al., 2001[12]
	- Information -> Verbal	Not available	- 136 women - Age: 40-86	- Comfort	None	Screening	Shrestha & Poulos, 2001[61]
	- Information -> Verbal	Radiographer	- 357 women	- Anxiety - Pain	None	Screening & Diagnostic	Rueda, 2015[60]
	- Information -> Verbal + a flip book of slides	A promotora	- 94 women - Mean age ≈ 48 years	- Satisfaction	None	Screening	Spalluto et al., 2019[62]
	- Information -> Written	Not applicable	- 501 asymptomatic women from the Menopause Unit. - Mean age 49.8 ± 6.8 years	- Anxiety - Pain	None	Screening	Alimoglu et al., 2004[56]
	- Information -> Written	Not applicable	- 63 women	- Anxiety - Pain	None	Not available	Yılmaz & Kıymaz, 2010[63]
Examination procedure	Clinical breast examination	Physician	- 23 70 respondents	- Satisfaction	None	Screening	Han et al., 2012[74]
	Sitting	Radiographer	- 33 women - Mean age ± SD: 69.6 years ± 4.6 years.	- Satisfaction	- Image quality	Screening	Evans, 2000[72]
	Sitting	Radiographer	-520 women - Mean age ≈ 55 years (SD ≈ 3)	- Pain - Comfort	- Image quality - Exam	Screening	Hagen et al., 2008[73]
Patient-related factors	Coping	Patient	- 220 women - Mean age: 47 years (30-71; SD: 7.7)	- Pain - Comfort	None	Screening	Asghari & Nicholas, 2004[75]
	Coping	Patient	- 99 women	- Pain	- Clinical parameters - Technical parameters	Diagnostic	Kornguth et al., 2000[76]
	Menstrual cycle	Not applicable	- 10 women (20 breasts) - Mean age ± SD: 22 ± 0.7	- Pain	- Clinical parameters - Technical parameters	Not available	Kitaoka & Kawashima, 2018[77]
Physical environment	Mammogram-only clinic	Not applicable	- 284 women - Mean age: ≈ 58 years	- Anxiety - Satisfaction	None	Diagnostic	Sherman et al., 2013[80]
	Static site vs. mobile van	Not applicable	- 11 women	- Comfort - Preference - Satisfaction	None	Screening	Chen et al., 2016[78]
	Static site vs. mobile van	Not applicable	- 1672 participants	- Satisfaction	None	Screening	Yoon et al., 2009[79]
	Analgesic premedication		- 294 Women	- Pain	- Safety	Screening	Freitas-Junior et al., 2018[49]

Relaxation techniques and analgesic care		Member of the study team	- Mean age: ≈ 49.2 years	- Comfort			
	Analgesic premedication	Not available	- 632 women (estimated enrollment) - Age: 35-70 Years	- Anxiety - Comfort - Pain	None	Screening & Diagnostic	Nct, 2020[28]
	Analgesic premedication	Not available	- 450 women (estimated enrollment)	- Pain - Comfort	None	Diagnostic	Nct, 2018[27]
	Analgesic premedication	Nurse	- 418 women - Age: 32-89 years	- Comfort - Satisfaction	- Image quality - Safety	Screening	Lambertz et al., 2008[50]
	Analgesic premedication and/or calming music	Not available	- 251 women (actual enrollment)	- Pain	None	Not available	Nct, 2016[26]
	Massage	Massage therapist	- 113 women	- Anxiety - Satisfaction	None	Screening & Diagnostic	Ashton et al., 2020[53]
	Multi-sensory relaxing environment	Not applicable	- 242 women - Mean age: 58.2 ± 11 years	- Anxiety - Pain - Satisfaction	None	Screening & Diagnostic	Sarquis-Kolber et al., 2019[55]
	Music vs relaxation	Member of the study team	- 143 women - Mean age ≈ 52 years (SD ≈ 11 years)	- Anxiety - Pain	None	Screening	Domar et al., 2005[51]
	Music	Nurse	- 100 women - Mean age ≈ 54 years (SD ≈ 10 years)	- Anxiety - Pain	None	Screening	Zavotsky et al., 2014[52]
	Music	Radiographer	- 60 participants	- Pain - Satisfaction	- Technical parameters	Not available	Nelson et al., 2023[30]
	Physical exercise	Not available	- 198 women - Age: 50-69 Years	- Pain	None	Not available	Cardoso de Almeida et al., 2018[54]
Screening equipment	Automated breast ultrasound	Not available	- 199 women	- Comfort - Pain - Satisfaction	None	Screening	Zintsmaster et al., 2013[68]
	Breast computed tomography	Radiographer	- 409 patients - Mean age ± SD: 48.01 ± 8.085 (35-89)	- Pain	None	Diagnostic	Li et al., 2019[65]
	Breast computed tomography	Radiographer	- 79 women - Mean age: 60.2 ± 10.0 years (34-82)	- Comfort - Pain - Satisfaction	- Image quality - Radiographer perspective	Diagnostic	Wetzl et al., 2021[67]
	Breast computed tomography	Radiographer	- 36 women - Mean age ± SD: 56.0 ± 9.8 (41−77)	- Comfort	- Dose - Image quality - Clinical parameters	Diagnostic	O'Connell & Kawakyu-O'Connor, 2012[66]
	Complementary MRI	Radiographer	- 1561 women - 20-70 years	- Pain - Satisfaction	None	Screening	Bredart et al., 2012[71]

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Table 1 (*continued*)

Category of intervention	Intervention	Intervention provider	Population	Experience-related outcomes	Other outcomes	Context	Study
	Contrast-enhanced spectral mammography (CESM) vs contrast-enhanced MRI (CEMRI)	Radiographer	- 49 patients - Mean age ± SD: 55 ± 9.5 (36–74)	- Anxiety - Comfort - Preference	None	Diagnostic	Hobbs et al., 2015[70]
	Pink Luminous Breast device	Patient	- 170 Puerto Rican women	- Comfort	- Clinical parameters	Not available	Ocasio-Villa et al., 2021[69]
Staff characteristics	Radiographer characteristics	Radiographer	- 210 women - Mean age: 54 years	- Pain	None	Screening & Diagnostic	Van Goethem et al., 2003[24]

professionals involved, and the main outcomes assessed. The results showed that strategies in place are variable and based on different technical, educational, communicational, psychological, or environmental methods. Thus, this review provides a holistic approach by combining all types of strategies and covering all aspects that can have an impact on patient experience.[81] The experience is critical, since if negative, the patient can develop trauma and anxiety, not returning to the mammography department for follow-up examinations,[10,11,82,83] even when BC screening is recommended once every two years for most countries.[84,85] Therefore, improvements in clients' experience[83] and satisfaction[86] with healthcare services are always a concern for the departments and national healthcare systems.

The pain associated with breast compression is frequently the main reason for a non-satisfying experience and attention is being given by industry and healthcare professionals to reduce it.[87,88] The techniques used for breast compression were the strategies most studied to improve clients' experience, as reported by this review. This can be explained by the psychological burden and pain that the compression adds to the other sufferings associated with the examination. In addition, compression is essential to reduce glandular radiation dose, improve image quality for diagnosis, and avoid returning for screening or other medical imaging examinations. However, four articles have successfully implemented compression reduction protocols to obtain a trade-off between the different components, such as pain and image quality.[36–39]

To improve the experience and reduce pain, self-compression by the patient with radiographer assistance, is another strategy largely studied in the included articles. This intervention was carried out on GE Healthcare brand senographs, generally the Pristina. While this approach of giving women greater control over the level of compression has already been highlighted in two reviews dating from 2007[89] and 2008,[16] our scoping review offers a comprehensive overview of current studies and demonstrates the growing number of studies since then. Furthermore, the interest in this intervention is not surprising since, in the process of care, patients generally present a passive role, with a decrease in self-efficacy.[90,91] On the contrary, the management of the degree of compression by the patients themselves, with a hand-held button, gives an active role and increases the perceived control over the unpleasant event. These elements are indeed decisive in the evaluation of pain.[90,91]

In the identified literature, pain happens to be the most studied outcome, twice as much as anxiety or satisfaction. As emphasized previously, this results from the fact that the majority of studies focused on compression. Nevertheless, several documents quantified other outcomes, such as image quality, parameters related to breast compression or glandular radiation dose. Implementing new interventions in practice may require additional human resources, as in the case of educational interventions dispensed orally, massages, or relaxation. However, very rarely the duration of the examination[29,73] or the influence of the intervention on the workflow[32] was estimated in the articles found and the budgetary cost was not quantified.

This review also shows that most of the articles evaluated device-based interventions, whether related specifically to breast compression, or the overall mammography machine. In radiology practice, the technical aspects are indeed generally more developed than the psychological or communication aspects due to the nature of the discipline, which focuses on medical imaging devices to diagnose and treat diseases. The complexity of these devices and the technological advances require a thorough understanding of the physical and technical principles underlying their use and an increased focus on these aspects to stay up to date.[92]

Alternative modalities to detect any changes in the breast and patient follow-up include MRI, Ultrasound, or Tomosynthesis.[93] Of

the screening devices studied as an intervention, this review pointed out that the most cited modality is tomosynthesis. This approach produces 3D images, overcoming breast tissue superposition. It has notably shown better results than digital mammography for abnormal interpretation rate, cancer detection rate, and specificity, or similar performance for sensitivity.[94] This technology is already recommended, along with digital mammography, as a screening method for people with an average risk of breast cancer.[84] This device also seems to cause less pain,[65,67] or improve patient comfort.[66] This is an additional benefit for patients, especially those with dense breasts. Indeed, it is known that denser breast are associated with higher pain during compression as well as a higher risk of developing BC, enhancing the need for screening.[95–97] As the scanner acquisition time differs between tomosynthesis manufacturers,[98] this could affect the comfort felt by patients. Authors should therefore indicate the name and brand of the device used, and possibly the scan time, which was not necessarely the case in the included articles.

In addition to the technical methods, other strategies were reported, although much less extensively. They refer to pharmacological interventions, in the form of tablets (e.g. tamoxifen, ibuprofen) or lidocaine cream applied to the breast, to reduce pain and discomfort. These strategies are notably considered in clinical trials. Other interventions rely on patient distraction, such as music, or a relaxing multi-sensory environment. Neuroimaging studies have indeed shown the benefit of distraction in reducing pain; this being considered as a multidimensional phenomenon, based in particular on emotion and sensation and, therefore, influenced by many factors such as anxiety.[99,100] The identified studies on distraction seem to show either a positive or an absence of effect on perceived pain, anxiety, or satisfaction. Nevertheless, these distraction strategies are also used in other contexts such as improving the experience of patients undergoing MRI[101,102] or radiotherapy.[103]

This review revealed that the vast majority of studies focused on women, and none mentioned the inclusion of men or transgender people. However, mammograms -diagnostic for men and screening or diagnostic for transgender (male to female or female to male)- may also be necessary.[104,105] This research gap on transgender people has also been outlined recently concerning the level of BC screening use.[106] However, the integration of these patients and more precisely the understanding of their experience is essential to define interventions tailored to their needs and achieve health equity, which constitutes a public health priority.[107] This priority also concerns other types of populations, such as the medically underserved patients, for whom mobile mammography units have been developed to reduce barriers to breast screening and diagnostic delays. These mobile units have been the subject of five identified studies, two of which specifically compared this environment to fixed units,[78,79] while the others focused on another type of intervention performed in mobile units.[14,42,74]

A gap in knowledge was also identified regarding women with breast implant. None of the studies included concerned this population and patients with this characteristic were even excluded from some of our articles. Given that most were testing a compression-related intervention (e.g.13,46,47), this may be an explanation for this exclusion criteria. However, mammography is particularly painful in breast-augmented women,[108] requiring additional research to better adapt the care of this population. This is part of a revolution that is happening in healthcare, moving from physician or organization-centered departments to client/patient and family-centered care. Patient-centered care (PCC) refers to engaging patients (and families or care partners) in their healthcare as well as in co-designing care with the professionals and community to achieve better outcomes in health.[109] The uniqueness of each client is important to take into account in health services, to consider their needs and, therefore, to be able to adequately address the clinical questions through the reference examination.[110]

This study has limitations -inherent to the scoping review methodology- namely the lack of quality assessment of the included studies. Another limitation was the inclusion of studies only if they were published in a language using the Latin alphabet, which may have excluded relevant documents in other languages. Additionally, this review focused exclusively on interventions evaluated and delivered within the mammography setting. Some relevant studies may not have been included, which could have influenced the findings, although a thorough literature search was carried out. Nevertheless, the equations and search strategy are available in the supplementary material, ensuring transparency and enabling others to replicate this research.

As a scoping review also aims to identify gaps that still require further work, the need for additional research on improving patient experience was identified. Besides the sexual identity of the population, this is the case regarding the preparation of patients for mammography. Thus, no study has investigated the conditions of preparation, such as waiting naked or wearing a gown, on patient satisfaction or experience. Yet the embarrassment caused by the nudity linked to the examination constitutes a recognized emotional trait in mammography, which is accompanied by a need for respect for privacy.[111–113]

Conclusion

A total of 60 studies evaluating strategies to improve patient experience in mammography were identified. These interventions were mostly delivered by radiographers. They range from highly technical interventions, using for example different types of compression paddles, to educational interventions, through oral communication or the use of brochures, and even psychological interventions, such as relaxation. They have been evaluated for their effectiveness on patient experience-related outcomes such as pain, anxiety, satisfaction, and patient comfort. Other outcomes were considered, the main one being image quality. This scoping review therefore provides a holistic approach offering guidance to radiographers, and other healthcare professionals and services, for better client-centered care and health outcomes such as pain and dose reduction, and improved image quality to increase lesion detectability. Further research is warranted, in particular on the psychological strategies, on men and transgender people. The financial cost of interventions should also be quantified to identify the strategies that show higher improvement with lower cost.

Conflict of interest statement

None.

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Appendix A. Supplementary data

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