

Review Article

Uptake of breast cancer risk-management strategies among unaffected BRCA 1/2 carriers: a systematic review of international evidence

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ABSTRACT

Background: Women carrying BRCA1/BRCA2 pathogenic variants face a substantially increased risk of breast cancer and may choose between risk-reducing mastectomy (RRM) or intensive surveillance. This systematic review aimed to synthesise the available evidence on the uptake of breast cancer risk management strategies among unaffected BRCA1/2 carriers.

Methods: A systematic review was conducted in accordance with PRISMA guidelines. Four electronic databases (PubMed, Scopus, Web of Science, ASSIA) and grey literature sources were searched for studies published since 1995. Eligible studies reported uptake of breast cancer risk management strategies among unaffected BRCA1/2 carriers. Two reviewers independently screened records, extracted data, and assessed methodological quality using Kmet criteria. Due to heterogeneity in study design and outcome definitions, findings were synthesised narratively.

Results: Thirty-two studies published between 2002 and 2025 were included. Uptake of RRM ranged from approximately 0% to 81.6%, with higher uptake consistently reported in North America and Norwegian cohorts and lower rates in several Asian and Middle Eastern populations. Intensive surveillance was commonly adopted among women not undergoing surgery, with adherence often exceeding 80–90%. Only a minority of studies explicitly quantified women not adopting any specific preventive strategy, the proportion of whom ranged from 2.8% to 9.7%.

Conclusions: Breast cancer risk management among unaffected BRCA1/2 carriers varies widely across settings. Surveillance was the most adopted strategy in most cohorts, whereas uptake of RRM showed marked international variability. More evidence, standardisation, and longitudinal research are needed to support organization, counselling, adherence, and equitable access to risk management in BRCA1/2 carriers.

1. Introduction

Germline pathogenic variants in BRCA1 and BRCA2 are associated with an increased risk of breast and ovarian cancer compared to the general population, with a lifetime risk that can reach approximately 70% for breast cancer and 45% for ovarian cancer [1,2]. To manage these risks, unaffected women carrying BRCA1/2 pathogenic variants may undergo intensive surveillance and/or consider prophylactic surgery, such as risk-reducing mastectomy (RRM) and risk-reducing salpingo-oophorectomy (RRSO) [3]. Although RRSO is primarily intended to prevent ovarian cancer, it remains relevant to discussions on breast cancer risk management, as it can modestly reduce breast cancer risk

and improve overall survival among carriers [1,2].

In addition, the decision to undergo RRSO is influenced by the limited effectiveness of available ovarian cancer screening methods [4]. Transvaginal ultrasound and CA-125 monitoring demonstrate poor sensitivity for early disease detection, leaving few validated alternatives to surgical prevention. Consequently, RRSO is often regarded as the most reliable ovarian cancer risk-reduction strategy, with evidence indicating risk reductions of up to 96% among unaffected carriers [5].

In contrast, decision-making regarding breast cancer risk management is more variable. Risk-reducing mastectomy is a demanding surgical intervention associated with physical and psychological implications, as well as potential complications; for this reason, many

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women consider it a less acceptable option [6,7]. Conversely, intensive breast surveillance—when consistently adhered to—has been shown to be a highly effective strategy for early detection and risk management [8,9].

Despite broadly concordant evidence, uptake of breast cancer preventive strategies varies markedly between health systems and over time [9]. These differences reflect structural factors (availability and cost of MRI coverage, reconstructive surgery capacity and access to specialised hereditary cancer clinics), cultural values and body-image considerations, counselling practices and high-profile media events (often termed the “Angelina Jolie effect”) [10,11]. Together, these contextual determinants influence the decision of unaffected carriers to undergo definitive surgical risk reduction, rely on intensive imaging surveillance or forego active preventive measures.

However, the available evidence remains fragmented, and to date no comprehensive synthesis has systematically examined how unaffected carriers manage their breast cancer risk or the proportion adopting each strategy. A rigorous consolidation of uptake patterns is essential to guide counselling practices, inform health-service planning, and support equity in access to risk-management options.

1.1. Review objective

The purpose of this systematic review is to systematically identify and analyze studies reporting the uptake rates of risk management strategies for breast cancer in BRCA1/2 carriers. Specifically, we focus on unaffected women and examine the proportion who chose prophylactic mastectomy, intensive surveillance, or no active preventive strategy.

2. Methods

2.1. Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) guidelines [12]. The protocol was registered on the Open Science Framework (OSF, <https://osf.io/ka5xu>), given that PROSPERO currently only accepts interventional reviews. The review process followed all PRISMA recommendations regarding protocol registration, systematic search, screening, data extraction, and reporting of results.

2.2. Review question

The review question was formulated using the PICO framework (Population, Intervention, Comparison, Outcomes): “What proportion of unaffected women carrying a BRCA1 or BRCA2 pathogenic variant choose prophylactic mastectomy, intensive surveillance, or no active preventive strategy for breast cancer risk management?” (Table 1).

2.3. Search strategy

Four databases (ASSIA- Applied Social Sciences Index & Abstracts, Pubmed, Scopus, Web of Science) were searched for papers published since January 1995. The search was conducted on April 2026. We chose

to start at 1995 because BRCA1/2 genes have been discovered in the mid-1990s, therefore BRCA testing was not available before. A detailed search strategy for all electronic databases is presented in Supplementary Files Table S1. The reference lists of all included studies were hand-searched for additional relevant reports or key terms. Targeted internet searching using Google Scholar was also examined for any additional studies of interest. Grey literature was also consulted through the OpenGrey Repository (formerly System for Information on Grey Literature in Europe).

All retrieved records were imported into Microsoft Excel, where duplicates were removed before screening. Titles and abstracts were independently screened by two reviewers (RGB, CDP), followed by full-text assessment of potentially eligible articles. Any disagreements were resolved through discussion with a third reviewer (GI).

The selection process and reasons for exclusion were documented in a PRISMA flow diagram. To ensure transparency and reproducibility, all steps of the search and selection process were recorded in an electronic logbook following the Excel-based systematic review method described by Godino [13].

2.4. Eligibility criteria

Studies were considered eligible if they were (a) published in English or Italian; (b) published in peer-reviewed journals since 1995 and reporting original research (using any methods); (c) where the study sample explicitly included BRCA carriers; (d) where the study sample explicitly included unaffected women without breast and ovarian cancer; (e) where the study sample explicitly included women facing a decision to manage breast cancer risk.

Studies were excluded if they included (a) high-risk women with BRCA test result negative or uninformative; (b) women at high-risk of ovarian cancer not due to a BRCA mutation; (c) pharmacological studies; (d) abstracts; (e) case reports or opinion papers; (f) books; (g) studies assigned a quality methodological score below 60%.

2.5. Quality appraisal

All articles considered for inclusion in the review were subjected to independent analysis (LG, CDP, RGB) using standard quality assessment criteria for evaluating both quantitative and qualitative original research [14]. Studies have been assessed relating to methodology and reporting of results and assigned 0 points (not addressed), 1 point (partially addressed) or 2 points (completely addressed). The total score was then reported in percentage using the Kmet and colleagues’ methods of scoring. Although they do not prescribe a mandatory cutoff, a threshold of 60% was adopted to ensure adequate methodological rigor. Discrepancies were discussed until consensus was achieved among the reviewers.

2.6. Data extraction and synthesis

Two independent researchers (LG, CDP) extracted data from the included studies using a pre-defined matrix. Extracted variables included author(s), year of publication, country, study design, data collection method, sample size, study objectives, and findings relevant

Table 1
PICO specifications.

Dimension	Specification
Population	Women who are confirmed carriers of a pathogenic mutation in the BRCA1 or BRCA2 gene, without a personal history of breast or ovarian cancer.
Intervention	Elective preventive strategies, including risk-reducing mastectomy or intensive imaging-based surveillance (e.g., MRI, mammography, ultrasound).
Comparison	No active prevention
Outcome	Proportion of BRCA mutation carriers opting for each preventive strategy (surgery, surveillance)

to the review question, as well as the uptake of preventive strategies—specifically, the proportion of unaffected BRCA1/2 carriers (women without a current or previous diagnosis of breast or ovarian cancer at the time of genetic testing) who chose prophylactic mastectomy, intensive surveillance, or no active preventive strategy. A third reviewer (GI) verified all extracted data to ensure completeness and accuracy. Discrepancies or uncertainties were resolved through consensus discussion.

Given the heterogeneity in study design, outcome definitions, and reporting, a quantitative meta-analysis was not feasible; therefore, results were synthesised narratively, emphasizing patterns and differences across studies.

3. Results

3.1. Search outcome

The results of the literature search are summarized in the PRISMA flowchart (Fig. 1). The search initially produced 7621 records and 1390 were duplicates, leaving 6231 for examination. Following the review of the title and abstract, 125 studies were read in detail by researchers. Thirty-two papers were then included in this review (Table 2). The complete Excel-based screening logbook is provided as supplementary material.

3.2. Characteristics of included studies

The 32 included studies were published between 2002 and 2025 and examined unaffected BRCA1/2 carriers, defined as women without a current or prior breast or ovarian cancer diagnosis at the time of genetic testing. Studies were conducted across several geographical regions,

including Western Europe [15–27], Eastern Europe [18,28–30], as well as North America [18,31–38], Oceania [39–41], the Middle East [18,42,43], and Asia [44–46].

Methodological approaches included prospective and retrospective cohort studies, as well as cross-sectional questionnaire-based studies. Sample sizes ranged from 19 unaffected BRCA1/2 carriers [34] to large national or multinational cohorts including more than 3000 participants [22]. Follow-up duration ranged from approximately one year [15] to more than five years [16,28,39]. While the level of detail varied, all studies reported data on uptake of prophylactic mastectomy, with several also providing information on surveillance practices and, in some cases, on the absence of documented preventive strategies. Overall, methodological quality was judged to be high, with most studies reporting appropriate data collection, sample characteristics, and recruitment procedures. Table 2 reports the quality scores for each included study, while the complete item-level quality appraisal for all studies is reported in the supplementary Excel-based logbook.

4. Uptake of breast cancer risk management strategies

Across studies, three main strategies for breast cancer risk management were analysed: RRM, intensive surveillance, and no documented preventive strategy (Table 3). Marked variability was observed across studies and countries.

4.1. Risk-reducing mastectomy

Among the included studies, uptake of RRM among unaffected BRCA1/2 carriers ranged from 0% to 81.6% (Table 3), reflecting substantial heterogeneity in clinical practice, healthcare systems, and historical context.

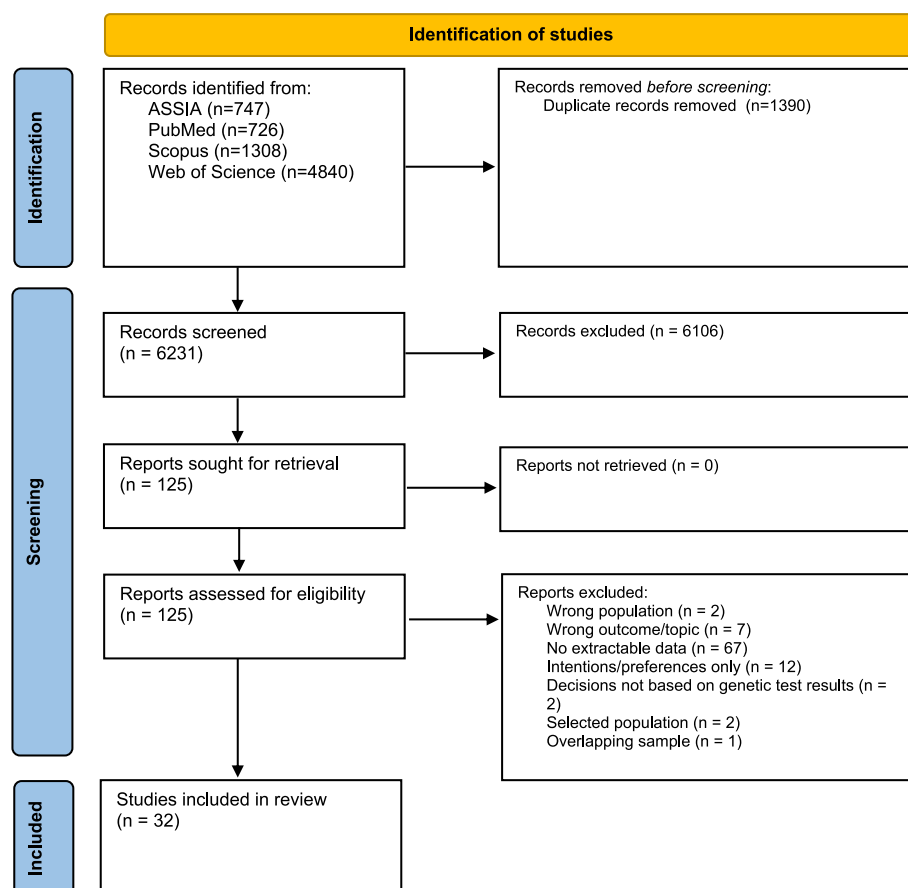


Fig. 1. PRISMA 2020 flow diagram.

Table 2
Characteristics, aims, and quality assessment of the included studies.

Author (Year)	Country	Study design	Sample (unaffected carriers)	Aim	Quality assessment
Borreani (2014)	Italy	Longitudinal	27	To describe the psychological impact of preventive options among BRCA1/2 carriers after genetic test disclosure	81.8%
Carroll (2011)	Ireland	Retrospective cohort	33	To describe the management of BRCA mutation carriers in an Irish hereditary cancer program and compare BRCA-related with sporadic breast cancer outcomes	81.8%
Claes (2005)	Belgium	Longitudinal	32	To examine surveillance behavior and preventive surgery after predictive testing.	77.3%
Collins (2013)	Australia	Prospective cohort	325	To estimate uptake of cancer risk-reducing measures among Australian BRCA1/2 mutation carriers	86.4%
Galmor (2021)	Israel	Retrospective cohort	427	To reevaluate RRBm uptake rates and identify factors associated with opting for RRBm among Israeli unaffected BRCA1/2 carriers	100%
Gronwald (2007)	Poland	Cross-sectional questionnaire study	212	To evaluate uptake of preventive measures among Polish BRCA1 carriers after disclosure of mutation status	68.2%
Hao (2020)	USA	Retrospective cohort	59	To determine healthcare utilization/costs after disclosure of BRCA1/2 pathogenic variants and estimate uptake of NCCN-recommended risk management	90.2%
Haroun (2011)	Canada	Cross-sectional questionnaire study nested within an MRI-screening program	246	To identify factors associated with switching from MRI-based surveillance to RRM and assess satisfaction with the decision	63.4%
Hyldebrandt (2025)	Norway	Retrospective cohort	1237	To investigate and compare uptake of RRM, temporal trends, and post-RRM breast cancer incidence among Norwegian BRCA1/2 carriers	95.5%
Johns (2017)	USA	Retrospective cohort	86	To identify risk-reducing strategies among cancer-free BRCA1/2 carriers and factors associated with choosing prophylactic mastectomy versus surveillance	86.4%
Julian-Reynier (2011)	France	Prospective cohort	101	To investigate cancer risk management and perceptions five years after testing.	77.3%
Jung (2020)	Korea	Retrospective cohort	514	To investigate trends in risk-reducing surgery among Korean BRCA1/2 mutation carriers	72.3%
Kearton (2018)	Australia	Retrospective cohort	92	To examine cancer risk management decisions of BRCA1/2 carriers in Tasmania.	90.9%
Kim (2024)	Korea	Retrospective cohort	31	To analyze patterns of surveillance, chemoprevention, and risk-reducing surgery among unaffected Korean BRCA1/2 carriers	63.6%
Koskenvuo (2013)	Finland	Retrospective cohort	49	To study the frequency and outcomes of risk-reducing mastectomy among Finnish BRCA1/2 mutation carriers	72.3%
Laitman (2013)	Israel	Prospective cohort	170	To assess uptake of risk-reducing surgery among Israeli BRCA1/2 carriers and evaluate physician influence on preventive choices	63.4%
Long (2017)	United Kingdom	Retrospective cohort	280	To investigate the uptake of risk-reducing surgery among BRCA 1/2 carriers in Wales.	81.8%
Ložar (2021)	Slovenia	Retrospective cohort	346	To analyze trends and timing of mastectomy uptake among unaffected carriers.	86.4%
Marcinkute (2022)	United Kingdom	Prospective cohort	887	To evaluate long-term uptake, timing, and effectiveness of risk-reducing surgeries among unaffected BRCA1/2 carriers	95.5%
Metcalfe (2005)	Canada/USA (multicenter)	Cross-sectional questionnaire study	81	To evaluate uptake of tamoxifen and other preventive measures among healthy BRCA1/2 carriers	77.3%
Metcalfe (2008)	9 countries (multicenter)	Prospective cohort	1383	To compare international variation in uptake of preventive options among carriers.	77.3%
Metcalfe (2012)	Canada	Prospective cohort	19	To evaluate uptake of cancer risk reduction strategies and long-term cancer-related distress after population BRCA screening	81.8%
Ofverholm (2019)	Sweden	Prospective cohort	249	To assess the impact of risk-reducing surgery on cancer incidence and mortality among BRCA carriers in Western Sweden	90.9%
Ohsumi (2022)	Japan	Retrospective cohort	154	To assess the uptake and determinants of risk-reducing mastectomy among BRCA1/2 carriers in Japan.	90.9%
Peshkin (2002)	USA	Prospective cohort	41	To evaluate breast cancer screening practices after BRCA1/2 testing	81.8%
Phillips (2006)	Australia/New Zealand	Prospective cohort	142	To describe preventive strategies among carriers aware versus unaware of mutation status.	90.9%
Filippo-Morton (2016)	USA	Retrospective cohort	87	To assess uptake and patterns of surgical and surveillance strategies among BRCA1/2 carriers in Carolina	72.7%
Singh (2013)	USA	Prospective cohort	136	To evaluate the impact of family history on uptake of risk-reducing surgery.	90.9%
Skytte (2010)	Denmark	Retrospective cohort	306	To estimate uptake and timing of preventive surgery among Danish BRCA carriers.	95.5%
This (2012)	France	Prospective cohort	158	To evaluate uptake of preventive options among BRCA1/2 carriers in a French cohort.	90.9%
Willert (2025)	Denmark	Retrospective cohort	3067	To examine time trends in unaffected BRCA1/2 carriers, uptake of BRRM and RR-BSO, and oncological effects of risk-reducing surgeries	100%
Zimovjanova (2023)	Czech Republic	Retrospective cohort	496	To assess uptake, timing, and effectiveness of risk-reducing surgeries among unaffected BRCA1/2 carriers	95.5%

Table 3
Breast cancer surveillance and preventive strategies among unaffected BRCA1/2 carriers by geographical area.

Geographical area	Country	Breast cancer surveillance programme	Age at surveillance start	Uptake of RRM	Uptake of surveillance	No active strategy	Study
Western Europe	Austria	Not explicitly stated	Not explicitly stated	20.0%	Mammography 100.0%; MRI 65.0%	Not reported	Metcalfe et al., 2008
	Belgium	Monthly BSE; semi-annual CBE; annual mammography (ultrasound as alternative)	≥30 years	9.0%	BSE 64.0% CBE 95.0% Mammography 95.0%	Not reported	Claes et al., 2005
	Denmark	Annual mammography plus ultrasound and CBE; annual MRI (from 2006) Not explicitly stated	Mammography ≥30 years; MRI ≥25 years	30.1%	Not reported	Not reported	Skytte et al., 2010
			Not explicitly stated	14.3%	Not reported	Not reported	Willert et al., 2025
	Finland	Not explicitly stated	Not explicitly stated	35.0%	Not reported	Not reported	Koskenvuo et al., 2013
	France	Annual mammography plus ultrasound; annual MRI (from 2003)	≥30 years or 5 years before the earliest family diagnosis	8.9% (8.3% among women receiving identical RRM information)	Not reported	Not reported	This et al., 2012
		Annual mammography plus MRI	Not explicitly stated (national practice ≥30)	6.9%	Overall 87.1% (mammography + MRI 67.0%; mammography only 33.0%)	6.0%	Julian-Reynier et al., 2011
		Not explicitly stated	Not explicitly stated	25.0%	Mammography 100.0%; MRI 66.7%	Not reported	Metcalfe et al., 2008
	Ireland	Not explicitly stated	Not explicitly stated	12.1%	Not reported	Not reported	Carroll et al., 2011
	Italy	Not explicitly stated	Not explicitly stated	10.0%	Mammography 100%; MRI 72.2%	Not reported	Metcalfe et al., 2008
		Not explicitly stated	Not explicitly stated	18.5%	Overall 70.4%	Not reported	Borreani et al., 2014
	Netherlands	Not explicitly stated	Not explicitly stated	32.7%	Mammography 100.0%; MRI 94.6%	Not reported	Metcalfe et al., 2008
	Norway	Not explicitly stated	Not explicitly stated	4.5%	Mammography 93.0%; MRI 14.1%	Not reported	Metcalfe et al., 2008
		Annual mammography, annual MRI (from 2008/2009)	≥25 years	81.6%	Not reported	Not reported	Hyldebrandt et al., 2025
Eastern Europe	Sweden	Annual mammography plus ultrasound; annual MRI	≥25 years	32.1%	Not reported	Not reported	Ofverholm et al., 2019
	United Kingdom	Not explicitly stated	Not explicitly stated	34.0%	Not reported	Not reported	Long et al., 2017
		Not explicitly stated	Not explicitly stated	32.0%	Not reported	Not reported	Marcinkute et al., 2022
	Czech Republic	Not explicitly stated	Not explicitly stated	31.5%	Overall 42.1%	Not reported	Zimovjanova et al., 2023
	Poland	Annual mammography MRI discussed but generally unavailable outside a Krakow research protocol Not explicitly stated	≥35 years	5.0%	Mammography 81.1%; MRI 5.7%	Not reported	Gronwald et al., 2007
			Not explicitly stated	2.7%	Mammography 65.5%; MRI 6.7%	Not reported	Metcalfe et al., 2008
	Slovenia	Annual mammography plus MRI	Not explicitly stated	25.1%	Not reported	Not reported	Ložar et al., 2021
North America	Canada	Not explicitly stated	Not explicitly stated	22.4%	Mammography 96.7%; MRI 47.8%	Not reported	Metcalfe et al., 2008
		Annual mammography plus ultrasound; annual MRI, semi-annual CBE	Not explicitly stated	16.0%	Non-extractable data ^a	Not reported	Haroun et al., 2011
		Not explicitly stated	Not explicitly stated	11.1%	Non-extractable data ^a	Not reported	Metcalfe et al., 2012
	Canada/United States	Not explicitly stated	Not explicitly stated	27.2%	Not reported	Not reported	Metcalfe et al., 2005

(continued on next page)

Table 3 (continued)

Geographical area	Country	Breast cancer surveillance programme	Age at surveillance start	Uptake of RRM	Uptake of surveillance	No active strategy	Study
	United States	Not explicitly stated	Not explicitly stated	Not extractable.	CBE 77%	Not reported	Peshkin et al., 2002
		Not explicitly stated	Not explicitly stated	36.3%	Mammography 59%	Not reported	Metcalfe et al., 2008
		Annual MRI plus age-based mammography	≥25 years	41.9% (before 2005: 36.0%; after 2005: 49.2%)	Mammography 97.5%; MRI 24.4%	Not reported	Singh et al., 2013
		Not explicitly stated	Not explicitly stated	43.7%	Not reported	Not reported	
		CBE every 6 months, annual mammography, and annual MRI	≥30 years	34.9%	Overall 41.0%	Not reported	Filippo-Morton et al., 2016
		Annual mammography, and annual MRI	≥25 years	3.5%	Overall 65.1%	Not reported	Johns et al., 2017
Oceania	Australia	Not explicitly stated	Not explicitly stated	21.0%	Mammography 45.8%; MRI 32.2%	Not reported	Hao et al., 2020
		Annual MRI plus mammography	≥30 years	38.0%	Not reported	Not reported	Collins et al., 2013
	Australia/New Zealand	Annual mammography; CBE every 6–12 months; BSE	≥40 years or 5 years before the earliest family diagnosis	11.0%	Overall 59.2%	Not reported	Kearton et al., 2018
Middle East	Israel	Not explicitly stated	Not explicitly stated	4.2%	CBE 80.0%; BSE 78.0%; Mammography 89.0%; MRI 2.2%	Not reported	Phillips et al., 2006
		Semi-annual CBE; mammography every 18–24 months, annual MRI	≥25 years CBE and MRI	12.9%	Mammography 95.5%; MRI 2.2%	Not reported	Metcalfe et al., 2008
		Not explicitly stated	≥40 years mammography	9.6%	Non-extractable data ^a	Not reported	Laitman et al., 2013
Asia	Japan	Not explicitly stated	Not explicitly stated	5.2%	Not reported	Not reported	Galmor et al., 2020
		Not explicitly stated	Not explicitly stated	1.2%	Not reported	Not reported	Ohsumi et al., 2022
		Not explicitly stated	Not explicitly stated	0.0%	Not reported	Not reported	Jung et al., 2020
		Not explicitly stated	Not explicitly stated	0.0%	Overall 19.4%	9.7%	Kim et al., 2024

Legend:RRMrisk reduction mastectomy.

BSEbreast self-examination.

CBEclinical breast examination.

MRImagnetic resonance imaging.

^a Structured post-test surveillance participation reported (100%), but not considered fully comparable uptake data due to study-driven follow-up.

Very low uptake rates (<10.0%) were observed in several Asian, Eastern European, Middle Eastern, North American and Western Europe settings including the following countries: Korea (0.0%–1.2%) [45,46], Poland (2.7%–5.0%) [18,30], the United States (3.5%) [38], Israel (4.2%–12.9%) [18,42,43], Norway (4.5%) [18], Japan (5.2%) [44], France (6.9%–8.9%) [16,17], and Belgium (9.0%) [15].

Low uptake rates (10.0%–19.9%) were reported in several European, Middle Eastern, and Oceanian settings, including Italy (10.0%–18.5%) [18,25], Australia/New Zealand (11.0%) [40], Canada (11.1%–16.0%) [33,34], Ireland (12.1%) [24], and Denmark (14.3%) [22].

Intermediate uptake levels (20.0%–39.9%) were observed across several European North America, and Oceania settings. In North America, uptake ranged from 22.4% in Canada [18] to 27.2% in combined Canada/United States cohorts [35], reaching 34.9%–36.3% in United States cohorts [18,37]. Comparable uptake rates were reported in Austria (20.0%) [18], Australia (21.0%) [41], France (25.0%) [18], Slovenia (25.1%) [28], Denmark (30.1%) [21], the Czech Republic (31.5%) [29], Sweden (32.1%) [27], the Netherlands (32.7%) [18], Finland (35.0%) [23] and the United Kingdom, where uptake ranged from 32.0% to 34.0% [19,20]. Uptake also reached 38.0% in a more recent Australian cohort [39].

The highest uptake rates ($\geq 40\%$) were observed in recent cohorts from the United States and Norway. In the United States, uptake reached 41.9% overall, increasing from 36.0% before 2005 to 49.2% after 2005 [31], while another cohort reported an uptake of 43.7% [32]. The highest uptake identified across the included studies was reported in Norway, where uptake reached 81.6% in a recent cohort [26].

4.1.1. Intensive surveillance

Among women who did not undergo RRM, intensive breast surveillance was the most frequently adopted management strategy across studies, although both adherence rates and surveillance protocols varied considerably by geographical area and study period (Table 3). Where reported, adherence to surveillance was generally high. Several European studies reported substantial uptake of surveillance programs even when the specific surveillance modalities were not fully detailed, including 70.4% overall uptake in an Italian cohort [25,42], 1% in a Czech cohort [29]. In Belgium, 95% of unaffected carriers adhered to annual mammography and clinical breast examination, with monthly breast self-examination also commonly reported [15]. Similarly, across European countries mammography was widely used among unaffected carriers (65.5%–100% across countries), whereas MRI uptake showed marked variability [18,30].

High adherence to surveillance was also observed in cohorts from North America and Oceania. In the United States, overall surveillance uptake ranged from 41.0% [32] to 65.1% [37], while earlier cohorts reported substantial use of clinical breast examination (77%) and mammography (59%) [36]. In a more recent United States cohort, mammography and MRI uptake reached 45.8% and 32.2%, respectively [38]. In a recent Australian cohort, 59.2% of unaffected carriers participated in an intensive surveillance program including annual MRI and mammography [39]. In an earlier Australian/New Zealand cohort, participation was high for mammography (89%), clinical breast examination (80%), and breast self-examination (78%), although MRI was not routinely incorporated into surveillance protocols at that time [40]. Lower surveillance uptake was reported in a recent Korean cohort, where 19.4% of unaffected BRCA1/2 carriers adopted surveillance as their primary management strategy [46].

Marked differences emerged in the imaging modalities used. Earlier studies conducted before the widespread introduction of breast MRI relied predominantly on mammography, often combined with clinical breast examination. This pattern was evident in Belgium [15] and Australia/New Zealand [40], as well as in Poland, Israel, Norway, and the United States, where MRI uptake was reported to range from 2.2% to 24.4% [18,30], with an earlier cohort from the United States not reporting MRI use at all [36]. In contrast, more recent European cohorts

reported broader integration of MRI into surveillance protocols. In France, 67% of unaffected BRCA 1/2 carriers underwent combined mammography and MRI [17,18], while similarly high MRI uptake was reported in the Netherlands (94.6%), Italy (72.2%), Austria (65.0%), and Canada (47.8%) [18].

4.1.2. No documented preventive strategy

The proportion of women classified as having “no documented preventive strategy”, defined as the absence of reported RRM or structured breast surveillance, was explicitly reported in only a limited number of studies [17,18,39,46] and was generally low (Table 3). In France, Julian-Reynier and colleagues [17] reported that 6.0% of unaffected BRCA 1/2 carriers neither underwent RRM nor participated in a defined surveillance program. Similarly, in a recent Australian cohort, Kearton and colleagues [39] observed that 2.8% of eligible women declined surveillance despite being offered screening. A higher proportion was reported in a recent Korean cohort, where 9.7% of unaffected BRCA1/2 carriers adopted no active preventive strategy [46].

In the large multicountry study by Metcalfe and colleagues [18], the proportion of unaffected BRCA1/2 carriers adopting no active preventive strategy was low overall (5.5%). However, this estimate was reported at the aggregate level and was not consistently stratified by individual country.

5. Discussion

This systematic review provides a comprehensive overview on the uptake of breast cancer risk management strategies among unaffected BRCA1/2 carriers, highlighting the considerable variability in the uptake of prophylactic mastectomy, intensive surveillance, and non-active strategies. Across the included studies, the proportion of women electing risk-reducing mastectomy ranged from 0% to 81.6%, with marked differences observed not only between continents but also within the same geographical regions. While higher uptake rates were generally reported in North America and in a recent Norwegian cohort, lower uptake was consistently observed in several Asian, Middle Eastern, and European cohorts. These geographic differences likely reflect variations in healthcare infrastructure (such as access to reconstructive surgery, MRI reimbursement, and hereditary cancer clinics), national guidelines, and broader sociocultural attitudes toward preventive surgery [9,18]. These international differences may also reflect how healthcare systems are organised and financed. In insurance-based settings such as the United States, long-term surveillance can involve substantial and unpredictable out-of-pocket costs, whereas RRM—despite its higher upfront burden—may be viewed as a more definitive and economically predictable option. Economic evaluations have shown that RRM may even be more cost-effective than lifelong surveillance for high-risk women [47,48], which may contribute to its higher uptake in these contexts.

Temporal changes were also evident, particularly in studies conducted after 2013, coinciding with the increased public visibility of hereditary breast cancer and the widely recognised “Angelina Jolie effect,” which has been associated with greater acceptance of surgical prevention [10,28,49]. However, more recent evidence indicates that substantial variability in preventive choices persists despite increasing standardisation of genetic testing and surveillance recommendations. Recent cohorts from Norway, Korea, and Australia continued to demonstrate markedly different uptake patterns, ranging from very high adoption of RRM to a persistent preference for surveillance-based approaches [26,39,46]. Similarly, a cohort from Hong Kong reported relatively low uptake of RRM (12.5%), with most BRCA1/2 carriers opting for intensive surveillance (97.2%), which enabled early detection and very low breast cancer-specific mortality [50]. Together, these findings suggest that preventive decision-making among unaffected BRCA1/2 carriers remains strongly shaped by local healthcare systems, cultural context, perceived cancer risk, and attitudes toward body image and surgical prevention.

Importantly, the heterogeneity observed across countries and regions should be interpreted in light of temporal changes in clinical protocols and healthcare organisation. Several included studies were conducted in periods when breast MRI was not yet routinely available or reimbursed, and surveillance strategies relied predominantly on mammography and clinical breast examination. Over time, the progressive integration of MRI into high-risk screening protocols has substantially altered both the intensity and perceived effectiveness of surveillance, potentially influencing women's preferences between long-term monitoring and surgical prevention. In contrast, more recent cohorts demonstrated broader integration of MRI into surveillance protocols. Consequently, differences in uptake across studies may reflect not only individual or cultural preferences, but also the evolving range of clinically endorsed and financially accessible options available at the time of decision-making.

Women who choose RRM often do so in response to a heightened perception of cancer risk, frequently exceeding objective estimates, and as a means of alleviating cancer-related anxiety. Although many report psychological relief after surgery, the decision is complex and emotionally charged: women may experience decisional conflict, regret, or concerns related to body image and femininity [6,7,16]. The irreversibility of the procedure and the permanence of its physical and psychological consequences further underscore the need to contextualise these choices within both individual and cultural frames.

In this context, intensive surveillance represented a commonly adopted strategy across many included studies, particularly in European cohorts where structured breast imaging programmes are well established. This preference may reflect not only the strength of surveillance infrastructures but also cultural norms that favour conservative management when supported by robust healthcare systems [3,9,51]. Psychological factors also contribute significantly to this pattern: women who choose surveillance may wish to preserve bodily integrity or avoid the emotional and physical implications of an irreversible intervention. Regular imaging can offer reassurance and a sense of control; however, it may also introduce cyclical anxiety related to repeated testing and anticipatory stress [52]. These dynamics suggest that surveillance is chosen when women balance perceived risk, personal tolerance for uncertainty, and their trust in healthcare systems—factors that may vary across countries and over time. Notably, longitudinal data suggest that adherence may decline over time [18], raising concerns about the long-term sustainability of this approach given the cumulative nature of breast cancer risk in BRCA1/2 carriers.

Only a small subset of studies clearly quantified women who adopted no preventive action, indicating that a true “no active strategy” is uncommon and generally limited to fewer than 10% of carriers when explicitly defined [17,18,39,46]. However, meaningful interpretation of this finding is limited by substantial heterogeneity in definitions and reporting. In most studies, the absence of preventive surgery could not be disentangled from reliance on surveillance, making it difficult to identify women who truly opted for no active risk management. Psychological factors—such as avoidance coping, limited risk internalisation, or fatalistic beliefs—may contribute; however, qualitative evidence suggests that inaction may also represent a deliberate response to probabilistic uncertainty when none of the available options is perceived as decisively protective [46,53]. However, this category should be interpreted with caution, as the absence of documented preventive strategies does not necessarily indicate that women actively chose to forego risk management, but may instead reflect incomplete reporting in primary studies or the use of alternative or non-standard preventive approaches that were not systematically captured. These conceptual and methodological inconsistencies underscore the need for clearer operational definitions and more standardised reporting of preventive behaviours in future research.

Finally, the findings of this review should be interpreted in light of the broad temporal span covered by the included studies, which ranged from early 2000s cohorts to contemporary studies published in 2025,

During this period, substantial changes have occurred in genetic testing, counselling models, surgical techniques, reconstruction options, and high-risk surveillance protocols. Importantly, however, the marked international variability observed in earlier studies persisted even in more recent cohorts, suggesting that differences in healthcare systems, access to preventive options, and sociocultural attitudes continue to shape management choices despite advances in clinical care. These findings highlight the need for more standardised and longitudinal updated research capable of distinguishing between surveillance adherence, delayed decision-making, and true non-participation in preventive strategies, while also accounting for evolving healthcare infrastructures and patient preferences over time.

5.1. Implications for practice

The findings of this review underscore the importance of individualized and longitudinal counselling that integrates medical, psychological, and sociocultural dimensions of decision-making. Healthcare professionals should provide clear, balanced and evidence-based information regarding the benefits, limitations and long-term implications of each preventive option, ensuring that women are supported in making informed and value-congruent choices. Moreover, sustained follow-up is essential to maintain adherence to surveillance among those opting for non-surgical strategies. From a health-system perspective, ensuring equitable access to RRM, intensive surveillance, and specialised genetic counselling services may help reduce disparities in uptake across different countries and clinical contexts. Investment in multidisciplinary hereditary cancer clinics and coordination pathways may further support high-quality, consistent care.

5.2. Limitations

This review has several limitations. First, the included studies were heterogeneous in design, sample size, definitions of outcomes, and follow-up duration, which restricted direct comparability and precluded meta-analysis. Adherence to surveillance was inconsistently reported, and definitions of “no documented preventive strategy” varied substantially, limiting the interpretability of findings from studies using broad or ambiguous classification schemes. Second, most of the included studies were observational and therefore subject to biases such as self-selection, recall bias, and residual confounding. Differences in preventive options, healthcare infrastructures, and cultural contexts across countries and over time may also have influenced uptake patterns. Third, although the review was conducted using rigorous and comprehensive methods, it remains possible that some relevant studies were not identified, particularly if published in non-indexed or grey literature sources. As a result, the synthesis presented here may not capture all existing evidence on uptake of preventive strategies among unaffected BRCA1/2 carriers. These limitations highlight the need for harmonised, prospective, multicentre research using standardised definitions and consistent reporting practices to generate more robust and comparable evidence. Another important limitation of the available evidence is the lack of consistent information on changes in risk management decisions over time. Although some studies included longitudinal follow-up, transitions between strategies (e.g., from surveillance to risk-reducing mastectomy) were not systematically reported. This limits the ability to capture the dynamic nature of decision-making and may underestimate the cumulative uptake of different preventive options. In addition, age-related data regarding the uptake of preventive strategies were inconsistently reported and therefore could not be systematically compared across different management options.

These limitations underscore the need for harmonised, prospective, multicentre studies using standardised definitions, clearer reporting of surveillance adherence and non-participation, and longitudinal assessment of preventive decision-making trajectories over time.

6. Conclusion

In summary, this review highlights substantial international variability in breast cancer risk management strategies among unaffected BRCA1/2 carriers. While intensive surveillance remains the predominant management approach across many included cohorts, uptake of RRM varied markedly across countries and healthcare settings, ranging from minimal adoption in some Asian populations to very high uptake in recent North American and Norwegian cohorts. The proportion of women adopting no documented preventive strategy remained relatively low when explicitly reported, although interpretation of this finding is limited by inconsistencies in definitions and reporting practices across studies.

The observed variability likely reflects a complex interaction between healthcare infrastructure, access to MRI-based surveillance and reconstructive surgery, national guidelines, cultural attitudes toward preventive surgery, counselling practices, and individual psychological preferences. Importantly, these differences persisted even in contemporary cohorts, suggesting that advances in genetic care alone may not eliminate disparities in preventive decision-making.

Future research should prioritise longitudinal evaluation of preventive trajectories, including transitions between surveillance and surgical prevention, as well as deeper investigation of the psychological, socio-cultural, and health-system factors shaping women's decisions over time. Greater standardisation in reporting preventive behaviours and surveillance adherence is also needed to improve comparability across studies and support more evidence-based, equitable and patient-centred care for unaffected BRCA1/2 carriers.

Data availability statement

All data supporting the findings of this study are derived from previously published articles and are publicly available. No individual participant data were collected or generated for this analysis. Summary data extracted from eligible studies are fully reported in the manuscript and its Supplementary Material.

Contributions

All the authors conceived the study. LG and DT designed the literature search plan. CDP, GRB and LG conducted the literature search and screening. LG, CDP and GI contributed to the analytical planned bias assessment approach. LG drafted the manuscript. All authors revised the manuscript and approved the final version. DT supervised the study.

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Declaration of competing interest

All authors declare no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ejso.2026.111991>.

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