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Original article

Participation in breast cancer screening among breast cancer survivors—A nationwide register-based cohort study

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ABSTRACT

The aim of this study was to analyse if breast cancer survivors without other breast imaging surveillance attend population-based screening differently than women not previously diagnosed with breast cancer. Further, to analyse if any differences depended on the women's age and years since previous cancer diagnosis.

The study was a register-based retrospective cohort study of all women invited to participate in the national breast cancer screening programme in 2015–2016. Participation rates were calculated for breast cancer survivors without breast imaging within 21 months (2–4 years, 4–6 years, 6–10 years and more than 10 years after diagnosis) and for women without previous breast cancer. Relative differences in participation rates between the two groups were calculated.

A total of 679,990 women were included in the study (2.6% breast cancer survivors).

For breast cancer survivors, participation rates increased with increasing number of years since the previous cancer diagnosis peaking at 80.3% if the cancer diagnosis was more than 10 years ago. For women with no previous breast cancer, participation rate was 80.3%.

The relative difference in participation was highest close to the breast cancer diagnosis and for the youngest women participation rates remained lower among breast cancer survivors even more than 10 years after the diagnosis.

In conclusion, regardless of age and years since previous breast cancer diagnosis, breast cancer survivors had lower or similar participation rates than women with no previous cancer diagnosis. This indicated that as many as one fifth of the breast cancer survivors are at risk of inadequate surveillance.

1. Introduction

Breast cancer is the most common cancer among women, representing a quarter of all cancers diagnosed in women worldwide [1]. In Northern and Western Europe, incidence has been increasing in most countries over the past decades whereas mortality has been decreasing resulting in an increased number of breast cancer survivors [2].

Breast cancer survivors treated with breast conserving therapy or unilateral mastectomy have an increased risk of breast cancer recurrence even more than 15 years after diagnosis [3]. Evidence suggests that detection of recurrence in patients without symptoms seems to have beneficial impact on survival of breast cancer when compared to symptomatic detection [4–6] although the impact of length and lead time remains unknown. Despite the paucity of the underlying evidence, recognized in the various articles, surveillance has been deemed likely to improve survival from breast cancer recurrence with a strategy of mammography every 12–24 months appearing to have the highest net benefits [7]. Only a few studies have examined the effect of surveillance mammography in an organised screening setting instead of a clinical setting; however no evidence suggests that surveillance should not be conducted within organised screening programmes [4,8,9]. In line with this, in 2015 the Danish Health Authority decided that breast cancer survivors could be offered a screening mammography instead of more comprehensive surveillance programmes [10,11]. More than 80% of eligible women participate when invited for organised mammography screening [12]. However, women with comorbidity, including

Abbreviations: Confidence interval, (CI).

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some kinds of cancer, are less likely to participate in organised breast cancer screening [13–15] and studies on cancer survivors' screening participation are ambiguous [16–18]. The aim of this study was to analyse if breast cancer survivors without other breast imaging within the past 21 months attend population-based screening differently than women not previously diagnosed with breast cancer. Further to analyse if any differences depended on the woman's age and years since previous cancer diagnosis.

2. Methods

2.1. Setting

In Denmark, a national organised breast cancer screening programme was implemented in 2007 inviting women aged 50–69 years for a screening mammography every second year [19,20]. Breast cancer survivors are invited regardless of participation in other surveillance because the system generating invitations for the population-based screening programme is not linked to individual medical records holding information on surveillance. Thus, in the invitation, breast cancer survivors are asked to contact the screening department if they have had a mammography within the past year.

Guidelines for surveillance after a breast cancer diagnosis are decided nationally by the Danish Health Authority. The frequency of clinical breast examination recommended in the guidelines the from 2004, 2010 and 2012 varied. However, at no point clinical breast examination was recommended less than every second year. Since 2015, guidelines have recommended that women undergoing breast conserving therapy have a diagnostic mammography 18 months after the operation. Hereafter the women can return to the screening programme until the age of 79 years if nothing contradicts this, e.g. high-risk gene mutation or very dense breast tissue. Women undergoing unilateral mastectomy can return directly to the screening programme if nothing contradicts it. Women with bilateral mastectomy are not offered mammography screening. In Denmark, five politically led regions are responsible for organising public healthcare. Therefore, implementation of guidelines may differ slightly between regions.

Diagnosis (including screening), treatment and surveillance of breast cancer are free of charge in Denmark owing to a tax-financed healthcare system [21]. Opportunistic screening for breast cancer is rarely used in Denmark [22].

2.2. Study design and population

The study was designed as a national, register-based retrospective cohort study of all women invited to participate in the national breast cancer screening programme in 2015–2016. Women who were breast cancer survivors at the time of invitation to mammography screening and had no breast imaging within the past 21 months were defined as exposed whereas women with no prior breast cancer diagnosis were defined as unexposed. Women who died within two years after invitation were excluded since they did not have sufficient follow-up time. Women registered with diagnostic mammography, MR-scanning, ultrasound or a needle biopsy from the breast 21 months prior to a screening invitation were excluded to ensure that non-participation in screening was not due to participation in some kind of recent surveillance (Fig. 1).

2.3. Material

The study population was identified using the Danish Quality Mammography Screening Database [20]. The database includes data on all Danish women aged 50–69 years who has been invited to breast cancer screening in the national Danish mammography screening programme. Based on this database, all women invited to participate in screening in 2015 and 2016 were identified and classified as participants if they were registered with a mammography from the time of invitation to the next invitation or two years (if no next invitation).

Data on previous breast cancers were retrieved from the Danish National Cancer Register holding information on cancer diagnoses from 1943 onwards [23]. From 1943 to 2003, diagnoses were classified according to the international classification of disease (ICD) version 7 and the ICD-10 thereafter. Accordingly, women registered with breast cancer before the date of invitation were classified as breast cancer survivors. If there were more than one breast cancer registered, only the most recent was included. Women with no previous breast cancer were those not registered with breast cancer before invitation to participate in screening.

Information on women who died before end of follow-up was retrieved from the Danish Civil Registration System [24] which was established in 1968 where all persons living in Denmark were registered for administrative use. The Danish Civil Registration System is updated on a regular basis and includes individual information on vital status and emigrations. Information on diagnostic mammography, MR-scanning, ultrasound or a needle biopsy was retrieved from the Danish National Patient Registry [25]. This register holds information on all public and private hospital activities since 1977 including information on treatments according to the Danish version of the Nordic Classification of Surgical Procedures.

Codes used to identify procedures and diagnoses are specified in Table 1.

2.4. Analyses

Participation rates were calculated as the percentage invited women that participated separately for breast cancer survivors and women without previous breast cancer. To explore whether time since last breast cancer diagnosis influences the participation rate, we calculated participation rates separately among women invited 2–4 years, 4–6 years, 6–10 years and more than 10 years after last breast cancer diagnosis. As participation in the national mammography screening programme might be lower in older age groups [26,27] and breast cancer survivors are in general older than women not previously diagnosed with breast cancer, the analysis were stratified in 5 year age groups.

In order to compare participation rates among breast cancer survivors and those with no previous breast cancer diagnosis, we also calculated a participation rate ratio (participation rate for breast cancer survivors/participation rate for women with no previous breast cancer diagnosis) with 95% confidence interval (CI) per age group and years since previous breast cancer.

All analyses were performed using SAS version 9.4.

3. Results

A total of 704,153 were eligible for inclusion of which 19,289 (2.7%) were excluded due to diagnostic mammography, MR-scanning, ultrasound or a needle biopsy from the breast 21 months prior to a screening invitation (12.2% of breast cancer survivors and 2.5% of women with no previous breast cancer diagnosis) and 4874 (0.7%) died before end of follow-up (1.9% breast cancer survivors and 0.7% with no previous breast cancer). Thus 679,990 women were included in the study, 17,822 (2.6%) were breast cancer survivors and 662,168 (97.4%) had no previous breast cancer diagnosis (Fig. 1).

For women aged 50–69 years with no previous breast cancer,

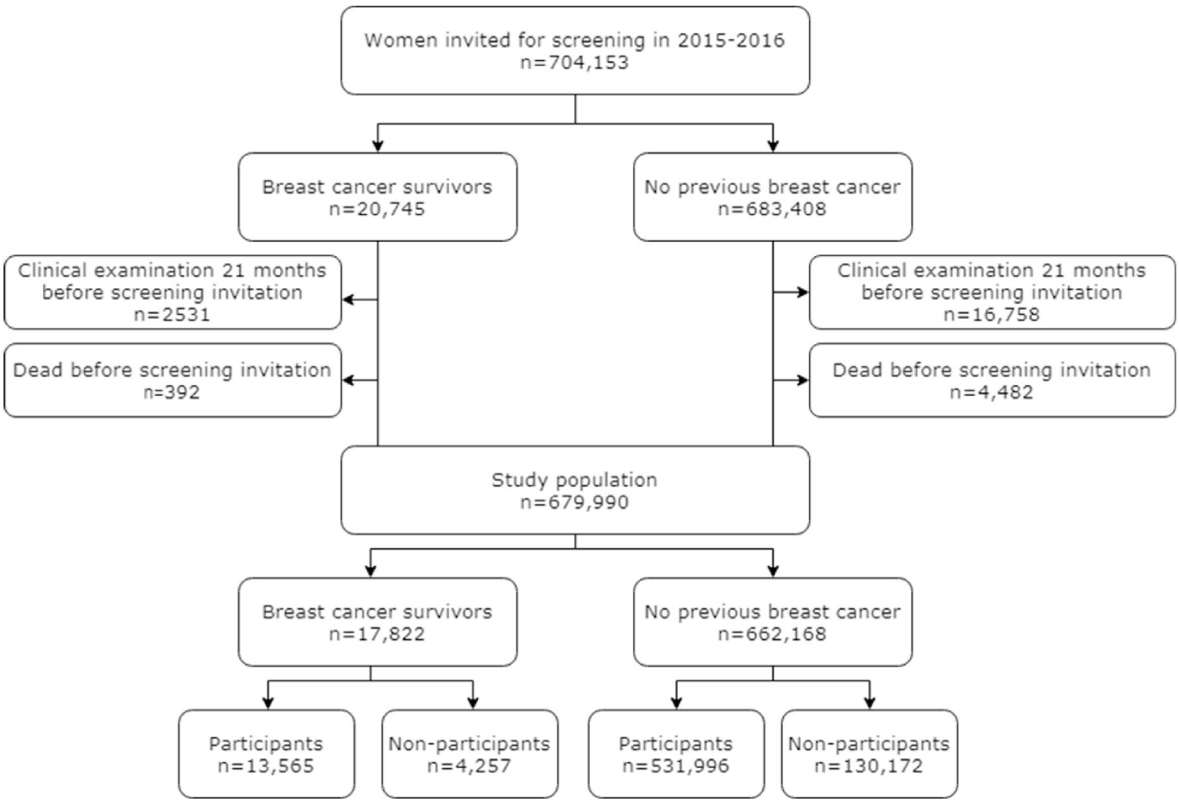

Fig. 1. Flow chart of study population.

Table 1
Data sources, coding system and codes applied.

	Data source	Coding system	Codes
Breast cancer survivor	Danish National Cancer Register 22	1943–2003:ICD-7	170
		2003- ICD-10	C50
Screening participation	Danish Quality Mammography Screening Database [20]	ICD-10	UXRC45 and at least one of the following codes: DZ108A, DZ123A, DZ123AA Or one of the following codes: DZ108A, DZ123A, DZ123AA Or UXRC45 and one of the following codes: ZPR01 N, ZPR00 N
Surveillance	Danish National Patient Registry [23]	ICD-10	UXRC40, UXRC40A, UXUC40, UXMC40, UXMC40A, KTHA10*
Death during follow-up	Danish Civil Registration System		

ICD: International Classification of Diseases versions 7 and 10.

participation rate was 80.3%. For breast cancer survivors, participation rates increased with increasing number of years since the previous cancer diagnosis, peaking at 80.3% if the cancer diagnosis was more than 10 years ago (Table 2).

For women with no previous breast cancer diagnosis, participation rates increased from 78.6% among women aged 50–54 years to 81.6% among women aged 65–69 years. For breast cancer survivors, the overall participation increased from 63.3% for those diagnosed 2–4 years ago to 80.3% for those diagnosed more than 10 years ago. Regardless of years since diagnosis, participation rates were lowest for the youngest women (50–54 years) (Table 2).

Among women aged 50–54 years, the participation rate ratio was 0.73 (95% CI: 0.68–0.78) 2–4 years after the breast cancer diagnosis and increased to 0.86 (95% CI: 0.81–0.90) if the previous breast cancer diagnosis was more than 10 years ago. For women aged 55–69 years the participation rate ratio was also statistically significant below 1 if the previous breast cancer diagnosis was less than six years ago. When the previous breast cancer was more than six years ago, the participation rate ratio was close to 1 (Table 3).

4. Discussion

4.1. Main findings

This national, register-based study showed that breast cancer survivors not participating in breast imaging surveillance outside the population-based screening program within the past 21 months yield lower or similar screening participation as women not previously diagnosed with breast cancer. This indicates that a substantial part of the breast cancer survivors was at risk of inadequate surveillance even though they are at increased risk of breast cancer compared to those without previous breast cancer.

Table 2
Participation rates (% [participants/invited]) among women with and without previous breast cancer invited in 2015–2016 per age group and years since previous breast cancer.

Years since previous breast cancer	Age group				
	Total	50–54 years	55–59 years	60–64 years	65–69 years
No previous breast cancer	80.3% [531,996/662,168]	78.6 [158,569/201,788]	79.8 [127,983/160,367]	81.8 [121,833/148,963]	81.6 [123,611/151,050]
2–4	63.3% [1617/2554]	57.1 [368/645]	68.6 [321/468]	66.2 [412/622]	63.0 [516/819]
4–6	71.9% [2352/3270]	59.7 [314/526]	74.6 [531/712]	74.5 [633/850]	73.9 [874/1182]
6–10	79.4% [3768/4743]	64.9 [466/718]	82.1 [851/1037]	82.5 [1031/1250]	81.7 [1420/1738]
>10	80.3% [5828/7255]	67.4 [477/708]	78.6 [914/1163]	82.4 [1739/2111]	82.4 [2698/3273]

Table 3
Participation rate ratios (participation rate for breast cancer survivors/participation rate for women with no previous breast cancer diagnosis) and 95% confidence interval per age group and years since previous breast cancer.

Years since previous breast cancer	Age group				
	Total	50–54 years	55–59 years	60–64 years	65–69 years
2–4	0.79 [0.77–0.81]	0.73 [0.68–0.78]	0.86 [0.81–0.91]	0.81 [0.77–0.86]	0.77 [0.73–0.81]
4–6	0.90 [0.88–0.91]	0.76 [0.71–0.81]	0.93 [0.90–0.98]	0.91 [0.88–0.95]	0.90 [0.87–0.93]
6–10	0.99 [0.97–1.00]	0.83 [0.78–0.87]	1.03 [0.999–1.06]	1.01 [0.98–1.03]	1.00 [0.98–1.02]
>10	1.00 [0.99–1.01]	0.86 [0.81–0.90]	0.98 [0.96–1.01]	1.01 [0.99–1.02]	1.01 [0.99–1.02]

4.2. Strengths and limitations

The major strength of this study was the large number of women included, both breast cancer survivors and women with no previous breast cancer. The prevalence of breast cancer among Danish women aged 50–69 years was 4% by the end of 2016 [28] which is fairly consistent with the 2.6% breast cancer survivors in this study, where those registered with diagnostic mammography, MR-scanning, ultrasound or a needle biopsy from the breast 21 months prior to a screening invitation were excluded. As expected, a higher proportion of breast cancer survivors than women with no previous breast cancer were excluded due to some examination of the breast within the past 21 months (12.2% and 2.5%, respectively). These women were not eligible for screening and by excluding them we ensured that non-participation in screening was not due to participation in some kind of surveillance. Further, a larger proportion of breast cancer survivors died before end of follow-up (1.9% and 0.7%, respectively) indicating that these women are more vulnerable than those not previously diagnosed with breast cancer.

The risk of selection and information bias was limited owing to the register-based study design. The study population was defined using the Danish Quality Mammography Screening Database which relies on valid data from the regional invitation systems, the National Pathology Registry, and the National Patient Registry [20]. Exclusion was based on the Danish National Patient Registry which is also considered a valid data source [29]. Information about previous cancers was retrieved from the Danish Cancer Register which has been shown to be a register of high quality [23]. We have no information though about women who have actively unsubscribed to the screening programme as these do not receive an invitation. However, in the Central Denmark Region only 0.6% of the eligible women have unsubscribed. Further, we do not have information on women who have had bilateral mastectomy and are therefore not eligible for screening. A British study have shown that in the years 2002–2011, 2–3% of women with breast cancer having their first operation and 0.5–1 per 100,000 women aged 25–69 years without breast cancer had bilateral mastectomy [30]. These numbers may be similar in a Danish context and even though more frequent among breast cancer survivors than those without breast cancer, women with bilateral mastectomy are not expected to influence these results.

Breast cancer survivors still participating in surveillance and scheduled for a clinical mammography shortly after their invitation was send, but without any examinations 21 months prior to invitation may appear as non-participants in screening where they should have been excluded from the analyses because they are still in some other surveillance. It was though not possible to exclude women with a clinical mammography shortly after their invitation to screening as we would thereby also exclude women attending mammography and being referred to further follow-up. This may have caused an overestimate of non-participation in screening among breast cancer survivors. However, no guidelines for surveillance after breast cancer has recommend surveillance less than yearly and therefore most women enrolled in surveillance programmes ought to have been excluded from our analyses.

The results from this study is generalizable to the Danish setting since the sample of women invited for screening in 2015 and 2016 should not differ from those being invited at other times. Further, the results could be generalized to other settings with similar health care services provided for breast cancer prevention and surveillance free of charge to women within similar age-groups. However, the results are only generalizable to breast cancer survivors not in any other surveillance during the past 21 months.

4.3. Other studies

Many guidelines recommend yearly mammography for breast cancer survivors [31–33] where we studied adherence to biennial mammography. Still, our results are in line with previous studies of adherence to surveillance mammography in a clinical setting demonstrating that breast cancer survivors under utilise surveillance mammography. However, these study show, in contrast to our, that use of mammography decreases as time passes after cancer treatment [34–36]. Participation rates in our study increases with years after diagnosis and are similar to participation rates of women with no breast cancer diagnosis after six years.

A meta-analysis showed that cancer survivors in general are 19% more likely than non-cancer controls to receive mammography [16]. However, this study included both childhood and adult cancer survivors from any cancer and not just breast cancer survivors, did not report on time since cancer diagnosis and predominantly included American studies, where insurance status may play an important role. Therefore these studies are not comparable to this study. In line with our study, a British study shows that breast cancer survivors are 22% less likely to receive mammography than controls [37] indicating that breast cancer surveillance within an organised breast cancer screening programme contains a significant risk of suboptimal surveillance. However, since the underutilisation of mammography has also been demonstrated within the clinical setting, attention must be paid to how surveillance of breast cancer survivors is best organised balancing both cost-effectiveness and patient needs. Further studies are needed to clarify reasons for non-participation in breast cancer surveillance regardless of the setting in order to improve adherence to surveillance programmes.

5. Conclusion

This register-based study shows that breast cancer survivors are not more likely to attend breast cancer screening than women without previous breast cancer even though they are at increased risk of breast cancer. Guidelines are being implemented these years, permitting surveillance of breast cancer survivors to be included in the national breast cancer screening programme. Special efforts must be paid to ensure that this will not cause breast cancer survivors to receive suboptimal surveillance.

Funding

The project was funded by the Danish Cancer Society. The funding agency had no influence on the scientific process.

Ethical requirements

The study was based on register data, and no contact was made to patients, their relatives or treating physicians. According to Danish legislation, data from national registers can be used for research purposes without consent from individual citizens or approval from an ethical review board. According to EU's General Data Protection Regulation (article 30), the project was listed at the record of processing activities for research projects in Central Denmark Region (J. no.: 2012-58-0006/1-16-02-89-17).

Data availability

The data that support the findings of this study are available from The Danish Health Data Authority. Restrictions apply to the availability of these data, which were used under license for this study. Data may be available from The Danish Health Data Authority with permission.

Declaration of competing interest

Authors declare no conflicting interests.

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