Lifestyle and Occupational Factors Associated with Participation in Breast Mammography Screening among Western Australian Women

Short Title: Lifestyle factors associated with breast screening

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Abstract

Objectives: Various lifestyle and occupational factors have been associated with an increased risk of breast cancer; however, limited research has investigated the relationship between these factors and participation in breast cancer screening. This study explores the associations between lifestyle and occupational factors and participation in breast mammography screening among women living in Western Australia.

Setting: This study involved 1,705 women aged 40 and over who participated as controls in the Breast Cancer Environment and Employment Study conducted in Western Australia.

Methods: Self-reported questionnaire data were collected on participation in mammography screening, demographic factors, and lifestyle and occupational variables (comprising smoking, physical activity, alcohol consumption, body mass index, use of contraceptive pill and hormone replacement therapy, breastfeeding, occupation, and participation in shift work). Multivariate modified Poisson regression was used to identify variables associated with ever participation in breast mammography screening.

Results: Just over 88% of women reported having ever had a mammogram. Likelihood of having ever had a mammogram was higher among women who had ever used hormone replacement therapy (adjusted Prevalence Ratio=1.05, 95% CI 1.02-1.07). Women who worked in clerical occupations (aPR=1.06, 95% CI 1.01-1.11) or home duties (aPR=1.05, 95% CI 1.00-1.11) were also more likely to report having ever had a mammogram compared to those in professional or technical occupations.

Conclusions: Participation in mammography screening was found to differ by lifestyle and occupational factors. These results have important implications for public health strategies on improving screening participation.

Introduction

Breast cancer is the most commonly diagnosed cancer among Australian women, with an estimated 17,586 new cases being diagnosed in 2017.[1] It accounts for approximately 28% of all cancers diagnosed in Australian women each year. Breast cancer is also the second leading cause of cancer death in Australian women, with an estimated 3,087 deaths from breast cancer in 2017. Australia has one of the best breast cancer survival rates in the world, with 90% of those diagnosed in 2009-2013 still being alive at five years post-diagnosis. The survival rate is even higher (98%) in women whose cancer is diagnosed at an early stage,[2] reinforcing the importance of early detection through cancer screening.

Mammography is the most common means of screening for breast cancer,[3] and is the only means of population-based screening that has been shown to reduce breast cancer mortality.[4] A recent analysis of 40 international studies undertaken by the International Agency for Research on Cancer demonstrated a clear reduction in breast cancer mortality among women attending mammographic screening. [3] In Australia, a modelling analysis using data from the population-based screening program, BreastScreen Australia, demonstrated that participation was associated with a 21-28% reduction in mortality. [5]

BreastScreen invites all women aged 50 to 74 to have a free two-yearly mammogram.[4] Those aged 40 to 49 and 75 and over are also eligible for free mammograms but are not actively invited. The latest data from BreastScreen shows that in 2015-2016, 54.8% of the target population (1,772,540 women) received a screening mammogram, a slight increase from the participation rate (53.7%) reported for the previous two-year period. BreastScreen does not report 'ever' screening rates; however, data from a nationally representative sample of Australian households conducted in 2014-2015 shows that 77% of women aged 50 and over reported having 'ever' screened for breast cancer. [6]

Participation in BreastScreen has been found to differ by age (highest in those aged 65-69) and area of residence (highest in those living in outer regional areas), but not across socioeconomic groups. [4] Other recent studies conducted in Australia have found various demographic and health factors to be associated with participation in breast cancer screening. For example, married women, those living in outer regional or remote areas, and those with private health insurance have been found to have higher rates of participation in breast mammography screening. [7, 8] Women with a family history of breast cancer and those who have ever used hormone replacement therapy (HRT) have also been shown to have higher rates of participation. [8, 9]

It has also been hypothesised that participation in breast cancer screening may be associated with lifestyle factors such as alcohol use and physical activity. For example, it has been reported that those participating in healthy lifestyle behaviours are also more likely to participate in preventative health behaviours, including cancer screening. [10] Whilst many of these lifestyle factors have been found to

be associated with breast cancer risk, fewer studies have investigated their association with screening participation. [9] A study conducted in Sweden found that current smokers, those who had not consumed any alcohol in the past year, and those participating in low levels of physical activity were less likely to participate in breast mammography screening. [11] An Australian study found that overweight or obese women and those who participated in adequate physical activity were more likely to have ever had a mammogram. [9] This study also found that women with a higher number of unhealthy lifestyle risk factors, including for example alcohol consumption, obesity, physical inactivity, and HRT use, were more likely to have participated in breast mammography screening.

Limited evidence also suggests that participation in breast cancer screening may be associated with occupational factors including shiftwork [12] and employment status. [8] A study conducted in the US, for example, found that women working alternative shifts were less likely to have had a mammogram in the last two years than those working regular daytime shifts, [12] while an Australian study found that those who were employed were more likely to have had a mammogram in the past two years. [8] A recent study of Australian nurses and midwives also found that shift workers and those working full-time were less likely to participate in breast screening compared with those working regular office hours and part-time or casual hours, respectively. [13] This may be related to practical reasons, as those working shift work and full-time hours may be less able to attend cancer screening appointments than those working regular or shorter hours. [12]

The aim of the current study is to further investigate the lifestyle and occupational factors associated with participation in breast cancer mammographic screening among women living in Western Australia.

Methods

Study population

We used data from the Breast Cancer Environment and Employment Study (BCEES), a case-control study conducted in Western Australia (WA) in 2009-2011. Full details of the methodology have been provided elsewhere.[14] The study was approved by the Human Research Ethics Committees of the Western Australian Department of Health (project number 2009/28) and the University of Western Australia (project number RA/4/1/2331). Data were collected by a self-administered postal questionnaire. All participants provided written informed consent. The BCEES included 1,205 breast cancer cases (response rate 57.8%) and 1,789 frequency age-matched controls (response rate 41.1%) who were randomly selected from the WA electoral roll. We analysed data from control women aged 40 years and over (n=1,705), in line with current BreastScreen screening recommendations.

Exposures assessed

Participation in breast mammography screening was ascertained by the question: “Have you ever had a mammogram (breast x-ray)?”. Demographic data collected included age, highest level of

educational attainment, country of birth (Australia or other), main language spoken in the home (English or other), and area of residence (metropolitan or non-metropolitan). Socioeconomic status was derived from participants' residential postcodes and coded according to the Socio-Economic Indexes for Areas Index of Relative Socioeconomic Advantage and Disadvantage 2011.[15] We also assessed the following health variables: family history of breast cancer (yes/no), menopausal status (pre- or post-menopausal), and number of children.

The lifestyle variables we assessed comprised smoking status, physical activity, alcohol consumption, body mass index, contraceptive pill and HRT use, and breastfeeding duration. These factors were assessed as they are part of the World Cancer Research Fund cancer prevention recommendations for reducing risk of cancer, including breast cancer, and/or they have been associated with risk of breast cancer. [16-18] Smoking status was classified as current, former, or never, with current and former smokers combined into a single group for analysis. Physical activity was assessed using a modified version of the Chasan-Taber Physical Activity Questionnaire which assesses recreational, household, and transport-related physical activity.[19, 20] All activities reported were assigned a metabolic equivalent (MET) value, derived from the Compendium of Physical Activities,[21] and MET-hours/week calculated by multiplying the MET-value by its frequency and duration. We then averaged MET-hours per week conducted over the lifetime and classified into quartiles for analysis.

Alcohol consumption was assessed as the usual number of alcoholic drinks consumed per week (categorised into <1, 2-3, 4-6, or 7+ drinks). Body mass index (BMI) was based on self-reported current weight and height and trichotomised into not overweight (<25 kg/m^2), overweight (25<30 kg/m^2), or obese (≥30 kg/m^2). Participants were also asked whether they had ever used the combined oral contraceptive pill (yes/no) and HRT (yes/no). Breastfeeding was assessed only for those women who reporting having given birth to at least one child. Participants were asked how many months in total they breastfed their children, and duration was then categorised into ≤6 months, 7-12 months, 13-24 months, and >24 months for analysis.

A full occupational history was collected for each participant, including job title for each job held for more than six months and time spent in each job. Occupation was coded according to the International Standard Classification of Occupations-1968 (ISCO-68).[22] We used data on the longest job held over the lifetime as well as the most recent job held. Where the participant held more than one job for the same amount of time, we used the most recent of those jobs in the longest job held analysis. In addition, women were asked whether their job involved "night work, shift work, or work at unusual hours". Those who answered yes to this question were then asked a series of questions including "Did you ever work between the hours of midnight and 5am?"; the answer to this question was used to define exposure to graveyard shift (yes/no).

Statistical analysis

We used modified Poisson regression with robust sandwich variance estimation[23] to estimate the prevalence ratio (PR) and 95% confidence intervals (CI) of participating in breast mammography screening by lifestyle and occupational variables. Analyses controlled for those sociodemographic and health variables which were significantly associated with both screening participation and lifestyle or occupational variables, where relevant. We used backward stepwise elimination with a cut-off of $p<.10$ to arrive at the final model. All statistical tests were two-sided with significance established at $\alpha=0.05$. All analyses were conducted in Stata 14 (College Station, Texas).

We also created a series of healthy lifestyle indices (HLI) based on the seven lifestyle variables investigated. We used a binary score (0/1) for each factor whereby a score of 1 indicated healthier behaviour (i.e. not a current or former smoker; those reporting ≥59 MET-hours per week; alcohol consumption of ≤1 drink per week; BMI <25 kg/m^2; never use of oral contraceptive pill; never use of HRT; breastfeeding duration of >6 months). We then summed the binary score for each of the factors. For the overall HLI, the scores ranged from 0 (least healthy) to 7 (most healthy). As there were a small number of individuals practicing less than 3 or more than 6 healthy behaviours, we combined the scores into 5 categories (0-2, 3, 4, 5, and 6-7 factors). A test for trend was conducted by entering the original HLI score into the model as a continuous variable.

We also conducted sensitivity analyses by excluding various factors from the HLI. First, we excluded smoking, as this factor has not been found to be associated with breast cancer risk. Scores ranged from 0 to 6, with scores combined into 5 categories for analysis (0-1, 2, 3, 4, 5-6). Next, we excluded use of oral contraceptive pill, HRT, and breastfeeding duration, and created a separate reproductive behaviour index comprising these factors. Scores for the reproductive index ranged from 0 to 3, while scores for the revised HLI (smoking, physical activity, alcohol consumption, BMI) ranged from 0 to 4.

Results

A total of 1,494 women aged 40 and over (88.1%) reported having ever had a mammogram (Table 1). Older women and those with a family history of breast cancer were more likely to report having ever had a mammogram, while those who were pre-menopausal were less likely to have had a mammogram. Likelihood of having had a mammogram increased with number of children; however this trend was no longer significant after controlling for other demographic factors.

With regard to lifestyle factors, women who were more physically active were more likely to have ever had a mammogram (Table 2). Those who had ever used HRT were also more likely to have ever had a mammogram. Likelihood of having ever had a mammogram did not differ by smoking status, alcohol consumption, BMI, contraceptive pill use, or breastfeeding duration.

Table 1. Ever breast mammogram screening, by sociodemographic characteristics

	Total number eligible	**n (%) screened**	**PR (95% CI) [a]**	**aPR (95% CI) [b]**
Total	1,705	1,494 (88.1)		
Age Group				
40-54	535	369 (69.1)	1.00	1.00
55-64	628	601 (96.2)	**1.39 (1.31-1.48)**	**1.09 (1.03-1.15)**
65+	542	524 (97.6)	**1.41 (1.33-1.50)**	**1.10 (1.05-1.16)**
p for trend			***<.001***	***<.001***
Highest level of education				
High school or lower	1,011	906 (89.6)	1.00	1.00
Post-high school	685	588 (85.8)	**0.96 (0.92-0.99)**	0.99 (0.96-1.02)
Country of birth				
Australia	1,110	970 (87.4)	1.00	1.00
Other	586	524 (89.4)	1.02 (0.99-1.06)	1.03 (0.99-1.06)
Area of residence				
Metropolitan	1,434	1,263 (88.1)	1.00	1.00
Non-metropolitan	262	231 (88.2)	1.00 (0.95-1.05)	0.97 (0.92-1.02)
Socioeconomic status [c]				
Lowest quintile (least advantaged)	82	75 (91.5)	1.00	1.00
Second quintile	237	217 (91.6)	1.00 (0.93-1.08)	1.01 (0.94-1.09)
Middle quintile	355	321 (90.4)	0.99 (0.92-1.06)	0.99 (0.92-1.07)
Fourth quintile	338	281 (83.1)	**0.91 (0.84-0.99)**	0.94 (0.87-1.02)
Highest quintile (most advantaged)	684	600 (87.7)	0.96 (0.89-1.03)	0.97 (0.91-1.05)
p for trend			***.021***	*.166*
Family history of breast cancer				
No	1,212	1,056 (87.1)	1.00	1.00
Yes	480	435 (90.6)	**1.04 (1.00-1.08)**	**1.07 (1.03-1.11)**
Menopausal status				
Post-menopausal	1,359	1,299 (95.6)	1.00	1.00
Pre-menopausal	337	195 (57.9)	**0.61 (0.55-0.66)**	**0.66 (0.59-0.73)**
Number of children				
0	165	129 (78.2)	1.00	1.00
1	122	104 (85.2)	1.09 (0.98-1.22)	1.04 (0.95-1.14)
2	663	589 (88.8)	**1.14 (1.04-1.24)**	**1.09 (1.02-1.17)**
3	471	423 (89.8)	**1.15 (1.05-1.25)**	**1.08 (1.00-1.17)**
4+	275	176 (91.2)	**1.16 (1.06-1.27)**	1.06 (0.98-1.14)
p for trend			***.001***	*.349*

Numbers may differ due to missing values

[a] Unadjusted model

[b] Adjusted for all other sociodemographic variables in model

[c] According to SEIFA index of advantage/disadvantage

Table 2. Ever breast mammogram screening, by lifestyle characteristics

	Total number eligible	**N (%) screened**	**Model 1 aPR (95% CI) [a]**	**Model 2 aPR (95% CI) [b]**
Smoking status				
Never	974	865 (88.8)	1.00	1.00
Former/current	716	624 (87.1)	1.01 (0.98-1.04)	1.01 (0.98-1.04)
Average physical activity per week (MET-hours)				
0-37	385	300 (77.9)	1.00	1.00
38-58	428	385 (89.9)	**1.10 (1.04-1.16)**	**1.09 (1.03-1.15)**
59-85	418	377 (90.2)	**1.07 (1.01-1.12)**	1.05 (1.00-1.11)
86+	431	398 (92.3)	**1.06 (1.01-1.12)**	1.05 (1.00-1.11)
p for trend			*.187*	*.324*
Usual alcohol consumption per week				
<1 drink	500	449 (89.8)	1.00	1.00
1-3 drinks	400	342 (85.5)	0.98 (0.94-1.02)	0.98 (0.93-1.02)
4-6 drinks	225	208 (92.4)	1.04 (1.00-1.09)	1.03 (0.99-1.08)
7+ drinks	563	488 (86.7)	1.01 (0.97-1.05)	1.00 (0.95-1.04)
p for trend			*.334*	*.692*
Current body mass index (kg/m^2)				
Not overweight (<25)	715	629 (88.0)	1.00	1.00
Overweight (25<30)	554	493 (89.0)	0.98 (0.95-1.02)	0.98 (0.95-1.02)
Obese (≥30)	385	336 (87.3)	0.96 (0.92-1.00)	0.96 (0.92-1.00)
Ever contraceptive pill use				
No	898	793 (88.3)	1.00	1.00
Yes	796	699 (87.8)	1.01 (0.98-1.04)	1.00 (0.97-1.03)
Ever HRT use				
No	1,119	927 (82.8)	1.00	1.00
Yes	577	567 (98.3)	**1.06 (1.03-1.08)**	**1.05 (1.02-1.07)**
Breastfeeding duration				
Never	315	273 (86.7)	1.00	1.00
≤ 6 months	319	297 (93.1)	0.99 (0.96-1.03)	1.00 (0.96-1.04)
7-12 months	289	256 (88.6)	0.97 (0.93-1.01)	0.97 (0.93-1.02)
13-24 months	398	351 (88.2)	0.97 (0.93-1.01)	0.97 (0.93-1.01)
>24 months	339	283 (83.5)	0.97 (0.92-1.02)	0.98 (0.93-1.03)
p for trend			*.210*	*.463*

Numbers may differ due to missing values
HRT: hormone replacement therapy; MET: metabolic equivalent
[a] Model adjusted for those variables significantly associated with both screening status and lifestyle variables (age, menopausal status, family history of breast cancer, number of children)
[b] Model adjusted for those variables significantly associated with both screening status and lifestyle variables (age, menopausal status, family history of breast cancer, number of children) plus smoking status, physical activity, alcohol consumption, BMI, contraceptive pill use, HRT use, and breastfeeding duration

When lifestyle factors were considered together in an overall HLI, there was no significant association with having ever had a mammogram (Table 3). However, when smoking was excluded from the HLI, those practicing a higher number of healthy behaviours were less likely to have ever had a

mammogram. This association attenuated, however, when controlling for demographic variables. When considering lifestyle behaviours only (smoking, physical activity, alcohol consumption, BMI), there was a significant trend whereby those practicing a higher number of healthy behaviours were more likely to have ever had a mammogram; again, this association attenuated when controlling for demographic variables. Finally, when considering reproductive behaviours only (ever use of oral contraceptive, HRT, breastfeeding duration), there was a significant trend whereby those practicing a higher number of healthy behaviours were less likely to have ever had a mammogram; this association remained after controlling for demographic variables.

Table 3. Ever breast mammogram screening, by healthy lifestyle indices

	Total number eligible	**N (%) screened**	**PR (95% CI) [a]**	**aPR (95% CI) [b]**
Overall healthy lifestyle index (HLI) score				
0-2 (Least healthy)	338	300 (88.8)	1.00	1.00
3	387	344 (88.9)	1.00 (0.95-1.05)	1.02 (0.97-1.06)
4	428	380 (88.8)	1.00 (0.95-1.05)	1.02 (0.97-1.06)
5	294	247 (84.0)	0.95 (0.89-1.01)	0.97 (0.92-1.03)
6-7 (Most healthy)	145	127 (87.6)	0.99 (0.92-1.06)	0.98 (0.92-1.05)
p for trend			*.166*	*.269*
HLI excluding smoking				
0-1 (Least healthy)	169	156 (92.3)	1.00	1.00
2	352	307 (87.2)	0.94 (0.89-1.00)	0.98 (0.93-1.03)
3	492	437 (88.8)	0.96 (0.91-1.02)	1.00 (0.95-1.05)
4	381	330 (86.6)	**0.94 (0.88-1.00)**	0.99 (0.94-1.05)
5-6 (Most healthy)	199	169 (84.9)	**0.92 (0.86-0.99)**	0.95 (0.89-1.01)
p for trend			***.041***	*.305*
Lifestyle behaviours only [c]				
0 (Least healthy)	179	148 (82.7)	1.00	1.00
1	455	393 (86.4)	1.04 (0.97-1.13)	1.01 (0.94-1.08)
2	561	498 (88.8)	1.07 (1.00-1.16)	1.02 (0.96-1.09)
3	351	316 (90.0)	**1.09 (1.01-1.17)**	1.02 (0.96-1.09)
4 (Most healthy)	79	74 (93.7)	**1.13 (1.04-1.24)**	1.01 (0.93-1.10)
p for trend			***.002***	*.437*
Reproductive behaviours only [d]				
0 (Least healthy)	126	123 (97.6)	1.00	1.00
1	475	439 (92.4)	**0.95 (0.91-0.98)**	1.00 (0.97-1.03)
2	645	555 (86.0)	**0.88 (0.85-0.92)**	0.97 (0.94-1.01)
3 (Most healthy)	412	341 (82.8)	**0.85 (0.81-0.89)**	**0.94 (0.90-0.98)**
p for trend			***<.001***	***.002***

Numbers may differ due to missing values

[a] Unadjusted model

[b] Model adjusted for those variables significantly associated with both screening status and healthy lifestyle index (age, menopausal status, number of children)

[c] Comprising smoking, physical activity, alcohol consumption, BMI

[d] Comprising ever use of oral contraceptive pill, ever HRT, breastfeeding duration

The likelihood of having ever had a mammogram was higher in those women who reported working in clerical occupations or home duties compared to those in professional or technical occupations (Table 4). There was no difference in likelihood of having ever had a mammogram by shift work status or duration.

Table 4. Ever breast mammogram screening, by occupational characteristics

	Total number eligible	N (%) screened	aPR (95% CI) [a]
Occupation – longest job held [b]			
Professional/Technical	369	307 (83.2)	1.00
Administrative/Managerial	47	42 (89.4)	1.06 (0.97-1.17)
Clerical	445	399 (89.7)	**1.06 (1.01-1.11)**
Sales	159	141 (88.7)	1.02 (0.96-1.08)
Service	203	178 (87.7)	1.04 (0.98-1.10)
Agricultural/Forestry	46	41 (89.1)	1.03 (0.91-1.15)
Production/Transport	53	48 (90.6)	1.03 (0.94-1.13)
Home duties	342	312 (91.2)	**1.05 (1.00-1.11)**
Occupation – most recent job [b]			
Professional/Technical	333	267 (80.2)	1.00
Administrative/Managerial	60	52 (86.7)	1.10 (1.00-1.21)
Clerical	337	290 (86.0)	**1.07 (1.01-1.14)**
Sales	136	115 (84.6)	1.01 (0.93-1.09)
Service	179	158 (88.3)	1.05 (0.98-1.12)
Agricultural/Forestry	32	28 (87.5)	1.02 (0.88-1.18)
Production/Transport	34	31 (91.2)	1.05 (0.94-1.18)
Home duties/retired	528	501 (94.9)	**1.06 (1.01-1.12)**
Graveyard shift [c]			
No	1,335	1,182 (88.5)	1.00
Yes	357	308 (86.3)	0.99 (0.95-1.03)
Graveyard duration			
No	1,335	1,182 (88.5)	1.00
1-10 years	183	157 (85.8)	0.99 (0.93-1.04)
>10 years	174	151 (86.8)	0.99 (0.94-1.04)

Numbers may differ due to missing values

[a] Model adjusted for those variables significantly associated with both screening status and occupational variables (age, menopausal status, number of children)

[b] Coded according to ISCO-68 (1 digit level)

[c] Those who reported ever working a graveyard shift (hours of work between midnight and 5am) in any job

Discussion

This study investigated the lifestyle and occupational factors associated with participation in breast mammography screening among Western Australian women. We found that 88% of women aged 40 and over had ever had a breast mammogram. Participation was higher in older women and those with a family history of breast cancer, in line with findings reported in previous Australian studies.[7-9] The participation rate in the current study (88%) is in line with nationally representative data from the National Health Survey conducted in 2014-2015, which found that 77% of women aged over 50 reported having 'ever' screened for breast cancer. [6] Our estimate also lies within the range of studies carried out in other States of Australia and other developed countries. For example, participation rates

of 65% were found in South Australia, [9] 92% in Sweden, [24] and 60.5% in Spain. [25] Discrepancies in participation rates reported between studies are likely due to the different inclusion and exclusion criteria of the studies, sample sizes, type of screening program, and mammogram screening recommendations.

We found that women who had ever used HRT were more likely to have ever had a mammogram, in line with previous Australian studies. A nationwide study, for example, found that women using HRT were 1.4 times more likely to have had a mammogram in the past three years,[7] while a survey of South Australian women found that those who had ever used HRT were 3.7 times more likely to have ever had a mammogram.[9] The authors of this latter study noted that the association may result from increased contact with medical practitioners, who may then recommend screening to women using HRT due to the associated increased risk of breast cancer. In support of this, past research has found an association between frequency of general practitioner visits and breast screening participation,[7] and recommendations from medical practitioners have been found to predict screening behaviour.[26] We also found that those practicing a higher number of healthy reproductive behaviours (never use of oral contraceptive and HRT, and breastfeeding duration of six months or greater) were less likely to have ever had a mammogram. It is likely that this finding is strongly influenced by the association between HRT use and likelihood of having had a mammogram.

We did not find a relationship between other known breast cancer risk factors, including alcohol consumption and overweight/obesity, and participation in breast mammography screening. This is in contrast to past research, which has found that women who did not consume alcohol were less likely to participate, [11] while those who were overweight or obese were more likely to have ever had a mammogram. [9] We did find however some limited evidence that women practicing more physical activity were more likely to have ever had a mammogram, in line with past research. [11]

We also found limited evidence that participation in breast mammography screening was associated with occupation. Those working in clerical occupations or home duties were more likely to have ever had a mammogram than those in professional or technical occupations. Past Australian research has not investigated differences in screening participation by occupation, although studies in the US have found higher rates of mammography screening participation among workers in the construction, health care, and services industries, as well as white collar occupations. [27, 28] Previous studies have also found that those working shift work were less likely to participate in breast mammography screening;[12, 13] however, we did not find any difference in screening participation by shift work status. This is line with a study conducted in Korea, who found that regular day time and alternative shift workers did not differ in their participation in breast cancer screening,[29] suggesting that more research is needed to clarify the relationship between shift work and screening participation.

Study limitations/strengths

This study has several strengths including the large sample size of women aged 40 and older living in Western Australia and the comprehensiveness of the data collection allowing for adjustment for a number of important variables associated with lifestyle and occupational factors and mammography screening. Regardless, it is a cross-sectional design, and thus causal and directional conclusions are limited. Another limitation is the fact that mammography screening was based solely on self-report, and women may have over-estimated their screening behaviour. This may be particularly so in the older age groups, where we found a very high proportion of women (97.6%) reporting having ever screened. However, a meta-analysis of the accuracy of self-reported mammography use relative to medical records found a high sensitivity (94.9%) and specificity (61.8%) of self-report. [30] Further, our overall participation rate roughly reflects that reported in the National Health Survey data, a nationally representative sample of Australian households. [6]

It may also be that those having a mammogram for purposes other than screening, including diagnostic purposes, have been included in our estimate of screening participation, as our question did not specifically exclude non-screening mammograms. Data from the US indicates that approximately 7% of mammograms in women without prevalent breast cancer are conducted for non-screening purposes. [31] However, given that women typically have multiple mammograms over their lifetime, and that our measure was of 'ever' having had a screening mammogram, it is likely that even those reporting a diagnostic mammogram may have also had a screening mammogram in the past. Thus, the magnitude of this potential overestimation is likely to be minimal.

In addition, body height and weight were not objectively assessed. Previous studies have shown that weight is often under-reported, especially among overweight and obese women, leading to an underestimation of body mass index. [32] Another limitation is that physical activity was collected through self-reported questionnaire, which may have led to an under- or over-estimation of physical activity, as a recent meta-analysis reported that self-report measures of physical activity differed in their accuracy and led to both under- and over-estimation depending on the measure. [33] Finally, the possibility of selection bias cannot be ruled out, particularly given the low response rate (41.1%) of controls in the BCEES. Women participating in this study may have been more likely to be invested in breast cancer and breast health and arguably more likely to have had a mammogram.

Conclusions

In conclusion, we found that participation in breast mammography screening was lower among those participating in less physical activity and those who had not used HRT. These findings have important implications for public health strategies on how to improve screening participation, providing information about the groups who are least likely to screen. Identifying factors associated with breast mammography screening participation can assist health professionals, and particularly general practitioners, to identify those who are less likely to participate, and consequently to encourage them

to undergo breast mammography screening. These findings will also enable those at high risk of not being screened to be targeted for additional reminders, including for example by post, telephone, or email.

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Declaration of Conflicting Interests:

The authors declare that there is no conflict of interest.

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