ARTICLE TITLE

Women's beliefs about breast cancer causation in a breast cancer case-control study.

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ABSTRACT

Objective:
Our study sought to ascertain women's beliefs about breast cancer risk factors and whether these beliefs differed by demographic factors and personal and family history of breast cancer.

Methods:
Participants in a case-control study of breast cancer rated the effect of 37 exposures on the risk of being diagnosed with breast cancer. Chi-square tests were undertaken to measure differences in responses between cases and controls for each exposure. Logistic regression was undertaken to ascertain whether demographic factors and personal and family history of breast cancer affected participants' ability to correctly identify known breast cancer risk factors.

Results:
A total of 2742 participants completed the questionnaire, comprising 1109 cases and 1633 controls. Significant differences ($p<0.05$) between cases and controls were found for 16 of the 37 exposures. Younger women and university-educated women were more likely to correctly identify known breast cancer risk factors. Women's perceptions about the effect of alcohol consumption on breast cancer risk, particularly regarding red wine, differed from that reported in the literature.

Conclusions:
Beliefs about risk factors for breast cancer may differ between cases and controls. Public health initiatives aimed at increasing awareness of breast cancer risk factors should consider that women's beliefs may differ by demographic factors and family history of breast cancer.

KEYWORDS

Breast cancer
Cancer causal beliefs
Cancer attribution
Cancer risk perception
Breast cancer risk factors

BACKGROUND

Breast cancer is the most commonly diagnosed cancer in women, comprising 28% of all female cancer cases diagnosed in Australia in 2008[1]. Known risk factors for breast cancer include increased age, a family history of breast cancer, hormonal and reproductive factors, excess weight, and alcohol consumption [1].

Several studies have shown that many women have misconceptions about breast cancer risk [2-5]. In a survey of 3005 Australian women without breast cancer, Jones et al found that only 36% of respondents correctly identified a family history of breast cancer as being a risk factor [3]. In contrast, 55% of respondents identified use of underarm deodorant and 90% identified stress as being risk factors for breast cancer [3], despite there being little evidence to support either association [6, 7]. As the authors note, women's knowledge of breast cancer risk factors are important if beliefs about risk lead to lifestyle modification to reduce cancer risk [3].

Several studies have demonstrated that perceived personal risk of breast cancer and beliefs about causal attributions for breast cancer may be associated with family history of cancer and sociodemographic factors, such as age, country of birth, ethnicity, socioeconomic status, and education level [3, 4, 8-11]. Beliefs about risk factors for breast cancer may also differ according to whether women have been diagnosed with the disease. In case-control studies, such differences have the potential to introduce systematic bias if self-reported exposure to factors is associated with beliefs about the effect of these factors.

We undertook a study to investigate women's beliefs about the risk factors for breast cancer, using participants from the Breast Cancer, Environment, and Employment Study (BCEES), which was a Western Australian case-control study [12].

METHODS

Participants

Cases comprised women residing in Western Australia (WA) who had incident breast cancer (ICD-10, C50) reported to the WA Cancer Registry (WACR) between 1st May 2009 and 31st January 2011, and who were between 18 and 80 years of age at the time of diagnosis. Controls were women without breast cancer, randomly selected from the WA electoral roll and frequency matched on five-year age groups. Cases and controls were excluded if they could not complete the initial questionnaire due to illness or insufficient English.

Participants were initially sent an invitation letter, an information brochure, a consent form, and the Lifestyle and Environment Questionnaire (LEQ). The LEQ asked women to report their lifetime exposure to a range of factors, including: occupational history; reproductive history, including use of hormone replacement therapy (HRT); sleep patterns; lifestyle; physical activity; and environmental

factors, such as exposure to pesticides. After returning the LEQ, participants were sent the Risk Perception Questionnaire (RPQ), which asked them to rate the effect of 37 specified exposures on the risk of being diagnosed with breast cancer.

A total of 2994 participants completed the LEQ, comprising 57.8% (1205) of the 2084 eligible cases, and 41.1% (1789) of the 4356 eligible controls. Of the 2994 study participants, 2742 (91.6%) completed the RPQ, comprising 92.0% (1109) of participating cases and 91.3% (1633) of participating controls.

Risk perception questionnaire

The RPQ asked participants to rate 37 items as to whether these items increased, decreased, or had no effect "on the chance of getting breast cancer". For each of the 37 items, participants could choose one of six responses: "Increase a lot", "Increase a little", "Decrease a little", "Decrease a lot", "No effect", and "Don't know". The RPQ also included an open-ended question in which participants were asked to state what they believed caused (their) breast cancer, the results of which are described elsewhere [13].

The RPQ exposure items had previously been used in a study of public perceptions of cancer risk factors in West Australian adults [14]. The items included lifestyle and environmental factors known to affect the risk of breast cancer (such as alcohol, HRT, and being overweight or obese [1, 15]); factors related to the primary hypotheses of the BCEES study (such as shift work, sleep patterns and pesticides); factors known to affect the risk of other types of cancer (such as asbestos); factors believed by many in the general population to affect the risk of cancer but for which there is no evidence of an association with cancer risk; and factors unlikely to affect risk of cancer, which were included to test for random responding (Table 2).

Statistical analyses

Data were analysed using Stata 12 and $p<0.05$ was considered a statistically significant difference. All missing answers (between 0.15% and 0.66% of responses for each item) were coded as "Don't know". Ratings were combined into four response groups for each of the 37 exposure items: "Increase" ("Increase a little" and "Increase a lot"), "No effect", "Decrease" ("Decrease a little" and "Decrease a lot"), and "Don't know".

Chi square tests were undertaken to ascertain differences in ratings between cases and controls for each exposure. Participants were then stratified by case-control status, and chi-square tests were undertaken to ascertain differences in ratings by age group (in 10-year increments), education level (university degree vs no university degree), family history of breast cancer (no family history, some family history, clear high risk, and unknown/missing), and country of birth (Australia/New Zealand, UK/Ireland, Europe, Asia, and other).

Logistic regression was undertaken to ascertain whether participants' ability to correctly identify factors as increasing or decreasing the risk of breast cancer was affected by a diagnosis of breast cancer, education level, age, country of birth, and family history of breast cancer. The RPQ exposures known

to affect the risk of breast cancer included risk factors pertaining to alcohol consumption ("Alcohol", "Beer", "Wine"), reproductive history ("Hormone Replacement Therapy"), and excess weight ("Being overweight or obese"), as well as one protective factor ("Being physically active") [1, 15]. For the five factors that increase the risk of breast cancer (alcohol, beer, red wine, being overweight or obese, and HRT), responses for "No effect", "Decrease" and "Don't know" were grouped together and compared with responses for "Increase". For "Being Physically Active", responses for "Increase", "No effect" and "Don't know" were grouped together and compared with responses for "Decrease".

Approval for the study was obtained from the Department of Health Western Australia Human Research Ethics Committee, project number 2009/28.

RESULTS

Participants completed the RPQ between November 2009 and September 2011. Although participants were frequency age matched, breast cancer cases were younger than controls (Table 1). Most participants were born in Australia or New Zealand. Controls were less likely to have had a university education. Cases were more likely to report a family history of breast cancer.

Of the 37 exposures, participants most frequently rated smoking as increasing breast cancer risk and being physically active as decreasing risk (Table 2). Cases more frequently responded "Don't know" than controls for 35 (94.6%) of the 37 items, the two exceptions being high fat food and alcohol. Controls more frequently responded "No effect" than cases for 26 (70.3%) of the 37 exposure items. The distribution of response ratings differed significantly between cases and controls for 16 (43.2%) of the 37 exposure items (Table 2); of these 16 items, 11 items were more frequently deemed by controls than cases to increase cancer risk (Table 2).

After stratifying by case-control status, participants' beliefs differed significantly by age group for 16 exposure items for controls and 15 items for cases, and by education level for 31 exposure items for controls and 29 items for cases. Women without a university degree more frequently responded "don't know" than university-educated women, and this effect was more pronounced in controls than in cases. Participants' beliefs differed by family history of breast cancer for one exposure item for controls and four exposure items for cases. Significant differences by country of birth were found for four exposure items for controls and five exposure items for cases.

Participants most frequently rated smoking, pesticides, passive smoking, stress, and food additives as increasing breast cancer risk (Table 2). Loud music, tea, lipstick, fruit, and red meat were most commonly rated as having no effect on the risk of breast cancer, while being physically active, vegetables, fish, high fibre foods, and meditation were most frequently believed to decrease risk. Participants most frequently responded "Don't know" for lipstick, shift work, interrupted sleep patterns, loud music, and tomato-based sauces.

Participants' ability to identify known breast cancer risk factors was similar for cases and controls. Of the six factors known to affect breast cancer risk, a significant difference in belief between cases and

controls was found only for red wine, with cases more likely than controls (OR 1.20. 95% CI:1.02–1.40) to identify red wine as a risk factor (Table 3). Younger women were more likely to accurately identify alcohol, red wine, beer, and HRT as increasing risk and being physically active as decreasing risk (Table 3). University-educated women were significantly more likely to identify alcohol, red wine, being overweight or obese and HRT as increasing risk and to identify being physically active as decreasing risk (Table 3).

DISCUSSION

As in other studies of both cancer survivors and the general population [2, 4, 5, 14], our study found that misconceptions about breast cancer risk factors were common amongst both cases and controls. Only two known risk factors were included in the ten most frequently identified exposures believed to increase risk; being overweight or obese and alcohol were ranked at eighth and ninth, respectively. Participants more frequently identified other exposures for which there is limited evidence of an association with breast cancer—such as stress, pesticides, food additives, mobile phones or mobile phone towers—than known breast cancer risk factors, such as red wine or beer. Although there is currently emerging evidence of an association between smoking and breast cancer, at the time when participants completed the RPQ, smoking was not known to increase breast cancer risk [16]; yet smoking was the factor most frequently cited by both cases and controls as increasing risk.

Although alcohol was correctly identified by 70.0% of participants as increasing breast cancer risk, fewer participants (54.5%) identified beer and fewer still (39.4%) identified red wine as increasing risk. Nearly one quarter (23.0%) of participants who believed that alcohol increased breast cancer risk nonetheless believed that red wine decreased risk. The inconsistencies in participants' beliefs about the effect of red wine and alcohol on breast cancer risk may reflect media reports about the alleged health benefits of red wine, in relation to both cancer and cardiovascular disease [17, 18].

Although there is little evidence to support a causal link between stress and cancer risk [8], our results are consistent with studies that show stress is commonly perceived as a risk factor for breast and other cancers [3, 4, 19-22]. The belief that stress increases breast cancer risk appears to be held both by people affected by cancer—who may attribute their own breast cancer to stress [20-22]—and by the general population in Australia [3], Austria [19] and the United Kingdom [10]. In unprompted open-text responses analysed by Thomson et al [13], almost half of BCEES cases attributed their own breast cancer to some form of mental state. When asked to rate the effect of stress on breast cancer risk in general, most participants in our study (81.1% of controls, 81.6% of cases) believed that stress increased the risk of breast cancer; consistent with this, approximately half of cases and controls believed that meditation decreased breast cancer risk.

Although all participants were asked to rate exposures for their effect "on the chance of getting breast cancer", cases may have been referring to their own cancer when evaluating exposures. The fact that cases more frequently responded "Don't know" than controls for the majority of exposure items may be due to cases being less willing than controls to attribute causation to breast cancer, perhaps because by

selecting any another response they would be implicitly attributing causation to their *own* breast cancer, rather than to breast cancer in general. Similarly, controls may have been more likely to respond "No effect" because they felt less personally involved than cases with regard to breast cancer causation and were therefore more willing to give a definitive response. These results have implications for future studies where knowledge of risk factors and beliefs about risk may influence participants' recall of past exposure and potentially lead to recall bias or rumination bias.

Our results support those of other studies [4, 9, 10] which demonstrate that demographic factors affect women's knowledge of breast cancer risk, with younger and more educated women being more likely to correctly identify known risk factors for breast cancer.

There were few significant differences between cases and controls in their ability to correctly identify known risk factors. However, there were significant differences in the overall pattern of responses for 16 of the 37 exposure items, particularly regarding exposures for which there is currently limited or emerging evidence of an association with breast cancer, such as shift work and interrupted sleep patterns. If beliefs about breast cancer causation affect participants' recall of exposure to these factors—and, consequently, affect self-reported exposure—then these differences would potentially introduce misclassification. It is therefore important to ascertain and adjust for participants' perceptions of disease causation in case-control studies.

Limitations

Prior to completing the RPQ, BCEES participants completed the LEQ, in which they reported their lifetime exposure to a range of exposures. Because some of these exposures were also included as RPQ items (alcohol consumption, lifetime smoking history, physical activity, HRT, sleep patterns, and exposure to pesticides) this may have alerted participants to the potential risk for these items, and affected the likelihood of participants rating these as increasing the risk of breast cancer. Cases may have been more attuned to these risk factors than controls, particularly if they had been exposed to any of these factors, and this may have affected their beliefs about risk.

Our results may also have been affected by the overall response fraction for the BCEES study. Although more than 90% of BCEES participants completed the RPQ (92.0% of cases, 91.3% of controls), the response fraction of the overall study was 46.5% (57.8% of eligible cases, 41.1% of eligible controls), and non-responders differed from responders by age for all BCEES invitees, and by remoteness for invited cases[23]. If women who participated in the BCEES study and who completed the RPQ were more interested in breast cancer than non-responders or more concerned with risk, they may have been more aware of breast cancer risk factors and this may affect the generalizability of our results. Older invitees (particularly controls) were more likely to complete the RPQ, but there were no differences in participation education, country of birth, or family history. There were significant differences between participating cases and controls in age, education, and family history, however these differences were adjusted for in logistic regression models.

Because differences in demographic factors were measured for 37 exposures after stratifying by case-control status, a high number of comparisons were drawn, which may have affected the validity of inferences.

CONCLUSION

This study supports previous research that has shown that women's perceptions about the risk factors for breast cancer differ from scientific evidence. Women believed that factors such as stress and food additives increased breast cancer risk, even where there was limited evidence of such an association. As in other studies, participants' ability to identify known risk factors for breast cancer was influenced by education and age. Public health initiatives and health promotion programs should consider that women's knowledge of breast cancer risk factors may differ according to demographic factors. The inconsistencies in women's beliefs about alcohol and breast cancer risk demonstrate a need for health campaigns to raise awareness that alcohol consumption—regardless of the type of alcoholic beverage—increases breast cancer risk.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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TABLES

Table 1: BCEES participant characteristics

	Cases (1109)		Controls (1633)		
	n	**(%)**	**n**	**(%)**	***p****
Age					<0.001
≤49	311	28.0	337	20.6	
50-59	303	27.3	485	29.7	
60-69	321	28.9	554	33.9	
70+	174	15.7	257	15.7	
Country of Birth					0.224
Australia/NZ	700	63.1	1091	66.8	
UK/Ireland	250	22.5	347	21.2	
Europe	61	5.5	82	5.0	
Asia	56	5.0	60	3.7	
Other	42	3.8	53	3.2	
Highest level of education					0.004
University degree or higher	241	21.7	282	17.3	
Family history of breast cancer					<0.001
No family history	668	60.2	1170	71.6	
Some family history	281	25.3	340	20.8	
High risk family history	157	14.2	119	7.3	
Unknown/Missing	3	0.3	4	0.2	

*Chi-square test for significant differences between cases and controls

Table 2: Participants' beliefs about the effect of lifestyle, environmental and diet factors on increased or decreased risk of breast cancer, ranked by frequency of responses

RPQ Exposure item	Established risk factor or protective factor for breast cancer[a]	All participants		Controls		Cases	
		Ranking	%	Ranking	%	Ranking	%
Items likely to be perceived as increasing risk, ranked by percentage of "Increase risk" responses							
Smoking*	No[b]	1	87.3	1	89.2	1	84.7
Pesticides	No	2	83.1	3	83.8	2	82.0
Passive smoking*	No[b]	3	82.8	2	84.8	4	79.9
Stress*	No	4	81.3	4	81.1	3	81.6
Food additives	No	5	79.5	5	80.1	5	78.5
Chemical fumes*	No	6	77.5	6	79.1	7	75.2
High fat food	No	7	75.9	7	76.0	6	75.7
Being overweight or obese	Yes[c]	8	73.5	8	73.2	8	73.9
Alcohol	Yes[b]	9	70.0	10	69.4	9	71.0
Asbestos**	No	10	67.0	9	69.7	11	62.8
Hormone replacement therapy*	Yes[b]	11	65.5	11	66.3	10	64.4
Car exhaust fumes	No	12	64.0	12	64.8	12	62.8
High voltage power lines*	No	13	62.3	13	64.7	13	58.8
Mobile phone towers*	No	14	59.4	14	62.1	14	55.5
Mobile phones	No	15	55.1	15	56.8	16	52.6
Beer	Yes[b]	16	54.5	16	54.9	15	53.9
Artificial sweeteners	No	17	52.7	17	53.6	17	51.5
Barbequed meat	No	18	48.9	18	49.8	18	47.6
Red wine*	Yes[b]	19[d]	39.4	21	37.4	19	42.4
Underarm deodorant	No	20	39.3	20	40.4	21	37.8
Salt*	No	21	37.9	19	40.7	23	33.8
Red meat	No	22	36.5	22	35.9	22	37.5
Interrupted sleep patterns**	No[b]	23	35.1	23	31.7	20	40.2
Coffee*	No	24	29.8	24	30.6	25	28.8
Shift work**	No[b]	25	29.4	25	27.8	24	31.7
Lipstick	No	26	11.7	26	11.9	26	11.4
Loud music*	No	27	8.0	27	7.2	27	9.1
Items likely to be perceived as decreasing risk, ranked by percentage of "Decrease risk" responses							
Being physically active	Yes[c]	1	70.1	1	69.9	1	70.4
Vegetables	No	2	61.7	2	61.5	2	61.9
Fish*	No	3	57.8	3	58.5	3	56.8
High fibre food	No	4	56.7	4	58.1	4	54.7
Meditation	No	5	54.8	5	55.5	6	53.7
Fruit	No	6	54.2	6	54.1	5	54.4
Organic foods	No	7	46.3	7	45.9	7	46.9
Tea	No	8	31.3	8	31.4	8	31.3
Vitamin supplements*	No	9	24.9	9	25.4	9	24.2
Tomato-based sauces	No	10	22.4	10	22.5	10	22.4

* $p<0.05$ for differences between cases and controls in the distribution of ratings.

** $p<0.001$ for differences between cases and controls in the distribution of ratings.

[a] Risk factors are deemed as carcinogenic agents with sufficient evidence for effect on breast cancer risk, and does not refer to agents with limited or unknown evidence.

[b] WHO. Carcinogenic agents with sufficient evidence include alcoholic beverages and estrogen-progestogen menopausal therapies. Agents with limited evidence include estrogen menopausal therapy, shift work involving circadian disruption, and tobacco smoking[15].

[c] AIHW[1].

[d] Red wine was the eleventh most frequently ranked exposure item as decreasing breast cancer risk.

Table 3: BCEES participants' knowledge of breast cancer risk factors, by demographic factors and family history of breast cancer

	Alcohol (Increase risk)	Red wine (Increase risk)	Beer (Increase risk)	Being overweight or obese (Increase risk)	Hormone replacement therapy (Increase risk)	Being physically active (Decrease risk)
	1920 (70.0%)	1080 (39.4%)	1495 (54.5%)	2015 (73.5%)	1796 (65.5%)	1922 (70.1%)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
History of breast cancer						
Controls	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Cases	1.04 (0.88–1.23)	**1.20 (1.02–1.40)**	0.92 (0.78–1.08)	0.98 (0.82–1.17)	0.95 (0.81–1.12)	0.98 (0.83–1.17)
Age						
≤49	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
50–59	0.80 (0.63–1.02)	**0.76 (0.62–0.94)**	**0.62 (0.50–0.77)**	1.03 (0.80–1.31)	**2.25 (1.80–2.81)**	**0.78 (0.62–0.99)**
60–69	**0.76 (0.60–0.96)**	**0.72 (0.58–0.89)**	**0.49 (0.40–0.61)**	0.81 (0.64–1.03)	**2.30 (1.85–2.87)**	**0.79 (0.62–0.99)**
70+	**0.65 (0.50–0.86)**	**0.64 (0.50–0.83)**	**0.43 (0.33–0.55)**	0.89 (0.67–1.17)	**1.35 (1.04–1.73)**	**0.72 (0.55–0.94)**
Highest education level						
No university degree	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
University degree	**1.45 (1.15–1.81)**	**1.29 (1.06–1.58)**	1.18 (0.96–1.44)	**1.70 (1.33–2.17)**	**1.56 (1.25–1.94)**	**2.01 (1.58–2.56)**
Family history of breast cancer						
No family history/ Unknown/Missing	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Some family history	0.97 (0.80–1.19)	1.16 (0.96–1.40)	1.12 (0.93–1.35)	**1.26 (1.02–1.57)**	1.06 (0.87–1.29)	1.10 (0.89–1.34)
Clear high risk	1.11 (0.83–1.48)	1.10 (0.85–1.43)	0.96 (0.74–1.24)	**1.37 (1.01–1.86)**	1.14 (0.87–1.50)	0.96 (0.73–1.27)
Country of birth						
Australia/New Zealand	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
UK/Ireland	0.99 (0.81–1.22)	0.87 (0.71–1.05)	0.92 (0.76–1.11)	1.00 (0.81–1.23)	1.13 (0.92–1.38)	1.06 (0.86–1.30)
Europe/Asia/Other	0.90 (0.70–1.15)	**0.59 (0.46–0.76)**	**0.64 (0.51–0.81)**	0.87 (0.67–1.13)	0.84 (0.66–1.07)	0.88 (0.68–1.13)