Relationship of attitudes toward uncertainty and preventive health behaviors with breast cancer screening participation

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Abstract

Background: Early detection of breast cancer is effective for prolonging survival, but the participation rate in breast cancer screening among target Japanese women remains low. This study examined the relationships between tendencies in decision-making under uncertainty conditions, health behaviors, demographics, and breast cancer screening participation in Japanese women.

Methods: Data for women aged 40 years or older obtained in the 2017 Keio Household Panel Survey were analyzed. Participants answered questions about breast cancer screening attendance in the last year, risk aversion, time preference, health behaviors (e.g., smoking habit, alcohol consumption, and medical treatment received in the last year), and demographic variables. Responses were analyzed using chi-squared tests, t-tests, and logistic regression analysis. Variables were entered into the regression model if they were significantly associated with breast cancer screening participation in univariate analysis.

Results: A total of 2,729 of 2,945 households responded to the questionnaire. Data from 708 questionnaires were analyzed. Among the respondents, 28.8% had participated in breast cancer screening in the past year. Factors found to significantly contribute to breast cancer screening participation included higher risk aversity (odds ratio [OR], 2.34; 95% confidence interval [CI] = 1.03-5.32; $p = 0.043$), medical treatment received in the last year (OR, 1.56; 95%CI = 1.06-2.30; $p = 0.026$), higher self-rated health (OR, 1.47; 95% CI = 1.18-1.83; $p = 0.001$), living above the poverty line (OR, 2.31; 95% CI = 1.13-4.72; $p = 0.022$), and having children (OR, 1.57; 95% CI = 1.02-2.42; $p = 0.042$). Factors not significantly associated with screening participation were smoker (OR, 0.20; 95% CI = 0.10-0.42; $p < 0.000$), alcohol drinker (OR, 0.56; 95% CI = 0.37-0.86; $p = 0.007$), self-employed (OR, 0.22; 95% CI = 0.10-0.46; $p < 0.000$), and unemployed (OR, 0.48; 95% CI = 0.26-0.90; $p = 0.022$). No significant relationship was observed between time preference and screening participation.

Conclusions: The results indicate that women who recognize the actual risk of developing breast cancer or have high awareness of breast cancer prevention tend to participate in breast cancer screening. Barriers to screening participation are not working for an enterprise that encourages screening and low income.

Background

Breast cancer is the most common cancer among women worldwide [1]. In Japan, it is the leading cause of death from cancer among women aged 30 to 64 years [2]. Both the number of women who are diagnosed with breast cancer and the number who die of the disease is increasing; 14,653 per 100,000 population died of breast cancer in 2018 in Japan [2].

Early detection and early treatment of breast cancer can lead to favorable prognosis [3, 4]. The 5-year net survival rate for breast cancer in the United Kingdom is reported to be 97.9% for stage 1 disease and 89.6% for stage 2, but this decreases to 72.0% for stage 3 disease and 26.2% for stage 4. [5]. In the United

States, the 5-year survival rate is 98.8% for localized female breast cancer but 27.4% for distant female breast cancer [6]. It is therefore critical to detect breast cancer early.

Mammography is the most effective screening tool to identify breast cancer and can help to decrease breast cancer mortality by allowing earlier treatment [7–9]. Since 2004, the Japan Ministry of Health, Labour and Welfare have recommended mammography screening for women aged 40 years or over every 2 years [10]. In the United States in 2016, 72.5% of women aged 40 years or over had undergone mammography screening within the past 2 years [11], and in Western industrialized countries, the Organization for Economic Co-operation and Development reported that 70–80% underwent mammography within the past five years [12]. However, the participation rate among Japanese women targeted for breast cancer screening continues to be low. In 2016, only 44.9% of the target women had undertaken mammography screening within the past 2 years [13], falling short of the 50% targeted participation rate set by the Basic Plan to Promote Cancer Control Programs [14]. Effective strategies are therefore urgently needed to increase the number of target women who undergo breast cancer screening in Japan.

Previous studies have revealed that breast cancer screening participation is associated with health-related lifestyle and behavioral factors; such as knowledge or health literacy of breast cancer [15–17], smoking habit [18, 19], alcohol consumption [19, 20], physical activity level [21], and self-perceived health [20, 22].

Economic factors are also barriers to breast cancer screening participation [23, 24]. According to Japan's Census on Cancer Control [25], one of the reasons for women not attending cancer screening was "economic burden" (12.6%), and several other demographic factors are associated with breast cancer screening participation, including higher level of education, lower occupational class [26, 27], regular visits to doctors [28, 29], living with a partner [30], having children [31], and older age [24, 28, 29].

Determinant factors of preventive health behaviors are receiving increased attention in the field of behavioral economics [32, 33]. Preventive health behavior or the use of preventive medical care to treat fear of disease and death are likely affected by tendencies or preferences in behavior or decision-making under uncertainty conditions [34, 35]. People often decide to use disease-prevention services in consideration of intertemporal tradeoff—whether they prefer receiving an immediate small reward or a delayed larger reward—as explained by time preference theory [34, 36]. For example, the decision to participate in cancer screening is influenced by psychological value, that is, time preference as to whether to place emphasis on the present or the future.

Another tendency in behavior or decision-making under uncertainty conditions is risk aversion. This concerns the attitude toward risk that people take when deciding to use disease-prevention services to decrease the probability of disease or death [34, 35]. Even a highly satisfactory behavior may be viewed as harmful to health and thus avoided. As such, participation in cancer screening may be affected by an individual's attitude to avoiding health problems caused by cancer [34, 35]. Those who have a higher time preference tend to place value on the current situation without considering the future and therefore prefer

not to engage in preventive health behaviors. Those who are likely to avoid risk tend to actively engage in preventive health behaviors [34, 35, 37]. Although tendencies in decision-making under uncertainty conditions is a crucial factor that could predict preventive health behavior, there are few empirical research studies addressing this topic.

Communities in Japan are struggling with improving breast cancer screening rates. Given that participants in breast cancer screening tend to have healthy habits, strategies have usually been proposed for people with poorer health behaviors or who are not interested in health behaviors. However, such strategies would not be fully effective considering the low rates of breast cancer screening participation in Japan. More effective tactics are needed both to encourage women to participate in breast cancer screening in order to decrease their risk of breast cancer-related health problems in the future and to improve screening participation rates.

Against his background, in this study we examined the relationship between tendencies in decision-making under uncertainty conditions and breast cancer screening participation among Japanese women. We also analyzed the relationship of health behaviors and demographics with breast cancer screening to explore more effective strategies for increasing the breast cancer participation rate of Japanese women.

Methods

Data from the Keio Household Panel Survey (KHPS) were used in this preliminary cohort study. The KHPS survey, conducted by Keio University, provides representative data from panel surveys of Japanese households [39].

Briefly, the KHPS was approved by the Ministry of Education, Culture, Sports, Science and Technology in Japan and has been conducted annually since 2004, surveying a total of 4,005 households nationwide. A stratified two-stage sampling method is used for the survey. KHPS respondents in 2004 were men and women born between 1935 and 1984. The demographic characteristics of the respondents are representative of Japanese households nationwide. The KHPS questionnaire includes items on place of residence, basic demographic data (e.g., year of birth, level of education, and gender), employment status, health status, health-related behaviors, and household economic condition.

The empirical analysis we conducted in this study primarily used the 2017 wave of the KHPS and partially relies on the 2004 wave for basic demographic data. The sample for the analysis was women aged 40 years or older, which corresponds with the recommended age for breast cancer screening in Japan.

The aim of the study was to explore the relationships between tendencies in decision-making under uncertainty conditions, health behaviors, demographics, and breast cancer screening participation in Japanese women.

Variables

The primary outcome was breast cancer screening participation in the last year (participated or did not participate).

Explanatory variables were variables related to risk aversion, time preference, health behaviors, and demography. Risk aversion was assessed using a question about deciding whether to take an umbrella out depending on the percentage likelihood of rain given in a weather forecast. Time preference was measured using a question about relative valuation placed on smaller immediate rewards or larger later rewards [40]: “How satisfied are you with receiving JPY 10,000 after 13 months instead of receiving it after 1 month?” (1 “interest rate = -5%” to 8 “interest rate = 40%”). The KHPS asked about the following health-related lifestyle variables: alcohol consumption (yes or no), smoking status (smoker or non-smoker), weekly physical exercise (yes or no), sleep duration (hours per night), and medical treatment received in the last year (yes or no). Self-rated health (SRH; 1 “poor” to 5 “excellent”) was also evaluated. The survey also asked about the following employment characteristics: working hours per week, relative poverty (household disposable income < JPY 122,000 per year or not), and employment type (regular, non-regular, self-employed, or unemployed). Demographic attributes obtained included gender (male or female), year of birth, marital status (married or single), children (none or ≥ 1), and level of education (junior or senior high school graduate, junior college or vocational school graduate, or university or graduate-school graduate). Residential area was also recorded.

Ratios of time preference and risk aversion were obtained as percentages, with a lower time preference ratio indicating lower time preference and a higher risk aversion ratio indicating higher risk aversion. To account for relative poverty, household disposable income was calculated by dividing household income by the square root of household size and then dividing participants into two groups: “living below the poverty line” with a household disposable income less than JPY 122,000 per year (JPY 122,000 is the poverty line, which is the median household disposable income in Japan) and “living above the poverty line” with a household disposable income equal to or more than JPY 122,000 per year. Age was calculated from year of birth.

Data analysis

Frequency (percentage) and descriptive statistics (mean and standard deviation [SD]) were first confirmed for all variables. Then, chi-squared tests were performed and adjusted standardized residuals (ASRs) were calculated in a preliminary analysis to compare those who participated in breast cancer screening with those who did not according to age, child status, marital status, level of education, employment type, relative poverty, medical treatment received in the last year, smoking status, alcohol consumption, and weekly physical exercise. The t-tests were also performed as preliminary analysis to compare differences between the groups in risk aversion, time preference, SRH, and sleep duration. Subsequently, logistic regression analysis was performed and odds ratios were calculated to identify the factors associated with breast cancer screening participation. Variables that were significant in the univariate analysis were entered into the model as exploratory variables.

All statistical analyses were conducted using SPSS Statistics 25.0 for Mac (IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$ (two-tailed).

Results

Demographic characteristics

In 2017, the KHPS questionnaire was distributed to 2,945 households, of which 2,729 responded (response rate: 92.7%). A total of 708 questionnaires had complete responses and met the inclusion criterion (answered by women aged ≥ 40 years). These responses were analyzed in the course of the present study (valid response rate: 24.0%).

Tables 1 and 2 show the descriptive statistics of the sample.

Table 1. Descriptive data of the analyzed sample (N = 708)

	n	%
Breast cancer screening (during the last year)		
Participated	204	28.8
Not participated	504	71.2
Age (years)		
40-49	170	24.0
50-59	180	25.4
60-69	183	25.8
70-79	150	21.2
80-85	25	3.5
Family type		
Living with family	622	87.9
Living alone	86	12.1
Marital status		
Married	533	75.3
Single	175	24.7
Children		
Yes	414	58.5
No	294	41.5
Level of education		
Junior or senior high school graduate	449	63.4
Junior college or vocational school graduate	135	19.1
University or graduate-school graduate	124	17.5
Employment type		
Regular	77	10.9
Precarious	219	30.9
Self-employed	145	20.5
Unemployed	267	37.7

Relative poverty			
	Poor ¹⁾	79	11.2
	Not poor ²⁾	629	88.8
Medical treatment received in the last year			
	Yes	348	49.2
	No	360	50.8
Smoking status			
	Smoker	125	17.7
	Non-smoker	583	82.3
Alcohol consumption			
	Yes	237	33.5
	No	471	66.5
Exercises weekly			
	Yes	167	23.6
	No	541	76.4
Region of residence			
	Government-designated city ³⁾	199	28.1
	City ⁴⁾	449	63.4
	Town or village ⁵⁾	60	8.5

1) Household disposable income < 122,000 yen

2) Household disposable income ≥ 122,000 yen

3) Population of ≥ 500,000

4) 500,000 > Population of ≥ 50,000

5) Population of < 50,000

Of the respondents, almost a third underwent breast cancer screening in the past year. Those in the age ranges of 60-69 years and 50-59 years comprised just over half of all respondents, and those aged 40-49 years comprised almost a quarter. Most lived with families; approximately three-quarters were married, and over half had children. Most were not university or graduate-school graduates. Relatively few were

regular employees whereas more than a third were unemployed. Health behavior variables revealed that most were non-smokers, more than two-thirds did not consume alcohol, almost a quarter performed weekly exercise, and almost half had received medical treatment in the last year. Mean time preference was 0.17 ± 0.15 and mean risk aversion was 0.60 ± 0.23 .

Table 2. Mean, standard deviation, and range of continuance variables

	Minimum	Maximum	Mean	SD
Sleeping duration	2	11	6.52	1.16
Self-rated health	1	5	3.23	0.91
Time preference	-0.05	0.4	0.17	0.15
Risk aversion	0	1	0.60	0.23

Univariate analysis of explanatory variables and breast cancer screening participation

Chi-squared tests and t-tests were performed to confirm the differences in explanatory variables according to breast cancer screening participation (Tables 3 and 4).

Table 3. Association of breast cancer screening participation with health behaviors and demographic variables¹⁾

		Breast cancer screening (during the last year)						p	χ^2
		Participated (N = 204)			Did not participate (N = 504)				
		n	%	ASR ²⁾	n	%	ASR ²⁾		
Age (years)									
	40-49	49	24.0	0.0	121	24.0	0.0	0.076	8.46
	50-59	65	31.9	2.5	115	22.8	-2.5		
	60-69	51	25.0	-0.3	132	26.2	0.3		
	70-79	34	16.7	-1.9	116	23.0	1.9		
	80-85	5	2.5	-1.0	20	4.0	1.0		
Family type									
	Living with family	187	91.7	2.0	435	86.3	-2.0	0.048	3.91
	Living alone	17	8.3	-2.0	69	13.7	2.0		
Marital Status									
	Married	161	78.9	1.4	372	73.8	-1.4	0.153	2.04
	Single	43	21.1	-1.4	132	26.2	1.4		
Children									
	Yes	141	69.1	3.7	273	54.2	-3.7	0.000	13.37
	No	63	30.9	-3.7	231	45.8	3.7		
Level of education									
	Junior or senior high school graduate	122	59.8	1.3	327	64.9	1.3	0.004	11.18
	Junior college or vocational school graduate	54	26.5	3.2	81	16.1	-3.2		
	University or graduate-school graduate	28	13.7	-1.7	96	19.0	1.7		
Employment type									
	Regular	29	14.2	1.8	48	9.5	-1.8	0.000	48.75

Precarious	93	45.6	5.4	126	25.0	-5.4		
Self-employed	15	7.4	-5.5	130	25.8	5.5		
Unemployed	67	32.8	-1.7	200	39.7	1.7		
Relative poverty								
Poor ³⁾	11	5.4	-3.1	68	13.5	3.1	0.002	9.61
Not poor ⁴⁾	193	94.6	3.1	436	86.5	-3.1		
Received medical treatment in the last year								
Yes	114	55.9	2.3	234	46.4	-2.3	0.023	5.19
No	90	44.1	-2.3	270	53.6	2.3		
Smoking status								
Smoker	10	4.9	-5.7	115	22.8	5.7	0.000	32.06
Non-smoker	194	95.1	5.7	389	77.2	-5.7		
Alcohol consumption								
Yes	45	22.1	-4.1	192	38.1	4.1	0.000	16.77
No	159	77.9	4.1	312	61.9	-4.1		
Exercises weekly								
Yes	49	24.0	0.2	118	23.4	-0.2	0.863	0.03
No	155	76.0	-0.2	386	76.6	0.2		

1) Chi-squared test and ASRs

2) ASR: adjusted standardized residual

3) Household disposable income per month < 122,000 yen

4) Household disposable income ³ 122,000 yen

Table 4. Comparison of continuance variables according to breast cancer screening participation

	Participated (N = 204)		Did not participate (N = 504)		p
	Mean	SD	Mean	SD	
Sleeping duration	6.34	0.94	6.59	1.23	0.005
Self-rated health	3.35	0.83	3.18	0.94	0.025
Time preference	0.18	0.15	0.17	0.15	0.792
Risk aversion	0.63	0.23	0.59	0.23	0.022

Chi-squared tests showed significant differences in breast cancer screening participation according to family type ($\chi^2 = 3.91$, $p < 0.048$), child status ($\chi^2 = 13.37$, $p < 0.000$), level of education ($\chi^2 = 11.18$, $p < 0.004$), employment type ($\chi^2 = 48.75$, $p < 0.000$), relative poverty ($\chi^2 = 9.61$, $p < 0.002$), smoking status ($\chi^2 = 32.06$, $p < 0.000$), and alcohol consumption ($\chi^2 = 16.77$, $p < 0.000$). Breast cancer screening participation during the last year was more likely among those who lived with family (ASR = 2.0), had children (ASR = 3.7), were a junior college or vocational school graduate (ASR = 3.2), were a precarious employee (ASR = 5.4), had received medical treatment in the last year (ASR = 2.3), were a non-smoker (ASR = 5.7), and had no alcohol consumption (ASR = 4.1). Conversely, breast cancer screening participation was less likely among those who were self-employed (ASR = 5.5) and were lived below the poverty line (ASR = 3.1).

Those who had participated in breast cancer screening during the last year showed significantly shorter sleep duration ($p = 0.005$), higher SRH ($p = 0.025$), and greater risk aversion ($p = 0.022$) than those who did not. No significant difference was observed in time preference between those who did and did not participate in breast cancer screening.

Association of explanatory variables and breast cancer screening participation

The variables that were significantly associated with breast cancer screening participation in the preliminary analysis (chi-squared tests and t-tests) were subjected to logistic regression analysis, with age and region of residence used as control variables (Table 5).

Table 5. Factors associated with breast cancer screening participation on logistic regression analysis

	B	Exp (B)	95% CI		p
			Lower	Upper	
Age (years; reference = 40-49)					
50-59	0.36	1.43	0.86	2.39	0.172
60-69	0.16	1.17	0.67	2.03	0.582
70-79	0.13	1.14	0.58	2.23	0.701
80-85	-0.07	0.93	0.28	3.15	0.907
Marital status (reference = Single)					
	-0.42	0.66	0.38	1.14	0.133
Children (reference = None)					
	0.69	1.99	1.20	3.30	0.008
Level of education (reference = Junior or senior high school graduate)					
Junior college or vocational school graduate	0.22	1.24	0.77	1.99	0.372
University or graduate-school graduate	-0.47	0.62	0.36	1.07	0.086
Employment type (reference = Regular)					
Precarious	0.04	1.04	0.57	1.87	0.905
Self employed	-1.54	0.22	0.10	0.46	0.000
Unemployed	-0.73	0.48	0.26	0.91	0.023
Relative poverty (reference = Poor ¹⁾)					
	0.93	2.54	1.23	5.23	0.011
Received medical treatment in the last year (reference = No)					
	0.46	1.58	1.07	2.34	0.021
Smoking status (reference = No)					
	-1.65	0.19	0.09	0.40	0.000
Alcohol consumption (reference = No)					
	-0.57	0.56	0.37	0.86	0.008
Sleep duration					
	-0.09	0.91	0.76	1.09	0.318
Self-rated health					
	0.38	1.47	1.18	1.83	0.001
Risk aversion					
	0.83	2.30	1.01	5.22	0.047
Region of residence (reference = Government-designated city ²⁾)					
City ³⁾	0.04	1.04	0.68	1.60	0.843
Town or village ⁴⁾	0.38	1.46	0.73	2.93	0.288
Log likelihood					
	-353.879				

- 1) Household disposable income < 122,000 yen
- 2) Population of $\geq 500,000$
- 3) $500,000 > \text{Population of } \geq 50,000$
- 4) Population of < 50,000

Factors found to significantly contribute to breast cancer screening participation in the past year included being more risk averse (odds ratio [OR], 2.34; 95% confidence interval [CI] = 1.03-5.32; $p = 0.043$), receiving medical treatment in the last year (OR, 1.56; 95% CI = 1.06-2.30; $p = 0.026$), having a higher SRH (OR, 1.47; 95% CI = 1.18-1.83; $p = 0.001$), living above the poverty line (OR, 2.31; 95% CI = 1.13-4.72; $p = 0.022$), and having children (OR, 1.57; 95% CI = 1.02-2.42; $p = 0.042$). Conversely, factors found not to contribute significantly to breast cancer screening participation were being a smoker (OR, 0.20; 95% CI = 0.10-0.42; $p < 0.000$), an alcohol drinker (OR, 0.56; 95% CI = 0.37-0.86; $p = 0.007$), self-employed (OR, 0.22; 95% CI = 0.10-0.46; $p < 0.000$), and unemployed (OR, 0.48; 95% CI = 0.26-0.90; $p = 0.022$). Time preference was not found to be significantly associated with breast cancer screening participation.

Discussion

This study investigated the relationships between tendencies in decision-making under uncertainty conditions, health behaviors, demographics, and breast cancer screening attendance to explore more effective strategies than currently implemented for increasing the participation rate of Japanese women in breast cancer screening. The results showed that those with higher risk aversion tended to participate in the screening. However, time preference was not observed to significantly affect participation. Women who underwent breast cancer screening were found to have healthy preventive behaviors such as not smoking, not drinking alcohol, and having received medical treatment in the last year. Higher SRH was also associated with breast cancer screening participation. Analysis of demographic characteristics revealed that the following factors were barriers to breast cancer screening: being self-employed, unemployed, and living in relative poverty. Furthermore, having children was positively associated with participation.

Characteristics of the sample in this study

The rate of participation in breast cancer screening in the last year was low (28.8%) in our sample compared with the rate of participation within the past 2 years obtained in the Comprehensive Survey of Living Conditions in 2016 (44.9%) [13], even though there was just a 1 year difference in the survey periods. The results of descriptive statistics indicated that most participants in the present study were non-smokers and did not drink alcohol. Also, their average sleep duration was the same as that reported in the National Health and Nutrition Survey 2016 [41]. Thus, we can view these women as likely to have

healthier behavior. On the other hand, the women in this study were less likely to have healthy behavior in relation to weekly physical exercise, compared with data from a census on physical fitness [42] showing that 37.8-71.5% of women engaged in physical exercise more than 1 day a week.

Relationships between tendencies in decision-making under uncertainty conditions and breast cancer screening participation

Our results indicate that women with higher risk aversion might actively participate in breast cancer screening to decrease the risk of delayed cancer detection. There is increasing awareness that early detection of breast cancer leads to more effective treatment and thus to better prognosis. Therefore, women with an accurate perception of breast cancer might undergo breast cancer screening to mitigate breast cancer risk. A meta-analytic review demonstrated that perceived risk is a predictor of breast cancer screening risk [43]. Women who recognize the actual risk of breast cancer developing or are anxious about developing breast cancer tend to participate in cancer screening [43, 44], so breast cancer screening participation could be increased by messages that emphasize the benefits of attending screening, the necessity of screening for improving quality of life even for women with breast cancer, and the risk of overlooking breast cancer developing. Also, to increase participation, it might be effective to provide appropriate health education information about the accuracy of breast cancer screening, advances in breast cancer treatment, and improvement of prognosis after treatment. However, the association between risk aversion and breast cancer screening participation has not yet been fully examined and results are not consistent across studies. Some studies have reported that women with higher risk aversion do not participate in breast cancer screening to avoid the risk that breast cancer might be detected, which provokes anxiety or psychological stress [34, 45]. Moreover, Sasaki and Ohtake (2018) suggest that individuals recognize the result of decision-making related to breast cancer screening differently depending on whether they take a gain-framing (safety concerns) perspective or loss-framing (risk concerns) one [35]. For example, on the one hand, individuals who are risk averse are unlikely to participate in breast cancer screening when considering the risky condition of “having breast cancer but its treatment might not be successful”. On the other hand, individuals who are risk-seeking are unlikely to participate in breast cancer screening when considering the uncertain condition of “not having breast cancer, but it might be detected”. Their survey measured risk aversion only from the perspective of loss-framing, but future studies should measure it from both the loss-framing and gain-framing perspectives to examine more effective strategies for improving participation in breast cancer screening.

The results of the present study also showed that time preference did not significantly affect breast cancer screening participation, unlike the findings of past studies [34, 35, 46]. However, a meta-analysis suggested that time preference is associated with addictive health behavior (e.g., smoking, alcohol consumption, or drug use) and not with preventive health behaviors such as attending cancer screenings or medical checkups [36]. Some studies have shown that the relationship of time preference with breast cancer screening participation is weaker than that with other factors [45, 47]. Time preference may be reflected in impulsive, addictive, or emotional behaviors rather than considered behaviors such as vaccination, medication compliance, or screening [36]. The effect of time preference might depend on

mood or thoughtfulness in decision-making or decision-taking behaviors [35, 36] but remains incompletely understood. Further research is needed to clarify this

Relationships between health behaviors and breast cancer screening participation

Smoking and alcohol consumption are risk factors for various cancers, including breast cancer [48]. Past research reported a positive association between high breast cancer knowledge and breast cancer screening participation, and suggested individuals might undergo breast cancer screening if they are knowledgeable about breast cancer, such as risk factors, usefulness of mammography, or causes [17, 49, 50]. In addition, individuals who are interested in preventing health problems or who actively engage in preventive health behaviors would be likely to engage more in healthy behaviors that can reduce the risk of disease or death. In contrast, individuals who engage in unhealthy behaviors such as smoking, alcohol consumption, or not attending medical checkup are less likely to engage in preventive activities [51, 52]. In particular, women who usually engage in preventive health behaviors would likely participate in breast cancer screening as a part of their preventive health behaviors [53, 54]. The results of the present study might reflect this behavioral characteristic. The survey that provided data for this study did not ask about knowledge of breast cancer; further investigation is expected to clarify the relationship of attending breast cancer screenings with preventive health behaviors like smoking and alcohol consumption and with breast cancer knowledge.

Several studies have demonstrated that frequent visits to medical doctors could increase opportunities to recommend breast cancer screening participation or promote awareness of cancer control [20, 28, 29], where those women who received medical treatment tended to undergo screening. The association between higher SRH and participation in breast cancer screening supports the findings of previous research [55, 56]. Individuals perceived as being in poorer physical health are less likely to participate in health checkups or screenings to avoid knowing the cause of their physical health status [57]. The participants in the present study with lower SRH had high risk aversion, which might have led to their non-participation in breast cancer screening.

Relationships between demographic factors and breast cancer screening participation

Regular employees have been shown to have the highest breast cancer screening participation rate [26, 58, 59], whereas unemployed and self-employed individuals are less likely to participate [58, 60, 61]. Employees of enterprises are more likely exposed to recommendations for breast cancer screenings or to organized breast cancer screenings, further promoting their participatory behavior. Self-employed or unemployed women likely have limited cancer control service benefits, so they miss opportunities to participate in screenings. Self-employed women might also find it difficult to take time off to attend screenings [62, 63]. This might explain the differences in breast cancer screening participation by employment status. Exposure to breast cancer screening opportunities or frequent recommendations for breast cancer screening is likely dependent on living environment or socioeconomic status. Inequalities in either or both could lead to health disparities, and breast cancer is no exception. As such, carefully designed recommendation strategies for breast cancer screening should be jointly implemented by the

government, medical facilities, and enterprises. Utilizing social marketing communications could also be effective, such as combining mass media, social network services, and individual mailings.

Our analysis suggests that relative poverty should not be overlooked as a barrier to breast cancer screening participation. Income and medical insurance have been shown to affect cancer screening participation [64]. Poverty tends to delay the early detection of breast cancer worldwide [65], and low income tends to lead to lower breast cancer screening rates [23, 24, 66]. Free vouchers or discount vouchers for mammography have been shown to significantly improve the breast cancer screening rate in Japan [67-70]. However, there are costs involved in carrying out screening, so the provision of free or low-cost screening to targeted women should be carefully considered. Individual screening recommendations and free vouchers would likely be effective in encouraging breast cancer screening participation [71]. Strategies and education programs should be prepared that will help women recognize breast cancer risk and the significance of attending screenings so that they can proactively participate in the screenings regardless of screening cost. However, as discussed above, support is urgently needed for those with lower income.

Finally, this study found that having children is associated with participating in breast cancer screening. Women with children have childcare responsibilities, so it is likely that their health awareness is already high and that they undertake preventive health behaviors.

In terms of limitations, this study was a preliminary study that used cross-sectional data to investigate the relationships between breast cancer screening participation and tendencies in decision-making under uncertainty conditions and preventive health behaviors. As such, causality cannot be inferred. The survey data were all self-reported, so the findings may have been affected by response bias [72, 73]. Further investigations are needed using objective data. The participants were from various regions of Japan, and more parameters of participants' medical conditions should be considered by region. Risk aversion and time preference can be measured from various perspectives, but the survey used only one questionnaire to address each. Further examination of the relationship between these tendencies and breast cancer screening participation should use several kinds of questionnaires on risk aversion and time preference.

Conclusions

This study used representative data from panel surveys of Japanese households and showed that women were likely to participate in breast cancer screening if they were not smokers, did not consume alcohol, and received medical treatment in the last year. Higher risk aversion, but not time preference, was found to be positively associated with breast cancer screening participation. Income status and employment status were also significantly associated with participation: those who were living below the poverty line, were self-employed, or were unemployed did not tend to participate in screenings. Higher SRH and having children were also factors related to breast cancer screening participation.

Abbreviations

ASR: adjusted standardized residual; CI: confidence interval; KHPS: Keio Household Panel Survey; OR: odds ratio; SD: standard deviation; SRH: self-reported health

Declarations

Ethics approval and consent to participate

We received approval from the Keio University Panel Data Research Center to use the KHPS data for our research (Approval No.1322: Data ID: 156-JHPS/KHPS2004-2018). The center also provided the data. According to Japan's Ethical Guidelines for Epidemiological Research, this study did not require ethical approval. The study complied with Keio University's data use policy and Japan's Ethical Guidelines for Epidemiological Research.

Consent for publication

Not applicable.

Availability of data and materials

The data are available from the corresponding author upon reasonable request. The dataset supporting the conclusions of this article is available in the Panel Data Research Center at Keio University with the approval by this organization (Approval No.1322: Data ID: 156-JHPS/KHPS2004-2018).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MS conceptualized and carried out the study and wrote the manuscript. NS provided important scientific comments on the study design, data analysis, and manuscript content. All authors contributed to and have approved the final manuscript.

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