pISSN 1598-2998, eISSN 2005-9256
https://doi.org/10.4143/crt.2020.495
Cancer Res Treat. 2021;53(1):55-64

Original Article

Impact of Awareness of Breast Density on Perceived Risk, Worry, and Intentions for Future Breast Cancer Screening among Korean Women

Anh Thi Ngoc Tran[1], **Ji Hae Hwang**[1], **Eunji Choi**[1], **Yun Yeong Lee**[2], **Mina Suh**[1,2], **Chan Wha Lee**[1,3], **Yeol Kim**[1,2,3], **Kui Son Choi**[1,2]

[1]National Cancer Center, Graduate School of Cancer Science and Policy, Goyang, [2]National Cancer Control Institute, National Cancer Center, Goyang, [3]Center for Cancer Prevention and Detection, National Cancer Center Hospital, National Cancer Center, Goyang, Korea

Purpose This study sought to examine perceived risk and concerns for breast cancer according to awareness of breast density and states thereof among Korea women and to identify the impact of such awareness on screening intentions.

Materials and Methods This study was based on the 2017 Korean National Cancer Screening Survey of a nationally representative and randomly selected sample of Koreans. Ordinal logistic regression was conducted to examine associations for awareness of and knowledge on breast density in relation to psychological factors. Multivariate logistic regression analyses were conducted to investigate significant factors associated with intentions to undergo breast cancer screening.

Results Among a total of 1,609 women aged 40-69 years, 62.0% were unaware of their breast density, and only 29.7% had good breast density knowledge. Awareness of one's breast density and knowledge about breast density were positively associated with perceptions of absolute and comparative risk and cancer worry. Women aware of their breast density (adjusted odds ratio [aOR], 1.35 for women aware of having a non-dense breast; aOR, 4.17 for women aware of having a dense breast) and women with a good level of breast density knowledge (aOR, 1.65) were more likely to undergo future breast cancer screening.

Conclusion Breast density awareness and knowledge showed positive associations with psychological factors and breast cancer screening intentions. However, the majority of Korean women were not aware of their breast density status and demonstrated poor knowledge about breast density. These results demonstrate a need for better health communication concerning breast density.

Key words Dense breast, Knowledge, Awareness, Perceived risks, Cancer worry, Screening

Introduction

Breast density is a measure of fibro-glandular to fatty tissue in the breast. Research has indicated that about 50% of women in their 40s have dense breasts [1], which, reportedly, increases the risk for breast cancer. Specifically, women with a dense area comprising 75% or more of the breast face a 4.6 times greater risk of breast cancer than women with a dense area smaller than 5% [2]. A highly dense breast may also lower the sensitivity of screening test to detect breast cancer, falling from 80% to 98% in less dense breasts to 30% to 64.4% in highly dense breasts [3]. Consequently, interval cancer rates are higher among women aged 50 to 74 years with extremely dense breasts or women aged 70 to 74 years with heterogeneously dense breasts [4]. Although the impact of higher breast density on breast cancer risk and mammographic masking is well known, previous studies have reported that the majority of women do not know their own breast density status and are not familiar with breast density [4-6].

With evidence of breast density as both an individual risk factor for breast cancer and a masking factor of mammographic examination, the United States mandates nationwide that women are to be informed of their breast density status [4,7,8]. This was initially implemented in an attempt to increase female awareness of the importance of breast density in breast cancer; however, others argued that it could elicit unnecessary psychological responses among women [9-11]. Research has shown that European American women who are aware of their breast density status have a stronger perception of breast cancer risk and worry, compared to those who were unaware. Yeh et al. [11] also documented increased perceived risk and worry about breast cancer among women after hearing about their breast density status from mammography tests. Psychological reactions, however, are not necessarily negative in that higher perceived risk and cancer worry might facilitate better screening behavior and drive intentions to undergo screening [12-16]. Indeed, some studies have reported that psychological reactions affected by awareness of breast density facilitated positive health behaviors [12,17,18]. Generally, a U-shaped relationship between psychological effect and favorable screening behaviors has been recognized [16].

Correspondence: Kui Son Choi
Graduate School of Cancer Science and Policy, National Cancer Center, 323 Ilsan-ro, Ilsandong-gu, Goyang 10408, Korea
Tel: 82-31-920-2912 Fax: 82-31-920-2189 E-mail: kschoi@ncc.re.kr
Received May 22, 2020 **Accepted** August 17, 2020 **Published Online** August 18, 2020

In South Korea, the National Cancer Screening Program for breast cancer was launched for women aged 40 years and older in 2002 [19]. Since 2007, women who have undergone breast cancer screening can learn their own breast density through the Breast Imaging-Reporting and Data System (BI-RADS) classification (4th edition) [20]. Meanwhile, however, studies have yet to examine the effects of becoming aware of one's breast density on psychological reactions, such as perceived risks and worry about breast cancer, among Korean women. Therefore, this study was conducted to assess degrees of perceived risk and cancer worry for breast cancer according to knowledge and awareness of one's own breast density status among Korean women. Finally, we investigated how awareness and knowledge of breast density could be related to intentions to undergo mammography screening.

Materials and Methods

1. Study population

Data were obtained from the 2017 Korean National Cancer Screening Survey (KNCSS), which is a nationwide cross-sectional survey designed to investigate screening rates among Korean men aged ≥ 40 years and women aged ≥ 30 years. Samples for the 2017 KNCSS were selected through stratified, multistage, and random sampling based on the 2017 Residence of Registration Population data. The survey was conducted from August 26 to September 29, 2017. There was a total of 4,000 participants from 15,907 random samples, with a response rate of 25.1%. Of all survey respondents, 1,609 women aged 40-69 years, who are eligible for breast cancer screening under the Korea National Cancer Screening Program (KNCSP), were finally included in the current study.

2. Measures

To assess whether women knew their own breast density status, two questions were asked: "Have you ever been informed of your breast density status through mammography test?". Women who answered "No" were considered as "Not know." Women who responded "Yes" were subsequently asked "Do you have a dense breast?" and classified as either "Dense" or "Non-dense." Depending on these questions, women were classified into three groups: (1) Yes, I have a high level of breast density (Dense); (2) Yes, I do not have a high level of breast density (Non-dense); and (3) No, I do not know my breast density status (Not know). Intentions to undergo breast cancer screening were assessed as having plans to undergo breast cancer screening within the next 2 years or not.

General knowledge about breast density was measured by the following two questions: The first questions was "Do you think breast density affects breast cancer detection in mammography screening?", to which respondents could choose one possible answer among (1) I do not know, (2) a higher breast density makes it easier to detect breast cancer, (3) no association, or (4) a higher breast density makes it difficult to detect breast cancer. The second question was "Does a higher breast density increase the risk for breast cancer?", with possible answers of "Yes" or "No." Women who answered both questions correctly were classified as having a "good level of knowledge on breast density," and the other women were classified as having a "poor level of knowledge on breast density."

Breast cancer worry specific to breast cancer was assessed via a five-point Likert scale question modified from Lerman's cancer worry scale [21,22]. We asked the participants, "How often do you worry about breast cancer?", to which the respondents could answer by choosing one of the five following items: (1) "never," (2) "rarely," (3) "sometimes," (4) "often," and (5) "always." The worry item used in our study refers to the frequency of thinking about breast cancer risk rather than the magnitude of breast cancer.

Perceived risk of developing breast cancer was assessed in absolute and comparative terms on a five-point Likert scale [23]. Perceived absolute risk was measured by the question, "How much of a possibility do you think you have of developing breast cancer in your lifetime?". Responses given were on a scale from 1 (No risk) to 5 (Very high risk). Perceived comparative risk was measured by asking, "Compared to other women of your age, how would you rate your risk of developing breast cancer?". Responses were given on a scale from 1 (Much lower) to 5 (Much higher).

Sociodemographic characteristics, including numerical age (divided into three groups: 40-49, 50-59, and 60-69 years), residential area (rural, urban, or metropolitan), monthly household income (< $3,000, $3,000-4,999, or ≥ $5,000), marital status (with a spouse or without a spouse), employment status, educational level (middle school graduate or lower, high school graduate, or college degree or higher), family history of cancer, and private cancer insurance status were collected.

3. Statistical analysis

A chi-squared test was conducted to observe differences in sociodemographic characteristics for the study participants according to awareness of their breast density. Means and standard deviations of perceived absolute risk, perceived comparative risk, and cancer worry for breast cancer were calculated, and the mean levels of these psychological factors were tested by one-way ANOVA. We also used the chi-squared test to document differences in the percentage

Table 1. Baseline characteristics of the study participants according to awareness of breast density, KNCSS 2017, Korea

Characteristic	Total	Awareness of density status		p-value	aOR (95% CI)
		Yes	No		
Total	1,609 (100)	612 (38.0)	997 (62.0)		
Age (yr)					
40-49	609 (37.9)	265 (43.4)	344 (34.5)	< 0.001	1.00
50-59	596 (37.0)	233 (38.0)	363 (36.4)		0.95 (0.74-1.21)
60-69	404 (25.1)	114 (18.6)	290 (29.1)		0.74 (0.54-1.03)
Region					
Rural	169 (10.5)	50 (8.2)	119 (11.9)	0.047	1.00
Urban	704 (43.8)	269 (43.9)	435 (43.6)		1.22 (0.84-1.78)
Metropolitan	736 (45.7)	293 (47.9)	443 (44.5)		1.24 (0.85-1.82)
Monthly household income ($)					
< 3,000	300 (18.6)	84 (13.7)	216 (21.7)	< 0.001	1.00
3,000-4,999	922 (57.3)	344 (56.2)	578 (58.0)		1.07 (0.77-1.49)
≥ 5,000	387 (24.1)	184 (30.1)	203 (20.3)		1.40 (0.96-2.03)
Educational level					
Middle graduate or lower	238 (14.8)	56 (9.2)	182 (18.2)	< 0.001	1.00
High school graduate	932 (57.9)	344 (56.2)	588 (59.0)		1.45 (0.99-2.11)
College degree or higher	439 (27.3)	212 (34.6)	227 (22.8)		2.05 (1.33-3.16)
Marital status					
With spouse	1,537 (95.5)	589 (96.2)	948 (95.1)	0.276	1.00
Without spouse	72 (4.5)	23 (3.8)	49 (4.9)		1.00 (0.58-1.71)
Family history of cancer					
No	1,278 (79.5)	488 (79.7)	790 (79.2)	0.809	1.00
Yes	331 (20.5)	124 (20.3)	207 (20.8)		1.00 (0.58-1.70)
Private cancer insurance					
No	188 (11.7)	53 (8.7)	135 (13.6)	0.003	1.00
Yes	1,421 (88.3)	559 (91.3)	862 (86.4)		1.16 (0.81-1.67)
Breast cancer screening history within the past 2 years					
No	572 (35.5)	174 (28.4)	398 (39.9)	< 0.001	1.00
Yes	1,037 (64.5)	438 (71.6)	599 (60.1)		1.63 (1.30-2.03)

Values are presented as number (%). aOR, adjusted odds ratio; CI, confidence interval; KNCSS, Korean National Cancer Screening Survey.

of those with breast density awareness and intentions to undergo screening within the next 2 years.

Ordinal logistic regression was conducted to identify factors associated with levels of perceived absolute risk, perceived comparative risk, and cancer worry. We also applied multivariate logistic regression models to investigate factors associated with screening intentions. Model 1 included the study participants' general characteristics and only perceived absolute risk, comparative risk, and breast cancer worry variables. Model 2 included the study participants' general characteristics, awareness of one's breast density, and breast density knowledge variables to eliminate multicollinearity between those factors. Model 3 included all covariates to estimate which factors contribute the most to women's intentions to undergo breast cancer screening. Statistical analyses were performed with STATA software (ver. 13, Stata Corp LP, College Station, TX), and $p < 0.05$ were considered statistically significant for all analyses.

Results

The sociodemographic characteristics of the study population are summarized according to awareness of breast density status in Table 1. Among the respondents, 62.0% answered that they did not know their breast density status. Women in their 60s, living in a rural area, with lower income and education level, without private health insurance, and no history of

Table 2. Responses and knowledge of breast density status according to breast density awareness

	Total	Awareness of density status			p-value
		Dense	Non-dense	Not know	
Total	1,609 (100)	343 (21.3)	269 (16.7)	997 (62.0)	
Knowledge on mammographic sensitivity					
High breast density lowers sensitivity	614 (38.2)	241 (70.3)	114 (42.4)	259 (26.0)	< 0.001
No association	211 (13.1)	22 (6.4)	47 (17.5)	142 (14.2)	
High breast density increases sensitivity	296 (18.4)	62 (18.1)	67 (24.9)	167 (16.8)	
I do not know	488 (30.3)	18 (5.3)	41 (15.2)	429 (43.0)	
Knowledge on breast cancer risk					
High breast density increases risk	1,037 (64.4)	241 (70.3)	185 (68.8)	611 (61.3)	< 0.001
High breast density decreases risk	572 (35.6)	102 (29.7)	84 (31.2)	386 (38.7)	
Breast density knowledge[a]					
Poor	1,131 (70.3)	173 (50.4)	176 (65.4)	782 (78.4)	< 0.001
Good	478 (29.7)	170 (49.6)	93 (34.6)	215 (21.6)	
Information sources on dense breast[b]					
TV, radio, electronic way	253 (15.7)	92 (26.8)	50 (18.6)	111 (11.1)	
Newspaper, book, etc.	139 (8.6)	67 (19.5)	26 (9.7)	46 (4.6)	
Internet	52 (3.2)	22 (6.4)	10 (3.7)	20 (2.0)	
Family or acquaintances	349 (21.7)	112 (32.7)	113 (42.0)	124 (12.4)	
Hospital or clinic	432 (26.9)	203 (59.2)	121 (45.0)	108 (10.8)	
Others	4 (0.3)	4 (1.2)	0	0	

Values are presented as number (%). [a]Good, women answered correctly for both knowledge questions; Poor, women answered at least one question wrong, [b]Percentage of study participants using the information source.

breast cancer screening within the past 2 years demonstrated less awareness of breast density. Women who were college graduates (adjusted odds ratio [aOR], 2.05; 95% confidence interval [CI], 1.33 to 3.16) or underwent breast cancer screening within the past 2 years (aOR, 1.63; 95% CI, 1.30 to 2.03) were more likely to be aware of their breast density status.

Breast density knowledge among Korean women is summarized in Table 2. Only 38.2% of women correctly answered that high breast density lowers mammographic sensitivity, and 64.4% of them correctly answered that high breast density increases breast cancer risk. The proportion of women who correctly answered both questions, who were categorized as having a good level of breast density knowledge, was 29.7% (Table 2). Of note, the proportion of women correctly responding to the breast density-related knowledge questions was significantly higher among those who knew that they had dense breasts. Concerning the information resources where women collected breast density knowledge, half of the women received information from hospitals or clinics.

Scores for perceived absolute risk, perceived comparative risk, and cancer worry about breast cancer are summarized in Table 3. Women aged 50-59 years, having higher socioeconomic status, who completed college education or higher, who had a family history of cancer, had breast density awareness, and a good level of breast density knowledge showed a significantly higher level of perceived risk and worry (Table 3).

In the ordinal regression analysis, women who were aware of their dense breast status were more likely to have higher perceived absolute risk, perceived comparative risk, and cancer worry (Table 4). Notably, women who were aware of their high dense breast had perceived risk and cancer worry scores three times higher than their counterparts. Further, women with a good level of knowledge on breast density reported a significantly higher level of perceived absolute risk (aOR, 1.82; 95% CI, 1.46 to 2.28), perceived comparative risk (aOR, 1.50; 95% CI, 1.19 to 1.89), and cancer worry (aOR, 1.75; 95% CI, 1.41 to 2.19). In general, women with moderate and high monthly household income (≥ $3,000) and with a family history of cancer showed a higher level of perceived risk and cancer worry. Interestingly, women who had private cancer insurance showed a lower level of perceived comparative risk and cancer worry. In contrast, women who had graduated high school or more were more likely to have higher perceived absolute risk.

Among respondents, 61.8% of women reported that they had intentions to undergo breast cancer screening (Table 5). The proportion thereof was significantly higher among women with the highest level of household income, private

Table 3. Mean and SD values of perceived absolute and comparative risk and cancer worry

	Perceived absolute risk		Perceived comparative risk		Breast cancer worry	
	Mean±SD	p-value	Mean±SD	p-value	Mean±SD	p-value
Total	2.86±0.72		2.83±0.69		2.70±0.78	
Age (yr)						
40-49	2.88±0.70	< 0.001	2.84±0.68	0.008	2.70±0.78	0.056
50-59	2.91±0.73		2.87±0.70		2.76±0.78	
60-69	2.73±0.69		2.72±0.66		2.58±0.74	
Region						
Rural	2.67±0.79	0.001	2.66±0.79	< 0.001	2.45±0.79	< 0.001
Urban	2.85±0.74		2.79±0.71		2.71±0.79	
Metropolitan	2.90±0.66		2.88±0.62		2.74±0.74	
Monthly household income ($)						
< 3,000	2.60±0.62	< 0.001	2.66±0.61	< 0.001	2.48±0.71	< 0.001
3,000-4,999	2.88±0.75		2.83±0.71		2.69±0.79	
≥ 5,000	2.99±0.63		2.92±0.65		2.87±0.73	
Educational level						
Middle graduate or lower	2.58±0.69	< 0.001	2.65±0.68	< 0.001	2.47±0.76	< 0.001
High school graduate	2.85±0.71		2.81±0.68		2.70±0.74	
College degree or higher	3.02±0.69		2.93±0.67		2.79±0.81	
Marital status						
With spouse	2.86±0.71	0.074	2.82±0.68	0.930	2.70±0.77	0.060
Without spouse	2.70±0.75		2.83±0.67		2.52±0.83	
Family history of cancer						
No	2.82±0.70	< 0.001	2.79±0.67	< 0.001	2.66±0.78	< 0.001
Yes	3.00±0.74		2.94±0.72		2.82±0.74	
Private cancer insurance						
No	2.79±0.72	0.161	2.82±0.70	0.940	2.68±0.69	0.745
Yes	2.86±0.71		2.82±0.68		2.70±0.78	
Breast cancer screening history within the past 2 years						
No	2.80±0.71	0.020	2.80±0.66	0.333	2.63±0.7	0.021
Yes	2.89±0.71		2.83±0.69		2.73±0.8	
Awareness of density status						
Not-know	2.73±0.65	< 0.001	2.70±0.62	< 0.001	2.52±0.69	< 0.001
Non-dense	2.86±0.62		2.84±0.63		2.81±0.71	
Dense	3.21±0.82		3.15±0.79		3.10±0.86	
Breast density knowledge[a)]						
Poor	2.76±0.68	< 0.001	2.75±0.67	< 0.001	2.59±0.75	< 0.001
Good	3.09±0.73		2.99±0.69		2.94±0.77	

SD, standard deviation. [a)]Good, women answered correctly for both knowledge questions; Poor, women answered at least one question wrong.

cancer insurance, a family history of cancer, and a college education. Moreover, women with a high/very high level of perceived absolute risk and perceived comparative risk and with an often/always level of cancer worry were more likely to express intentions to undergo breast cancer screening, as were women with a dense breast and a good level of knowledge on breast cancer. The results from the three multiple logistic regression models are provided in Table 5. In model 1, women who had a high or very high level of perceived comparative risk (aOR, 1.82; 95% CI, 1.09 to 3.03) and who often or always worried about developing cancer (aOR, 1.85; 95% CI, 1.14 to 3.01) were more likely to undergo breast

Table 4. Ordinal logistic analysis of factors associated with perceived absolute risk, perceived comparative risk, and cancer worry

	Perceived absolute risk	Perceived comparative risk	Cancer worry
Age (yr)			
40-49	1.00	1.00	1.00
50-59	1.29 (1.02-1.62)	1.18 (0.93-1.50)	1.20 (0.96-1.51)
60-69	1.29 (0.96-1.73)	1.01 (0.75-1.37)	1.05 (0.78-1.40)
Region			
Rural	1.00	1.00	1.00
Urban	1.20 (0.85-1.69)	1.21 (0.85-1.70)	1.45 (1.04-2.03)
Metropolitan	1.31 (0.93-1.85)	1.49 (1.05-2.10)	1.50 (1.08-2.10)
Monthly household income ($)			
< 3,000	1.00	1.00	1.00
3,000-4,999	1.71 (1.28-2.28)	1.32 (0.99-1.77)	1.36 (1.02-1.81)
≥ 5,000	1.91 (1.36-2.66)	1.52 (1.08-2.15)	1.85 (1.32-2.58)
Educational level			
Middle graduate or lower	1.00	1.00	1.00
High school graduate	1.65 (1.19-2.29)	1.30 (0.94-1.81)	1.46 (1.06-2.02)
College degree or higher	2.18 (1.48-3.21)	1.52 (1.03-2.25)	1.39 (0.95-2.04)
Family history of cancer			
No	1.00	1.00	1.00
Yes	1.49 (1.17-1.90)	1.53 (1.19-1.96)	1.41 (1.11-1.78)
Private cancer insurance			
No	1.00	1.00	1.00
Yes	0.74 (0.54-1.02)	0.64 (0.46-0.89)	0.67 (0.49-0.91)
Breast cancer screening history within the past 2 years			
No	1.00	1.00	1.00
Yes	1.00 (0.82-1.23)	0.88 (0.71-1.09)	0.98 (0.81-1.20)
Awareness of density status			
Not know	1.00	1.00	1.00
Non-dense	1.26 (0.97-1.64)	1.34 (1.02-1.76)	1.88 (1.45-2.45)
Dense	3.23 (2.47-4.22)	3.68 (2.77-4.88)	3.96 (3.03-5.17)
Knowledge of breast density[a)]			
Poor	1.00	1.00	1.00
Good	1.82 (1.46-2.28)	1.50 (1.19-1.89)	1.75 (1.41-2.19)

[a)]Good, women answered correctly for both knowledge questions; Poor, women answered at least one question wrong.

cancer screening in the next 2 years. Perceived absolute risk showed no significant association with breast cancer screening intentions. In model 2, women who knew their breast density status were more likely to have screening intentions, especially those with dense breasts who 4.66 times more frequently reported having screening intentions (aOR, 4.66; 95% CI, 3.28 to 6.63 for dense breast women). Also, women who had a good level of knowledge of breast density were more likely to have intentions to undergo breast cancer screening (aOR, 1.68; 95% CI, 1.28 to 2.19). In model 3, the full model, women with highly dense breasts (aOR, 4.17; 95% CI, 2.89 to 6.02) and with a higher level of knowledge on breast density (aOR, 1.65; 95% CI, 1.26 to 2.16) were significantly more likely to have intentions to undergo breast cancer screening. Women with private cancer insurance and a history of breast cancer screening within the past 2 years also more frequently reported having intentions to undergo breast cancer screening. Psychological measures, however, were no longer significant in Model 3.

Discussion

In this study, we conducted a cross-sectional survey to assess awareness and knowledge of breast density among Korean women and the impacts thereof on psychological

Table 5. Multivariate logistic analysis of factors associated with intentions to undergo mammography screening

	Intention to undergo breast cancer screening in the next 2 years, n (%)			Model 1	Model 2	Model 3
	Yes	No	p-value	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Total	994 (61.8)	615 (38.2)				
Age (yr)						
40-49	385 (38.7)	224 (36.4)	< 0.001	1.00	1.00	1.00
50-59	405 (40.7)	191 (31.1)		1.26 (0.97-1.65)	1.33 (1.01-1.75)	1.32 (1.01-1.74)
60-69	204 (20.6)	200 (32.5)		0.64 (0.47-0.89)	0.68 (0.48-0.95)	0.67 (0.48-0.94)
Region						
Rural	100 (10.1)	69 (11.2)	0.692	1.00	1.00	1.00
Urban	433 (43.6)	271 (44.1)		0.94 (0.65-1.37)	0.89 (0.60-1.28)	0.88 (0.60-1.29)
Metropolitan	461 (46.3)	275 (44.7)		0.96 (0.66-1.39)	0.89 (0.61-1.31)	0.89 (0.61-1.30)
Monthly household income ($)						
< 3,000	160 (16.1)	140 (22.8)	< 0.001	1.00	1.00	1.00
3,000-4,999	551 (55.4)	371 (60.3)		0.92 (0.67-1.27)	0.97 (0.70-1.34)	0.95 (0.69-1.32)
≥ 5,000	283 (28.5)	104 (16.9)		1.42 (0.97-2.09)	1.48 (1.00-2.19)	1.44 (0.97-2.14)
Educational level						
Middle graduate or lower	130 (13.1)	108 (17.6)	< 0.001	1.00	1.00	1.00
High school graduate	566 (56.9)	366 (59.5)		0.77 (0.54-1.11)	0.74 (0.52-1.07)	0.74 (0.51-1.06)
College degree or higher	298 (30.0)	141 (22.9)		0.91 (0.59-1.41)	0.79 (0.51-1.22)	0.78 (0.50-1.22)
Marital status						
With spouse	956 (96.2)	581 (94.5)	0.108	1.00	1.00	1.00
Without spouse	38 (3.8)	34 (5.5)		0.88 (0.50-1.43)	0.88 (0.52-1.51)	0.87 (0.51-1.50)
Family history of cancer						
No	776 (78.1)	502 (81.6)	0.086	1.00	1.00	1.00
Yes	218 (21.9)	113 (18.4)		1.14 (0.87-1.50)	1.13 (0.86-1.50)	1.10 (0.83-1.47)
Private cancer insurance						
No	88 (8.9)	100 (16.3)	< 0.001	1.00	1.00	1.00
Yes	906 (91.1)	515 (83.7)		1.82 (1.29-2.59)	1.55 (1.09-2.21)	1.60 (1.12-2.29)
Breast cancer screening history within the past 2 years						
No	255 (25.7)	317 (51.5)	< 0.001	1.00	1.00	1.00
Yes	739 (74.3)	298 (48.5)		2.97 (2.38-3.70)	2.70 (2.15-3.39)	2.70 (2.14-3.40)
Perceived absolute risk						
Moderate or below	792 (79.7)	549 (89.3)	< 0.001	1.00	-	1.00
High or very high	202 (20.3)	66 (10.7)		1.09 (0.72-1.66)	-	0.87 (0.56-1.35)
Perceived comparative risk						
Moderate or below	833 (83.8)	575 (93.5)	< 0.001	1.00	-	1.00
High or very high	161 (16.2)	40 (6.5)		1.82 (1.09-3.03)	-	1.46 (0.85-2.51)
Cancer worry						
Rarely or never	350 (35.2)	276 (44.9)	< 0.001	1.00	-	1.00
Sometime	475 (47.8)	299 (48.6)		1.11 (0.88-1.41)	-	1.05 (0.83-1.34)
Often or always	169 (17.0)	40 (6.5)		1.85 (1.14-3.01)	-	1.30 (0.78-2.19)
Awareness of density status						
Not know	523 (52.6)	474 (77.0)	< 0.001	-	1.00	1.00
Non-dense	174 (17.5)	95 (15.5)		-	1.40 (1.04-1.88)	1.35 (1.00-1.83)
Dense	297 (29.9)	46 (7.5)		-	4.66 (3.28-6.63)	4.17 (2.89-6.02)
Breast density knowledge						
Poor	628 (63.2)	503 (81.8)	< 0.001	-	1.00	1.00
Good	366 (36.8)	112 (18.2)		-	1.68 (1.28-2.19)	1.65 (1.26-2.16)

aOR, adjusted odds ratio; CI, confidence interval.

responses and intentions for future breast cancer screening. We discovered that only 38% of women were aware of their breast density status and that only 29.7% had a good level of knowledge on breast density (e.g., the masking effect of breast density on mammography test results and associations with breast cancer risk). Our results indicated that having awareness about one's breast density status and having a good level of knowledge on breast density significantly increases perceived risk of and concerns for developing breast cancer by as much as 1.5-4 times. Furthermore, our results suggested that such psychological responses and breast density-related cognition boosted intentions to attend future screening tests.

Interestingly, ordinal regression analysis in this study revealed a significant association for awareness of breast density status with a higher level of perceived absolute and comparative risk and worry about breast cancer. Scores for these psychological reactions were significantly higher among women who reported that they had dense breasts. Additionally, perceived risk and cancer worry were significantly higher among women with a good level of knowledge on breast density. This trend was similar to that in previous studies showing that after informing women of their breast density status, they tended to show increased anxiety or psychological responses [12,13,17,18,24]. To be specific, Manning et al. reported that in a group of European American women, discovery of breast density status led to a higher perceived risk of developing breast cancer [10,11]. Another study conducted in Santiago indicated that after being informed of breast density status, perceived risk of breast cancer increased [11]. However, the opposite was observed among African American women with dense breasts who perceived themselves to be at lower risk, which could possibly be explained by race differences [10].

We also examined characteristics associated with differences in perceived risk and cancer worry. We discovered that Korean women aged 50-59 years of higher household economic status with a family history of cancer were more likely to have higher perceived risks of and greater concerns for developing breast cancer, as in previous studies [12,17]. Meanwhile, women with a high school education or greater were likely to have a higher perceived risk of developing breast cancer in their lifetime but were not greatly worried about developing cancer. Although the effect of perceived risk on screening intentions among women has remained somewhat unclear, it has been thought to be a facilitator for cancer screening attendance [11-13,25]. Our study demonstrated that intentions to undergo breast cancer screening were significantly greater among women with a high or very high perceived comparative risk. Meanwhile, concerns for developing breast cancer also had a positive impact on screening intentions, which is consistent with previous findings on perceived risk and worry in relation to screening behaviors [12,13,16].

Overall, we found that awareness and knowledge of breast density significantly boosted intentions to undergo screening within the next 2 years, consistent with a previous study in the United States [11]. This suggests that providing knowledge of a woman's actual breast density status, as well as information on what effects breast density has, might positively influence screening intentions and might help promote an active role in decision-making processes to prevent breast cancer [10]. Notably, women with dense breasts had an odds ratio for intending to undergo future screening about four times higher than that in women without dense breasts or those not aware of their breast density status. This can be explained by the fact that women with dense breasts likely received much better explanations about their breast status and that the greater risk of developing breast cancer posed by a denser breast might have strengthened intentions to undergo breast cancer screening.

The prevalence of dense breasts among Asian women, including Korean women, is high, precisely 54.5% of Korean women aged 40-69 years, which is significantly higher than that in Western countries [20]. However, previous studies have reported that only a small proportion of Korean women get to know their own breast density status [10,11]: although women who have undergone mammographic screening through the NCSP are to be informed of their breast density status since 2007, the percentage of women who aware of their breast density status is only 38.2%. Moreover, as noted in the current study, women exhibited a lack of knowledge of the effects of a dense breast on mammographic sensitivity. Knowledge of these effects was especially low among women who did not know the density of their breasts. The majority of women who did know the density of their breasts had acquired knowledge on breast density from medical staff, while the other women had acquired information from their family members and acquaintances. This reflects the importance of a health professional in helping women understand breast density and the need for an efficient route for disseminating information on breast density to Korean women.

While a dense breast is considered a significant risk factor for breast cancer, there are some concerns as to which methods for classifying density are suitable for screening. The BI-RADS classification is the most widely used method for assessing mammographic density; however, its assessment is based on a qualitative method and is less effective than other methods, such as Cumulus [26]. In BI-RADS classification, the upper two classes reflective of a "dense" breast tend to show lower sensitivity in breast cancer screening and to increase the risk of false-negative mammography results,

especially in older women [3]. This limitation imposes a need for high inter-radiologist agreement and more experienced and well-skilled radiologists in mammography reading [20]. Cumulus, a semi-automated thresholding method regarded as a gold standard, was developed to improve reproducibility and has a well-established relationship with cancer risk [27,28]. However, this method also requires trained observers, and the best threshold for separating dense tissue from fat is unclear [27]. Therefore, understanding the limitations of mammographic density measurements is essential when assessing the risk of breast cancer. More objective and quantitative breast density measures, combined with digital radiographic systems for mammography, should be implemented.

One of the strengths of our study is that it is the first study to describe an interrelated association between breast density awareness, breast density knowledge, and screening intentions among Korean women. Our findings can be generalized to Korean women aged 40 years and older, as the study samples were nationally representative. Despite these strengths, our study still has several limitations that should be considered. First, due to the nature of the cross-sectional study design, the ability to deduce causal relationships from the observed associations may be limited. Further studies with a qualitative or longitudinal design are recommended. Second, because the study data were obtained using a self-reported questionnaire, information bias may be present, and participants could have missed information related to their breast density awareness. Third, breast density information based on BI-RADS classification may be inaccurate due to low sensitivity and specificity of mammographic screening in Korea. Despite these limitations, notification of mammographic results indicating the presence of dense breasts would be of utmost importance, allowing clinicians to make prompt decisions or guidelines for women with high breast density, including suggesting them to undergo supplementary tests. In the long run, further study will be needed to determine whether giving an individual information on their breast density leads to reductions in the mortality rate of breast cancer.

In this study, we discovered positive associations for breast density awareness and knowledge with psychological reactions and screening intentions among Korean women. Currently, a large proportion of Korean women lack awareness of the density of their breasts and knowledge of the impact of breast density on breast cancer risk and detection. To encourage favorable screening behaviors, improvement of breast density, and knowledge through effective health communication between health professionals and women is recommended.

Ethical Statement

This study was approved by the IRB of the National Cancer Center, Korea (approval number: NCCNCS-08-129). The study subjects were asked to provide informed consent, and only those who agreed were able to participate in the survey.

Author Contributions

Conceived and designed the analysis: Tran AT, Suh M, Kim Y, Choi KS.
Collected the data: Hwang JH, Choi E, Lee YY.
Contributed data or analysis tools: Suh M, Lee CW, Kim Y, Choi KS.
Performed the analysis: Tran AT, Choi E.
Wrote the paper: Tran AT, Choi KS.

Conflicts of Interest

Conflicts of interest relevant to this article was not reported.

Acknowledgments

This study was supported by a Grant-in-Aid for Cancer Research and Control from the National Cancer Center of Korea (#1910231). We appreciate the International Cooperation & Education Program (NCCRI·NCCI 52210-52211, 2020) of National Cancer Center, Korea for supporting the education and training of Anh Thi Ngoc Tran.

References

1. Kerlikowske K, Gard CC, Sprague BL, Tice JA, Miglioretti DL; Breast Cancer Surveillance Consortium. One versus two breast density measures to predict 5- and 10-year breast cancer risk. Cancer Epidemiol Biomarkers Prev. 2015;24:889-97.
2. Pettersson A, Graff RE, Ursin G, Santos Silva ID, McCormack V, Baglietto L, et al. Mammographic density phenotypes and risk of breast cancer: a meta-analysis. J Natl Cancer Inst. 2014;106:dju078.
3. Al Mousa DS, Ryan EA, Mello-Thoms C, Brennan PC. What effect does mammographic breast density have on lesion detection in digital mammography? Clin Radiol. 2014;69:333-41.
4. Santiago-Rivas M, Benjamin S, Jandorf L. Breast density knowledge and awareness: a review of literature. J Prim Care Community Health. 2016;7:207-14.
5. Manning MA, Duric N, Littrup P, Bey-Knight L, Penner L, Albrecht TL. Knowledge of breast density and awareness of related breast cancer risk. J Cancer Educ. 2013;28:270-4.
6. Rhodes DJ, Radecki Breitkopf C, Ziegenfuss JY, Jenkins SM, Vachon CM. Awareness of breast density and its impact on breast cancer detection and risk. J Clin Oncol. 2015;33:1143-50.
7. Manning M, Albrecht TL, Yilmaz-Saab Z, Penner L, Norman

A, Purrington K. Explaining between-race differences in African-American and European-American women's responses to breast density notification. Soc Sci Med. 2017;195:149-58.
8. Santiago-Rivas M, Benjamin S, Andrews JZ, Jandorf L. Breast density awareness and knowledge, and intentions for breast cancer screening in a diverse sample of women age eligible for mammography. J Cancer Educ. 2019;34:90-7.
9. Ho N, Kim J, Prasad V. Dense breasts and legislating medicine. Cleve Clin J Med. 2013;80:768-70.
10. Manning M, Albrecht TL, Yilmaz-Saab Z, Shultz J, Purrington K. Influences of race and breast density on related cognitive and emotion outcomes before mandated breast density notification. Soc Sci Med. 2016;169:171-9.
11. Yeh VM, Schnur JB, Margolies L, Montgomery GH. Dense breast tissue notification: impact on women's perceived risk, anxiety, and intentions for future breast cancer screening. J Am Coll Radiol. 2015;12:261-6.
12. Orom H, Kiviniemi MT, Shavers VL, Ross L, Underwood W 3rd. Perceived risk for breast cancer and its relationship to mammography in Blacks, Hispanics, and Whites. J Behav Med. 2013;36:466-76.
13. Consedine NS, Magai C, Krivoshekova YS, Ryzewicz L, Neugut AI. Fear, anxiety, worry, and breast cancer screening behavior: a critical review. Cancer Epidemiol Biomarkers Prev. 2004;13:501-10.
14. Ho SS, Choi KC, Wong CL, Chan CW, Chan HY, Tang WP, et al. Uptake of breast screening and associated factors among Hong Kong women aged ≥50 years: a population-based survey. Public Health. 2014;128:1009-16.
15. Choi E, Lee YY, Yoon HJ, Lee S, Suh M, Park B, et al. Relationship between cancer worry and stages of adoption for breast cancer screening among Korean women. PLoS One. 2015;10:e0132351.
16. Hay JL, McCaul KD, Magnan RE. Does worry about breast cancer predict screening behaviors? A meta-analysis of the prospective evidence. Prev Med. 2006;42:401-8.
17. Robb KA, Miles A, Wardle J. Demographic and psychosocial factors associated with perceived risk for colorectal cancer. Cancer Epidemiol Biomarkers Prev. 2004;13:366-72.
18. Rogers RW, Mewborn CR. Fear appeals and attitude change: effects of a threat's noxiousness, probability of occurrence, and the efficacy of coping responses. J Pers Soc Psychol. 1976;34:54-61.
19. Kim Y, Jun JK, Choi KS, Lee HY, Park EC. Overview of the National Cancer screening programme and the cancer screening status in Korea. Asian Pac J Cancer Prev. 2011;12:725-30.
20. Jo HM, Lee EH, Ko K, Kang BJ, Cha JH, Yi A, et al. Prevalence of women with dense breasts in Korea: results from a nationwide cross-sectional study. Cancer Res Treat. 2019;51:1295-301.
21. Lerman C, Trock B, Rimer BK, Boyce A, Jepson C, Engstrom PF. Psychological and behavioral implications of abnormal mammograms. Ann Intern Med. 1991;114:657-61.
22. Lerman C, Trock B, Rimer BK, Jepson C, Brody D, Boyce A. Psychological side effects of breast cancer screening. Health Psychol. 1991;10:259-67.
23. Vernon SW, Myers RE, Tilley BC. Development and validation of an instrument to measure factors related to colorectal cancer screening adherence. Cancer Epidemiol Biomarkers Prev. 1997;6:825-32.
24. McQueen A, Vernon SW, Meissner HI, Rakowski W. Risk perceptions and worry about cancer: does gender make a difference? J Health Commun. 2008;13:56-79.
25. Shiryazdi SM, Kholasehzadeh G, Neamatzadeh H, Kargar S. Health beliefs and breast cancer screening behaviors among Iranian female health workers. Asian Pac J Cancer Prev. 2014;15:9817-22.
26. Sak MA, Littrup PJ, Duric N, Mullooly M, Sherman ME, Gierach GL. Current and future methods for measuring breast density: a brief comparative review. Breast Cancer Manag. 2015;4:209-21.
27. Eng A, Gallant Z, Shepherd J, McCormack V, Li J, Dowsett M, et al. Digital mammographic density and breast cancer risk: a case-control study of six alternative density assessment methods. Breast Cancer Res. 2014;16:439.
28. Boyd NF, Byng JW, Jong RA, Fishell EK, Little LE, Miller AB, et al. Quantitative classification of mammographic densities and breast cancer risk: results from the Canadian National Breast Screening Study. J Natl Cancer Inst. 1995;87:670-5.