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Body mass index, breast density, and the risk of breast cancer development in relation to the menopausal status; results from a population-based screening program in a native African-Arab country

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Abstract

Background: Risk factors are traits or behaviors that have an influence on the development of breast cancer (BC). Awareness of the prevalent risk factors can guide in developing prevention interventions.

Purpose: To evaluate the correlation between the breast density, body mass index, and the risk of breast cancer development in relation to the menopausal status in a native African-Arab population.

Material and methods: The study included 30,443 screened females who were classified into cancer and non-cancer groups and each group was further sub-classified into pre- and postmenopausal groups. The breast density (BD) was reported and subjectively classified according to the 2013 ACR BI-RADS breast density classification. The weight and height were measured, and the body mass index (BMI) was calculated and classified according to the WHO BMI classification.

Results: A statistically significant difference was calculated between the mean BMI in the cancer and non-cancer groups (p: .027) as well as between the pre- and postmenopausal groups ($p < .001$). A positive statistically insignificant correlation was calculated between the breast density and the risk of breast cancer in the premenopausal group (OR: 1.062, p: .919) and a negative highly significant correlation was calculated in the postmenopausal group (OR: 0.234, $p < .001$).

Conclusion: BMI and BD are inversely associated with each other. The current studied population presented unique ethnic characteristics, where a decreased BD and an increased BMI were found to be independent risk factors for developing breast cancer.

Keywords

Breast cancer risk factors, breast density, body mass index, breast cancer

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Introduction

Despite the recent advances in the detection and management of breast cancer (BC), the incidence rate is rising.[1] This means that there is a great need to find alternative ways to reduce BC. This might be achieved through applying

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prevention protocols and through confronting some risk factors (RFs).[2]

RFs are traits or behaviors that have an influence on the development of BC and they can make some individuals more susceptible. The RFs for developing BC are comparable across all regions of the world. However, their prevalence and their genuine impact can vary remarkably from one region to the other. Awareness of the prevalent RFs can guide in developing prevention interventions. Many women may have multiple risk factors; some of which are confounders and some of which are synergistic. Increased body mass (BMI) index and breast density (BD) are two of the most prevalent RFs for breast cancer although they are inversely related.[3–5]

An increased BMI is considered an important modifiable risk factor for the development of BC. There is no comprehensive universal agreement on the relationship between BMI and BC.[6–8] The results of the observational studies that have examined the correlation between the BMI and BC are contradictory. Some researchers believe that an increased BMI may increase the risk of BC development in the pre- and postmenopausal periods[9–11] whereas others assert that an increased BMI may reduce the risk of BC during premenopausal period and increases it in the postmenopausal period.[12–14] Other researchers have suggested that the geographical site or some genetic factors may influence the relationship between BMI and BC.[15,16]

BD refers to the amount of epithelial and connective tissue stromal tissue elements compared with the amount of adipose tissue within the breast.[17] According to published literature, increased BD is considered an independent RF for BC[18,19] In addition to its impact on breast cancer risk, BD reduces the accuracy of mammography resulting in an increased number of interval BC.[17]

Most published literature assess the impact of BD and BMI on the development of BC individually, yet only a few investigators have focused on how these inversely related RFs interact and whether this interaction is affected by the woman's menopausal status or not.[20–22] The majority of these studies have been carried among white women or among American African population. To our knowledge, no similar studies have been performed on any native African or Arab female population. In both the Arab and African female population, BC exhibits unique epidemiological features which differ from those described in Western countries. The median age at presentation is one decade younger than in Europe and North America and the patients are mainly premenopausal. Tumors are comparatively advanced at presentation. However, these unique features have not been thoroughly investigated raising concerns about the impact of exposure to the different RFs.[23,24]

In this work, we studied the complex relationship between the BMI and BD as RFs for developing BC in relation to the menopausal status in a native African-Arab screened female population.

Material and methods

This retrospective analytical case-control study included 30, 433 asymptomatic Egyptian women who underwent routine screening mammography at the Egyptian National Breast Cancer Screening Program: "The Women's Health Outreach Program" during the study period. Women with symptomatic breast cancer or beyond the legible age for screening (40 years) were excluded as they were exempted from the screening program.

The epidemiologic data were obtained on the same visit of the screening mammogram by a face-to-face interview of the participants with the administration staff and the technologists. Epidemiologic data included the participants' age, residence, phone number, age at menarche, age at menopause, parity, lactational history, history of hormonal intake, past history and family history of breast cancer. Based on the epidemiologic data, we stratified the participants according to their menopausal status into pre- and postmenopausal groups.

Anthropometric measurements were computed on the same visit of the mammography screening. The height (in cm) and weight (in kg) were measured by the technologist using a Stadiometer with a fixed scale. The BMI was then calculated (the weight divided by the height squared) and the participants were then classified according to the World Health Organization Classification of BMI.[24,25] For statistical analysis, we grouped the BMI into normal/underweight (<25) and overweight/obese (≥25) subgroups.

Assessment of the breast density on mammograms was performed by two blinded readers with different experience levels. If the two readers gave discordant results, a third independent reader was brought in. BD was subjectively assessed by estimating the proportion of fibro glandular tissue in the breast, relative to fat. BD was classified using the American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) Breast Density Classification (A: fatty, B: scattered density, C: heterogeneously dense, and D: extremely dense).[26] For statistical analysis, we grouped the BD into predominantly fatty (A and B) and predominantly dense (C and D) subgroups.

Collected data was fed to a comprehensive structured report and was exported to a statistical program (IBM, Statistical Package for Social Sciences (SPSS) software version 21.0, IBM Corp., Chicago, USA, 2013).

Descriptive statistics were done for quantitative parametric data as mean ± SD (standard deviation), and for qualitative data as number and percentage. Inferential analyses were performed for quantitative variables using independent t-test. For qualitative data, inferential analyses of

Table 1. Cross tab showing the number and percentage of the female participants in the two body mass index groups in both cancer and non-cancer groups as regards their menopausal status.

Menopausal status	Body mass index		Cancer and non-cancer Count/%	Cancer	Non-cancer	Total
Premenopausal	BMI group	Overweight and obese	Count	82	13,071	13,153
			%	0.6	99.4	100.0
		Underweight and normal	Count	5	699	704
			%	0.7	99.3	100.0
	Total		Count	87	13,770	13,857
			%	0.6	99.4	100.0
Postmenopausal	BMI group	Overweight and obese	Count	181	15,069	15,250
			%	1.2	98.8	100.0
		Underweight and normal	Count	7	1329	1336
			%	0.5	99.5	100.0
	Total		Count	188	16,398	16,586
			%	1.1	98.9	100.0
Total	BMI group	Overweight and obese	Count	263	28,140	28,403
			%	0.9	99.1	100.0
		Underweight and normal	Count	12	2028	2040
			%	0.6	99.4	100.0
	Total		Count	275	30,168	30,443
			%	0.9	99.1	100.0

BMI: body mass index.

Table 2. The estimated risk of body mass index among the pre- and postmenopausal groups.

Menopausal status	Odds ratio	95% CI	*p* value
Premenopausal	0.877	0.354–2.170	0.776
Postmenopausal	2.280	1.071–4.862	0.028**

independent variables were done using chi square test for differences between proportions. Correlations were evaluated using Pearson correlation for numerical parametric data. Tests for trend were performed to calculate odds ratio (OR) and 95% confidence interval (CI) as a measure of relative risk. Logistic regression model was then used to evaluate independent risk factors. The *p*-value is a statistical measure for the probability that the results observed in a study could have occurred by chance. The level of significance was considered as following: at p value < .050 is significant, p value < .010 is highly significant and p value ≥.050 is non-significant.

Results

The study included 30,443 screened females. According to the results obtained from the program's registry 275/30,443 (0.9%) participants had pathologically proven BC *(cancer group)*, while 30,168/30443 (99.1%) participants had normal or benign breast mammographic findings *(non-cancer group)*. These women were re-classified into *pre-menopausal* (13, 857/30, 443, 45.5%) and *postmenopausal* (16, 586/30,443, 54.5%) groups.

The correlation between the BMI and the risk of BC development

The BMI was calculated for 30,443 female participants. It ranged from 16.7 to 53.8 with mean value of 33.7 ± 6.05 (mean ± SD). The participants were classified according to WHO BMI classification into underweight (24/30,443, 0.1%), normal weight (2016/30,443. 6.6%) overweight (6264/30,443, 20.6%) and obese (22,139/30,443, 72.7%). For statistical analysis, we grouped the BMI into two groups: underweight/normal weight (<25) and overweight/obese (≥25) subgroups. The number and percentage of participants in the two BMI groups calculated in both the cancer and non-cancer groups as regards their menopausal status are illustrated in Table 1.

When considering the distribution of the BMI in the cancer and non-cancer groups considering their menopausal status, we found that 263/275 (95.7%) of the cancer group and 28,140/30,168 (93.3%) of the non-cancer group were overweight and obese.

An *independent T-test* was performed to compare the means of the BMI in the cancer and non-cancer groups as well as in the pre- and postmenopausal groups. The mean BMI was significantly higher in the cancer (p value: 0.027) and postmenopausal groups (p value: < .001).

(a)

(b)

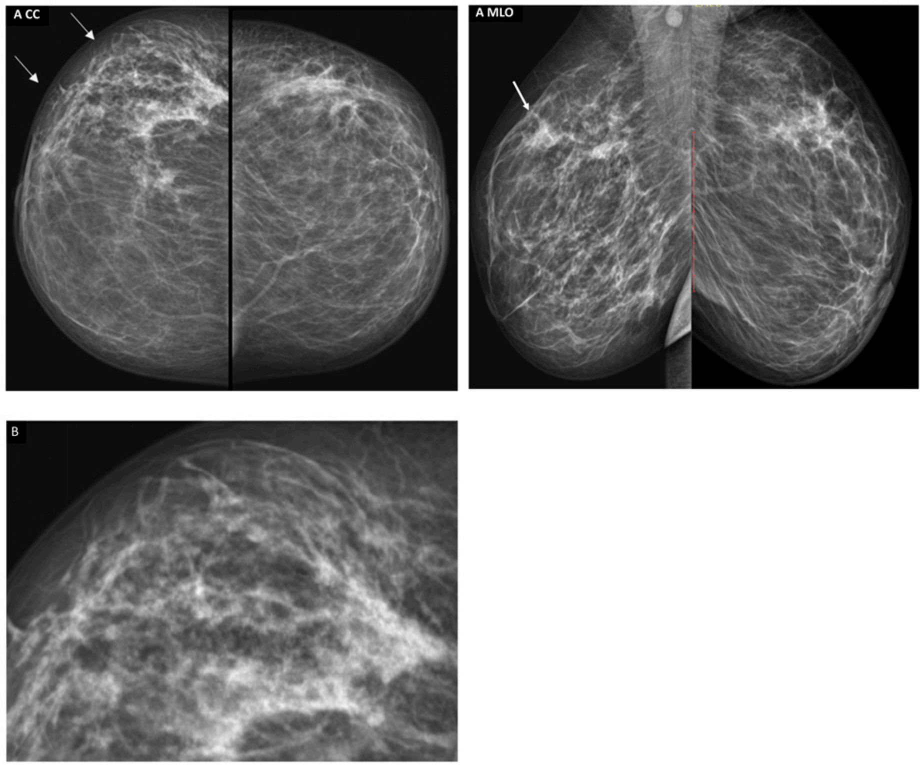

Figure 1. (a and b): Screening mammogram of a 43-year-old premenopausal female. Her calculated BMI is 38.7 (obese). It is matching a predominantly fatty breast parenchyma (ACR B). Her mammogram shows a right UOQ focal asymmetry with grouped microcalcifications (arrows in (a)). They are more appreciated in the magnification view (b). Core biopsy revealed high grade DCIS.

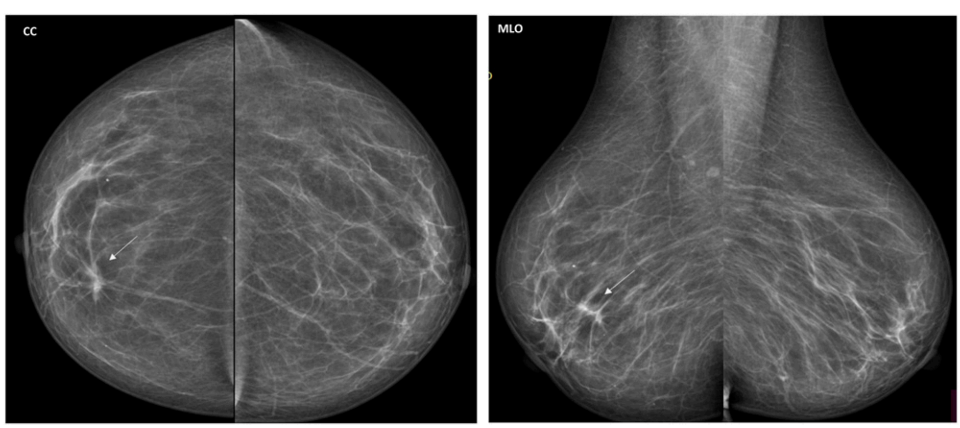

Figure 2. Screening mammogram of a 66-year-old postmenopausal female. Her calculated BMI is 33.8 (obese). It is matching a predominantly fatty breast parenchyma (ACR B). Her mammogram shows a right LIQ malignant mass lesion (arrows).

To estimate the risk of BMI among both the pre- and the postmenopausal groups, *chi square test* was carried out and *Pearson's correlation coefficient*, *odds ratio*, and *95% confidence interval* were calculated (Table 2). A negative insignificant difference was found between the BMI groups in the premenopausal period (OR: 0.877, p value: .776) while a statistically significant positive difference was found between the BMI groups in the postmenopausal period (OR: 2.280, p value: .028) (Figures 1 and 2).

Table 3. Cross tab showing the number and percentage of the female participants in the two breast density groups calculated in both the cancer and non-cancer groups as regards their menopausal status.

Menopausal status				Cancer and non-cancer		
				Cancer	Non-cancer	Total
Premenopausal	Group density	Dense	Count	3	503	506
			%	0.6	99.4	100.0
		Fatty	Count	84	13,267	13,351
			%	0.6	99.4	100.0
	Total	Count		87	13,770	13,857
			%	0.6	99.4	100.0
Postmenopausal	Group density	Dense	Count	7	147	154
			%	4.5	95.5	100.0
		Fatty	Count	181	16,251	16,432
			%	1.1	98.9	100.0
	Total	Count		188	16,398	16,586
			%	1.1	98.9	100.0
Total	Group density	Dense	Count	10	650	660
			%	1.5	98.5	100.0
		Fatty	Count	265	29,518	29,783
			%	0.9	99.1	100.0
	Total	Count		275	30,168	30,443
			%	0.9	99.1	100.0

The correlation between the BD and the risk of BC development

The female participants were classified according to the ACR breast density classification (A: fatty, B: scattered density, C: heterogeneously dense, and D: extremely dense). For statistical analysis, they were re-grouped into a predominantly fatty breast group (ACR A and B: 29783/30443, 97.8%) and a predominantly dense breast group (ACR C and D: 660/30443, 2.2%). Table 3 is a cross tabulation showing the number and percentage of participants in the two groups calculated in both the cancer and the non-cancer groups regarding their menopausal status**.**

Considering the distribution of the BD in the cancer and non-cancer groups considering their menopausal status we found that 265/275 (96.4%) of the cancer group and 29,518/30,168 (97.8%) of the non-cancer group had a predominantly fatty breast. Out of the 10/275 (3.6%) cases diagnosed with breast cancer in dense breasts, 8 cases were diagnosed upon re-call and three were diagnosed on subsequent screening (Figures 3 and 4).

To estimate the risk of BD among both the pre- and the postmenopausal groups, *chi square test* was carried out and *Pearson's correlation coefficient*, *odds ratio* and *95% confidence interval* were calculated (Table 4). A positive statistically insignificant difference was found between the BD groups in the premenopausal period (OR: 1.062, *p* value: .919) while a statistically significant negative difference was found between the BD groups in the postmenopausal period (OR: 0.234, *p* value: .000).

The correlation between the BMI and BD

Correlation between BMI and BD in both the cancer and non-cancer groups. The number and percentage of the female participants in the BMI groups and BD groups regarding their menopausal status are shown in (Table 5).

The correlation between the BMI and the BD was assessed using the ***Pearson's correlation coefficient***. A high statistical negative correlation was found between the BMI and the BD among both premenopausal (OR: 0.289. *p* value: .000) and postmenopausal (OR: 0.292, *p* value: .000) groups as shown in Table 6 (Figures 5 and 6).

Correlation between BMI and BD in the cancer group. Table 7 represents a cross tab between the BMI and BD in the cancer group in both the pre- and the postmenopausal groups. When comparing the pre- and postmenopausal groups of the cancer patients, no statistically significant difference was found as regards the BMI in both groups (*p* value: .877) while a statistically significant difference was found as regards the BD in both groups (*p* value: .001). A statistically insignificant number of women (9/275, 0.003%) were both obese and had a dense breast parenchyma.

On the other hand, an insignificant negative correlation was calculated between the BMI and the BD density in the premenopausal group (*p* value: .12) and a significant

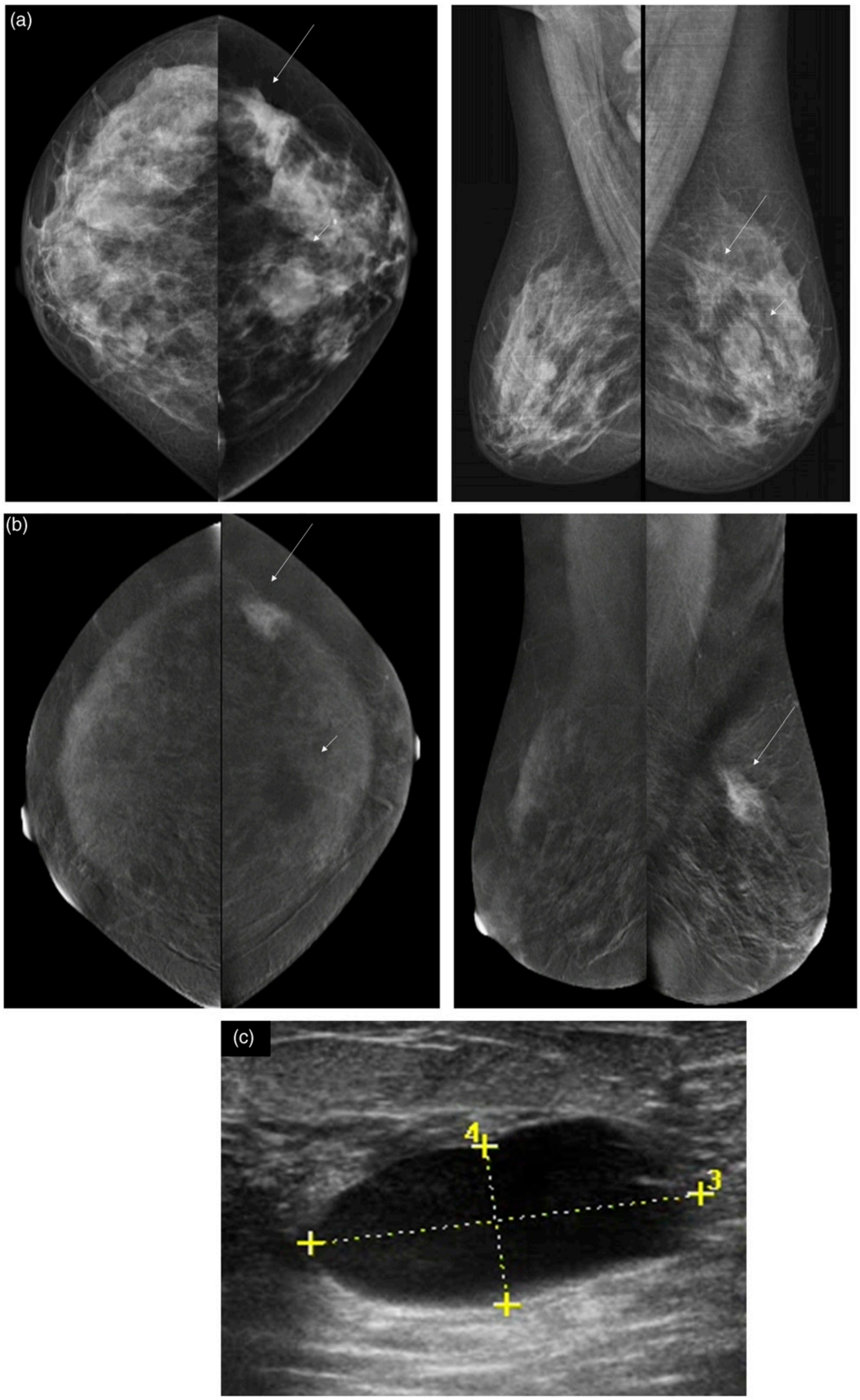

Figure 3. (a, b, and c): Screening mammogram of a 49-year-old premenopausal female with a dense breast parenchyma (ACR D). Her mammogram shows a left LIQ oblong shaped, obscured mass lesion (short arrows in (a)). Patient was recalled and contrast mammography was performed. The lesion showed negative contrast enhancement denoting a cystic nature (short arrow in (b)) which was confirmed on complementary ultrasound (c). An enhancing malignant lesion was incidentally identified in the left UOQ (long arrows in B) and was identified on retrograde revision of the mammography films (long arrow in (a)).

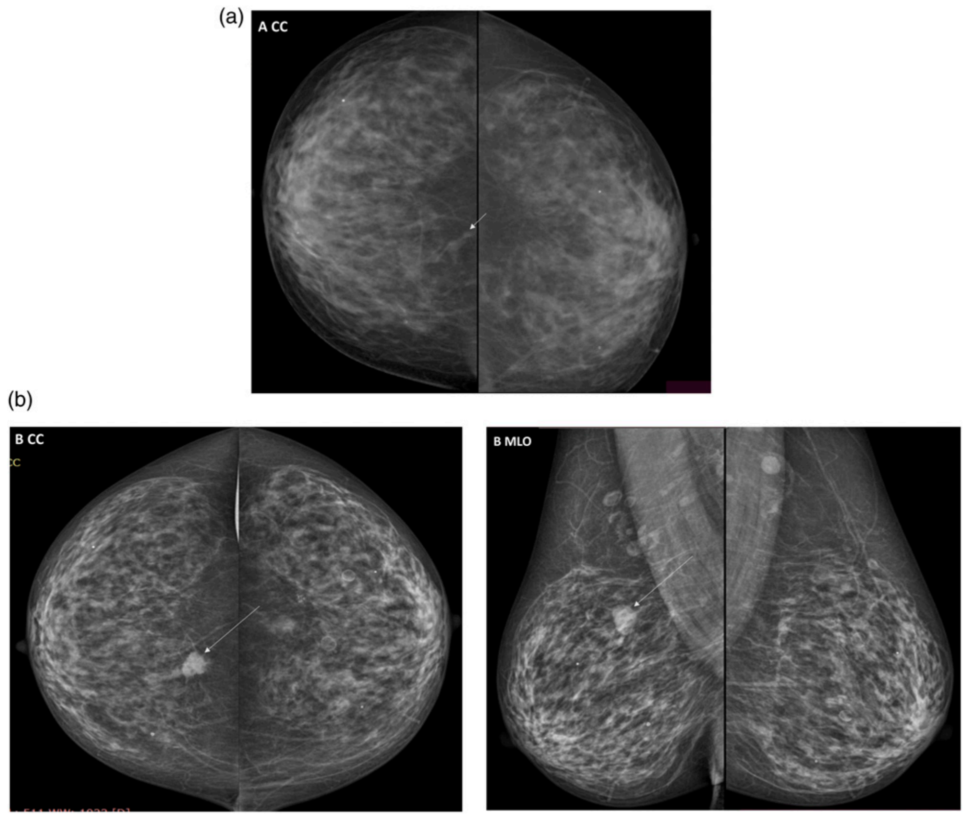

Figure 4. (a and b): Screening mammogram of a 64-year-old postmenopausal female Her calculated BMI is 31.8 (obese). It is mismatching with a predominantly fibroglandular breast parenchyma (ACR C). Her mammogram shows a right UIQ malignant mass lesion (long arrows in (b)) that was missed in older studies (short arrows in (a)) due to the small lesion size and the dense breast parenchyma.

Table 4. The estimated risk of the breast density among the pre- and postmenopausal groups.

Menopausal status	Odds ratio	95% CI	*p* value
Premenopausal	1.062	0.334–3.367	.919
Postmenopausal	0.234	0.108–0.506	.000**

correlation was calculated in both the *postmenopausal* group (*p* value: .035) and in the total cancer patients (*p* value: .01)

Logistic regression analysis

A *logistic regression analysis* was performed to evaluate the independence of each risk factor in the development of breast cancer apart from other risks.

BMI showed a high positive statistical significance (*p* value: .001 and OR: 1.034), i.e., an increase in BMI causes an increase in BC risk by an odds of 1.034 (3.4%).

Breast density was of high negative statistical significance (*p* value: .009 and OR = 0.419), i.e., a decrease in breast density results in an increase in BC risk.

Discussion

Although BC is the most common female cancer all over the world, its incidence, mortality, and survival rates vary significantly among different parts of the world. This may be attributed to the unique population structure, genetic and environmental factors. Another reason behind these variations is because the prevalence rates of some common RFs for BC differ according to the race and ethnic group.[27] Numerous RFs have been implicated in the rising incidence and mortality rates of BC; therefore, more emphasis is needed for personalized risk prediction and control strategies.[28,29]

In this study two of the commonest potentially modifiable risk factors have been evaluated. We sought to study the complex relationship between the BMI, BD and the risk of BC development in relation to the menopausal status in 30,433 African-Arab screened population who have joined the “Women’s Health Outreach Program.” Knowing that there is a paucity in literature discussing the risk factors in the native Arab and African female population, we also looked at the ethnic variations based on comparing the results of the current study with the previously published

Table 5. Cross tab showing the number and percentage of the participants in the body mass index groups and the breast density groups regarding their menopausal status.

Menopausal status				Group density: Non-dense	Group density: Dense	Total
Pre- menopausal	BMI group	Underweight/normal	Count	630	74	704
			%	89.5	10.5	100.0
		Overweight/obese	Count	12,721	432	13,153
			%	96.7	3.3	100.0
	Total		Count	13,351	506	13,857
			%	96.3	3.7	100.0
Post -menopausal	BMI group	Underweight/normal	Count	1301	35	1336
			%	97.4	2.6	100.0
		Overweight/obese	Count	15,131	119	15,250
			%	99.2	0.8	100.0
	Total		Count	16,432	154	16,586
			%	99.1	0.9	100.0

Table 6. Correlation between body mass index and breast density groups regarding their menopausal status.

Body mass index/breast density	Odds ratio	95% CI	*p* value
Premenopausal	0.289	0.223–0.375	.000**
Postmenopausal	0.2929	0.200–0.428	.000**

literature. The changes in the prevalence and nature of the studied potentially modifiable RFs amongst the enrolled African-Arab female population have highlighted unique ethnic traits for African and Arab women.

The evidence in literature discussing the link between BMI and BC is complex and is still unclear. It is believed that adipose tissue of obese women generates excessive estrogen which promotes the development of BC. Although there is an established relationship between the increased BMI and the increased risk for BC among postmenopausal women,[8,15,30,31] this relationship is still inconsistent in the premenopausal women. Some studies have shown a negative correlation,[32–34] while others have suggested no association.[31,35] In this study, the mean BMI was 34.5 ± 5.8 in the cancer group and 33.7 ± 6.06 in the non-cancer group. A statistically significant difference (*p* value: .02) was found between the cancer and non-cancer groups in the postmenopausal subgroups with a direct correlation between BMI and BC (OR: 2.280). In the premenopausal group the difference was insignificant (*p* value: .776) with an inverse correlation between the BMI and BC (OR: .877). After performing the logistic regression analysis, the results showed that BMI is an independent highly significant risk factor contributing to an increase in breast cancer risk by an odds of 1.034 (3.4%). The results of the current study are concordant with the meta-analyses performed by *Xia and colleagues***,** and *Guo and colleagues* who stated that the BMI during the perimenopausal period can decrease the risk of BC by 0.07. They stated that this association was not statistically significant. Contrary to this, an increase in the BMI during the postmenopausal period can significantly increase the risk of breast cancer by odds of 0.21. This evidence means that an increased BMI is not a protective factor against breast cancer during the premenopausal period and at the same time it is a significant risk factor for developing breast cancer during the postmenopausal period.[36,37]

According to the *Egypt Health Issues survey conducted in 2015***,** the proportion of overweight or obese women increases as women get older.[38] The alarming number of overweight and obese women included in the current study (95.7% of the cancer group and 93.3% of the non-cancer group) signals the importance of creating intensive awareness programs aiming for maintaining positive and healthy lifestyle choices throughout these individuals' lifetime to reduce BC risk as a means of BC prevention.

Most previous studies have shown that BD is an important breast cancer RF with a reported two- to 6-fold increased risk of developing BC in women with dense breasts. In addition to its role in the increased BC risk, BD reduces mammographic accuracy.[39,40] In a meta-analysis performed by McCormack, et al. they found that the relative risk of BC is collectively 2.92 for women with heterogeneously dense breasts and 4.64 for women with extremely dense breasts when compared to women with an entirely

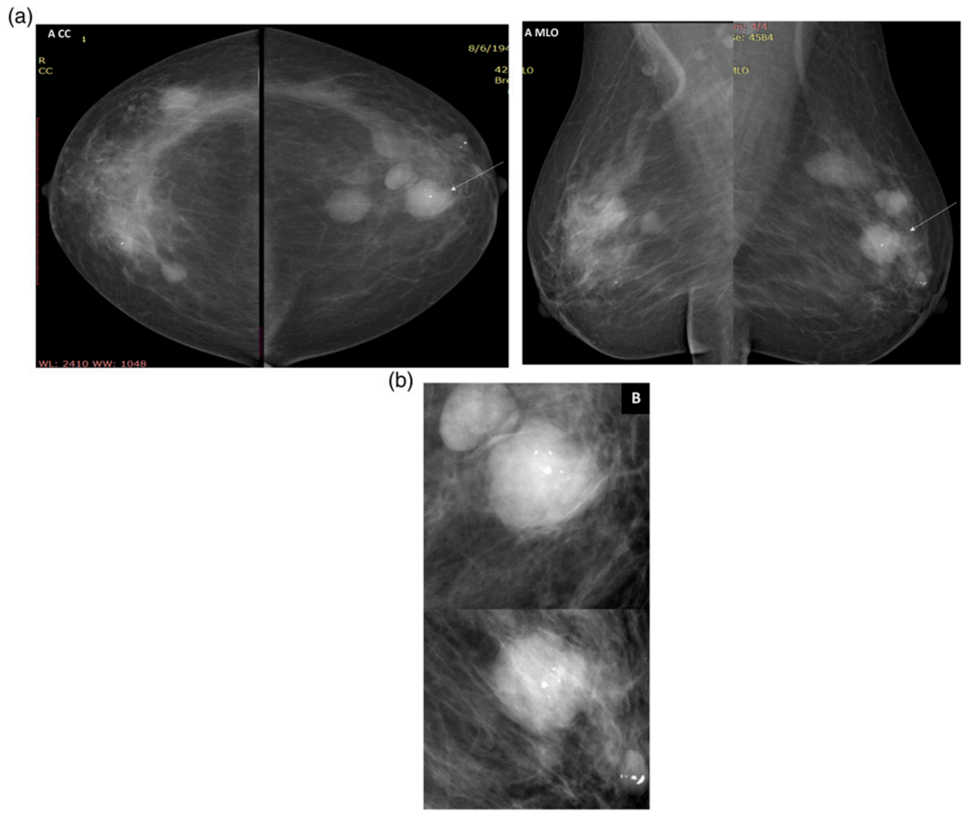

Figure 5. (a and b): Screening mammogram of a 63-year-old postmenopausal female. Her calculated BMI is 24.7 (normal weight). It is inversely related to a predominantly fibroglandular breast parenchyma (ACR C). Her mammogram shows bilateral partially obscured mass lesions proved to be cysts on ultrasound except for a single mass showing microcalcifications seen in the left retro-areolar region (arrows in (a)). It is more appreciated in the magnified images (b). Core biopsy was performed, and it proved to be an IDC grade 2.

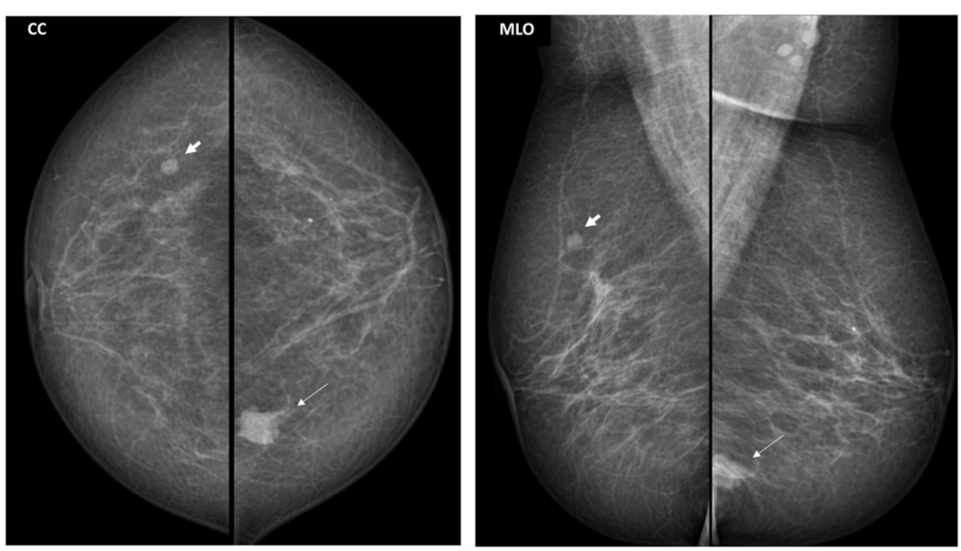

Figure 6. Screening mammogram of a 59-year-old postmenopausal female. Her calculated BMI is 38.8 (obese). It is matching a predominantly fatty breast parenchyma (ACR B). Her mammogram shows a left LIQ malignant mass lesion (long arrows) and a right UOQ intra mammary non-specific node (short arrows).

Table 7. Cross tab between body mass index and breast density groups in the cancer patients regarding their menopausal status.

Menopausal status	BMI		Breast density		
Premenopausal	BMI		Fatty	Dense	Total
		Underweight/normal	4	1	5
		Overweight/obese	80	2	82
	Total		84	3	87
Postmenopausal	BMI		Fatty	Dense	Total
		Underweight/normal	7	0	7
		Overweight/obese	174	7	181
	Total		181	7	188
Total cases			Fatty	Dense	Total
		Underweight/normal	11	1	12
		Overweight/obese	254	9	263
	Total		265	10	275

BMI: body mass index.

fatty breast.[41] Lee, et al. and Sickles, et al. have commented that these figures may be misleading since they resulted from comparing relative risks for women with dense and entirely fatty breasts; the latter comprising only 10% of the screening population. They stated that when replacing the entirely fatty breast (ACR A) with the scattered fibro glandular densities (ACR B), the relative BC risk associated with BD would be much smaller and was estimated to be about 1.2 for women with heterogeneously dense breasts and 2.1 for women with extremely dense breasts.[42,43] The variable density comparison groups used in different analyses has led to uncertainty regarding the actual magnitude of cancer risk associated with dense breasts and it is even stated in some studies that BD is a much lower risk than other RFs.[42]

The current studied female population showed unique ethnic characteristics as regards the BD as a RF. Upon studying the correlation between the BD and BC risk according to the menopausal status, it was found that in the premenopausal females, the BD was of direct statistically insignificant relation (*p* value: .919, OR: 1.062), while in the postmenopausal females, BD showed an inverse highly significant relation to breast cancer (*p* value:<.001, OR: 0.234). After performing the logistic regression analysis, it was found that in this unique studied population, decreased BD is an independent RF for breast cancer and this was of high statistical significance (*p* value: .009) (OR: 0.419).

Several researchers have investigated the relationship between the dense and the non-dense areas on mammograms (representing the fibro glandular and fat components respectively) and the BC risk. Some researchers have found that both the dense and non-dense areas are independent RFs and have reported a positive association with the dense area and an inverse association with the non-dense area.[44,45] A few researchers, as Lokate et al., have found a positive association between the non-dense area and the risk of BC development.[46] They referred this to experimental studies that suggested that fat tissue produces estrogen and specific proteins which could enhance the proliferation of malignant cells. An insignificant correlation between the non-dense area and the risk of BC was reported by Torres-Meija et al. and Stone et al.[47,48]

The observed discrepancies remain controversial but could be caused by important variations in technique of BD assessment, the adjustments performed in the analyses and, to a certain extent, the differences in the nature of the population under study, including ethnicity, lifestyle variations and menopausal status. In the current study, the largest percentage of the studied population were postmenopausal and were overweight and obese.

In the studies performed by Harris et al. and Boyd et al., they both found that percent density and BMI are inversely linked and act as confounders of each other's effects. Evaluations of the relationship among body size, mammographic density, and BC risk have shown that the positive association between obesity and breast cancer becomes stronger with an adjustment for mammographic density, particularly measures that reflect percent dense area. On the other hand, the positive association between mammographic density and breast cancer becomes stronger with an adjustment for obesity in both premenopausal and postmenopausal women. These findings suggest that obesity and mammographic density independently play a role in the association with BC, rather than a role as a mediating factor.[49,50]

When comparing the pre- and postmenopausal groups of the cancer patients, no statistically significant difference was found as regards the BMI in both groups (*p* value: .877) while a statistically significant difference was found as regards the BD in both groups (*p* value: .001) where a much larger number of obese women were postmenopausal. A statistically insignificant number of women (9/275, 0.003%) were both obese and had a dense breast parenchyma in both groups.

In conclusion, ethnic variations influence the potential impact of the different RFs for developing BC. The current studied population presented unique ethnic characteristics, where a decreased BD was found to be an independent RF for BC. On the other hand, BMI was found to be a significant RF for developing BC especially during the postmenopausal period. This together with the alarming number of obese and overweight females in the studied population signals the importance of applying strict weight control strategies as a preventive measure against BC in this unique African-Arab population.

Declaration of conflicting interests

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References

1. Siegel R, Naishadham D, and Jemal A. Cancer statistics. CA Cancer J Clin 2012; 62: 10–29.
2. Alegre MM, Knowles MH, Robison RA, et al. Mechanics behind breast cancer prevention - focus on obesity, exercise, and dietary fat. Asian Pac J Cancer Prev 2013; 14: 2207–2212.
3. Shieh Y, Scott CG, Jensen MR, et al. Body mass index, mammographic density, and breast cancer risk by estrogen receptor subtype. Breast Cancer Res 2019; 21: 48.
4. Engmann NJ, Golmakani MK, Miglioretti DL, et al. Population-attributable risk proportion of clinical risk factors for breast cancer. JAMA Oncol 2017; 3: 1228–1236.
5. Pettersson A, Graff RE, Ursin G, et al. Mammographic density phenotypes and risk of breast cancer: a meta-analysis. J Natl Cancer Inst 2014; 106: dju078.
6. Minatoya M, Kutomi G, Asakura S, et al. Equol, adiponectin, insulin levels and risk of breast cancer. Asian Pac J Cancer Prev 2013; 14: 2191–2199.
7. Nindrea RD, Aryandono T, Lazuardi L. Breast cancer risk from modifiable and non-modifiable risk factors among women in southeast Asia: a meta-analysis. Asian Pac J Cancer Prev 2017; 18: 3201–3206.
8. Cheraghi Z, Poorolajal J, Hashem T, et al. Effect of body mass index on breast cancer during premenopausal and postmenopausal periods: a meta-analysis. PloS One 2012; 7: e51446.
9. Barlow WE, White E, Ballard-Barbash R, et al. Prospective breast cancer risk prediction model for women undergoing screening mammography. J Natl Cancer Inst 2006; 98: 1204–1214.
10. Tian YF, Chu CH, Wu MH, et al. Anthropometric measures, plasma adiponectin, and breast cancer risk. Endocr Relat Cancer 2007; 14: 669–777.
11. Mathew A, Gajalakshmi V, Rajan B, et al. Anthropometric factors and breast cancer risk among urban and rural women in South India: a multicentric case-control study. Br J Cancer 2008; 99: 207–213.
12. Montazeri A, Sadighi J, Farzadi F, et al. Weight, height, body mass index and risk of breast cancer in postmenopausal women: a case-control study. BMC Cancer 2008; 8: 278.
13. Palmer JR, Adams-Campbell LL, Boggs DA, et al. A prospective study of body size and breast cancer in black women. Cancer Epidemiol Biomarkers 2007; 16: 1795–1802.
14. Loi S, Milne RL, Friedlander ML, et al. Obesity and outcomes in premenopausal and postmenopausal breast cancer. Cancer Epidemiol Biomarkers 2005; 14: 1686–1691.
15. Chen Y, Liu L, Zhou Q, et al. Body mass index had different effects on premenopausal and postmenopausal breast cancer risks: a dose-response meta-analysis with 3,318,796 subjects from 31 cohort studies. BMC Public Health 2017; 17: 936.
16. Badr LK, Bourdeanu L, Alatrash M, et al. Breast cancer risk factors: a cross- cultural comparison between the West and the East. Asian Pac J Cancer 2018; 19: 2109–2116.
17. Titus-Ernstoff L, Tosteson AN, Kasales C, et al. Breast cancer risk factors in relation to breast density (United States). Cancer Causes Control 2006; 17: 1281–1290.
18. Freer PE. Mammographic breast density: impact on breast cancer risk and implications for screening. Radiographics 2015; 35: 302–315.
19. Boyd NF, Martin LJ, Yaffe MJ, et al. Mammographic density and breast cancer risk: current understanding and future prospects. Breast Cancer Res 2011; 13: 223.
20. Wong CS, Lim GH, Gao F, et al. Mammographic density and its interaction with other breast cancer risk factors in an Asian population. Br J Cancer 2011; 104: 871–874.
21. Conroy SM, Woolcott CG, Koga KR, et al. Mammographic density, and risk of breast cancer by adiposity: an analysis of four case-control studies. Int J Cancer 2012; 130: 1915–1924.
22. Yaghjyan L, Colditz GA, Rosner B, et al. Mammographic breast density and breast cancer risk: interactions of percent density, absolute dense, and non-dense areas with breast cancer risk factors. Breast Cancer Res Treat 2015; 150: 181–189.
23. Corbex M, Harford JB. Perspectives on breast cancer in Arab populations. Lancet Oncol 2013; 14: e582.
24. Hashim MJ, Al-Shamsi FA, Al- Marzooqi NA, et al. Burden of breast cancer in the Arab world: findings from Global Burden of Disease, 2016. J Epidemiol Glob Health 2018; 8: 54–58.
25. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser. 2000; 894: i–xii.
26. Sickles EA, D'Orsi CJ, Bassett LW, et al. ACR BI-RADS® Mammography. In: ACR BI-RADS® Atlas, breast imaging

reporting and data system. Reston, VA: American College of Radiology, 2013. https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems/Bi-Rads
27. Hortobagyi GN, de la Garza Salazar J, Pritchard K, et al. ABREAST investigators the global breast cancer burden: variations in epidemiology and survival. Clin Breast Cancer 2005; 6: 391–401.
28. Momenimovahed Z, Salehiniya H. Epidemiological characteristics of and risk factors for breast cancer in the world. Breast Cancer (Dove Med Press) 2019; 11: 151–164.
29. Brooks JD, Nabi HH, Andrulis IL, et al. Risk assessment for prevention and early detection of breast cancer: integration and implementation (PERSPECTIVE I&I). J Pers Med 2021; 11: 511.
30. Gravena AAF, Romeiro Lopes TC, Demitto MO, et al. The obesity and the risk of breast cancer among pre and postmenopausal women. Asian Pac J Cancer Prev 2018; 19: 2429–2436.
31. Amadou A, Ferrari P, Muwonge R, et al. Overweight, obesity and risk of premenopausal breast cancer according to ethnicity:a systematic review and dose-response meta-analysis. Obes Rev 2013; 14: 665–678.
32. World Cancer Research Fund, Research. AIC: continuous update project report. Food, nutrition, physical activity, and the prevention of breast cancer 2017. https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-Report-2018.pdf
33. Michels KB, Terry KL, Willett WC. Longitudinal study on the role of body size in premenopausal breast cancer. Arch Intern Med 2006; 166: 2395–2402.
34. Reeves GK, Pirie K, Beral V, et al. Million women study C cancer incidence and mortality in relation to body mass index in the million women study: cohort study. BMJ 2007; 335: 1134.
35. Sangrajrang S, Chaiwerawattana A, Ploysawang P, et al. Diet and physical inactivity and risk of breast cancer in Thai women. Asian Pac J Cancer 2013; 14: 7023–7027.
36. Guo Y, Andersen SW, Shu XO, et al. Genetically predicted body mass index and breast cancer risk: Mendelian randomization analyses of data from 145,000 women of European descent. PLOS Med 2016; 13: e1002105.
37. Xia X, Chen W, Li J, et al. Body mass index and risk of breast cancer: a nonlinear dose-response meta-analysis of prospective studies. Sci Rep 2014; 4: 7480.
38. Egypt Health Issues Survey 2015. Cairo, Egypt and Rockville, Maryland, USA: Ministry of Health and Population and ICF International. Available at: https://www.unicef.org/egypt/media/521/file/eg_EHIS_2015.pdf
39. McCarthy AM, Ehsan S, Appel S, et al. Risk factors for an advanced breast cancer diagnosis within 2 years of a negative mammogram. Cancer 2021; 127: 3334–3342.
40. Vierkant RA, Degnim AC, Radisky DC, et al. Mammographic breast density and risk of breast cancer in women with atypical hyperplasia: an observational cohort study from the Mayo Clinic Benign Breast Disease (BBD) cohort. BMC Cancer 2017; 17: 84.
41. McCormack VA, dos Santos Silva I. Breast density and parenchymal patterns as markers of breast cancer risk: a meta-analysis. Cancer Epidemiol Biomarkers Prev 2006; 15: 1159–1169.
42. Lee CI, Chen LE, Elmore JG. Risk-based breast cancer screening: implications of breast density. Med Clin North Am 2017; 101: 725–741.
43. Sickles EA. The use of breast imaging to screen women at high risk for cancer. Radiol Clin North Am 2010; 48: 859–878.
44. Pettersson A, Hankinson SE, Willett WC, et al. Nondense mammographic area and risk of breast cancer. Breast Cancer Res 2011; 13: R100.
45. Velásquez García HA, Sobolev BG, Gotay CC, et al. Mammographic non-dense area and breast cancer risk in postmenopausal women: a causal inference approach in a case–control study. Breast Cancer Res Treat 2018; 170: 159–168.
46. Lokate M, Peeters PH, Peelen LM, et al. Mammographic density and breast cancer risk: the role of the fat surrounding the fibroglandular tissue. Breast Cancer Res 2011; 13: R103.
47. Torres-Mejía G, De Stavola B, Allen DS, et al. Mammographic features and subsequent risk of breast cancer: a comparison of qualitative and quantitative evaluations in the Guernsey prospective studies. Cancer Epidemiol Prev Biomarkers 2005; 14: 1052–1059.
48. Stone J, Ding J, Warren RM, et al. Using mammographic density to predict breast cancer risk: dense area or percentage dense area. Breast Cancer Res 2010; 12: R97.
49. Boyd NF, Martin LJ, Sun L, et al. Body size, mammographic density, and breast cancer risk. Cancer Epidemiol Prev Biomarkers 2006; 15: 2086–2092.
50. Harris HR, Tamimi RM, Willett WC, et al. Body size across the life course, mammographic density, and risk of breast cancer. Am J Epidemiol 2011; 174: 909–918.