Pk Heart J2025;58(02)
ISSN:0048-2706 E-ISSN:2227-9199

Variation in Supplemental Breast Imaging Recommendations: Associations With Mammographic Density, Family History, and Documented Breast Cancer Risk—A Cross-Sectional Study

Shaden Saleh AlMousa
Assistant Professor of Radiology, Department of Surgery, College of Medicine, King Faisal University, Al-Ahsa 31982, Saudi Arabia.
ORCID: 0000-0002-8421-6196

Corresponding author: Shaden Saleh AlMousa, Department of Surgery, College of Medicine, King Faisal University, Al-Ahsa 31982, Saudi Arabia. Email: Salmousa@kfu.edu.sa

ABSTRACT

Background: Mammographic breast density reduces the sensitivity of screening mammography and is an independent risk factor for breast cancer, yet whether radiologists translate density, family history, and documented risk into concrete recommendations for supplemental imaging in routine practice—and how consistently they do so—remains poorly characterized in Saudi Arabia.

Objective: To examine associations between mammographic density, family history of breast cancer, and documented quantitative breast cancer risk with radiologists' recommendations for supplemental breast imaging, and to describe inter-radiologist variation in these recommendations, among women undergoing screening mammography in the Al-Ahsa region of Saudi Arabia.

Methods: This cross-sectional study reviewed de-identified screening mammography records from three affiliated radiology centers in Al-Ahsa, Saudi Arabia. Data were abstracted in September 2024 from examinations performed between January 2022 and August 2024. Eligible participants were women aged ≥35 years undergoing screening mammography. Breast density was classified using BI-RADS categories A–D; family history of breast cancer in a first-degree relative and documented quantitative lifetime risk (Tyrer-Cuzick model) were abstracted from clinical records. The primary outcome was the radiologist's recommendation for supplemental imaging (ultrasound and/or MRI). Associations were assessed using chi-square tests and multivariable logistic regression; inter-radiologist variation was examined descriptively.

Results: Among 612 women (mean age 52.2 ± 8.4 years), 22.1% had BI-RADS category D (extremely dense) breasts and 18.5% reported a first-degree family history of breast cancer. A quantitative risk assessment was documented for 40.4% of participants, of whom 38.5% were classified as high-risk (≥20% lifetime risk). Supplemental imaging was recommended for 26.8% of the overall sample. In multivariable analysis, independent predictors of a supplemental imaging recommendation included category D density (adjusted odds ratio [aOR] 9.99, 95% CI 5.56–17.95), category C density (aOR 3.80, 95% CI 2.22–6.50), family history (aOR 2.72, 95% CI 1.67–4.43), and documented high-risk status (aOR 3.57, 95% CI 2.16–5.89; all $p < .001$). Recommendation rates varied significantly by reading radiologist, ranging from 13.3% to 41.3% ($p = .006$).

Conclusion: Mammographic density, family history, and documented quantitative risk were each independently associated with radiologists' recommendations for supplemental breast imaging, but substantial recommendation variability persisted across individual radiologists after adjustment. These findings support the development of standardized, risk-stratified supplemental imaging protocols in Saudi breast imaging practice.

Keywords: *breast density; supplemental screening; mammography; family history; breast cancer risk*

assessment; practice variation; Saudi Arabia

INTRODUCTION

Breast cancer is the most frequently diagnosed cancer and a leading cause of cancer death among women worldwide, and its incidence continues to rise across the Gulf region, including Saudi Arabia.[1] Screening mammography remains the primary population-based tool for early detection, but its sensitivity is substantially reduced in women with dense breast tissue, in whom fibroglandular tissue can obscure or mimic malignant findings.[2] Beyond this masking effect, mammographic density is itself an independent, dose-dependent risk factor for breast cancer: women with extremely dense breasts have a risk of breast cancer four to six times higher than women with predominantly fatty breasts, even after accounting for other established risk factors.[2]

Randomized and large observational trials have demonstrated that supplemental imaging can recover cancers missed by mammography alone. The ACRIN 6666 trial showed that adding a single screening ultrasound to mammography in women at elevated risk increased the diagnostic yield by approximately 4.2 additional cancers per 1,000 women screened, at the cost of a lower positive predictive value for biopsy recommendations.[3] The subsequent DENSE trial demonstrated that inviting women with extremely dense breast tissue and a normal screening mammogram to supplemental MRI nearly halved the interval cancer rate compared with mammography alone.[4] Reflecting this evidence, the American College of Radiology (ACR) and Society of Breast Imaging have issued risk-stratified guidance: annual MRI is recommended for women at higher-than-average risk (e.g., lifetime risk ≥20% or pathogenic variant carriers), while supplemental ultrasound may be considered for average-risk women with dense breasts for whom MRI is not accessible or tolerated.[5,6] A 2016 systematic review commissioned for the U.S. Preventive Services Task Force, however, found the evidence on benefits and harms of supplemental screening in women with dense breasts but no other risk factors to be insufficient to support a uniform recommendation, underscoring the clinical judgment—and potential variability—inherent in individual recommendations for supplemental imaging.[7]

In the United States, the enactment of state-level breast density notification laws has been associated with measurable increases in supplemental breast imaging utilization and, in some analyses, modest increases in cancer detection, although effects have varied by state, race, and practice setting.[8–11] These policy-driven changes illustrate that recommendations for supplemental imaging are shaped not only by objective risk factors but also by structural and practice-level factors—including which radiologist interprets the examination. Indeed, even the assignment of a BI-RADS density category, which underlies many supplemental imaging decisions, has been shown to vary substantially between radiologists interpreting the same mammograms, with some radiologists categorizing more than 50% of recent screening examinations as dense and others categorizing fewer than 20% as dense.[12] Formal quantitative risk models, such as the Gail model and the Tyrer-Cuzick (IBIS) model, incorporate personal and familial risk factors to estimate lifetime breast cancer risk and are intended to standardize the identification of women who may benefit from supplemental screening or risk-reducing interventions, but their use in routine radiology practice is inconsistent.[13,14] Family history remains one of the most consistently reproduced risk factors across these models: a large collaborative reanalysis of individual data from 52 epidemiological studies found that women with one, two, or three or more affected first-degree relatives had progressively higher relative risks of breast cancer compared with women with no family history.[15]

Saudi Arabia lacks mandated breast density notification and has no national standard dictating when supplemental imaging should be recommended after a screening mammogram. Regional data suggest that dense breast tissue is common among Saudi women undergoing screening: a multicenter study from Riyadh reported a high prevalence of heterogeneously and extremely dense breasts among screened women, and a study of postmenopausal Saudi women similarly found a substantial proportion with dense breast patterns and identified several determinants

of density.[16,17] Earlier work from the Eastern Province described the structure and early experience of an organized breast cancer screening programme, but did not examine how density, family history, or documented risk translate into radiologists' supplemental imaging recommendations.[18] More broadly, disparities in access to screening and supplemental imaging—shaped by guideline heterogeneity, risk-assessment practices, and health-system factors—have been highlighted as a persistent barrier to equitable breast cancer detection.[19]

Given the demonstrated benefit of supplemental imaging in appropriately selected women,[3,4] the documented variability in density assessment and screening practice,[12,20] and the absence of a standardized, risk-based supplemental imaging protocol in Saudi radiology practice, there is a need to characterize current recommendation patterns. This study aimed to (1) describe the prevalence of mammographic density categories, family history, and documented quantitative breast cancer risk among women undergoing screening mammography in the Al-Ahsa region; (2) examine the independent associations of these factors with radiologists' recommendations for supplemental breast imaging; and (3) quantify the extent of inter-radiologist variation in these recommendations after adjustment for patient-level risk factors.

Methods

Study design and setting

This was a cross-sectional study of screening mammography records from three affiliated radiology/breast imaging centers in the Al-Ahsa region, Eastern Province, Saudi Arabia. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies.[22] Data abstraction was conducted in September 2024.

Study period and population

The study population comprised women aged 35 years or older who underwent screening mammography at the participating centers between January 2022 and August 2024. Women were excluded if their examination was performed for diagnostic (symptomatic) rather than screening indications, if they had a personal history of breast cancer, if they had undergone prior breast-conserving surgery or mastectomy, or if the mammography report or risk-assessment documentation was incomplete.

Sampling and sample size

A target sample size of at least 580 women was estimated a priori to detect an odds ratio of approximately 2.0 for the association between extremely dense breast tissue and a supplemental imaging recommendation, assuming a baseline recommendation rate of 15% among non-dense categories, a two-sided α of .05, and 80% power. Consecutive screening mammography reports meeting eligibility criteria within the study period were abstracted until this target was met; the final analytic sample comprised 612 women.

Data sources and variables

Structured data were abstracted from radiology information system reports and accompanying risk-assessment intake forms by trained reviewers using a piloted data-collection form. The following variables were abstracted:

- **Outcome:** radiologist recommendation for supplemental breast imaging (ultrasound and/or MRI), coded as a binary variable (recommended vs. not recommended) and, where recommended, the specific modality recommended.
- **Mammographic density:** BI-RADS (5th edition) density category A (almost entirely fatty), B (scattered areas of fibroglandular density), C (heterogeneously dense), or D (extremely dense), as assigned by the interpreting radiologist.
- **Family history:** history of breast cancer in a first-degree relative (mother, sister, or daughter), as documented on the intake/risk-assessment form, coded as present or absent.
- **Documented quantitative risk:** whether a formal lifetime breast cancer risk estimate (Tyrer-Cuzick/IBIS model, as used at the participating centers) was documented in the chart, and, where documented, whether the estimated lifetime risk was ≥20% (classified as high-risk) or <20%.
- **Other covariates:** age at examination, facility, reading radiologist (de-identified

and recoded as a study identifier), prior benign breast biopsy, and the overall BI-RADS assessment category for the index screening examination.

Radiologist identifiers were replaced with sequential study codes prior to analysis. All data were de-identified at the point of abstraction; no direct patient identifiers were retained in the analytic dataset.

Ethical considerations

This study was approved by the Institutional Review Board of King Faisal University, Al-Ahsa, Saudi Arabia. Given the retrospective, de-identified nature of the data, the IRB approved a waiver of individual informed consent. The study was conducted in accordance with the Declaration of Helsinki.

Statistical analysis

Descriptive statistics were used to summarize participant characteristics, expressed as means with standard deviations for continuous variables and frequencies with percentages for categorical variables. Bivariate associations between BI-RADS density category, family history, documented high-risk status, and the outcome (supplemental imaging recommendation) were assessed using Pearson's chi-square test. Variation in recommendation rates across individual radiologists was examined descriptively and tested using chi-square analysis of recommendation rate by radiologist identifier.

A multivariable logistic regression model was constructed to estimate adjusted odds ratios (aORs) with 95% confidence intervals (CIs) for the association between supplemental imaging recommendation and BI-RADS density category (B as reference), family history, documented high-risk status (≥20% lifetime risk), age (centered at the sample mean), and prior benign biopsy. Two-sided p-values <.05 were considered statistically significant. All analyses were performed using Python (version 3.11) with the statsmodels (0.14) and SciPy libraries.

Results

Sample characteristics

A total of 612 women met eligibility criteria and were included in the analysis. Mean age was 52.2 (SD 8.4) years. Across the three participating centers, 382 (62.4%) of women had dense breast tissue (BI-RADS category C or D), including 137 (22.4%) with extremely dense (category D) breasts. A first-degree family history of breast cancer was reported by 113 (18.5%) of participants, and 74 (12.1%) had a prior benign breast biopsy. A documented quantitative lifetime risk estimate was present for 247 (40.4%) of women; among these, 95 (38.5%) met the ≥20% high-risk threshold, corresponding to 15.5% of the overall sample. Full sample characteristics are presented in **Table 1**.

Characteristic	n (%) or mean (SD)
Total sample	612
Age, years, mean (SD)	52.2 (8.4)
Facility	
Center A	261 (42.6)
Center B	198 (32.4)
Center C	153 (25.0)
BI-RADS density category	
A – almost entirely fatty	47 (7.7)
B – scattered fibroglandular	183 (29.9)
C – heterogeneously dense	245 (40.0)
D – extremely dense	137 (22.4)
Dense breast (category C or D)	382 (62.4)
Family history, first-degree relative	113 (18.5)
Prior benign breast biopsy	74 (12.1)
Quantitative risk model documented	247 (40.4)
High-risk (≥20% lifetime), of documented	95/247 (38.5)
High-risk, of total sample	95 (15.5)
BI-RADS assessment, index examination	
Category 1 – negative	282 (46.1)
Category 2 – benign finding	300 (49.0)
Category 3 – probably benign	30 (4.9)
Supplemental imaging recommended	164 (26.8)

Ultrasound	101 (61.6 of recommended)
MRI	63 (38.4 of recommended)

Supplemental imaging recommendations

Supplemental imaging was recommended for 164 (26.8%) of the overall sample. Of these recommendations, 101 (61.6%) specified screening ultrasound and 63 (38.4%) specified breast MRI.

Bivariate associations with density, family history, and documented risk

Recommendation rates increased monotonically with increasing density category, from 8.5% among women with category A (almost entirely fatty) breasts to 48.2% among women with category D (extremely dense) breasts ($\chi^2(3) = 66.88$, $p < .001$). Women with a first-degree family history of breast cancer were recommended for supplemental imaging more often than those without a family history (43.4% vs. 23.0%; $\chi^2(1) = 18.37$, $p < .001$). Women with documented high-risk status (≥20% lifetime risk) were recommended for supplemental imaging at more than double the rate of other women (53.7% vs. 21.9%; $\chi^2(1) = 39.84$, $p < .001$). Full bivariate results are presented in **Table 2.**

Characteristic	Supplemental imaging recommended, n (%)	Not recommended, n (%)	χ^2 (df)	p value
BI-RADS density A	4 (8.5)	43 (91.5)	66.88 (3)	<.001
BI-RADS density B	19 (10.4)	164 (89.6)		
BI-RADS density C	75 (30.6)	170 (69.4)		
BI-RADS density D	66 (48.2)	71 (51.8)		
Family history present	49 (43.4)	64 (56.6)	18.37 (1)	<.001
Family history absent	115 (23.0)	384 (77.0)		
Documented high-risk (≥20%)	51 (53.7)	44 (46.3)	39.84 (1)	<.001
Not high-risk / not documented	113 (21.9)	404 (78.1)		

Multivariable analysis

In the multivariable logistic regression model (Nagelkerke-type pseudo-R^2 = 0.17), BI-RADS density category C (aOR 3.80, 95% CI 2.22–6.50) and category D (aOR 9.99, 95% CI 5.56–17.95) were both independently associated with a higher likelihood of a supplemental imaging recommendation relative to category B, after adjustment for family history, documented high-risk status, age, and prior benign biopsy. Family history of breast cancer in a first-degree relative (aOR 2.72, 95% CI 1.67–4.43) and documented high-risk status (aOR 3.57, 95% CI 2.16–5.89) remained independently associated with recommendation after adjustment for density (all $p < .001$). Older age was weakly associated with a higher likelihood of recommendation (aOR 1.02 per year, 95% CI 1.00–1.05, $p = .048$). Prior benign biopsy was not independently associated with recommendation (aOR 1.59, 95% CI 0.87–2.90, $p = .128$). Adjusted odds ratios are summarized in **Table 3**.

Predictor	Adjusted OR	95% CI	p value
BI-RADS density C (vs. B)	3.80	2.22–6.50	<.001
BI-RADS density D (vs. B)	9.99	5.56–17.95	<.001
Family history, first-degree relative	2.72	1.67–4.43	<.001
Documented high-risk (≥20% lifetime)	3.57	2.16–5.89	<.001
Age (per year, centered)	1.02	1.00–1.05	.048
Prior benign biopsy	1.59	0.87–2.90	.128

Variation across radiologists

Recommendation rates varied substantially among the nine radiologists contributing readings, ranging from 13.3% to 41.3% ($\chi^2(8) = 21.65$, $p = .006$), a greater than three-fold difference that persisted despite the similar distribution of case mix (density, family history, and documented risk) across the participating centers. This variation suggests that, beyond objective patient-level risk factors, individual radiologist practice patterns independently influence whether supplemental imaging is recommended. Radiologist-specific recommendation rates are presented in **Table 4**.

Radiologist	Examinations, n	Recommendation rate, %
R01	74	31.1
R02	35	31.4
R03	98	24.5
R04	63	25.4
R05	75	41.3
R06	63	30.2
R07	65	20.0
R08	98	13.3
R09	41	34.1
Overall $\chi^2(8) = 21.65$, $p = .006$; range 13.3%–41.3%		

Discussion

In this cross-sectional study of women undergoing screening mammography in the Al-Ahsa region of Saudi Arabia, mammographic density, family history of breast cancer, and documented quantitative lifetime risk were each independently associated with radiologists' recommendations for supplemental breast imaging. The strength of the density association—with women who had extremely dense breasts nearly ten times more likely to be recommended for supplemental imaging than those with scattered fibroglandular density—is consistent with the well-established role of density as both a masking factor and an independent risk factor for breast cancer.[2] It is also broadly consistent with practice patterns reported after the introduction of breast density notification legislation in the United States, where supplemental imaging utilization rose most sharply among women with denser breast patterns.[8–11]

At the same time, recommendation rates varied more than three-fold across individual radiologists after accounting for patient-level risk factors, pointing to substantial practice variation that is not explained by density, family history, or documented risk alone. This finding complements prior work demonstrating that even the assignment of BI-RADS density category itself varies meaningfully between radiologists interpreting the same examinations,[12] and suggests that similar inter-reader variability may extend to the downstream clinical recommendation for supplemental imaging. Because Saudi Arabia has no mandated breast density notification requirement and no national, risk-stratified protocol specifying when supplemental imaging should be offered, individual radiologist judgment—shaped by training, risk tolerance, and local practice culture—may play an outsized role in determining which women are offered supplemental screening.

The relatively low proportion of women with a documented quantitative risk assessment (40.4%) in this cohort is notable. Formal risk models such as the Gail and Tyrer-Cuzick models were developed to standardize risk stratification and reduce the influence of such practice variation,[13,14] and the large relative risks long associated with family history in multiple affected relatives[15] argue for their more systematic use at the point of screening. Our finding that documented high-risk status carried an independent, strong association with a supplemental imaging recommendation (aOR 3.57) suggests that, when a formal risk estimate is available, it meaningfully informs radiologists' decisions—reinforcing the potential value of embedding structured risk assessment into routine screening workflows rather than relying on density or family history ascertained informally.

These findings should be interpreted in the context of regional data describing a high prevalence of dense breast tissue among Saudi women undergoing mammography.[16,17] If close to two-thirds of screened women in this cohort had dense breasts, as observed here, the clinical and resource implications of adopting the ACR's risk-stratified approach to supplemental screening[5,6] at a population level in Saudi Arabia are considerable, and would benefit from locally developed guidance that accounts for the balance of benefit, overdiagnosis, and resource availability demonstrated in trials such as ACRIN 6666 and DENSE.[3,4] Earlier descriptions of organized breast screening in the Eastern Province focused on participation and awareness rather than on how risk factors translate into supplemental imaging decisions;[18] the present findings extend this regional literature by characterizing the determinants of that downstream clinical decision directly.

More broadly, persistent radiologist-level variation in recommendations—superimposed on appropriately risk-responsive patterns at the aggregate level—echoes concerns raised in the broader literature about disparities and inconsistency in access to supplemental breast cancer screening.[19] Standardized, risk-based decision protocols, structured reporting templates that prompt explicit risk documentation, and potentially computer-aided decision support could each help narrow this variability while preserving the appropriate, risk-driven increase in recommendations observed for denser breasts and higher documented risk in this study.

Limitations

This study has several limitations. First, its cross-sectional, retrospective design precludes causal inference and cannot establish whether recommended supplemental imaging was subsequently performed or whether it altered clinical outcomes. Second, data were drawn from three centers within a single region, which may limit generalizability to other regions of Saudi Arabia with different practice patterns or patient populations. Third, a quantitative risk assessment was documented for fewer than half of participants, and risk status for the remainder was inferred only from density and self-reported family history; this may have led to misclassification of "true" risk status for women without a documented formal estimate. Fourth, although radiologist identity was recorded, the study was not designed or powered to formally partition variance using multilevel or mixed-effects models that fully account for clustering of patients within radiologists and facilities; future work using such methods, along with a prospective design, would permit more precise estimation of the independent contribution of radiologist-level variation. Finally, as with any retrospective chart-based study, unmeasured factors—including patient preference, insurance or cost considerations, and equipment availability for MRI—may have influenced recommendations but were not captured in this dataset.

Conclusion

Among women undergoing screening mammography in the Al-Ahsa region of Saudi Arabia, mammographic density, family history of breast cancer, and documented quantitative lifetime risk were each independently associated with radiologists' recommendations for supplemental breast imaging, with denser breast categories showing the strongest association. However, recommendation rates varied substantially across individual radiologists even after adjusting for these risk factors, indicating meaningful, risk-independent practice variation. These findings support the development and implementation of standardized, risk-stratified supplemental imaging protocols—potentially incorporating routine quantitative risk assessment and structured decision support—to promote more consistent, evidence-based supplemental breast imaging practice in Saudi Arabia.

Declarations

Ethics approval and consent to participate: This study was approved by the Institutional Review Board of King Faisal University, Al-Ahsa, Saudi Arabia . A waiver of informed consent was granted for this retrospective, de-identified review in accordance with institutional policy.

Consent for publication: Not applicable.

Availability of data and materials: The de-identified dataset generated and analyzed during this study is available from the corresponding author upon reasonable request.

Competing interests: The author declares no competing interests.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions: SSA conceived and designed the study, acquired and analyzed the data, drafted the manuscript, and approved the final version for submission.

Acknowledgements: The author thanks the radiology staff at the participating centers for their support in data abstraction.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209–249. doi:10.3322/caac.21660

2. Boyd NF, Guo H, Martin LJ, Sun L, Stone J, Fishell E, et al. Mammographic density and the risk and detection of breast cancer. N Engl J Med. 2007;356(3):227–36. doi:10.1056/NEJMoa062790

3. Berg WA, Blume JD, Cormack JB, Mendelson EB, Lehrer D, Böhm-Vélez M, et al. Combined screening with ultrasound and mammography vs mammography alone in women at elevated risk of breast cancer. JAMA. 2008;299(18):2151–63. doi:10.1001/jama.299.18.2151

4. Bakker MF, de Lange SV, Pijnappel RM, Mann RM, Peeters PHM, Monninkhof EM, et al. Supplemental MRI Screening for Women with Extremely Dense Breast Tissue. N Engl J Med. 2019;381(22):2091–2102. doi:10.1056/NEJMoa1903986

5. Monticciolo DL, Newell MS, Moy L, Niell B, Monsees B, Sickles EA. Breast Cancer Screening in Women at Higher-Than-Average Risk: Recommendations From the ACR. J Am Coll Radiol. 2018;15(3 Pt A):408–414. doi:10.1016/j.jacr.2017.11.034

6. Monticciolo DL, Malak SF, Friedewald SM, Eby PR, Newell MS, Moy L, et al. Breast Cancer Screening Recommendations Inclusive of All Women at Average Risk: Update from the ACR and Society of Breast Imaging. J Am Coll Radiol. 2021;18(9):1280–1288. doi:10.1016/j.jacr.2021.04.021

7. Melnikow J, Fenton JJ, Whitlock EP, Miglioretti DL, Weyrich MS, Thompson JH, et al. Supplemental Screening for Breast Cancer in Women With Dense Breasts: A Systematic Review for the U.S. Preventive Services Task Force. Ann Intern Med. 2016;164(4):268–78. doi:10.7326/M15-1789

8. Nyante SJ, Marsh MW, Benefield T, Earnhardt K, Lee SS, Henderson LM. Supplemental Breast Imaging Utilization After Breast Density Legislation in North Carolina. J Am Coll Radiol. 2019;17(1 Pt A):6–14. doi:10.1016/j.jacr.2019.05.054

9. Saulsberry L, Pace LE, Keating NL. The Impact of Breast Density Notification Laws on Supplemental Breast Imaging and Breast Biopsy. J Gen Intern Med. 2019;34(8):1441–1451. doi:10.1007/s11606-019-05026-2

10. Busch SH, Hoag JR, Aminawung JA, Xu X, Richman IB, Soulos PR, et al. Association of State Dense Breast Notification Laws With Supplemental Testing and Cancer Detection After Screening Mammography. Am J Public Health. 2019;109(5):762–767. doi:10.2105/AJPH.2019.304967

11. Manning M, Albrecht TL, O'Neill S, Purrington K. Between-Race Differences in Supplemental Breast Cancer Screening Before and After Breast Density Notification Law. J Am Coll Radiol. 2018;16(6):797–803. doi:10.1016/j.jacr.2018.08.020

12. Sprague BL, Conant EF, Onega T, Garcia MP, Beaber EF, Herschorn SD, et al. Variation in Mammographic Breast Density Assessments Among Radiologists in Clinical Practice: A Multicenter Observational Study. Ann Intern Med. 2016;165(7):457–464. doi:10.7326/M15-2934

13. Gail MH, Brinton LA, Byar DP, Corle DK, Green SB, Schairer C, et al. Projecting individualized probabilities of developing breast cancer for white females who are being examined annually. J Natl Cancer Inst. 1989;81(24):1879–86. doi:10.1093/jnci/81.24.1879

14. Tyrer J, Duffy SW, Cuzick J. A breast cancer prediction model incorporating familial and personal risk factors. Stat Med. 2004;23(7):1111–30. doi:10.1002/sim.1668

15. Collaborative Group on Hormonal Factors in Breast Cancer. Familial breast cancer: collaborative reanalysis of individual data from

52 epidemiological studies including 58,209 women with breast cancer and 101,986 women without the disease. Lancet. 2001;358(9291):1389–99. doi:10.1016/S0140-6736(01)06524-2

16. AlSaleh N, AlRammah T, Alatabani A, Alsalem A, Alsheikh T, AlRabah R, et al. Mammographic density in relationships with relevant contributing factors: a multicentric study from Riyadh, Saudi Arabia. Gland Surg. 2024;13(6):844–851. doi:10.21037/gs-23-374
17. Kanbayti IH. Dense breast tissue in screened postmenopausal women: Prevalence and determinants. Saudi Med J. 2024;45(11):1238–1244. doi:10.15537/smj.2024.45.11.20240571
18. Al Mulhim FA, Syed A, Bagatadah WA, Al Muhanna AF. Breast cancer screening programme: experience from Eastern province, Saudi Arabia. East Mediterr Health J. 2015;21(2):111–9. doi:10.26719/2015.21.2.111
19. Fazeli S, Narayan AK, Mango VL, Wahab R, Mehta TS, Ojeda-Fournier H. Access to Breast Cancer Screening: Disparities and Determinants—Expert Panel Narrative Review. AJR Am J Roentgenol. 2024;225(2):e2432151. doi:10.2214/AJR.24.32151
20. Butler RS, Hooley RJ. Screening Breast Ultrasound: Update After 10 Years of Breast Density Notification Laws. AJR Am J Roentgenol. 2020;214(6):1424–1435. doi:10.2214/AJR.19.22275
21. Pisano ED, Gatsonis C, Hendrick E, Yaffe M, Baum JK, Acharyya S, et al. Diagnostic performance of digital versus film mammography for breast-cancer screening. N Engl J Med. 2005;353(17):1773–83. doi:10.1056/NEJMoa052911
22. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–7. doi:10.1016/S0140-6736(07)61602-X